The Colliery Engineer.

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VOL. XII.—NO. 1. SCRANTON, PA., AUGUST, 1891. WITH WHICH IS COMBINED THE MINING HERALD.

AN ELEMENTARY TREATISE ON THE PRINCIPLES OF COAL-MINING.

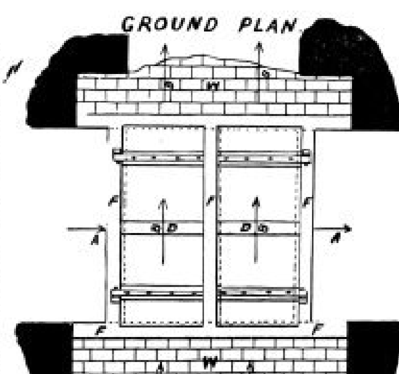
For the Use of Candidates for Mine-Foremen's Certificates, Mining Students, Mine-Foremen, Mine-Superintendents, Mining-Engineers, etc.

BY A. A. ATKINSON, DURHAM, ENG.

In the workings of a colliery it occasionally occurs that it is necessary a current of fresh or intake air may have to cross a current of return air, and it is requisite and essential that the two currents should not intermix with each other; and this passage is affected by means of an air-crossing, one current passing either above or below the other, but usually the return current is taken above the intake current, though not necessarily so. In case the crossing occurs in a main intake road where there is a considerable volume of fresh air going into the workings and where the crossing will probably have to last some considerable time, in some instances for a number of years, it is usual to put in a substantial air-crossing, and these are generally built with brick or stone side walls, with a brick arching built across from the side walls, the return air usually passing over the top of the arching. In case the seam is liable to a heavy thrust or pressure from the strata lying either immediately above or below the seam of coal, and from which the brick arching would be likely to suffer damage and become leaky, instead of the arching it may be of advantage to put on a wooden top for the crossing, as this is less liable to derangement by the pressure and likewise more easily remedied when it does become injured; besides occupying less height than the arching, and being cheaper also. The side walls are built of suitable thickness, say from 12 to 24 inches, according to the strength considered necessary, and the space between them being from say 6 to 10 or 12 fee. to suit the purposes for which the road is required, such as kind of haulage and size of airway needed. In case a brick arching is decided on, the two side walls are built up about 3 or 4 feet in height, commencing them on as solid a foundation as can conveniently be got. The arching may consist of 2, 3, or 4 courses of bricks according to the strength required. The nearer the shape of the arching is to a true semicircle, the stronger it will be.

Perhaps the best air-crossing considered from a point of strength is the "natural air-crossing," which is one made in the adjacent strata, as it may be a stone drift or tunnel driven from the seam and passing either above or below the intake airway. This is perhaps a costly method, but in case of an explosion occurring a considerable advantage would be likely to be derived from a natural crossing, as the force of the explosion might be insufficient to cause such damage as to allow fresh air to escape at this point into the return airway. Natural air-crossings are, however, very rarely made; it is much better to try and avoid explosions themselves, than think of counteracting their damages.

The wooden topped air-crossing is one that is much adopted, and consists of the two side walls, similar to those in an arched crossing but built somewhat higher, say 5, 6, or 7 feet in height. On the top of each of these walls a wooden beam or balk is built in, the beam being about 12 inches wide by 3 or 4 inches thick, and the length of it a little longer than the air-crossing is to be. Then cross-pieces of wood are laid from beam to beam, these cross-pieces generally being about 9″ or a foot wide, and 3″ thick; their joints may be tongued and grooved to make them air tight, or simply planed and laid close to each other with a thin lathe of wood nailed



over the joints on either the top or bottom side of them, or perhaps better on both sides, so as to make them as air tight as possible. The cross-pieces are spiked at both ends to the beams on which they rest, to keep them in position.

It is occasionally necessary to construct an air-crossing in a set of workings near the face and to last generally on such occasions for only a short time. This perhaps most frequently happens in working out the pillars of coal in a "Broken Flat or District." It is usual in such cases to construct the crossing wholly of wood and on a small scale, as compared with crossings over which large volumes of air have to pass and which have to stand in use for a much longer period. The ordinary ½″ brattice wood is used. The two sides are fitted up and nailed to props set for the purpose. Then the top is put on and the work finished by plastering up all the joints with hair lime. This in cases of thick seams may be done without taking down any roof-stone to allow the return-air to pass over the top of the crossing, but in case there is not sufficient height for this in the ordinary thickness of the seam, it may be necessary to take down some stone for the required height.

The three accompanying sketches show the plan of a valve air-crossing. It has been built with the hope that it may be of service in preventing the great delay, so frequently experienced at crossings, in attempting to restore the ventilation after explosions, which delays are, no doubt, the cause of a great many deaths. Perhaps the only more perfect crossing than this, is that formed by a drift overlapping the fresh air drift, or natural crossing; but it is not always convenient to have such crossings, as a strong roof to form them in is required.

In a few cases crossings have been formed by an old boiler, put together in segments, minus its ends.

FIRE-DAMP.

As carbureted hydrogen gas is the most important one met with in coal mines, it may be useful to give further particulars of it. It is well known to all concerned in mining, inasmuch as it is most frequently met with, and as having been a means of causing the loss of so many valuable lives. When found in any considerable quantity it constitutes perhaps the greatest danger the mining world can have to contend with. It is given off more or less freely by almost all coal seams, and also from the adjacent strata. It appears to be pent up in the small pores of the coal and stone, and when the working of them takes place the gas is liberated and becomes mixed with the surrounding atmosphere. From its lightness it finds its way to the roof of the workings, as it is lighter than air by almost one-half—1,000 cubic feet of fire-damp at 32° Fahr., and 30″ barometer, weighing 45·22 lbs., whilst the same quantity of air under the same conditions weighs 80·79 lbs. It has rather a pungent smell, some people resembling it to the smell of garlic. Fire-damp strictly speaking does not consist of this one gas (carbureted hydrogen), but others are intermixed with it, though perhaps only to a small extent. Carbureted hydrogen constituting over 90% of fire-damp, as will be seen from the following table:

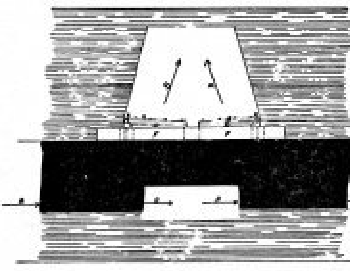
FIRE-DAMP ANALYSES.

Name of Colliery and Seam.	CH_4	N.	O.	CO_2.	H.	
Wallsend, from Pipe on Surface	92·8	6·9	·	0·3	·	= 100·00
Jarrow, Bensham Seam	81·1	14·2	0·6	2·1	·	= 100·00
Hebburn " "	86·0	12·3	·	1·7	·	= 100·00
Jarrow, Low Main Seam	79·7	14·3	3·0	2·0	0·3	= 99·30
Jarrow, Five Quarter Seam	93·4	4·9	·	1·7	·	= 100·00
Oakwellgate, " "	98·2	1·3	·	0·5	·	= 100·00
Hebburn, Seam 24 feet below Bensham	92·7	6·4	·	0·9	·	= 100·00

When met with this gas has to be diluted and so rendered harmless by a sufficient amount of fresh air. Sometimes it comes off as a blower without any previous warning, and some blowers have been known to render foul large areas of workings and large volumes of fresh air in a very short time; such force have they come away with sometimes from the seam of coal itself and at other times from the floor or roof stone. Then again in extracting the pillars of coal or in the "broken workings" large volumes of fire-damp are known to exist in the goaves or exhausted districts.

In detecting fire-damp the usual method is to use a locked safety-lamp, on the flame of which the presence of the gas can be seen: on nearing a place where it is thought likely for the gas to be, the flame of the lamp should be carefully lowered by pulling down the wick until a small light is attained and the lamp then slowly raised, at the same time keeping a careful watch on the flame. Should fire-damp be present it will quickly become known through its action on the flame, which will slightly rise in length as though something were drawing it upwards. If the wick of the lamp be further lowered to a very small light the gas may be seen to burn within the gauze with a blue flame and surrounding the flame of the lamp. It requires practice to become able to detect the gas, and every possible care should be taken that no harm befalls the lamp, and that no inexperienced person is allowed to go

END VIEW.



where gas is, by having every place known to contain it properly fenced off, in order that no unauthorized person may approach it. The consequences of an explosion of fire-damp are sometimes most terrible—and few people who have not had an experience of seeing the effects of one can form an idea of the results. The intensity of an explosion depends on many circumstances, such as the amount and composition of the gas present, nature of the workings—whether dry and dusty or damp, and if dry and dusty then the nature and amount of coal-dust may greatly intensify the explosion. Fire damp, when mixed with air, acts in a varying manner when ignited, according as the mixture of the gas and air varies. It has been discovered that when mixed with air in the proportion of one volume of fire-damp to 9½ volumes of air the mixture is at its most explosive point—as the quantity of air increases or decreases from this proportion so the explosive force or power diminishes; till at 5 volumes of air to one of gas it explodes but weakly, and similarly with 13 volumes of air to one of gas an explosion would only be slight. The force that is displayed by an explosion may be almost said to be incalculable, owing to a want of knowledge of the amount and chemical mixture of the explosive gas, though it may be worked out in theory, as is shown in the following, by a well known mining engineer:

1 lb. of CH_4 burning to CO_2 and H_2O gives off 23,550 units of heat. Suppose the initial temperature to be 62° Fahr. = 521° absolute.

1 lb. CH_4 = 12 oz. of C + 4 oz. of H.

12 oz. of C + 32 oz. of O = 2·75 lbs. CO_2.

4 oz. of H + 32 oz. of O = 2·25 lbs. H_2O.

And 64 oz. of O are contained in about 17 lbs. of air.

We have then, taking specific heat at constant volume,

CO_2 2·75	× ·1711 = ·470 units of heat to raise	2·75 lbs. of CO_2 one degree.			
H_2O 2·25	× ·364 = ·819	"	"	2·25 lbs. of H_2O	"
N 13	× ·1727 = 2·245	"	"	13 00 lbs. of N	"
18	3·534			18·00	

Then the degrees the mixture will be raised are

$$\frac{23550}{3 \cdot 534} = 6663^\circ \text{ Fahr.}$$

and the volume it will seek to attain $= \dfrac{521 + 6663}{521} = 13 \cdot 8$,

that is the steady pressure due to the explosion = 13·8 atmospheres; but to this must be added a considerably increased force due to shock, the amount of which can not be calculated. When it is remembered that 13·8 atmospheres are equal to 30,000 lbs. per square foot, whereas the force of a hurricane moving at the rate of 100 miles an hour is only 50 lbs. per square foot, some idea of the terrific force of an explosion may be realized.

When fire-damp is present in the air to the extent of only 2% in volume it just becomes detectable with an ordinary safety-lamp, and when present in greater proportion it is more easily detected. In some mixtures the flame of a safety-lamp is immediately extinguished. A more recently discovered method of examining the air in collieries by means of a safety-lamp burning alcohol enables a smaller quantity of fire-damp to be detected than with the ordinary safety-lamp. Perhaps a few words on this recent improvement may be pardoned. The new lamp consists essentially of an ordinary Davy lamp on a slightly enlarged scale, and instead of burning Colza oil is made to burn methylated spirits of wine, but preferably alcohol. A wick of a circular shape, and improved if made of silk, is employed and passed over a round tube, the height of which is regulated by means of a screw passing through the bottom of the lamp. A short conical chimney is placed round the flame, and the latter is so manipulated by the screw as not to appear above the top of this chimney when burning in pure air; but the top of the flame should be exactly level with the top of the chimney. After having carefully adjusted the flame in pure air, on taking the lamp into a mixture of fire-damp and air the spirit flame shows an elongated flame of light, a good deal larger than would be seen in the case of the ordinary vegetable or animal oils being used. The greatest possible care should be taken in treating this lamp and it ought never to be taken into a place where the atmosphere consists of anything even approaching a very explosive mixture. The inventor of the lamp—Herr Pieler—only intended it for use in the laboratory, to be used in connection with samples of air taken from the mine. The ordinary gauze of the lamp is protected by means of a thin iron shield covering the whole of the lamp and fitted with holes at the top and bottom, thus shielding the flame from the current. A small graduated glass window is fixed in the iron shield to enable the flame to be watched. The reservior of the lamp is filled with alcohol, care being taken not to overcharge it. On lighting the lamp it needs to have the flame adjusted most carefully "in a dark place," so that the top of it shall exactly reach the upper edge of the conical chimney. As much depends on this adjustment it requires considerable practice to become able to do it accurately. If the lamp becomes heated its accuracy cannot be depended on, and further it very quickly becomes dangerous. In an atmosphere with so small a volume as ¼ per cent. of fire-damp present, there is seen above the upper edge of the small conical chimney, a faint dun-colored light whose edges and tapered point are rendered indistinct by the reflection, and whose height is about 1½ inches.

Fire-damp, if breathed in an undiluted state, would soon cause death—and even in a strong mixture of it and air a curious sensation is at once felt by any one who enters into it; the head becomes light and the drums of the ears feel as though they were being tightened. The presence of this gas in mines is one of the reasons that has caused the ventilation of them to be one of the crucial points in their management.

The following will show the result as regards the gases in the case of an explosion of fire-damp and air:

Suppose there are 2 volumes of fire-damp or 2 CH_4.

C requires O_2 = 2 volumes of oxygen, forming 2 volumes CO_2

H_4 also requires O_2 = 2 volumes of oxygen, forming 4 volumes of H_2O.

And CH_4 therefore requires 4 volumes of oxygen.

But 1 volume of air contains ·21 volume of oxygen, and 19 volumes of air will be required for 4 volumes of oxygen, therefore 9½ volumes of air are required for 1 volume of CH_4.

The composition of after-damp, the resulting gases, is 1 volume CO_2 + 2 volumes H_2O (steam) + 7½ volumes N.

Of course the resulting after-damp will vary somewhat owing to the variation in the explosive mixture; all the marsh gas (CH_4) will be effected and its composition disturbed, and in all probability carbonic oxide (CO) is formed as a result of most explosions. It will be observed that none of the gases formed by an explosion are able to sustain life, and they are very poisonous, and many deaths occur owing to this circumstance; and one of the chief dangers the explorers have to contend with is the deadly after-damp.

The only effective method of dealing with fire-damp is to dilute it with air and so render it harmless, this being the only safe and reliable method; and every attention must be paid to the matter of ventilation in order to render it successful. In olden days it was a common practice, when the volume of fire-damp would be small and the quantity in a working place known, to set it on fire purposely and so get rid of it; or a man would take off his coat and dash it about among the gas a few minutes to disperse it—perhaps only to collect again in either case—but these means have long since been condemned and forbidden.

In order to drain goaves or old workings of fire-damp bore-holes from the surface as a means for an outlet have been suggested, but the cost of this method and the uncertainty of the bore-holes giving vent render them impracticable. In a very few instances the gas has been piped from a blower or a goaf to the upcast shaft or to the surface, but this likewise is found to be beyond the limit of utility. I have known gas piped from a blower underground, brought to the surface and utilized for raising steam in the boilers at a colliery. A tract of virgin ground might be drained possibly by bore-holes from an upper seam, but it is very seldom this is resorted to.

MEASUREMENT OF AIR-CURRENTS.

Three principal methods have been in common use to ascertain the amount of air traveling the different airways in mines, but two of them are now generally discarded.

First. Walking along a passage at the same rate as the passing air, noting the distance traveled in a certain time, and so computing the quantity of air passing.

This method is one of the old-fashioned ways of measuring the quantity of air, before the more improved method had been thought of. Any one will see that it can only be considered a rough and uncertain means and not at all satisfactory, so far as accuracy is concerned; and especially as compared with the efficiency that has been attained in the present day. The *modus operandi* was as follows: A length of airway of 100 or 200 yards was selected that was of as even and regular dimensions as could be chosen, the nearer the whole length of the selected portion was of a certain area the better; then a man with a burning open light, say a candle, walked the length of the selected portion, going with and at the same rate as the air-current, being guided in this by the flame of the candle which was held in such a manner as to be fully exposed to the current of air, and proceeding at such a rate as to keep the flame of the candle perfectly vertical and unswayed, either by the rate of his progress or by the traveling air; the time occupied in traveling the distance being noted in seconds by means of a watch. Then taking the average sectional area of the airway so walked over and multiplying it by its length and dividing by the average time occupied in walking, ascertained by a few trials, the result was taken as the quantity of air flying, generally expressed in so many cubic feet per minute; for instance:

Suppose the length of airway traveled to be 600 fee

Average sectional area of airway to be 40 square fee

Length of time occupied in traversing it to be minutes.

Then $\dfrac{600 \times 40}{3} = 8000$ cubic feet of air per minute.

The sectional area would be ascertained by measuring the passage at stated intervals of say 10 or 15 yards, and taking an average of all the measurements. Of course this method is open to many objections, and should not be practiced at the present day.

Second. The next way is that of ascertaining the velocity of the air by means of observing the rate at which particles travel that are held in suspension in the air. The general way of measuring the volume by this means was to select a portion of the air passage as in the latter case, of as even area as possible. Then to explode a small quantity of gun-powder at the starting point, and note how long the smoke given off was in reaching the other end of the selected portion of the gallery, and the quantity of air is calculated in the same manner as in the previous case. This method is still in practice to a certain extent, and in ascertaining the velocity and quantity of air in shafts is still the usual mode.

Third. The third and best means is effected by the anemometer; an instrument invented for the purpose.

The anemometers mostly used are constructed with vanes, which are made to revolve by the pressure of the passing air acting on their surface. They are somewhat delicate instruments and should be used with care. By mechanism the number of revolutions of the vanes is recorded on a dial marked on the face of the instrument. The experimenter stands in the airway, holding the anemometer in his hand and in such a position that it is fully exposed to the current of air. By means of a lever, something after the same style as is used in a stop-watch, he sets the mechanism in motion on receiving a signal from a person who is acting as time-keeper. The instrument is allowed to run for one, two, or three minutes, as may be determined on, and the points on the dial face are brought to a standstill at the end of the allotted time by means of the stop-lever. The number of revolutions made is read off, and with the sectional area of the airway at the point of measurement, we have the necessary figures for the calculation, as each revolution of the anemometer represents one lineal foot in the passage of the current of air. Take for instance the figures

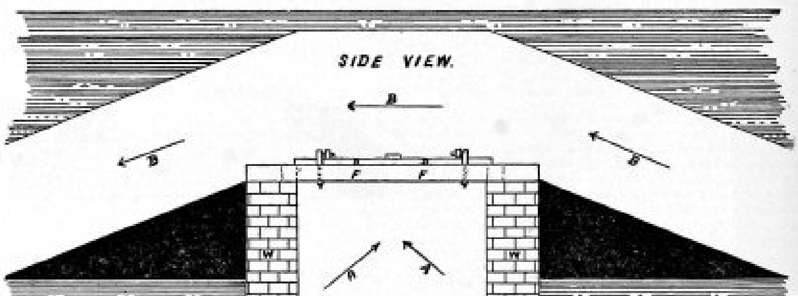
Sectional area 50 square feet.

No of revolutions of instrument in 2 minutes as 445.

Then $\dfrac{50 \times 445}{2} = 11{,}125$ cubic feet of air per minute.

It may be mentioned that in careful calculations some

SIDE VIEW.



other points have to be taken into consideration, such as correction of instrument for friction, atmospheric pressure and temperature of air, an allowance for the friction caused by the passage of the air through the mine, and an allowance for the presence of the measurer's body being in the airway.

The following rules are given by Professor Merivale for general use in measuring air-currents :

1. Use the recorded revolutions of the anemometer as correct ; do not bother with any formula (for friction).

2. Measure always at the same time of day, say noon, when the men are at dinner, the tubs at rest, the doors mostly likely shut, and the ventilation moving along its proper channels.

3. Always use the same places in the airways and see that they are as regular and straight as possible.

4. Take the record at several points, say at top, bottom, and center and the two sides, and use the average of these records for the velocity of the current.

A good idea is to have these rules printed in the book used for recording the results of measurements, and carried by the person whose duty it is to measure the air.

1. Sectional area is to be entered in the book at the time of each measurement ; height × width = area.

2. The person measuring must hold the anemometer at arm's length in front of his body, and keep the face of the instrument square on to the current of air and keep moving it slowly up and down and across the whole area of the passage.

3. The index figures of the instrument to be entered continuously.

4. Take the velocity for one minute and make complete entry.

5. Take the velocity for two minutes and divide by two, should the average be near that of the first reading, enter the average as the velocity.

For careful measurements in all cases add or subtract as the case requires, the correction due to the instrument for friction. This correction is necessary as the instruments do not record the actual velocity of the air, especially in feeble currents. A certain force of air is required in the starting of the instrument to overcome friction and put the anemometer in motion, the force varying with every separate instrument made ; some revolving in a current as slow as 30 feet a minute, but most of them require a velocity of 50 feet—though 40 feet is the accepted average required to start them. The formula of correction used for true velocities is

$$V = 0{\cdot}97 \times R + 40.$$

V = True velocity.

R = Recorded revolutions.

40 = Feet allowed to start instrument.

The following is an extract from an unpublished paper by T. J. Taylor, Esq., an eminent North Country mining engineer in his day :

1. Shallow coal seams have lost their fire-damp by its escape to the day. It is replaced in those beds by water and carbonic acid gas.

2. In mines which are deeper than those of the first head, the communication with the day is more intricate and difficult. Nevertheless in them also, the gas continued to escape so long as its tension much exceeded that of the atmosphere, and what remains is that of feeble expansive power which indicates exhaustion to a point that just balances the atmosphere. Here is situated the region of common blowers, the study of which has, by an inadequate generalization, deceived us into a belief that the state of the barometer has a good deal to do with explosions ; whereas no more in reality is established by the circumstance of a coincidence between its fluctuations and the issue of fire-damp than this, that the original supply of gas is in such situations very nearly spent off by the system of natural drainage alluded to.

Under this second head are to be ranked the masses of liberated gas in goaves and old workings, as well as the common blowers of fire-damp and stythe. It may be added, that in connection with the first and second heads, barometric observations are very useful ; but to the third, and really dangerous category, they are inapplicable.

3. In the next gradation of depth we have the fire-damp of great tension, the high pressure gas, as it may be called, distinctively from the little compressed gas of the second head. We are now at a depth where the dryness of the beds indicates them to be unreached by fissures from the day, and existent in a state that may be considered uninfluenced, as yet, by external causes of change. It is here, therefore, and not until we arrive here, that an opportunity occurs of studying the fire-damp in its more dangerous form. What we have previously ascertained is correct enough so far as it goes, but very imperfect; and, as already intimated, the cause of a generalization on the subject, which is far from being sufficiently comprehensive.

In these deep mines, so long as no more than the capillary issue goes on, the gas is yielded gradually, and is quite manageable; there is then no collected mass of it ; it is entangled in the cellular structure of the coal, and encounters too much resistance to escape at all freely. We have, however, seen, that even under these circumstances, a gradual and continuous issue takes place until the tension becomes very high, provided the gas issues into a confined receiver. And it evidently does not matter, in principle, whether such receiver be the artificial space of a mine barred up by water, or a natural cavity in that mine equally protected with the other from communication with the open atmosphere.

We may remark, however, that the tension is likely to be greater in the natural receiver than the artificial one, since the chances are that in an extensive mine-space, there may be some crevices through which the gas escapes as its tension increases.

It is scarcely necessary to say that natural cavities are to be found in mines ; they exist, in reality, both in roof and thill, above, below, and also in the beds of coal ; their formation, we must conclude, is due to those disturbances which have so much shaken the earth's strata, and they are most common in the neighborhood or along the line of faults, being precisely the situation where bags of foulness are most frequently met with.

It does not follow that every cavity will yield, on being reached, its stock of high-pressure gas ; on the contrary, the gas may be forced by its pressure through the cleavages of the coal as the workings approach it ; and when the cavity is reached, there may in this case be little or no gas given off ; sometimes a fissure or a fault may communicate at a distance with the cavity in which case the drainage is also gradual on account of the resistance which has to be overcome. But that the mine does contain in its cavities, and at its first opening, this high-pressure gas, is an obvious deduction from the premises. And whenever the intervening coal and strata accompanying it are compact enough to act as a dam, the gas will at length be reached and given off at this high rate of tension.

[TO BE CONTINUED.]

ABSTRACT OF A PAPER BY MR. RICHARD SUTCLIFFE, M. E.

(Proceedings Manchester Geological Society.)

Seeing that a number of colliery owners in different parts of the country proposed sinking new pits, most of which were intended to reach a very considerable depth, and therefore must occupy a long period of time before winning the coal, he began to study and enquire to see if there was no means of improving upon the slow method of sinking as at present prevails, and he came to the conclusion that it was quite easy to devise a more speedy, safe, and cheaper system by the adoption of machinery instead of hand labor, and by replacing the present practice of sinking in the middle of the pit, by what he thought to be a more rational mode of cutting-out and setting free the layers of strata all around the pit bottom in advance of the sinking. To accomplish this he had designed and patented a machine which could be worked by means of compressed air, electricity, or such other motive power as the user might decide to adopt, but he preferred the former (compressed air) on account of its cooling effects on the pit bottom, as well as its general utility in a mine. The machine consisted of a frame of steel or iron girders, firmly secured together with angle brackets at the center, and cross girders at one end to carry bearings, which took the driving shaft. Four shoes were fitted one at each end to the girders, and allowed to slide freely on the same to the ex ent of 2 or 3 ins., and having a flange at each side of the webs of the girders. Brackets were also secured to the sides of the girders near the ends, and these brackets contained two flanges each, between which flanges a nut was fitted, and worked by means of a ratchet, and in these flanges were suitable holes through which a screw passed, and was coupled to the shoe at each end of the girders. The air engines, or their equivalents, were fixed on the girders so as to gear into the cog wheel, which was keyed on the shaft, as was also the pinion, which meshed or geared into an annular rack and rotated it when the engines were set in motion. The size of the engine cylinders was about 8 in. by 12 in. An annular rack composed of four or more pieces for convenience in handling, and with which was cast a vertical flange or shroud about 2 ft. deep and 1 in. thick, to take girders and their strengthening stays. To the underside of the girders were secured four strong brackets, one at each end, fitted with journals which carried runners, upon which runners the annular rack traveled, carrying with it the whole of the under portion of the machine, a cutting barrel or cylinder composed of eight segmental steel castings, four of which were extended upwards to take slides which worked within the girders, and also the pistons of hydraulics. On the under end of the cutting barrel were cast tool boxes or sockets, to hold cutting tools, and on the internal side of the barrel were spirally-placed ribs at frequent intervals, which served to keep the annular channel clear of broken earth or *debris* by scooping out the material, and they also assisted to preserve the rotundity of the barrel by strengthening it. Also for the latter purpose an internal flange was placed at the top of these ribs, and four hydraulics for the purpose of regulating the feed and withdrawing the cutting barrel from the groove cut, or to lower the girders and their connections for a fresh cut. When the machine was being made ready for a cut, the girders were securely and firmly fixed in a horizontal position by pressing the shoes, which were packed with wood, to increased friction and absorb vibration, against the sides of the pit by means of the screws and nuts, care being taken that a small space was left between the annular ring in order that the weight might be lifted off the cutting pieces before starting the machine, and when working it should be allowed to feed as it cuts. When out to their full extent the shoes should be released from the pit sides and the upper portion allowed to descend, either by means of the hydraulics or the capstan rope, on which the whole machine might hang. Small flexible tubes were conveyed from a small plunger and fixed at the engine to the hydraulics, so as to be able to work them from the engine when desirable instead of by hand. The girders in this machine were arranged to allow two sinking buckets to pass, one on each side, but where it was desirable to have only one sinking rope near the center of the pit, the girders could be placed parallel and kept sufficiently apart. Assuming this machine to have twenty single and twenty double cutting pieces acting at the same time in the groove and making one revolution per minute in the pit bottom, it should cut at least 30 in. per hour in ordinary sinking stone, and with the stone set free all around layer after layer could be filed away without any powder. Sheet-iron shields were allowed to hang from the stationary girders to protect the workmen from the rotating portion of the machine. When it was necessary to cut a walling bed, special cutters were secured to the machine, and these cutters expanded outwardly as the cutting barrel descended from the annular rack. Mr. Sutcliffe next proceeded to describe his new method of sinking. In order to expedite the raising of the sinking material he used guide ropes, and in the following manner: Suspended on four guide ropes were two parallel beams of timber tied together at each end by iron plates, in which were fixed four set-screws, which pressed against the sides of the pit in order to steady the guide ropes and beams in their proper position. On these beams were secured flooring deals so as to cover the whole of the pit except the openings required for the sinking buckets, air pipes, etc., in order to facilitate working thereon and to afford additional protection to the sinkers underneath to that supplied by the special walling scaffold to be used in putting in the walling simultaneously with the sinking. For the walling or lining of the shaft he employed concrete, and to do so he placed on the flooring deals above referred to a temporary walling crib, composed of iron or steel, and made in four pieces or segments, which were connected together by four bolts or screws and nuts, with suitable brackets, as shown. The top of this temporary walling crib was placed on a level with the wall bed or annular step, and there expanded by the screws or bolts and nuts until made securely fast from pressure against the sides of the pit. When segments of wood were placed upon it in order to facilitate the closing of the next lift below to be afterwards put in underneath, a course of bricks, or blocks, with quick-setting cement, or a low course of rich concrete was next set partly resting on the annular step cut for walling bed, and partly on the temporary walling crib. On the inner side of the wood packing was next placed a circular course of casing composed of angle iron frames, lined with corrugated sheet iron having the undulations placed horizontally in eight segments of a height of 3 ft. bolted together and having a wood packing piece in one vertical joint to facilitate the withdrawal of the same. The freshly-made concrete was poured in behind this casing, taking care that it was properly placed and packed all round by a careful hand and suitable utensils, and when filled and packed to the top another course of casing was placed on the first and filled in at the back with concrete in like manner, and so on, placing course upon course and filling them with concrete at the back, until the bottom of the lift of lining or walling above is reached and closed up to. When the lift of walling to be put in was a long one, the annular steps might be cut at intervals of from eight to twelve yards, so as to distribute the weight of the walling on the surrounding strata for extra security, instead of allowing it to rest entirely on the material composing the lining of the pit. It would be at once seen that a short time sufficed to allow the withdrawal of the temporary walling crib, when it could be lowered with the guide ropes and reset for another lift of walling, leaving the corrugated casings above, secured by the undulations in the lining, until required for the fresh lift, when they could be brought down and reset at the same time as sinking proceeded. In conclusion, he might say he expected and believed that six yards per day of three shifts could be sunk and lined as safely and as easily as the amount now attained in ordinary sinking.

New Electric Mining Lamps.

At a meeting of the Inventor's Institute, held at Chancey Lane, London, Messrs. Charles N. Gawsentes and Walter L. Strong exhibited a new miner's electric lamp for which they claim the following advantages :

"Its weight does not exceed 3 lbs. 12 ozs.; it gives a regular and constant light for fourteen hours ; the cost of maintenance for a week's work, calculated at from 72 to 90 hours, does not exceed 5d., all charges included ; the cost of construction of each lamp does not exceed 5s.; the battery can be guaranteed to last for five years ; and the interior resistance does not undergo any alteration during that period. It is claimed that, whilst eliminating all sources of danger, whether by an explosion or fire, the new lamps give greater light, and that light is produced at a cheaper rate than the ordinary lamps in general use. The safety-lamp now used in the mines gives an illuminating power equal to $\frac{1}{15}$th of a candle. Supposing this power can be regularly maintained for twelve hours, the lamp will then have given a total light of $\frac{12}{15}$ths of a candle. The new electric lamp has an illuminating power estimated at three-fourths of a candle, consequently its total light in the same period is equal to eight candles ; that is, a light nine times greater in quantity and eleven times greater in effect upon the surface to be illuminated in consequence of the power of diffusion. The existing ordinary miners' lamps, giving $\frac{1}{15}$th candle power, cost 3½d. per week. The new electric lamp, giving nine times that light and offering every security, cost 5d. per week, thus showing a great economy over the ordinary lamp, and which to give an equal light would cost 3½ × 9 = 31½ pence."

At a recent meeting of the French Academy of Sciences a full description was presented of an accumulator miners' lamp. The lamp weighs 1,600 grammes complete (about 3½ lbs.) and is of about one c. p. It runs nominally for 12 hours with complete regularity, but its actual lighting power continues effective up to 14 or even 16 hours. Five hours suffices for the recharge, a current of one ampere and four volts being required. The lamp is furnished with an accumulator formed of two little cells of ebonite, each containing five plates three inches long and one and four-fifths inches wide. Two of these are positive plates of solid lead peroxide weighing about 180 grammes (about 6 ozs.) and having a capacity of seven ampere hours. The other three plates are of spongy lead. Frequent charge and discharge is found to rather improve the quality of the positive plates up to a certain limit, and there is very little tendency to disintegration. The exterior case of the lamp is of galvanized steel, and a space of about 2½ inches is reserved between this metallic case and the battery itself. This is provided with rubber cushions to avoid injury from shocks.

Forty-three mineral producing counties in Georgia, Alabama and Tennessee, in a convention of more than 100 delegates, held at Chattanooga, Tenn., have decided to make a tri-state exhibit at the World's Fair.

THE PRINCIPLES AND PRACTICE OF COAL MINING ON THE PILLAR SYSTEMS.*

BY W. S. GRESLEY, M. E.

[Written for the Colliery Engineer].

Figs. 27 and 27*a* will afford some general idea of the way in which a thick highly inclined coal bed is sometimes worked in France. Fig 27 is a cross profile of the seam and system, while Fig. 27*a* is a map or horizontal diagramatic view across a part of the workings about the middle of the profile Fig. 27. The seam is about 40 ft. thick, on a 20° pitch. The main openings are not made in the coal, but in the bottom rock or floor (a sandstone), Fig. 27 showing the gangways thus ⌂ ⌂ ⌂. These are driven about every 20 ft. apart vertically and the seam is crosscut to the top rock, roof or hanging wall about every 48 ft. and 20 ft. thick of coal worked out on a withdrawing method, in step-fashion to the floor, the gob being closely packed with refuse sent in from the surface or quarried in the mine as the mining out of the coal goes on. The packing material is conveyed into each section or lift through gravity planes. Usually three separate "lifts" or "heights" are in work at the same time, namely, the *highest* which will be nearly exhausted; the *middle* in full operation; and the *lowest* being opened up.

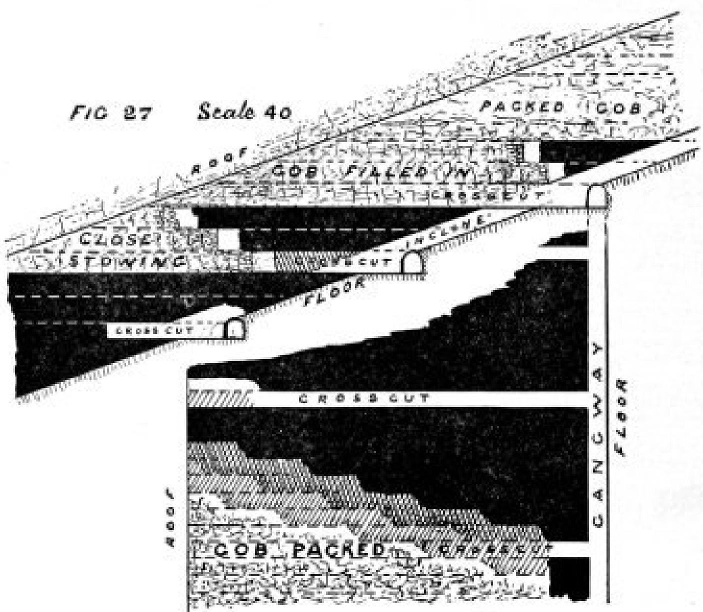


FIG 27 Scale 40

FIG 27 a Scale 40'

Without quite a number of profiles and different views it is impossible to fully illustrate this very instructive and interesting mining method. We hope to refer to it again at a future time. A modified form of this system (where the seam has two splits divided by by several yards of rock) is used at Blanzy, in France, each bench being about 51 ft. thick and the pitch 25° to 30°. Here, they drive galleries or gangways in the middle of each split 46 feet apart vertically (the height of each lift) and work crosscuts every 46 feet, off which are opened short horizontal forward ranges or stalls, taking 7½' high of coal in each cut or step. The excavations are well gobbed or stowed with sand, earth, clay, etc., taken into the mine.

Each pair of gangways serves two heights—one to the rise and one to the dip. The cars are manipulated in both by compressed air machinery, small engines being used for each series of working places. These either raise the empties and those containing the refuse for stowing to the higher working-places; or lower the refuse and hoist the fulls, if working to the dip. The engines being in the gangways. In gobbing the worked-out places, dry or pack-walls are first built along the face and then the rubbish thrown in behind. This procedure enables the props to be drawn where possible without letting down the overlying coal. Each working-place is practically a *cul de sac* (no air is circulated in it) but where gas is troublesome 12-inch galvanized pipe is carried in for main air course. The workings, even the stalls, are lighted by electricity. These modes of coal mining have, as it will be seen, no reference to the *natural* beds, benches, or stratification of the seams; the seam being worked out in *horizontal slices* no matter what pitch. [See dotted white lines Fig. 27.] By methods, not unlike the above, thick mineral veins or metalliferous deposits lying at various angles are mined; the ores of iron and copper in particular.

Figs. 28 and 28*a* are map and profile of some details of room and pillar working in flat seams. The coal is mined on the "face" or at right angles or nearly so with the direction of the "butt" entries. The Figs show the position of the track, where the props are stood; position of "breakthroughs" for air, rooms going forward, (an undercutting machine in one of them,) entry pillars and stumps left in or to be removed, a rib being drawn, and the fallen in gob.

Fig. 28*a* is taken through the second room from right. Two miners work in each room or on a rib, and will get from 4 to 8 tons, of 2,000 lbs. per shift, according to the nature of the seam and other circumstances. The yield per acre by this system will of course vary in different places, but may be put down a little over 1,100 tons per ft. thick on the average.

Fig. 29. Machines are here employed not only to undermine the face of the coal but also to drive the entries and start the rooms. The coal here may be flat or inclined. It is supposed to be worked nearly full "face," and the bulk of it got in kind of long walls, as are intended to be shown by the parallel dotted white and black lines. The main entries then are driven on the "end" and the productive, or branch entries, on the "face." The idea here is that all the entries are machine-driven, either by the *Stanley* or some other type. To work a room, a narrow heading is put through between the entries by machines, driven both ways if preferred, and a track laid right through. The full *length* of the room is then undercut, on one or both sides, and preferably by machines, and the coal broken out as in a Longwall face, taking one cut after another until the place is wide enough—until the roof becomes too weak to stand and must be allowed to cave. While one room is being worked in this way the next is being opened up, or in a less or more forward condition, and so on, advancing or retreating from or towards the openings, as circumstances suggest as the better way to work. One important feature of this method is that the traffic is all in one direction, because the empties go into a room at one end, are loaded and *pass on* out at the other. Ribs or pillars between the rooms ("Longwall rooms" would be a good term to use) are formed as thick as found necessary and may be drawn by using proper precautions in timbering, etc. In the Fig. five Longwall rooms are driven through, but in the first one only have long cuts been mined off the side of the opening heading. It is evident that facilities are afforded by this system for getting large quantities of coal in the best condition at a low cost and from a very small area of mine-workings open at one time. As to the speed of driving the headings, Stanley's machine (which cuts a circular core from 5 ft. to 7 ft. in diameter, or reduces to small the entire coal cut out) in clean coal will do from 35 to 45 lineal ft. a day, if not more

Up in the long cuts the undermining and breaking-out is done at night so that the loaders may work by day. Several hundred tons of coal may be sent out daily from each place.

Fig. 30. Profile of three "chambers" (rooms or breasts) with gangways, in a twin or split seam of Anthracite. The seams are beginning to pitch rapidly on the left, and, in order to make one gangway serve the two splits, chambers are worked one over another and the coal in the upper is put through a short "rock chute," to the gangway which is driven in the lower split.

It may be remarked here, that twin seams are usually worked as *one* until the "dividing rock" or "parting" exceeds 3 or 4 ft. when it answers best to work each split as a *separate* seam, the chambers and the pillars being formed one below or above the other, according to which split is worked first. And in working such seams it is usual to take the lower split first, going in with the bottom coal, dropping the dividing measure, and working the top coal backwards or retreating on the top of the fallen *debris*. Local conditions may, however, obtain so that when the bottom split has been worked (by chambers), the dividing slates fall *en masse* upon the floors of abandoned places, and the top split is then taken out advancing by working upon the top of fallen slate. We are of course speaking now of where the pitch is quite moderate—where the mine car goes to the face—a dip of not more than 12 degrees. Chambers so worked, and where the inclination of the seam is very regular and slight, may be carried in as much as 600 feet from gangway.

[TO BE CONTINUED.]

Labor Saving Records.

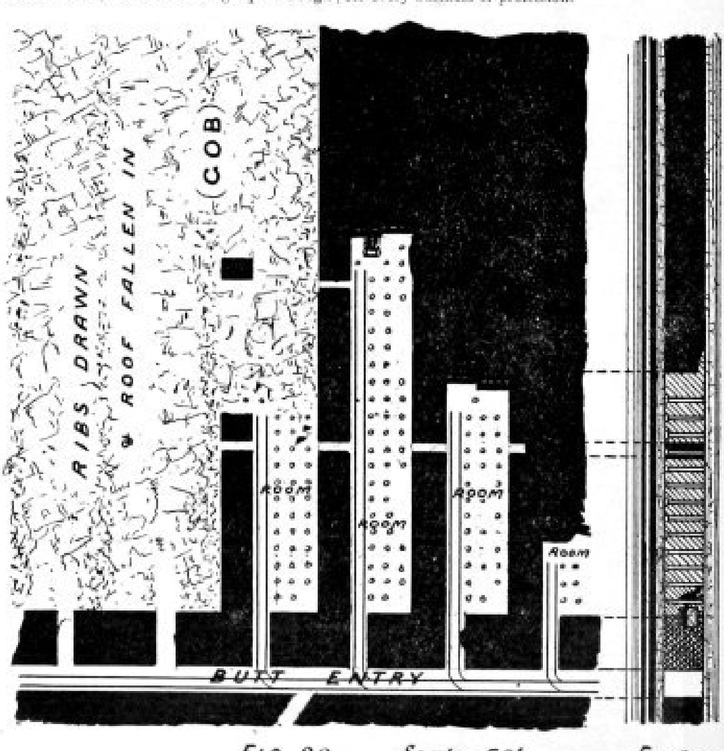


FIG 28 Scale 50' FIG. 28 a.

*Commenced in No. 8, Vol. XI., *i. e.*, the issue of March, 1891. Back numbers may be had by addressing The Colliery Engineer Co., Coal Exchange, Scranton, Pa.

COKE MAKING.

In the Western Kentucky Coal Fields.

BY JNO. B. ATKINSON, EARLINGTON, KY.

[June, 1890, Meeting of the Engineering Association of the South.]

Most of the coals found in the Western Kentucky field are coking coals, and readily coke in the Bee-hive oven. The two most regular and valuable veins of coal so far developed in this field, B, and D, vary but little chemically and physically at the various openings in Hopkins, Ohio, Muhlenburgh, Webster, and Union Counties, while the lower veins vary much, both chemically and physically at the various openings in the above-named counties.

Vein B, after being crushed and thoroughly washed, averages 5·0 per cent. ash and 2·9 sulphur in the coal. Vein D, under same conditions, shows 6·0 per cent. ash and 2·5 sulphur.

The sulphur in all the coals in this field that causes trouble in the coke, is that which is chemically combined with the coal, and may be termed organic sulphur, and this cannot be separated by washing. The pyrites can be eliminated without great difficulty by washing.

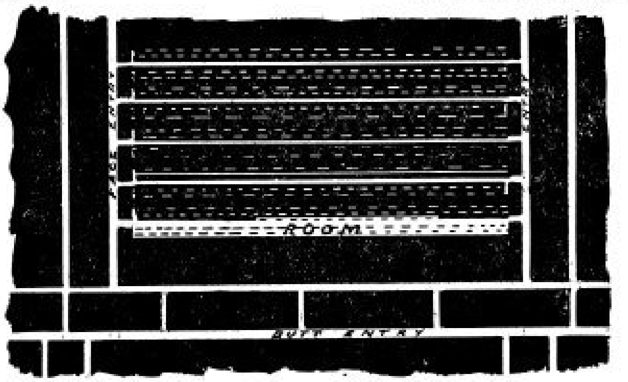


Fig 29 Scale 200

THE PRINCIPLES AND PRACTICE OF COAL MINING ON THE PILLAR SYSTEMS.

The coals of this field are different from ordinary coking coals, in the fact that the reduction of ash, after a certain condition is reached, does not reduce the sulphur.

Testing the lower veins, at one opening is found coal that will make coke with 7·572 per cent. ash, and 1·482 per cent. sulphur: while at another opening in the same vein, but a few hundred feet away, the coke made from the coal will show 8·893 per cent. ash, and 2·556 per cent. sulphur. Still another opening will show 18·542 per cent. ash, and 2·567 per cent. sulphur. The best results obtained from the lower veins showed in the coke 4·953 per cent. ash, and 1·168 per cent. sulphur. Could this limit of ash and sulphur be maintained, then would this field take a high position as a producer of coke equal to the best for metallurgical purposes, its nearness to great markets giving it great advantages. But the great uncertainty of the quality of the coal in these lower veins will possibly prevent any extended development for coking purposes, the good coal of to-day running into the very inferior coal of to-morrow.

During the year 1882, two Bee-hive ovens were built by the St. Bernard Coal Company for experimenting with the coals of the Western Kentucky fields. A crude system of washing the coals was used with fair results, physically, in the coke produced, but it was soon discovered that much of the sulphur of the coals was organic, and impossible to remove by washing. During 1887 twenty-one ovens were built, together with a washing plant and coke crusher. The idea was to convert the waste slack of the mines into crushed coke to be used in the place of Anthracite coal for base-burning stoves and heating furnaces. It was soon discovered that the coke was valuable for smelting silver and lead ores, for making steam, drying brick-kilns, where wood was formerly used, and for many other purposes, besides being crushed for domestic use. The coke made had a beautiful luster; very hard, but somewhat brittle, but with strength to bear any furnace burden. In 1888 twenty-two ovens were added to the former plant.

During the winter of 1887-88, the writer visited various coking and coal-washing plants in Europe, hoping to learn something in the way of desulphurizing coke. In Upper Silesia, Germany, coal-washing plants, made by Messrs. Simon and Luhrig, of Manchester and Dresden, were found perfect in operation and results—far superior to anything yet attempted in this country. All the sulphur, slate, and clay physically mixed with the coal were taken out, but no attempts were made anywhere to attack the organic sulphur, and nothing was learned as to how to make better coke in Western Kentucky in the way of desulphurizing it.

Much has been written of the value of steam as a desulphurizer of coke, and the writer learned of an effort made in England to do this, by admitting steam through the bottom of the oven and cooling the red-hot coke, instead of the usual way of wetting down with water. A visit was made to the place where the works were said to be, but the visit only demonstrated that the firm had failed financially and departed for parts unknown, leaving sulphur still a fixed fact in the coke. In all the researches of the writer this was the only practical attempt to desulphurize coke with steam. One of the ovens at Earlington was fitted with a system of perforated pipes under the tile floor, a perforation at each corner of the tile, the tile being twelve inches square. When the oven was burned and ready to be drawn, the pipes were connected with a boiler and the steam turned on. The coke cooled at the bottom first, the cooling process gradually reaching the top. Around the sides of the oven the coke was not reached by steam, and the water was turned on this coke. Samples of the coke cooled by steam showed 2·84 per cent. sulphur while samples of the coke cooled by water gave 2·9 per cent. sulphur. Practically no reduction of sulphur.

In another experiment the bottom of the oven was kept continually wet by means of perforated pipes, while the oven was burning. It was hoped that the steam from this moisture, when passing through the red-hot coke in its effort to escape, would be decomposed, and the hydrogen in passing, seize upon an atom of sulphur and take it out, while the oxygen was supposed to pick up a small piece of carbon at the same time, with resultant of less sulphur and more ash in the coke. But alas! the hydrogen either shirked its duty or the sulphur was too coy. The water disappeared, but the sulphur stayed in full force, and so far this effort was a failure.

In another experiment a portion of red-hot coke was cooled in the oven by steam through the hose, instead of water. Another portion of the coke was drawn red-hot and cooled in the air, while a third portion was cooled with water in the usual way with the following results:

Steam	2·485 % Sul.
Water	2·665 % Sul.
Air	2·780 % Sul.

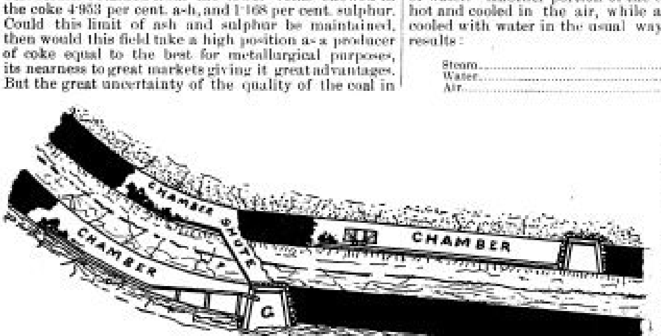


Fig 30 Scale 50'

THE PRINCIPLES AND PRACTICE OF COAL MINING ON THE PILLAR SYSTEMS.

In another experiment a solution of chloride of manganese was used to cool the coke, with no beneficial result.

After many experiments it has been determined that, by careful washing, a coke can be made from veins B and D, with an average ash of 12 per cent. and sulphur 2·3 to 2·6 per cent.

A new washing plant, now in operation at Earlington gives for the first examination of twelve ovens, the following analysis:

Moisture and volatile matter	1·351 %
Fixed carbon	86·021 %
Ash	12·628 %
Sulphur	2·523 %
Color of ash, reddish-brown	
True specific gravity	1·68
Apparent specific gravity	0·90
Per cent. of cells by volume	67·56
Weight per cubic foot	56·00

During the past summer, arrangements were made to test the coke in a blast furnace. The coke was used after charcoal, and 155 tons of pig-iron made. The ores were Tennessee brown ores, containing much silica and phosphorus. The coke used had lain upon the yard fully nine months, exposed to the weather.

It contained:

Moisture and volatile matter	2·746 %
Fixed carbon	82·578 %
Ash	14·656 %
Sulphur	2·787 %
Phosphorus	Trace.

This coke showed remarkable strength in the furnace and great heating and gaseous properties. The flux used was the Nashville lime rock, mixed with mud. It was a very wet time and the sweepings of the quarry were used, as it were, the furnace going out of blast immediately.

The foundryman selected three samples of pig-iron, at the writer's request, the best, the poorest, and intermediate.

Examination of these samples showed:

	No. 1.	No. 2.	No. 3.
Silicon	1·663	3·850	5·936
Sulphur	0·139	0·914	0·189
Phosphorus	1·246	1·238	1·441
Carbon	2·606	2·618	4·282

The coke is in part responsible for the sulphur in this pig, a quality of pig equal to much now made in the South and West, and the writer believes that, with the better coke of to-day, with good ores and a proper limestone, the sulphur can be largely reduced in the pig, and Western Kentucky take an important part in the wonderful progress of the South in making iron.

Coke made from unwashed slack of vein D gives:

Fixed carbon	79·94
Ash	20·06
Sulphur	3·54

Amongst other experiments, the slack coal, before coking has been treated to a strong solution of salt. Again, finely powdered fluor-spar has been intimately mixed with it, then layers of limestone alternately with layers of slack have been tried in the oven.

None of these experiments have reduced the sulphur in the coke. Up to this time coke has been made from slack coal only. The washing plant at Earlington is placed midway between the tipples of D and B veins. The slack is carried to this plant from either tipple and dumped into a common hopper and elevated to the sluice washer where it meets a stream of water. This sluice consists of two troughs, each 30 inches wide by 12 inches high, by 30 feet long at an inclination of 1 inch to 26 inches. One trough is used whilst the other is cleansed. Most of the pyrites, slate and clay, are deposited on the bottom of the sluice, the clean slack being carried to the lower end of the sluice by the water, where it passes over a screen into a Deshler jig washer, the water passing through the screen, and into the washer below the washer screen. This jig washer takes out the dirt that entered the washer with the slack, and the clean slack with the water passes into a trough and flows to the bins. Much fine slack is saved in this way. The continually increasing pile of washed slack in the bins acting as a partial filter, the water flowing off through perforated drainage pipes on the sides and in the floor of the bins. The bottom of the washing sluice is 48 feet above the railroad track on which the coke is loaded, this height being necessary to permit the washed product to flow into the storage bins, from which it is dumped through the floor of the bins into the charging larry. The waste from the sluice and jig washers is carried by water through troughs to the waste bank.

When run of mines coal is crushed and used, I should use only the jig washer. In a recent experiment with five tons of B coal crushed and washed the resultant coke showed:

Volatile matter	1·162
Fixed carbon	87·893
Ash	10·945
Metallic iron	2·222
Phosphorus	0·009
Sulphur	2·600

Analysis of the ash:

Silicon	4·437
Perox. iron	3·177
Alumina	2·405
Lime	0·391
Magnesia	0·142
Phosphoric acid	0·023

Some time ago I sent several barrels of B coal to Messrs. Simon and Luhrig, of Dresden, who washed and coked it. The resultant coke showed in one case:

Volatile matter	0·765
Fixed carbon	89·117
Ash	10·118
Sulphur	2·196

Another sample showed:

Volatile matter	1·090
Fixed carbon	88·546
Ash	10·364
Sulphur	2·196

Another sample showed:

Volatile matter	1·029
Fixed carbon	88·049
Ash	10·931
Sulphur	2·346

The fixed carbon and ash obtained from my best results at Earlington compare favorably with these obtained in Germany, but the sulphur is greater, due possibly to the fact that the German experiment was necessarily conducted with a small amount of coal.

In the recent experiment with run of mines coal from vein B, the coal was very carefully weighed before crushing and washing, and the resultant coke showed but 46·73 per cent. of the original weight of coal. The fixed carbon of vein B, being 49·50 per cent. this result shows a loss of 2·77 per cent. of coke as compared with the theoretical amount.

All the Western Kentucky coals are low in fixed carbon, not often exceeding 51 per cent. This is a matter of great importance to those who may attempt coke making in this field.

The coke used in making iron and many of the experiments heretofore referred to, was made from slack coal washed in the sluice washer only, being made before the present washing plant was built.

SAMPLING ORES WITHOUT USE OF MACHINERY.

BY WILLIAM GLENN, BALTIMORE, MD.

[Cleveland Meeting, June, 1891. American Institute of Mining Engineers.]

The taking of proper samples of crude ores seems to be less thoroughly understood, or less carefully practiced, than its importance requires. We all know how often we encounter the reports of very accurate assays and analyses, the weight of which, as evidence, wholly depends on the method of obtaining the sample, and is very probable *nil*, because there has been no proper sampling. Passages might be cited from technical books, and from current technical literature (all the work of writers whom we delight to honor) to show that even among high scientific authorities there is too little acquaintance with the practical art of the sampler. There is no metallurgical or chemical establishment which does not frequently receive samples truly representing nothing. They consist usually of bits of ore, or what not, selected because they are worse or better than the average of what they are meant to represent. And they are worthless, no matter who made the selection. Where conscious choice is permitted to enter into the operation, a fair sample will not result, unless by a miracle.

The work of sampling is often looked upon as within the realm of boys and of pensioners only. At least, though the manual labor be left to subordinates, the principles on which it is conducted and the safeguards with which it is surrounded are not unworthy of the study of experts; and experts should be ready to teach these principles and enforce them in practice. For exact sampling is the indispensable first step towards learning the value of any boxful, carload, or shipload of ore.

I propose to give a simple account of the method of sampling by hand, such as I have always pursued. There is nothing new about it. So far as I know, it is the immemorial old method, as old at least as Cornish copper mining. Perhaps my fellow members in the Institute may suggest improvements in it. If not, it will constitute a record in our *Transactions* to which laymen and beginners may be referred.

There are two principal processes to be considered: First, how to take the gross sample of the lot of ore; second, how to proceed with that sample. Really, there is no iron bound rule governing the first step; each may have a way of his own; yet most samplers proceed in much the same way. But once having the rough sample, there is no question as to what shall be done with it. It is to be worked down after the orthodox fashion. It must be broken and mixed and quartered until only a few ounces remain. The sampler bottles this residue; the chemist does the rest.

Assume that we have a rough sample, weighing a ton, of any ore with its gangue. Assume that by some manner of magic we can at once reduce the whole of it to dust. Evidently, if we could mix it long enough and well enough upon a clean, tight floor, it would finally become homogeneous. In that case, we could fill half a dozen small bottles from any part of the pile, and they would be fair samples. But the work would have to be admirably done; so well done that a single gramme taken from the pile would properly represent the entire ton of sample. Really this would entail a great deal of labor. And if the rough sample weighed 15 tons or more, as it would if taken from a shipload, the bare labor of mixing that quantity of dust until homogeneous is wearying even to think of. We cannot proceed upon the proposition that a final sample may be obtained in any such way. Yet upon a rock similar to this many are wrecked.

To take, for illustration, a definite case, let us assume that we have to sample a 10-ton pile of 10 per cent. copper ore, prepared for market. It will consist of masses generally the size of one's fist, but of all smaller masses and even of dust. We shall require for the work a clean, tight floor or pavement, an iron mortar and pestle, a shovel, a small hammer, a piece of iron for an anvil, and, lastly, a broom. Besides these we shall find convenient a wheelbarrow or a barrel or box of some kind.

For convenience and force I will put my description into the form of homely directions, such as I might give to my workman.

Begin by shoveling the pile roughly into the form of a flattened cone or a flattened pyramid; say we choose the pyramid. Now make a trench straight through the pile, cutting it into two nearly equal parts. And again by a trench (at right angles to the first) divide these halves into four nearly equal quarters. A part of the ore taken from these trenches will form the sample required. Proceed as follows:

Having the wheelbarrow ready, begin at the middle of any side of the made-up pile and cut the first trench. Cast the first shovelful to the right, the second to the left, the third into the wheelbarrow. Repeat this order of shoveling until the barrow is full, then empty it upon the well-swept floor intended to receive the sample. Continue in the same way until the trench has passed through the pile, when there will result two rather long and narrow piles. Begin the second trench, extending it across the middle of the two piles, casting the first shovelful right, the second left, the third into the barrow. Proceed in the same way as with the first trench. When done, you will have shoveled about 6,000 pounds of ore. As every third shovelful was thrown into the barrow, there will result about 2,000 pounds of sample upon the floor. That this is a fair sample of the original pile is based upon the assumption that each third shovelful thrown into the barrow was like the first and second ones cast into the piles. The hypothesis is reasonable and freely to be trusted.

Having the sample, proceed with it after the regulation method, as follows:

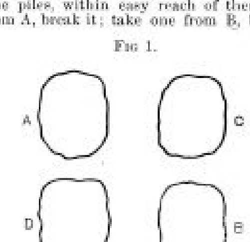
Spread it thinly upon the floor; now examine it. If there be any lumps which look larger than the general run, place the anvil upon the pile, and between that and the hammer break those lumps. The next step is to thoroughly well mix the sample. Begin at one edge of it and shovel the ore over upon itself. Move around to the opposite side of the pile, and from that side shovel the ore again upon itself and back to its original place upon the floor. Having it well mixed, form it into a flattened cone and sweep all the dust upon and around the pile. You have now to halve and quarter the sample as follows:

Commence at any point and shovel a road through the center of the pile, casting the shovelfulls alternately right and left as you proceed. This movement will result in cutting the pile into two elongated nearly equal ones. Beginning at the middle of one of them, shovel a road through it in the same way as was done before. And in precisely the same way cut the other pile in two; sweep upon each pile the dust belonging to it. These movements will result in four piles, as in Fig. 1.

If the sample were well mixed, when and as directed in these notes, then will each of the quarters A B C D have the same composition as have all the others. But if, upon inspecting them, you judge one or another to be poorer or richer than the others, you will have then sufficient evidence that the work has been badly performed. In that condition of affairs, mix well together all the piles, and once more halve and quarter them. Having made all the quarters of the same composition, it follows that any two of them may safely be accepted as representing the original 2,000 pounds of rough sample. This opens a road leading in the right direction, since it enables us finally to get rid of half the sample. We may cast out two of the quarters and retain the other two for the sample. It is a matter of indifference which two are retained, say A and B. Remove from the floor C and D, together with the dust belonging to them.

We have again to break the larger stones, until there remain none larger than walnuts. Place the anvil between the piles, within easy reach of them. Take a stone from A, break it; take one from B, break that.

Fig 1.



Plan of ore piles after quartering.

Continue in this way, taking stones alternately from each pile, until all are reduced to the size stated. By proceeding in this way the sample is more or less mixed while being broken. Complete the mixing as before, by shoveling all of the sample forth and back over the floor. Form it once more into a flattened cone, and sweep the dust upon and around it. Divide the cone into two halves, and those into four quarters, precisely as you before did, and as illustrated in Fig. 1. You have now to reject two of these quarters. The unwritten law of the sampler says that it must be those holding the positions A and B, because those were retained in the last quartering. Remove A and B from the floor, retaining C and D for the sample. These would now weigh about 500 pounds.

Proceeding as before, break down the lumps of ore until none are left larger than say 1-inch cubes. Again mix well the sample, make it into a pile, sweep up the dust, halve and quarter the pile. Reject two quarters (C and D, of course), retain two, precisely as in former quarterings.

Once more break the lumps, this time down to half-inch cubes. Mix well the sample, make it into a pile, sweep up the dust, halve and quarter, reject two quarters. The two quatrers retained would weigh about 125 pounds. Break it down until comparable to fine gravel and coarse sand. Mix and quarter once more.

The two quarters this time retained would weigh about 60 pounds. With the mortar and pestle break this to something approaching coarse sand. Again mix and quarter. The quarters this time retained are to be ground yet finer, mixed and quartered.

If you have no mortar and pestle, the hammer and anvil may be substituted throughout. After getting the material into the form of coarse sand, it is best to mix and quarter it upon a sheet of paper, even an old newspaper.

At this point the sample would weigh about 15 pounds; its larger grains would be in size like coarse sand. It would be safe now, without further breaking, to mix and quarter it twice, or until its weight did not exceed 4 pounds. Run this through the mortar and then mix and quarter it twice, or down to 1 pound weight. Grind this to something approaching powder, and, for the last time, mix and quarter it. Have ready 6 wide-mouth 1-ounce bottles. Place them in a line, side by side, upon a sheet of paper. From the other paper pour the ground sample in a small stream, forth and back across the mouths of the bottles, until they are all full up to their shoulders. Cork, seal, and label them and the sampling is done, and properly done.

If there should lurk in your mind a suspicion that this half-pound residue of dust may not, after all, properly represent the rough sample with which you began, go back over the work, and try to decide precisely where in the quarterings the sample retained ceased to be a sample. If you can decide upon that point exactly, then you will know just where you failed to do your work properly. The error will be with you and not in the method.

It does not, in the slightest, matter of what solid a sample may consist, or how much or how little it may be, it should be worked down in the manner just detailed. Whether a sample consist of 20 tons or of 1 ounce, it matters not, except as to breaking and grinding.

A word may be added as to larger and rougher ore-piles than have as yet been mentioned. It is not unusual for one to have a pile of 100 tons, or 200 tons, which one would like to sample. Such piles are apt to consist of lumps larger than a man's head, together with masses of all smaller sizes. Where a pile is formed by dumping ore uniformly upon its top, the likelihood is that the pile is homogeneous. In such a case, it is safe to make short cuts into it at several points around its base, and to consider as sample the ore so gotten. It is safer to make one cut through the pile, retaining as sample each third shovelful, as in the case of the copper ore we have just considered. In forming ore-piles of the weights given, it is a good custom to put upon a separate platform each tenth or twentieth barrow-load coming from the mine; the small pile will prove a fairly good sample of the large one. But no matter how it may be gotten, the rough sample is to be broken and mixed and proceeded with after the regulation method.

No account is here taken of moisture-samples or of sampling train-loads or ship-loads. This paper is meant to help beginners, but it would be, in the writer's judgment, a benefit to others also, if our members, who are practically acquainted with sampling would present their own methods with regard to the various branches of the art. The precautions especially required in sampling rich silver ores, for instance, might well be made the subject of comparison and discussion.

DISCUSSION.

R. W. Raymond, New York City: I am glad that this subject has been brought to the attention of the Institute. Mr. Glenn has by no means overstated its importance; and yet, with the exception of the paper of Mr. D. W. Brunton (*Trans.* xiii., 639) describing a mechanical ore sampler, I can recall little or nothing in our *Transactions* concerning it. The practice in the West, with regard to silver ores, etc., is affected by various considerations. As a general rule, such ores are either already fine or are crushed before treatment. I think it is now generally admitted that a good mechanical sampler connected with the crushing-machinery takes a fairer average sample (usually one-fifth or one tenth of the total lot of ore, according to the richness and the consequent importance of exact determination of value as a basis of payment to the miner) than can be got by throwing aside the fifth or tenth shovelful in unloading. At all events, the mechanical sampler cannot be suspected of bias, conscious or unconscious, provided it is so constructed as to deliver impartially the coarser and finer particles of the stream of ore passing through it. Disputes are therefore avoided by using it.

But for many classes of ore the sample is still taken with the shovel; and it is after this has been done, whether mechanically or by hand, that the process begins, which can properly be compared with that described by Mr. Glenn. The differences between this process and his are required by the following principal considerations:

1. The material; namely, ores carrying, besides lead or copper, more or less silver and gold, is so much more valuable that small errors in determining its contents may be the source of large loss to the buyer or seller.

2. It is almost always finer than the crude material contemplated by Mr. Glenn. Either it has been crushed before the sampling begins, or it is so generally fine when received that the preliminary stages of sampling may be, in the judgment of the manager, performed without crushing. This, however, always involves a risk, the assumption of which by a prudent manager, is justified only when the conditions are favorable; for instance, when the character of the ore is well-known; when its grade is not too high; when the difference in richness between coarser and finer pieces is not great; when careful experiment has shown that sampling without a preliminary crushing is sufficiently accurate; when avoiding the extra cost of crushing would be an important saving, or when the crushing machinery of the establishment is fully occupied with material which must be reduced before sampling. The nature of the contract between the smelter and the miner is another element to be taken into account. Perhaps the ore is not to be paid for strictly according to sample-assay (a thing which now and then happens, though not often, in the purchase of large dumps at a round price, or the treatment of ores on joint account, to be settled by the net results, instead of the preliminary assays, or under special contracts, in which the loan of money or other inducement to the miner has secured special terms). Perhaps, again, the smelter owns the mine, and can thus afford to save current expense by taking some risks in sampling his own ore which he would not take with ore for which he had to pay according to the sample-assay.

I think it may be said, however, that the sampling works proper, that is, those which are not parts of smelting works, but stand between the smelter and the miner, as agents for the latter in the sale of ore, warranting to the purchaser the accuracy of their determination of its contents, always crush everything they receive. And I think it may be said, also, that when the capacity of crushing and sampling apparatus is adequate, and the arrangements for receiving and handling ore are so perfect as to avoid both demurrage on railway cars and re-handling of material, the crushing and mechanical sampling of all lots received is not only better, but cheaper, than shovel-sampling of crude cargoes. The matter may indeed be left to the discretion of a competent manager; but the most competent mangers are not anxious to multiply the matters which are left even to their own discretion, still less to the discretion of subordinates. There are innumerable things which have to be watched daily and hourly around great smelting works; and it is a relief when any one department can be placed in the category of comparative routine, calling for fidelity rather than discretion. Moreover, the exact determination of all the elements of an ore of the class here contemplated is as important on technical as on commercial grounds. Without it, the metallurgist can neither calculate his charges successfully nor be held responsible if he fails to do so. And the sample taken of each new lot of ore received is not only assayed for its valuable contents, such as lead, copper, silver, and gold, and for sulphur, iron, silica, and zinc (which may affect the price to be paid for it), but also analyzed for all its earthy bases, so that it may be properly mixed for smelting with other ores or fluxes. Now it is quite likely that the gangue minerals of an ore may break very differently, according to their natural hardness or cleavage, in the ordinary processes of mining and shipment.

Moreover, the same car load from a given mine may contain ores from different stopes, varying so greatly in character and condition that even if the average of gold or silver were reasonably uniform, the average of silica, lime, magnesia, baryta, etc., would not be so, and the lumps might be entirely different in these particulars from the finer stuff.

With these digressions and explanations, I repeat the general statement that the ore to be sampled in the West is generally fine. But for the rough sampling of ore at the mine, or in localities where proper crushing cannot be done, the procedure described by Mr. Glenn seems to be a good one for the preliminary stages.

3. Notwithstanding the general fineness of the crude pile, and no matter to what degree it may have been reduced by crushing (short of the final reduction to impalpable powder), there is still a distinction between coarser and finer particles, and in the majority of cases this distinction is one of value as well as size. Many of our western ores carry silver, for instance, not only as an accessory ingredient of galena, but also in the form of finely-disseminated "true silver-ores" accompanying the galena. These are usually not only in fine crystals or specks, to begin with (often not distinguishable to the naked eye), but brittle besides, so that the shocks and abrasion of mining, transportation, crushing and handling reduce them to still smaller size. In the stamp-mill they make "slimes." In concentration they are very likely to escape and leave the headings impoverished, though clean from gangue—"poor but honest," so to speak. In sampling, they present the greatest danger of error.

Something similar might be said concerning the tenor of gold in many ores. Although true gold-ores are not common, yet in a lot of ore consisting largely of auriferous pyrites, for instance, there will certainly be more or less oxidized material, in which there is fine, free gold. I confess, however, that so far as my observation goes, this is not the source of as serious difficulty in sampling as are the brittle ores of silver. That is a point on which I hope some of our members who have had wider practical experience with the sampling of gold-bearing ores will throw further light. My own knowledge comprises more particularly the practice of lead-smelters; and in that practice the gold in the ores purchased, though it is determined and paid for, has not been hitherto a point raising special questions of difficulty. Or rather, the precautions taken as to the fine dust of silver ores cover the question of gold also, so that this has not called for separate consideration. Moreover, almost all the distinctively gold-bearing ore of the country, as well as a great part of the silver-ore, is reduced by wet-crushing for amalgamation or other subsequent treatment, and consequently sampled by battery-assays—a process which is not here under consideration, and which does not encounter the precise difficulty just described. I am inclined to think that in lots of crude fine ore, or of ore dry-crushed for sampling, oxidized material containing gold would not present as much difficulty as silver ore, because it is less likely to form fine flying or sifting or rolling dust. The iron oxide tends rather to pack or adhere—at least to lie where it falls—unless it has been artificially dried and pulverized.

But the difference of value between coarse and fine particles may be due to other minerals than those already mentioned. And there may even be cases in which the greater value is in the coarser material. I need not, however, enlarge further under this head.

4. Obviously such a difference would have no effect, if the whole mass to be sampled were so thoroughly mixed that the proportions of different sizes were uniform throughout. But this is not practicable, because the coarse and fine particles behave differently as to rolling and sifting over or through the pile upon which they are shoveled. Consequently, it becomes necessary, in order to secure a correct final average, to make the distribution of sizes in each pile formed *symmetrical*, since it cannot be made truly *uniform*. At a later stage, as will be seen, the whole of the sample thus secured is reduced to powder. Yet still the precaution of making symmetrical piles for quartering is continued to the last.

With these explanations I will describe the quartering of a sample of ore (say one fifth or one-tenth of a gross lot) as practiced at some of the leading works in the West.

The mass is first shoveled into a ring on the sampling-floor, and this ring is then shoveled toward the center, each shovelful being carefully delivered upon the summit of the pile in the center, so that they shall roll equally in all directions. A conical heap having thus been formed, it is pulled down and spread out. The workmen walk round and round the pile, pulling with the shovel, as it were, the ore towards them, so that it rolls outward. The lower six inches of the pile is not disturbed, and when this process is finished, the conical heap has become a truncated cone of larger base-area and six inches height. This flat heap is now quartered by pressing a stick or a board held edgewise down into it so as to mark the diametrical divisions. Two opposite quarters are cut out with the shovel and removed. The other two are again mixed, formed into a conical heap, and flattened out as before. This procedure is repeated until the quantity has been reduced to one or two wheel-barrow-loads, when, if the material has never been mechanically crushed, it is crushed in the rolls to say half-inch maximum size. The quartering is then continued till the sample has been reduced to a panful. This is ground say to 60-mesh size (after a partial preliminary drying, if necessary to facilitate the grinding in a rotary fine crusher) and then taken to the assay-laboratory, where it is thoroughly dried (say for twenty-four hours at 212° F.), and rubbed fine until the whole will pass through an 80-mesh sieve. Quartering is then resumed and continued until the sample is only sufficient to fill three bottles, one of which is for the assay of the works, one for the customer, and the third for the umpire-assay, if such should be required.

The details of this practice may vary in different works, and I trust our members, many of whom are engaged in such work, will give us, in the way of criticism or suggestion, the benefit of their experience. It is perfectly evident, as Mr. Glenn says, that a vast amount of skill and precision is daily wasted by our chemists in the delicate analysis of samples that mean nothing. To cite a single instance, I have recently studied with much interest the various papers in our *Transactions* concerning the practical results of the magnetic concentration of iron-ores. In Mr. Birkinbine's paper, presented at the New York meeting, there is a simple formula, by which he calculates from the percentages of iron in the crude ore, the concentrates, and the tailings the quantity of crude ore required to furnish a ton of concentrates; and he applies this formula in testing the comparative economy of different magnetic concentrators. But in several instances the actual quantities of crude ore, concentrates, and tailings have been reported, and they do not agree with the results of calculation by this formula. Now the formula is mathematically accurate, and there is no reason to doubt the accuracy of the chemical work. It follows that the samples, either of the crude ore, of the concentrates, or of the tailings, could not have been accurate. It is certainly to be desired that future tests of such work should include more thorough sampling, and that future accounts of such tests, should include descriptions of the method of sampling employed. In the absence of certainty as to the fundamental data, the application of mathematics to the discussion of results seems to be labor thrown away.

ELECTRIC MINING MACHINERY.

At the tenth ordinary meeting of the Institution of Civil Engineers (England), a paper was read on "Electric Mining Machinery," by Messrs. Llewellyn B. and Claude W. Atkinson, Assoc. MM. Inst. C. E. During the last four years, the authors had been connected with the application of electricity to mining, and had spent a considerable amount of time underground, in experimental work and in teaching those who would have charge of the electrical machinery.

It was pointed out in what way the conditions of mining work differed from those existing in other industries, and how they had been dealt with, and some of the machinery now actually employed was described. The use of compressed air was then discussed, and the results of experiments were given, showing that the efficiency of this method of transmitting power was 45·8 per cent. for an air pressure of 19 lbs. per square inch, decreasing to 25·8 per cent. for an air pressure of 40 lbs. From more recent experiments by Professor Kennedy, F. R. S., M. Inst. C. E., it was found that in practice an efficiency of 31 per cent. might be realized, or 45 per cent. if the air was heated before being passed into the motor. In the case of the electrical transmission of energy, except when distributed into very small units, there was little difficulty in obtaining 50 per cent. of the power expended in the engine, and there were cases in which an efficiency of 75 per cent. had been realized. One of the most important points with regard to the employment of electricity in coal mines was whether a motor would be likely to cause an explosion. It was necessary in the case of a machine which, perhaps, might have to work for several hours without attention, to guard against the possible accumulation of an explosive atmosphere around the brushes. For this purpose the authors had enclosed either the whole armature or the commutator only in a practically air-tight casing, and the method had been successfully applied to a motor of 40-horse power. The temperature had been kept down to 70 degs. Fahr. above that of the atmosphere by allowing a sufficiently large cooling surface, namely, 2·3 square inches per watt. To meet the objection that if the fire-damp should leak into these covers the resulting explosion might be as disastrous as if they did not exist, it was pointed out that whenever the proportion of marsh gas to air exceeded 3 to 4 per cent. combustion would take place quietly, and the resulting carbonic acid would tend to prevent explosion in the case of further leakage. Moreover, the authors proposed, in special cases, to introduce a constant supply of carbon dioxide from a steel cylinder into the interior of the casing, thus preventing the ingress of an explosive mixture. Similar methods were adopted for enclosing the switches, and sparking was prevented by providing a resistance coil of small self-induction, which was always connected to the ends of the magnetizing coil so as to form a path through which the current in the latter might continue even when the main circuit was broken. The switch itself also had a resistance coil connected to the several points with which it made contact, so that by slowly opening the circuit sparking was practically done away with. The application of electricity to pumping in mines was then described and illustrated. The use of belts for driving was not recommended on account of the want of space and the difficulty of keeping them in good condition in dirty and wet situations. The employment of electric power for actuating coal-cutting machinery was suggested in 1873 by Mr. Henry Wilde, and first practically applied by Mr. F. Mori, in 1887, whose machine was illustrated. It had a cutter of the bar type, revolving upon its axis, and was driven by a dynamo having a normal output of 10 horse power, situated at a distance of about a mile. It was built by Messrs. W. T. Goolden and Co. Their next machine was one in which the armature shaft itself was made to carry the cutter bar. Later developments of these electrical coal cutters were given. The proper form and dimensions of the cutters were then discussed at some length, the authors preferring the bar type to that in which the tools were fixed into the periphery of a disc, not only as being less liable to be held fast by a fall of coal, but as cutting to a much greater depth. The cutter bar ran at a rate of 500 revolutions per minute, and on an average, including stoppages, from 20 to 30 square yards per hour might be cut in fairly hard coal. At Lord St. Oswald's Colliery, at Nostell, 55 yards were bored to an average depth of 3 ft. 8 in. in seventy-five minutes. The relative cost of cutting coal in this way and by hand showed a difference in favor of the machine of 1s. 6d. per ton. An electric boring machine was described, and also an arrangement for driving an Ingersoll percussive rock-drill by electricity, as well as a special form of dynamo adapted for use in transmitting power for electric mining work, with a high voltage. The authors arrived at the following conclusions:

(*a*). That electric power was destined to become an important factor in mining mechanics, on account of: (1). The facility with which it could be used with machines which required to be moved from time to time; (2), the great economy in first cost and reduced cost of working owing to its efficiency being higher than that of compressed air, or any other medium of power transmission; (3), the smaller cost of maintaining the cables, as compared with piping, on shifting floors in roadways, etc.

(*b*). That the methods described were sufficient to obviate all objections to the use of electric motors in coal mining, whether by excluding inflammable gases or by constructions which would allow of their safe combustion.

(*c*). That the experiments, trials, and practical work, extending over four years, showed that: (1). Electrical pumps might be used with advantage and economy for mine draining; (2), electrical coal cutters could replace hand labor, with saving in cost, and increased production of coal; (3), electrical drilling machines were available in place of machinery worked by hand or compressed air.

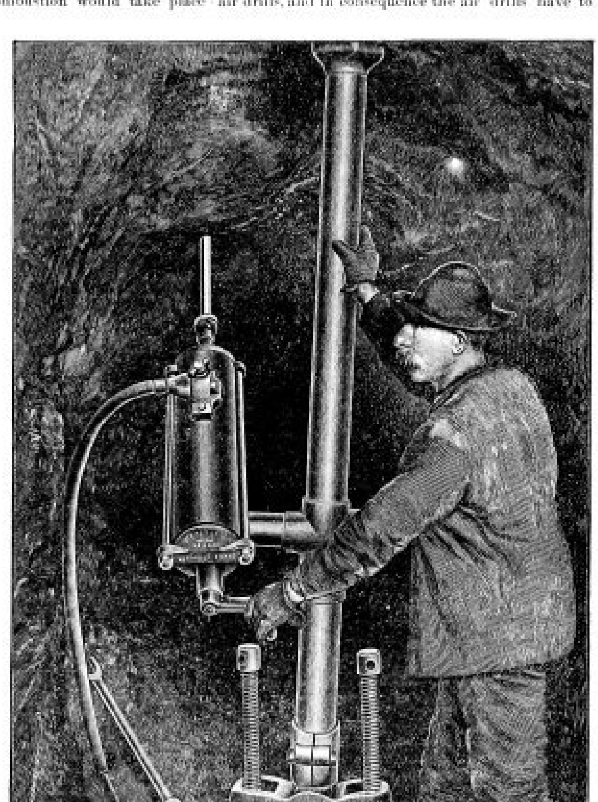
Electric Percussion Drills.

The following is an extract from a letter received by H. Ward Leonard, of the Edison General Electric Company from the engineer in charge of the "Last Chance" Mine, at Wardner, Idaho:

"Operating two air drills for twenty-four hours, required five cords of wood, while, for running four electric percussion drills for the same length of time, each drill doing more work than the air drills, it required only one and one-half cords of wood. The electric percussion drills have been found to do more work than air drills, and in consequence the air drills have to be replaced by electric drills.

"The air plant was situated 1,000 feet higher up the mountain than was required with the electric drill and the fuel had to be carried to the air plant this increased distance over that necessary for the electric percussion drill."

We show herewith a view of the electric percussion drill on a shaft column as taken from a photograph in the "Last Chance" Mine.



Correspondence

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

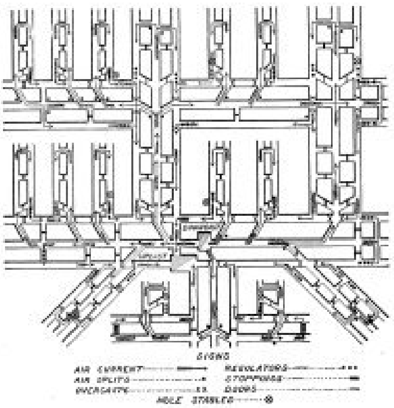
The Editor is not responsible for views expressed in this Department.

☞ *Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.*

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following plan for ventilating mine submitted by Arthur Crosland in the June issue of THE COLLIERY ENGINEER:



I would use to ventilate this mine a Guibal fan 12′ 6″ in diameter, and 5′ 8″ in width. It should produce 25,000 cu. ft. of air, making 210 revolutions per minute with a water-gauge of 2½ inches. This ought to be sufficient to overcome any emergency which might occur in the mine. I would have it a force fan.

Yours, etc.,
JACK.

Delaney, Pa., June 22d.

Ventilation.

The Colliery Engineer:

SIR:—I submit the following in answer to "T. S. C.," of Gardner, Ills.:

(1). We can solve this question by the use of the formula

$$\frac{K\ l\ o\ q^2}{a^3},$$ and as K, o, and q, are the same in each airway they will cancel, we have left $\frac{l}{a^3}$. Assuming 1,000′ to be the length of the 6′ × 6′ airway, then

$$\frac{l}{35^3} = \frac{1{,}000}{36^3},$$

and by transposing

$$\frac{1{,}000 \times 35^3}{36^3} = 857',$$

length of the 5′ × 7′ airway, and

$$\frac{1{,}000 \times 32^3}{36^3} = 702',$$

length of the 4′ × 8′ airway.

(2). Murchline, on page 87 of his book, gives the following formula:

$$a = \frac{\cdot000385 \times q}{\sqrt{w}},$$

where a = equivalent orifice in sq. ft., q = cubic feet of air per minute, and w = height of water-gauge in inches. The pressure required for the large airway = ·32 lbs., and for the small airway 2·41 lbs., then 2·41 − ·32 = 2·09 lbs. to be spent on the regulator. This is equal to a water-gauge of 2·09 ÷ 5·2 = ·4019, then

$$\frac{\cdot000385 \times 12{,}000}{\sqrt{\cdot4019}} = 7{\cdot}28' +.$$

Yours, etc.,
M.

Hollowayville, Ill., June 19th.

Pumping.

Editor Colliery Engineer:

SIR:—Would you kindly place the following question in your columns for answer and explanation:

In a shaft 100′ deep a pump is placed with 5′ suction and 95′ discharge. Will it require more, or less power, if the pump is placed up the shaft with 20′ suction and 80′ discharge?

Yours, etc.,
BEGINNER.

Mount Pleasant, Pa., July 1st.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to "T. S. C.," of Gardner, Ill.:

The formula used in finding the rubbing surface is

$$S = \frac{P\ a}{K\ v^2},$$

and when S is found and dimensions of airway are given the length is easily obtained. In this question P K and v are the same and by canceling these factors the formula becomes

$$\frac{a}{v^2} : \frac{a}{v^2} :: 1 : x.$$

Assuming the length of the large airway to be 1, the length of the second would be

$$\frac{1{\cdot}03}{1^2} : \frac{1}{1{\cdot}03^2} :: 1 : {\cdot}91,$$ and the length of the third would be

$$\frac{1{\cdot}125}{1^2} : \frac{1}{1{\cdot}125^2} :: 1 : {\cdot}702.$$

Therefore, the comparative lengths are 1, ·91, ·702.

(2). Their lengths are as 1 is to 2·25, then

$$\sqrt[5]{2{\cdot}25^2} : \sqrt[5]{1^2} :: 36 : 25,$$

and the $\sqrt{25}$ is 5, the size of the regulator.

Yours, etc.,
A. B.

Hanna City, Ill., June 16th.

Ventilation and Mining.

Editor Colliery Engineer:

SIR:—Will some of your correspondents kindly answer the following questions:

(1). In Wilson's book on mine ventilation the following formula is given to find the perimeter of an elliptical shaft:

$$\frac{\sqrt{\frac{A^2 + a^2}{2}} + \frac{A + a}{2}}{2} \times 3{\cdot}1416.$$

Please explain it by working it out fully.

(2). In opening out a gangway to the width of a double track or turnout, how would you increase the length and diameter of your collars?

(3). If there are two airways of the same length one being 12′ by 6′, and the other 9′ by 9′, what pressure applied to the former would give the same quantity of air that a pressure of 10 lbs. per sq. ft. gives to the latter?

Yours, etc.,
A. L. G.

Audenried, Pa., June 22d.

Mensuration.

Editor Colliery Engineer:

SIR:—I submit the following in answer to question (2), by "Inquirer," in the May issue:

The perimeter is found as follows:

$$8^2 + 5^2 = 89, \text{ and } 89 \div 2 = 44{\cdot}5.$$

$$\sqrt{44{\cdot}5} = 6{\cdot}67'.$$

And, 8′ + 5′ = 13′ ÷ 2 = 6·5′, then

6·67′ + 6·5′ = 13·17′ ÷ 2 = 6·585′, which multiplied by 3·1416 = 20·687′ perimeter.

Yours, etc.,
J. A.

Nanticoke, Pa., June 30th.

Sustaining Life Under Pressure of Air.

Editor Colliery Engineer:

SIR:—In answer to questions by "Rescuer," of Jeanesville, Pa., in the June issue, please insert the following:

(1). There is a slope 624 feet long having a perpendicular depth of 100 feet and it is filled with water. Breasts are driven up 416 feet in length and 100 feet perpendicular height from a gangway which is level from bottom of slope. The compressed air holds the water back 80 feet from face of breast.

How many cubic feet of air is in one of the breasts which is 4 feet high and 30 feet wide, and what would be the volume of this air if the pressure of water were removed? Allow the temperature to be 62° Fahr., the weight of a cubic foot of air to be ·0763122 lbs., and of water 62·355 lbs.

The head of water standing over the chamber considered will be

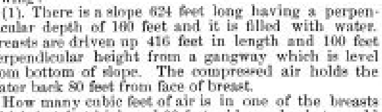
$$\frac{80 \times 100}{416} + 60 = 79{\cdot}2'.$$

And

$$\frac{79{\cdot}2 \times 62{\cdot}5}{144} = 41{\cdot}3 \text{ lbs. per sq. in. pressure above}$$

the atmosphere.

41·3 + 14·7 = 56 lbs. total pressure, which equals 3·8 atmospheres.



Now

4 × 30 × 80 = 9,600 cu. ft., volume of breast, and 9,600 × 3·8 = 36,480 cu. ft., with air at natural pressure.

(2). How long would the amount of air contained in a breast as above described, maintain the lives of four men? I gave a similar question which was published in the *Mining Herald* five years ago, taking figures and conditions from an accident in Wales where the shaft workings broke into a creek and some of the miners were enclosed for ten days. By cutting through a pillar 40 yards thick from an adjoining colliery all were rescued alive, but one of the rescuing party was killed by the pressure of the air driving him against the sides of the opening as they broke through.

A grown man at rest requires ·25 to ·35 cu. ft. of air per minute, which when breathed vitiates from 4 to 5 cu. ft., so that from a sanitary point of view the air could be breathed for 38 hours only.

However, under these circumstances taking ½ cu. ft. per man per minute, there is enough oxygen to sustain life for 608 hours, or 25 days.

Of course it all depends on whether the men are of sufficiently healthy physique to withstand the unhealthy conditions for so long a time.

Yours, etc.,
HUCKLEBERRY.

Montreal, Canada, June 17th.

Answers to Miscellaneous Questions.

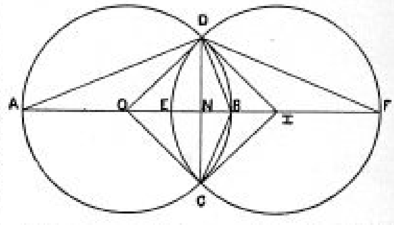
Editor Colliery Engineer:

SIR:—Please insert the following in answer to "Inquirer," whose questions appeared in the May issue of your journal:

(1). By "P a" is meant the total pressure or the area multiplied by the pressure per square foot. There is no other method to find the velocity under the above conditions. The formula may be reduced, however, to

$$V = \sqrt{\frac{P\ a}{K\ s}}$$

(2). By hypothesis the perimeter of the ellipse is equal to the arcs D B C and D E C, with a radius equal to B O = E H.



In the diagram let D C represent chord of arc D B C, and A F its bisector. Then will D B = B C; and the angle B N D = B N C. Now D O B = O D A + O A D (being supplements to D O A); and O D A = O A D, therefore D O B = 2 (O A D).

Again O A D = N D B (being measured by equal arcs); hence B O D = 2 (N D B). Then,

$$\frac{B\ N}{D\ N} = \text{tan. } B\ D\ N = \frac{2{\cdot}5}{4} = {\cdot}625 \text{ tan. } 32° \text{ in}$$

round numbers, hence

D O B = 64°, therefore D O B + B O C = 64° × 2 = 128°, again,

B A : B D :: B D : B N, then

$$\frac{B\ D^2}{B\ N} = B\ A. \text{ But,}$$

$$B\ D^2 = B\ N^2 + D\ N^2 = 2{\cdot}5^2 + 4^2 = 22{\cdot}25, \text{ hence}$$

$$\frac{22{\cdot}25}{2{\cdot}5} = 8{\cdot}9 = B\ A, \text{ and } 8{\cdot}9 \div 2 = O\ B = 4{\cdot}45.$$

Again, 8·9 × 3·1416 = 27·96024, circumference, and 27·96024 ÷ 360° = ·076 length of one degree. Therefore

·076 × 128 = 9·728 = D E C, then

9·728 × 2 = 19·556 = D E C B, or perimeter of ellipse.

An approximate rule to find the length of an arc is

$$\frac{8\ c - C}{3} = \text{arc, when}$$

c = chord of half arc.
C = chord of arc.

Applying the above rule we have

$$c = \sqrt{22{\cdot}25} = 4{\cdot}71, \text{ then}$$

$$\frac{(4{\cdot}71 \times 8) - 8}{3} \times 2 = 19{\cdot}78 \text{ the perimeter.}$$

Yours, etc.,
R. M. S.

Avoca, Pa., June 18th.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to question by "Thomas H. Picton," which appeared in the June issue:

[Solution is similar, and same result obtained as that of "J. E. J.," received on June 24th.—ED].

Yours, etc.,
J. D.

Clay City, Ind., July 1st.

Siphon.

Editor Colliery Engineer:

SIR:—I would like some of your readers to answer the following question:

Can a siphon have too much fall for its lift, and why?

Yours, etc.,
MINER.

Elizabeth, Pa., June 22d.

The Practical Work of Engines.

Editor Colliery Engineer:

SIR:—I notice in the July issue of your journal that "Equity," suggests that "I apply the same rule to direct, as I do to geared engines." I would say that I did so in my communication, with the exception that I deducted one-third of the load for frictional resistance in first motion engines, and one-half in geared engines. In either case my rule formulated would be:

For first-motion engine

$$A \times P \times V \times \cdot 67.$$

For geared engine

$$A \times P \times V \times \cdot 5.$$

A = area of cylinders.
P = $\frac{2}{3}$ of boiler pressure.
V = velocity ratio.

The decimals are constants. Taking the data given by "Equity" and using these rules we have:

904·8, area of cylinder, × 40 lbs., which is $\frac{2}{3}$ of boiler pressure = 36,192 lbs., and

$$36{,}192 \text{ lbs.} \times \frac{125\cdot 664}{452\cdot 4}, \text{ or } \cdot 28 \text{ nearly,}$$

velocity ratio, = 10,133·76 × ·67 = 6,789·6192 lbs.

The actual ability of "Equity's" engine is 7,988 lbs., so that my rule would be on the safe side by 1,199 lbs., nearly.

If we take the data given by "Equity," but use $\frac{11}{12}$ of boiler pressure as "Mechanical Engineer" does, and use "Mechanical Engineer's" rule we have:

452·4, area of cylinder, × 55 lbs., which is $\frac{11}{12}$ of boiler pressure, = 24,882 lbs.

And

$$24{,}882 \times 20'' = 497{,}640 \div 72'' = 6{,}911 \text{ lbs.}$$

So that there is only a difference of 122 lbs. of load between "Mechanical Engineer" and myself. "Mechanical Engineer" is fully 1,000 lbs. on the safe side if we take "Equity's" figures as the actual ability of his engine.

The theory given in these formulæ are *stated laws of mechanics*, but the assumptions are the results of experience. The actual load given by "Equity" shows that the practical part is in error—what shall be done? Shall we assume the coefficient of friction to suit this one case, or shall we go by the old golden rule which our fathers in England and Scotland used after many years of practical experience? If engine builders have a higher state of perfection in their engines in these latter days they should let us know it so that we can deduct the proper amount of load for frictional resistance.

I feel indebted to "Equity" for the data he has laid before us and I hope many will follow his example. With the permission of my superior officers I intend at an early date to make a like experiment which will be laid before your readers.

In conclusion I would say in one or two articles (not the one "Equity" refers to) I sent your journal I did wrong in using the double stroke of piston as diameter of crank circle. Those examples will easily be detected as I made a full statement of the law on the subject as given by Ball. The results given, divided by 2, will be correct answers in those cases.

Yours, etc.,
H. L. D. W.

Lethbridge, N. W. T., Canada, July 24th.

Mensuration.

Editor Colliery Engineer:

SIR:—Please insert the following in reply to "Inquirer," question (2).

(Same as solution of "F. B.," of Maccan, Cumberland Co., N. S., inserted in July issue).

Yours, etc.,
J. D.

Clay City, Ind., July 2d.

Ventilation.

Editor Colliery Engineer:

SIR:—I submit the following answers to questions by "Inquisitive" in the April issue:

(1) Using Atkinson's co-efficient, what would the w. g. be in a mine having 3 circular shafts, two downcast, 11′ and 10′ in diameter respectively, and one upcast 800′ deep, 8′ in diameter, the quantity being 100,000 cubic feet per minute?

Since the depth of the downcast shafts is not given, we shall assume it to be 800′. Now, in order to find the quantity passing in each shaft we shall apply the rule—the quantity passing is proportional to the square root of the result of the area divided by the rubbing surface multiplied by the area, or

$$\sqrt{\frac{a}{s}} \times a,$$

which for the 10′ shaft is ·49502 cubic feet, and for the 11′ shaft is ·57,175. These results being the relative quantities for each shaft; we find the actual quantities by proportion for as the total relative quantity is to the relative quantity in each shaft, so is the total actual quantity to the actual quantity in each shaft, thus for the 10′ shaft

1·06677 : ·49502 :: 100,000 : (x), or 46,394 cubic feet, and for the 11′ shaft

1·06677 : ·57175 :: 100,000 : (x), or 53,606 cubic ft.
46,394 + 53,606 = 100,000 cubic feet.

We find the pressure for each shaft by the formula

$$P = \frac{K\ S\ V^2}{a}$$

For the 10′ shaft we find P = 2·417
For the 11′ shaft we find P = 2·001
4·418 lbs.

This is equal to an average pressure of 2·209 lbs. in each shaft. Although this is a high pressure, it is small compared with that encountered when attempting to force 100,000 cubic feet of air through one 8′ shaft.

The area of the upcast is 50·2656 square feet, and the whole quantity passing divided by this gives 1988 feet passing through one square foot per minute. Then, by the formula

$$P = \frac{K\ S\ V^2}{a}$$

We find that we have a pressure of 36·025 lbs. per square foot. By adding this to the pressure in the downcast shafts we have

36·025 + 4·418 = 40·443 lbs., and this divided by 5·2 lbs. gives a w. g. of 7·78.

This, of course, is for the shafts alone, and is not obtained in practice. It represents a horse-power of 122·5, and assuming that 75% of useful effect can be realized from an engine, it will require one of nearly 163 horse-power.

(2) Would the w. g. resulting from this ever be met with in practice?

This w. g. would not be met with in practice, as the velocity in the upcast is too high, as it is impossible to force such large quantities of air through such small passages.

(3) Is it possible for such a quantity of air to be circulated under the above conditions?

It is not possible to force such a volume of air through one outlet, it would be necessary to provide more or larger outlets.

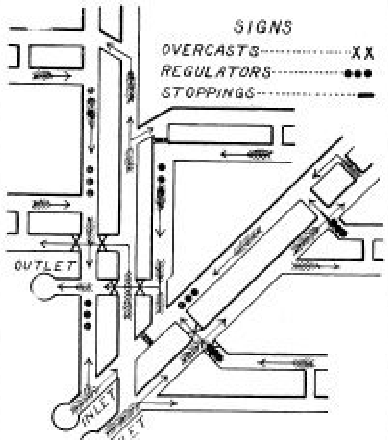
Yours, etc.,
S. U. P.

Red Bank, Pa., June 24th.

Ventilation.

Editor Colliery Engineer:

SIR:—I submit the following plan in answer to "S. U. P.," in the June issue:



There could be a double door placed between No. 1 and No. 2 inlets (No. 1 inlet being the lower one as shown in figure), if the south side coal was brought to No. 2 inlet only. This would avoid the least confusion in the two currents, the regulators could be more easily arranged, and less of them would be required according to the length of each split, other things being equal. But if all the coal is brought to No. 1 inlet, or to both, so as to suit outside arrangements, then the passage from one inlet to the other should be kept free from doors, and regulators used as shown.

Yours, etc.,
JOSEPH CAIN.

Whitwell, Marion Co., Tenn., June 26th.

Examination Question.

Editor Colliery Engineer:

SIR:—I submit the following in answer to "J. W. S.:"

The weight of a cubic foot of air in the downcast is found as follows:

$$W = \frac{1\cdot 3253 \times 30}{459 + 40} = \cdot 07967 \text{ lbs.}$$

$$\text{The motive column} = \frac{5\cdot 2}{\cdot 07967} = 65'.$$

The temperature of the upcast will equal the depth of the shaft multiplied by 459 plus the temperature of the downcast, divided by the depth of the shaft minus the motive column, then subtract 459.

$$T = \frac{400 \times (459 + 40)}{400 - 65} - 459 = 136\cdot 8°.$$

Proof,

$$\frac{1\cdot 3253 \times 30}{459 + 40} \times 400 = 31\cdot 8 \text{ lbs. weight of column}$$

in downcast.

$$\frac{1\cdot 3253 \times 30}{459 + 136\cdot 8} \times 400 = 26\cdot 6 \text{ lbs, weight of column}$$

in upcast. Thus, 31·8 − 26·6 = 5·2 lbs. the ventilating pressure.

NOTE.—The quantity passing is an unnecessary factor in the question as it will vary with the area and rubbing surface, the pressure remaining constant. In other words, a larger shaft will pass a larger volume than a smaller one with the same pressure.

Yours, etc.,
T. S. C.

Gardner, Ill., July 28th.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to "A. S.," of Wilkinsburg:

To find the pressure we must first find the weight of a cubic foot of air in each shaft, and multiply the difference by the depth of shaft. By using the formula

$$W = \frac{1\cdot 3253 \times B,}{459 + T}$$

and assuming the barometer to be 30″, we find the weight of a cubic foot of air in the downcast to be ·07952, and in the upcast to be ·05729, then

$$\cdot 07952 - \cdot 05729 = \cdot 02223,$$

which multiplied by the depth of the shaft, 500′, gives 11·115 lbs., the pressure. Then by the formula

$$q = \sqrt{\frac{P\ a}{K\ S}} \times A,$$

we find the volume to be 16,332·5 cubic feet per minute.

Now, when the length is increased 4,000′ the volume will vary in inverse proportion as the square root of the length. In both calculations the depth of shaft is added to the length of airway making the first airway 1500′ long and the second 4,500′ long, then as the lengths are as 45 is to 15 we have the proportion

$$\sqrt{45} : \sqrt{15} :: 16{,}332\cdot 5 : x,$$

or 9,506·9 cubic feet the volume in long airway.

The lengths are only considered to the furnace, the velocity will be greater in the furnace shaft on account of the expansion of the air. The difference in temperature is 193·9°, and as air expands $\frac{1}{459}$ of itself for each degree of heat added the volume becomes $\frac{193\cdot 9}{459}$ greater in the upcast, or 6,899·68′ = expansion, and

$$16{,}332\cdot 9 + 6{,}899\cdot 68 = 23{,}232\cdot 58,$$

which gives a velocity of 929·3′ per minute when passing through short airway.

Yours, etc.,
S. U. P.

Red Bank, Pa., July 29th.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following for solution in your next issue:

If an airway 6′ × 6′, and 15,000′ long, can pass 12,000 cubic feet per minute, what should be the length of a square box with an area of 28·5714 sq. ft. and a rubbing surface equal to 18,000 sq. ft. placed in an airway 7′ × 8′, and 600′ long to pass the same quantity—the section between the box and the airway to be closed?

NOTE.—The box may be taken as a separate airway.

If Jas. Stirling should happen to see this question, I would like him to solve it by the same principle as he solved the regulator question in your July issue.

Yours, etc.,
S. M. ROBERTS.

Avoca, Pa., July 29th.

Ventilation.

Editor Colliery Engineer:

SIR:—Will some of your readers kindly answer the following questions:

(1). In an elliptical shaft, whose diameters are 8′ and 14′ respectively, and whose depth is 600′, with a volume of 43,982·4 cubic feet of air passing per minute, what is the velocity?

(2). Using Atkinson's coefficient of friction, what would be the pressure and water-gauge resulting?

Yours, etc.,
S. U. P.

Red Bank, Pa., July 30th.

The Practical Work of Engines.

Editor Colliery Engineer:

SIR:—"Equity," who writes in the July number, evidently mistakes the principle of moments from that of work in comparing the formulæ with "the practical work of engines."

The load which an engine can *pull at a certain speed* is a different quantity from that which it can *start*. I beg leave to offer this solution to his quandary:

The steam pressure total upon the piston multiplied by the lever arm of its application, cannot be exceeded by the products of the load L, by its lever arm. This is a question of static equilibrium, whence, for the direct acting hoister the relation is:

$$2\ A\ a\ P\ C\ f = L\ R + \text{friction},$$

which with the figures given, F = $\frac{1}{3}$, gives L = 10,000 as the *maximum* load which the engine can start.

If we desire to investigate the dynamic equilibrium, an element of time enters which has therefore the relation

$$D\ L + \text{friction} = 4\ A\ a\ P\ S\ f, \text{ or}$$

L = 6,347, if F is $\frac{1}{3}$, and f the coefficient of engine 1, with a second motion engine, the formula, respectively is:

$$A\ a\ P\ C\ y\ f = L\ R\ x + \text{friction},$$

in which x and y are the number of teeth in the pinion and drum wheels.

"Theory" is but a formulation of the phenomena of "practice" and its statements properly applied and properly understood need not give any such confusion as "Equity" is laboring under. If "theory" were so badly in error as he fears, it would have, long since, been replaced by a more serviceable "practical" formula.

Yours, etc.,
THEORIST.

Golden, Col., July 27th.

Arithmetic.

Editor Colliery Engineer :

SIR :—I submit the following in reply to "S. U. P.," of Red Bank, Pa.:

The general rule for extracting the root of any number is

(1). Prepare the given number for extraction by pointing off as the root directs.

(2). Compute the first figure in the root by trial, and, in this case, raise it to its fourth power and subtract the result from the first period in the dividend.

(3). To the remainder annex the first figure in the next period, treating this as a new dividend.

(4). Raise the root already found to the given power less one, and multiply this by the index of the given power, the result will be the new divisor.

(5). Find a quotient figure by division, and annex it to the root.

(6). Involve the new root thus found the number of times indicated by the given power, and subtract this result from the number of periods in the given number as are represented by the last figure brought down.

(7). To the remainder bring down the first figure of the next period for a new dividend.

(8). Find a new divisor as before, and thus proceed to the end.

For example what is the 4th root of 56,249,134,561 ?

562,4913,4561 (487
256
256) 3,064 Dividend.
5,308,415 Subtrahend.
442,368) 3,164,974 Dividend.
56,249,134,561 Subtrahend.

$4 \times 4 \times 4 \times 4 = 256 =$ Divisor.
$48 \times 48 \times 48 \times 48 = 5,308,416 =$ Subtrahend.
$48 \times 48 \times 48 \times 4 = 442,368 =$ Divisor.
$487 \times 487 \times 487 \times 487 = 56,249,134,561 =$ Subtrahend.

Yours, etc.,
F. W.

Grassy Run, Pa., July 27th.

Answers to Miscellaneous Questions.

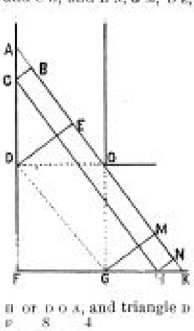
Editor Colliery Engineer :

SIR :—Please insert the following in answer to Joseph Quigley, whose questions appeared in the June issue :

(1). What is the longest rail or prop that can be taken down a shaft 6′ × 6′ and 8′ high in the bottom?

If a line A K was taken down, the point where it would meet at O, would be the middle of that line, which proves to be twice D G. Now, the length of the prop B U H C will depend upon its thickness; suppose the thickness of the prop B C, to be 1 foot.

Now, N A is parallel to D G and C H, and B N, G M, D E, and B C are parallels.



Again, D E = G M, and G K = D O, and the angle G M K = the angle D E O, then triangle D E O = triangle G M K, and E O = M K, and M E = O K = D G = $\sqrt{(OD)^2 + (OG)^2} = \sqrt{6^2 + 8^2} = 10$, and A K = 20 K = 20.

Then angle M G O + O G D = right angle, M G K + M G O = right angle ; then, O G D = M G K = N H K; and $\frac{OD}{OG} = \tan. DGO \frac{6}{8} = \cdot 75$.

Again, the angle B A C = N H K, therefore B C A = N K H or D O A, and triangle D O A = F G D; tan. $ACB = \frac{DF}{FG} = \frac{8}{6} = \frac{4}{3}$.

Hence, $1 \times \cdot 75 = \cdot 75$, or (tan. N H K) (N H) = N K; and $1 \times \frac{4}{3} = \frac{4}{3}$, or (tan. A C B) (C B) = B A.

Then,

$$\cdot 75 = \frac{3}{4}, \text{ and } \frac{3}{4} + \frac{4}{3} = 2\tfrac{1}{12};$$

whence,

$$20 - 2\tfrac{1}{12} = 17\tfrac{11}{12} = \text{N B or length of prop.}$$

Reducing the above work to a formula, we have

$$2\sqrt{H^2 + W^2} = \left(\frac{W T}{H} + \frac{H T}{W}\right).$$

H = height at bottom of shaft.
W = width of shaft.
T = thickness of prop.
All taken at the same denomination.

NOTE.—In the above demonstration no allowance has been made for width and breadth.

(3). What actual quantity of air can be expected from a fan of 20 feet diameter 7 feet in breadth of blades, with an orifice of 8 feet, and velocity of 50 revolutions per minute?

It is impossible to know what quantity of air any fan will produce without knowing the condition of the mine (or water-gauge due to the resistance of the mine), and water-gauge due to resistance of fan. Also the percentage such fan is given.

In regard to the latter part of the question, which reads as follows : "The area of an airway at entrance of upcast to the fan is 90 feet and an anemometer applied at that point, indicates more air than the capacity of the fan as computed from the above dimensions. Can such ever be the case? If so, I do not understand the cause, and would like the opinion of some of your readers on it.

I say that no machine can produce more than its capacity.

If theory don't correspond with practice, I say that it is not a correct theory.

If Mr. Quigley will be so kind as to show us how he made his calculation and experiment, then perhaps it will be possible to show him where he is wrong. I would refer Mr. Quigley to D. Murgue's "Theories and Practice of Centrifugal Ventilating Machines," by A. L. Steavenson.

Yours, etc.,
R. M. S.

Avoca, Pa., June 17, 1891.

Correction.

Editor Colliery Engineer :

SIR :—My pump formula in the April issue was incorrectly stated. It should have been $D^2 L N \times \cdot 034 =$ gallons, and removing decimal point one place to right = lbs. Am much obliged to the two gentlemen for their corrections, but think that "Tyro" made the thing more absurd than it really was by moving the decimal point to the left instead of the right, as I stated it.

Yours, etc.,
J. V.

Punxsutawney, Pa., July 26th.

Examination Question.

Editor Colliery Engineer :

SIR :—In answer to problem by "J. W. S.," of Westville, Pictou Co., N. S., the first thing necessary is to find the weight of a cubic foot of air in the downcast, which is done by the use of the formula

$$W = \frac{1 \cdot 3253 \times B}{T + 459},$$

assuming the barometric pressure to be 30″, we have

$$\frac{1 \cdot 3253 \times 30}{40° + 459°} = \cdot 0796773.$$

Now $5 \cdot 2 \div 400 = \cdot 013 =$ difference in weight of 1 cubic foot of downcast and upcast air, therefore

$W - p$, or $\cdot 013 - W = \cdot 0666773$, and

$$\frac{1 \cdot 3253 \times B}{W} = 596 \cdot 29°,$$ subtracting the constant 459°, we have 137·29° as temperature of upcast.

Yours, etc.,
J. V.

Punxsutawney, Pa., July 26th.

[Similar solutions to this question were received from "S. U. P.," of Red Bank, Pa., July 29th, and from David P. Brown, of Adelaide, Pa., July 30th.—ED.]

Mensuration, Mining, and Ventilation.

Editor Colliery Engineer :

SIR :—Please insert the following questions in the Correspondence Department of THE COLLIERY ENGINEER:

(1). The inside measurements of a pit car are length, 6′ 6″; depth, 2′ 6″; the bottom section 1′ in height, and 3′ 2″ in width; the top measurement of upper section is 4′ in width, how many bushels of coal will it contain, computing 2,688 cubic inches to the bushel?

(2). How would you proceed to develop a coal field of 1,000 acres, 4′ thick and lying 500′ below the surface, with an inclination of 1′ in 300′ West to East. Also give a description of all the necessary appliances required, the output to equal 1,200 tons daily.

(3). In a mine generating a large amount of fire-damp, where the coal vein dips 10′ in every 100′, what ventilating apparatus would be best, and where would you erect the same?

(4). If a mine generated 200 cubic feet of fire-damp per minute, and 1,000 cubic feet of black-damp, there being 120 persons employed, how much air would be required to keep the workings in a healthy condition?

Yours, etc.,
MINER.

Philipsburg, Pa., July 27th.

Arithmetic.

Editor Colliery Engineer :

SIR :—In answer to "S. U. P.," of Red Bank, Pa., I would say that the simplest rule for extracting the 4th root is by logarithms. For example the log. of 28,561 = 4·455760, which divided by index of root

$$\frac{4 \cdot 455760}{4} = 1 \cdot 113943,$$

which is the log. of 13 the required result.

I would like to say to all readers and students of mining that THE COLLIERY ENGINEER POCKET-BOOK contains a table of logarithms, and a large amount of formulæ not to be found in any one book published, and is just the book for students of mining who cannot afford a large number of books and who wish to advance themselves.

Yours, etc.,
J. V.

Punxsutawney, Pa., July 26th.

Certificated Mine Bosses and Mine Superintendents.

Editor Colliery Engineer :

SIR :—In the last issue (July) of THE COLLIERY ENGINEER, "L.," of Mansfield, Pa., seems to take great objections to mine superintendents passing an examination. I would ask him if he thinks it would be a degredation to do so, or does he think that a mine superintendent is simply a figurehead to draw his fat salary every month. One is led to think by his letter that a superintendent has no care for the management of the valuable mining property, or for the protection of precious lives. He seems to think that any kind of a man will do for mine superintendent—men even who have no tastes or ability for mining pursuits, but whose only object is a remunerative situation, and who are entirely dependent upon the mine bosses under them for carrying on the work in and around the mines. I again would say that I know *scores* of just such mine superintendents, and "I have not had a great many changes, neither have I had a great many superintendents over me." But I have come in contact with a great many. Mine bosses need not fear "L.'s" assertion, viz.: "I think if the superintendent has to hold a certificate of competency, it will benefit his position by giving him more pay, and will lessen that of the mine boss by giving him less pay and all the hard work." That is just the position the mine boss stands in now.

In conclusion I will say that my mining experience convinces me that the *educated practical* man is the most *successful* manager, when all other things are equal.

Yours, etc.,
M.

Ohio, July 23d.

Ventilation.

Editor Colliery Engineer :

SIR :—I submit the following in answer to Thomas H. Picton's questions on ventilation which appeared in the June issue :

[This solution is similar to that by "J. E. J.," of Moosic, Pa., which was inserted in the July issue. The result obtained is the same, 498·38′.—ED.]

Yours, etc.,
T. S. C.

Gardner, Ills., July 7th.

Arithmetic.

Editor Colliery Engineer :

SIR :—In reply to "S. U. P.," of Red Bank, Pa., I would say that the simplest method of extracting the 4th root of a number is to extract the square root of the square root. Thus

$$\sqrt{28,561} = 169, \text{ and } \sqrt{169} = 13, \text{ therefore}$$
$$\sqrt[4]{28,561} = 13.$$

Yours, etc.,
A. B. C.

Pittston, Pa., July 24th.

[Similar solutions to this question were subsequently received from "W. N. S.," of Falls Creek, Pa., and "J. E. J.," of Moosic, Pa.—ED.]

Ventilation.

Editor Colliery Engineer :

SIR :—Please insert the following in answer to "A. S.," of Wilkinsburg :

SIR :—Supposing we have 2 shafts of equal depth, 500 feet each, and 5′ x 5′ area. The average temperature in the downcast shaft is 41°, and in the upcast or furnace shaft, 234·9°. What amount of air will this furnace power produce in an air-course 1,000 feet in length, and 5′ x 5′ area? And what amount of air will this same power produce in an air-course of the same size, and 4,000 feet in length?

The pressure produced under the above conditions is found thus :

$$\frac{1 \cdot 3253 \times 30 \times 500}{459 + 41°} - \frac{1 \cdot 3253 \times 30 \times 500}{459 + 234 \cdot 9} = 11 \cdot 11 \text{ lbs.}$$

Now,

$$V = \sqrt{\frac{P a}{K s}}$$

Substituting their values we have

$$\sqrt{\frac{11 \cdot 11 \times 25}{\cdot 0000000217 \times 20,000}} = 799 \cdot 985,$$

and $799 \cdot 985 \times 25 = 19,999 \cdot 625$ quantity in the short airway.

Airways with the same power pass quantities according to

$$\frac{1}{\sqrt[3]{s}} \times a,$$

then for the first airway we have

$$\frac{1}{\sqrt[3]{1 \times 1}} = 1.$$

For the second

$$\frac{1}{\sqrt[3]{4 \times 1}} = \cdot 63.$$

The quantity passing in the long airway will be $19,999 \cdot 625 \times \cdot 63 = 12,599 \cdot 763$ cubic feet.

Yours, etc.,
A. B.

Hanna City, Ill., July 21st.

Examination Question.

Editor Colliery Engineer :

SIR :—Please insert the following in answer to "J. W. S.," of Westville, Pictou Co., N. S.:

First find the motive column from the pressure, thus

$$\frac{5 \cdot 2}{5 \cdot 2} = 1 \text{ water-gauge.}$$

Assuming water to be 833 times heavier than air, we have

$$\frac{833 \times 1}{12} = 69 \cdot 4′,$$

the length of the motive column producing ventilation.

As air expands $\frac{1}{459}$ of its volume for every degree of heat added to its temperature we have

$$\frac{400}{459} = \cdot 871$$

as the rate of expansion in the upcast shaft, due to the addition of 1° of heat. But from the motive column we can see that it must be expanded 69·4 ft. Therefore it must be raised as many degrees as the rate of expansion due to 1° is contained times into the motive column, thus

$69{\cdot}4 \div {\cdot}871 = 79{\cdot}67^\circ$ the number that must be added to the temperature, or

$79{\cdot}67^\circ + 40^\circ = 119{\cdot}67^\circ$ the average temperature required in the upcast shaft.

Yours, etc.,
J. I. P.

Whitney, Pa., July 24th.

[A solution to this question using the same principles, and obtaining the same result was also received from D. M. Harr, of Hoult, W. Va., July 26th.—Ed.]

Mechanics.

Editor Colliery Engineer:

SIR:—Will some of your correspondents kindly answer the following question in your next issue, as I am very anxious to have it solved:

At what inclination must a self-acting incline 700′ in length be laid in order that a trip of three cars may be run in two minutes, a full car weighing 3 tons, an empty car ½ ton, the rollers and sheaves 700 lbs., and the rope 200 lbs.

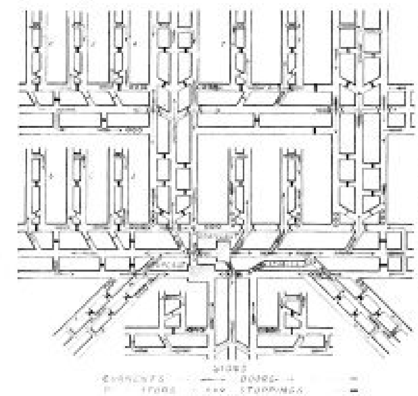
Yours, etc.,
LEARNER.

Westville, Pictou, Co., N. S., July 13th.

Ventilation.

Editor Colliery Engineer:

SIR:—I send in the following plan of ventilation as requested by Mr. Arthur Crossland:



I would say that if this is a true plan of underground colliery entries, it is the first local mine I ever saw that had enough openings, for certainly this has enough. I have numbered some of the double entries on plan, 1, 2, 3, 4, etc., as it may not be necessary to arrange them in separate currents for the distance they are to be driven, by so doing we avoid 5 overcasts, and add 5 doors, but if the mine is a gaseous one it would be best to have the overcasts and avoid the doors. I believe it is wise to avoid doors at all times wherever possible.

I would have the haulage ways in the intake entries, which are the middle entries. These entries should be wide enough for double track, and the endless-rope system could be adopted, using the tail-rope system for slants.

For 400 men and 20 mules it would require not less than 100,000 cu. ft. of air per minute. The selection of a fan requires careful consideration, I would use a Guibal exhaust fan.

All splits equal in length will not require regulators, so it may be possible to do away with some of the regulators shown.

Yours, etc.,
JOSEPH CAIN.

Whitwell, Marion Co., Tenn., June 20th.

Algebra.

Editor Colliery Engineer:

SIR:—Will some of your correspondents kindly work out the following algebraic equation:

$x^2 + y = 7$, and $x + y^2 = 11$,

what are the values of x and y?

Yours, etc.,
A. B. C.

Pittston, Pa., July 24th.

Examination Question.

Editor Colliery Engineer:

SIR:—I submit the following in answer to question by "J. W. S.," of Westville, Pictou Co., N. S.:

A furnace at the bottom of a shaft 400′ deep produces 15,000 cubic feet of air per minute with 5·2 lbs. pressure per square foot. The temperature in the downcast shaft is 40° F., what is the temperature in the upcast shaft?

Assuming the barometer to stand at 30″, we will find the weight of a column of air 1′ square and 400′ deep in the downcast by the following rule:

$$\frac{1{\cdot}3253 \times 30'' \times 400'}{459 + 40^\circ} = 31{\cdot}87 \text{ lbs.}$$

Supposing the shafts to be the same depth, the ventilating pressure being 5·2 lbs. the weight of a similar air column in the upcast will be

$$31{\cdot}87 - 5{\cdot}2 = 26{\cdot}67 \text{ lbs.}$$

Having found the weight of the air column in the upcast the temperature is found by the formula

$$\frac{1{\cdot}3253 \times 30'' \times 400'}{26{\cdot}67} - 450^\circ = 137^\circ.$$

The quantity passing is not a necessary factor in solving the question.

Yours, etc.,
A. B.

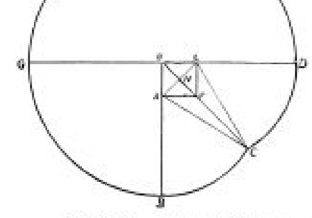
Hanna City, Ill., July 21st.

[Answers to this question, precisely the same as above, were received from "P.," of Whitney, Pa., July 27th, and from Thomas Mather, of South Fork, Pa., July 30th, as they are the same they are not inserted. —Ed.]

Mensuration.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to T. W. Hale, of Scranton, Pa., whose question appeared in the May issue:



The area of D G B = $100^2 \times 3{\cdot}1416 \times \frac{3}{4} = 23{,}562$ square ft.

The sum of the angles that can be formed around the point F = 4 right angles. The angle E F A = a right angle, and the exterior angle = 3 right angles or 270°. The line O C bisects it; then, A F C = E F C = 135°.

In the triangle A F C, A F = 25′; A C = 75′; and A F C = 135°. Therefore

A C : A F :: Sin. 135° : Sin. C, or

75 : 25 :: ·70111 : ·23571; C = 13° 38′.

The angle A = 180° − (135° + 13° 38′) = 31° 22′; the angle C A B = 90° − 31° 22′ = 58° 38′.

The area of the sector A C B = $75^2 \times 3{\cdot}1416 \times \frac{58^\circ\ 38'}{360} = 2883$ square feet.

The area of the triangle A F C = A C ½ Sin. A = 75 × 6·51 = 488·25.

Sin. 31° 22′ = ·52051 × 25 = 13·01 = Sin. A.

The area = 23562′ + 2 (2883 + 488·25) = 30304·5 square ft. surface the horse can graze over.

Yours, etc.,
A. B. C.

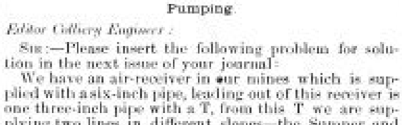
Pittston, Pa., July 24th.

Pumping.

Editor Colliery Engineer:

SIR:—Please insert the following problem for solution in the next issue of your journal:

We have an air-receiver in our mines which is supplied with a six-inch pipe, leading out of this receiver is one three-inch pipe with a T, from this T we are supplying two lines in different slopes—the Summer and Rock. Now ten feet from the T, or receiver, on the



Rock slope side the three-inch pipe with one valve and two elbows making three turns with T, we tap a six-inch pipe which runs 1,800′. Now then 100′ from the six-inch pipe we wish to run a pump, should we make the connection from the six-inch pipe to the pump which is the 100′ with two three-inch pipes, (which can be reduced down to 2½ inches to make connection to the pump) or would one three-inch line do as well leading from the six-inch pipe to the pump, which is 100′, taking into consideration the condition of the supply from the receiver as above stated?

Again, suppose we make the connection from the receiver to the six-inch line with two three-inch pipes, and run from six inch pipe to pump with one three-inch line, will we have better results.

If not too much trouble, I would be pleased to receive an early reply to the above questions.

Yours, etc.,
J. T. ROGERS.

Pratt Mines, Ala., July 18th.

Mr. Thomas Foulds, of Treverton, Pa., an old-time colliery official, has invented a metallic railway tie. The support, or under side of the tie is corrugated. A broad and flat surface is given for the support of the rails. The plate is of such width as to preserve flanges upon either side of the corrugated bearings which are V-shaped. These flanges are provided with holes to receive bolts or fastenings for holding the rails to the plate. The corrugated bearings are for supporting and resisting any breaking strain or pressure while a train is passing over the rails. They are closed at the ends by caps, so as to prevent dirt or stones entering, and also to materially enhance the supporting power of the bearings.

The Coal and Iron Region of North Carolina.

Mr. Rody Maher, of Bedford Co., this State, writes us from Greensboro, N. C., as follows:

"My visit to North Carolina began at Greensboro, and here let me say, my surprise began, for I did not expect to find it such a busy, prosperous and growing city. I recommend our young men who are contemplating a change, to go to Greensboro. There are a number of Northern people here, and all are doing well. I could write a great deal about this "City of Flowers," but coal and iron, is what I want to tell you about.

Here I found the "Greensboro Coal and Mining Co." recently organized, with mines at Walnut Cove, Stokes County, about thirty miles distant.

I visited this property, and was so interested that I remained several days, long enough to make a thorough examination. I will not tax you with a detailed account of all I saw, but will say I was most agreeably surprised. The development of the property was only fairly begun, but the coal, taken out near the surface, is of such good quality, as to encourage active operations. It is semi-Bituminous, and I think, will coke well. In burning, it produces great heat, and leaves no clinker. When sufficient depth is reached, the coal must prove of very fine quality. This is the "Dan River Coal Field," and the property must have been developed years ago, but for the lack of transportation facilities. Now two railroads are in close proximity, and the demand for this kind of coal is enormous. The Company has shipped only a small quantity, for experimental purposes, but have daily enquiries from coal consumers. The work is progressing as rapidly as possible, and they expect to begin shipping in a few weeks. There are several good seams, and this Company may work two at the same time, to enable them to supply the demand, especially so, if it cokes well, as they will then supply the Greensboro Steel furnaces.

The iron properties, in the same County, are very valuable. I was shown some of the finest magnetic iron ore and manganese I ever saw. These iron properties, are the finest in the South, and as the ore is so conveniently located for mining, the Company that develops them will reap an enormous harvest. These properties, consisting of several thousand acres, have been secured, and a Company is about to be organized, to develop them."

Explosion of Gas.

Thirteen men were burned by an explosion of gas at the Lehigh Valley Coal Co.'s York Colliery at Pottsville, Pa., on the 8th instant. One will probably die, the others will recover.

The explosion occurred in a tunnel in the second lift of the slope. A shot fired had cut into the vein toward which the tunnel was being driven, and also liberated a strong feeder of gas. As soon as the smoke had cleared away the men returned to the face, with naked lights on their hats and fired the gas. The coal and timbers caught fire, and it was with considerable difficulty that the injured men were taken out. After the work of rescue was finished, the fire was extinguished. Mine Inspector Gay visited the colliery the day before the accident, and while in the tunnel warned the men that they were approaching the coal, and directed that they go in with safety-lamps after each shot. Disobedience of this order was the cause of the accident.

Mr. H. A. Kingsbury, for many years purchasing agent for the Lackawanna Iron and Coal Co., has opened a store room and office at No. 435 Spruce Street, this City, for the sale of Mine and Mill Machinery and Supplies. Among the specialties handled by Mr. Kingsbury, at manufacturers' prices, are the standard brands of gum belting, and mechanical rubber goods, manufactured by the Gutta Percha and Rubber Manufacturing Co.; Chas. A. Schieren & Co's leather belting; the Jno. A. Roebling's Sons Co.'s wire ropes; safety-lamps of all descriptions; Gilbert's universal and interlocking wood split pulleys; boilers, engines, and pumps of all descriptions; iron and steel in bars or sheets; water and gas pipe; chute plates; forgings; shafting, and hangers; and in fact all kinds of machinery and supplies used in mine or mill work. Mr. Kingsbury's experience with the Iron and Coal Co. has specially fitted him for the business in which he has engaged, and we heartily commend his establishment to our readers as one in which they can secure first-class goods at prices that will compete with any establishment in the country.

The Lidgerwood Manufacturing Company, New York, Chicago, and Boston, are doing an immense business in their standard hoisting engines. They are enlarging their present works in Brooklyn, N. Y., and have just opened a branch house in Pittsburgh, at 99 First Avenue. It will be in charge of Mr. A. G. Harmes, of that city, and anyone desiring anything in the line on hoisting machinery will do well to give him a call. Our readers are cordially invited.

Mr. W. L. Bellis, of Cleveland, Ohio, manufacturer of the Bellis Mining Collar, writes us as follows:

"Enclosed please find check in payment of bill of July 1st. Among recent new orders are those from Abbott and Blakslee, Coal Glen, Jefferson County Pa.; The Cresson and Clearfield Coal and Coke Company, Frugality, Pa.; The Moundsville Coal Company, of West Virgina; John Cooper & Co., Coopers, West Virginia, (two orders); St. Bernard Coal Company, Earlington, Ky.; H. S. Odbert, Canal Dover, Ohio; The Davis Mining Co., Davis, West Virginia, and many others. All purchasers speak in the highest terms of the collar, and have adopted it for general use. My advertisement in THE COLLIERY ENGINEER is the best one I have out."

The Colliery Engineer.

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Scranton, Pa.

Cable Address—"Retsof, Scranton."

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THE COAL PRODUCTION OF THE UNITED STATES.

WE have compiled from the Census Bulletins compiled by Mr. John H. Jones and issued under the supervision of Dr. David T. Day, special agent in charge of the Division of Mines and Mining, an interesting table, which shows the wonderfully rapid development of our vast coal resources.

A study of this table reveals some interesting facts. It shows that coal is mined in 29 of the 44 states of the Union, and that the coal fields are so located as to be convenient not only to the present great centers of population, but also convenient to the portions of our territory that are most rapidly being populated by immigrants from the North and East, and emigrants from Europe.

The coal production has almost doubled in the past decade, though the population has only increased 24·57%. As the coal mined was all utilized it is evident that not only has the domestic consumption largely increased, but the consumption of coal for steam, purposes in manufacturing establishments must have been increased in a ratio at least twice as large as that shown for the growth of the population. Comparatively none of this coal was exported.

In 1880 the Anthracite coal produced comprised about 40% of the total amount mined. In 1889 it represented about 32·36% of the whole production. That the ratio remains so high for Anthracite is remarkable, as the region producing it is of limited area, and the development of the western and southern fields placed a competitor in many markets, that owing to closer proximity and less cost of mining, could be sold at much lower prices. There were two features, however, that tended to keep the higher priced Anthracite from falling lower in the percentage, and they were its favorable location, so near the great centers of population and manufactures in the East, and its superiority as a domestic fuel. It will be seen from the table that while the production of Anthracite increased but 59%, the production of Pennsylvania Bituminous coal increased about 97%, and this greater increased production of Pennsylvania Bituminous, in connection with the remarkable increase in the neighboring States of Ohio, West Virginia, and Virginia, has materially restricted the growth of the Anthracite trade in eastern markets, and has been the cause of the low prices at which Anthracite has been sold and is now selling.

The development of the western and southern fields has also tended to restrict the market for Anthracite not only by meeting it in southern and western markets as a competitor, but by also wresting a large portion of the western and southern trade from the Pennsylvania Bituminous, and thus diverting it into eastern markets to compete with Anthracite.

Another interesting feature of the table is the number of employes at American collieries. The total number of 296,974 employes shows that a population of nearly or quite 1,200,000 people is directly dependent on the working of the coal mines; for a ratio of four to one in this instance is a very moderate one.

The number of collieries given represents only those that ship their product to market by rail or water. The small mines worked for local sales are not included.

TABLE SHOWING A CONDENSED CENSUS OF THE COAL INDUSTRY OF THE UNITED STATES.

STATES.	Production in Short Tons in Year 1889.	Production in Short Tons, in Year 1880.	Increase.	Number of Persons Employed at Collieries.	Number of Collieries.
Pennsylvania { Anthracite	45,544,970	28,640,819	16,904,151	125,229	342
Pennsylvania { Bituminous	36,174,089	18,425,163	17,748,926	53,780	525
Illinois	12,104,272	6,115,377	5,988,895	23,934	358
Ohio	9,976,787	6,008,595	3,968,192	19,343	323
West Virginia	6,231,880	1,829,844	4,402,036	9,778	115
Iowa	4,061,704	1,461,116	2,600,588	9,193	172
Alabama	3,378,484	323,972	3,054,512	6,762	44
Maryland	2,939,715	2,228,917	710,798	3,734	32
Indiana	2,845,057	1,454,327	1,390,730	6,448	94
Missouri	2,567,823	844,304	1,723,519	6,739	123
Kentucky	2,399,755	946,288	1,453,467	5,144	79
Colorado	2,360,536	462,747	1,897,789	1,445	58
Kansas	2,230,763	771,142	1,459,621	5,063	127
Tennessee	1,925,689	495,131	1,430,558	4,306	39
Wyoming	1,388,947	589,595	799,352	2,682	35
Washington	993,724	145,015	848,709	1,847	12
Virginia	865,786	43,079	822,707	1,565	11
Indian Territory	752,832		752,832	1,887	10
New Mexico	486,463		486,463	1,054	18
Montana	363,301	224	363,077	857	8
Arkansas	279,584	14,778	264,806	568	8
Utah	236,651		236,651	565	4
Georgia and North Carolina	226,156	154,994	71,162	788	3
California and Oregon	186,179	280,155	*93,976	443	10
Texas	128,216		128,216	549	4
Michigan	67,431	100,800	*33,369	261	6
Dakota and Nebraska	30,307	200	30,107	76	5
Totals	140,747,591	71,336,582	69,411,009	296,974	2,539

* Decrease.

NOTE.—The production given in first column is for calendar year 1889. That in the second column is for the year ending May 31, 1880.

ROAD TAXES IN THE ANTHRACITE REGIONS.

JUDGE RICE, of Luzerne County, Pa., recently rendered a decision in the case of Coxe Bros. & Co. and the supervisors of Hazle and Foster Townships, in which he holds that Messrs. Coxe Bros. & Co. have the right to work out their road taxes, amounting to nearly $4,000. The *Scranton Republican*, in its issue for the 7th inst., designates the law under which this decision was made, "an absurd law" and criticises Hon. Eckley B. Coxe for taking advantage of it. In the course of the editorial it is stated that "The lower end of Luzerne County is flooded with the cheapest kind of cheap foreign labor, brought there by Mr. Coxe and other coal operators, and it will probably not cost Mr. Coxe more than $2,500 to work out the $4,000 of his road taxes."

It is surprising that the *Republican* is so ignorant of the state of affairs in many of the townships in each of the coal counties of the State, and also ignorant of the notorious fact that many township officials are best described by a term sometimes applied to them in Schuylkill County, viz.: "Township Robbers." Taxes for years, in some of these townships were either stolen outright or paid to cliques who did a minimum amount of work on the roads for a maximum price. The roads have been in miserable conditions at all seasons of the year, and as the heaviest taxpayers are the most frequent users of the roads, they naturally want them kept in good condition, especially when they pay the tax to have it done. With this object in view, the Philadelphia and Reading Coal and Iron Co., the Lehigh Valley Coal Co., and the Girard Estate have for years been working out their road taxes in Schuylkill, Columbia, and Northumberland Counties. The work is always done under the direction of the township supervisor, but a check is kept on him by the employment of a time-keeper, whose wages are paid by the corporations in addition to the full amount of the taxes levied. The result is better roads because some return is obtained for the money expended upon them. In Lackawanna and Luzerne Counties, the same system has prevailed to a lesser extent and always with beneficial results to the taxpayers. In Pittston Township, Luzerne County, and Carbondale Township, Lackawanna County, it has resulted in the full amount of money paid as road tax being spent intelligently on the roads, and prevented it from being diverted to line the pockets of dishonest township officials.

Mr. Coxe in working out his road tax benefits the public. The roads will be kept in repair to the extent of the amount of his taxes at least, and the public will have better roads in Hazle and Foster Townships than they have had for years. Mr. Coxe will have the trouble and expense of seeing the taxes judiciously expended but his own teams will also have the advantage of good roads.

As for the cheap labor in the lower part of Luzerne County, it was not brought there by "Mr. Coxe and other operators," any more than the better class of Irish, Welsh, and German emigrants were. They came at first in small numbers, and came voluntarily. Each Hun found that work was plenty and wages higher than he ever dreamed of at home, and each one of them became an emigrant agent, and induced others to come, and later arrivals are doing the same thing. Their presence in the coal regions is due to our loose emigration laws. If any of them work on the township roads, it is because the supervisors employ them, and they are paid the same wages as other laborers, when supervisors do not charge them premiums on their jobs. The supervisor has the power to employ the workmen, Messrs. Coxe Bros. only ask the right to pay them, and keep a check on the time-book.

In connection with this matter the *Republican* commends Mr. Albert Lewis and Genl. Paul Oliver for the construction of a road from Laurel Run to Bear Creek, in Luzerne County, which is an excellent piece of work, and was built at the expense of the gentlemen named. Inasmuch as the road mentioned is a greater convenience to Messrs. Lewis and Oliver than to anyone else, we cannot see how they are entitled to more credit than Mr. Coxe is, as he is spending time and money to secure good roads and thus benefiting all residents of the townships affected and thousands of others who are compelled to use the roads.

SENSATIONAL JOURNALISM AND THE COAL MINING INTERESTS.

IT is not astonishing that the mass of the American public possesses distorted and ridiculous views of the state of society and the relative positions of employers and employes in the coal fields. It is hard to see how it can possess any other views because its ideas are shared by and have been imbibed from "the Great American Educational Mediums"—the daily press.

The dispatches which convey this false information are in many instances sent to metropolitan dailies by correspondents located in the coal regions, who are paid for their services in proportion to the amount of sensation they can inject into their telegrams. They frequently convey the idea to general readers that colliery owners and colliery officials are as a rule a set of inhuman fools. We use the expression, harsh as it may seem, because it is the only one that aptly fits. The dispatches chronicling mine accidents are frequently couched in such terms as to leave the reader to infer that the colliery owners and officials have no regard either for human life or property. If such was the case they would certainly be inhuman fools. But, the colliery owners and officials are men that stand deservedly high in every mining community. They not only use every possible means to prevent accidents for Humanity's sake, but do so for economic reasons as well.

In the same manner the mine workers are indirectly traduced. The general impression throughout agricultural and manufacturing districts is that the miners are a set of roughs but little better than criminals. The reverse is the truth; there is no class of workingmen that are possessed of larger hearts or have a higher regard for morality than American coal miners.

If, owing to extensive mining operations, a slight depression of the surface occurs, it is heralded over the country as a great cave-in, by which whole towns were endangered, etc., etc. The facts usually are that a small portion of comparatively worthless surface is sacrificed to win coal beneath it that is of infinitely more value, and the colliery officials and mining engineers expected what slight caving there was.

Many reputable journals do not want such matter from their correspondents, but the news editors not having knowledge of the subject are imposed upon. There are other journals that require just such matter from their correspondents because their circulation is built up by appealing to the morbid taste for sensational news of a certain portion of the public.

In some instances, colliery owners and colliery officials are themselves to blame. Because exaggerated stories have been printed, they refuse to give reporters the facts connected with important happenings around their collieries. The reporters are therefore compelled to get their information from unreliable and ill-informed sources and this in many instances causes the publication of misstatements. It would be far better if all colliery officials would make it a point to give full and correct information to the correspondents and then hold them responsible for misstatements.

The local papers of the coal fields are not free from this fault of incorrectly reporting accidents and other colliery happenings and in their case there is not so much excuse as in the case of metropolitan journals. It is strange that editors, many of them born and raised in mining communities, will permit the publication of incorrect and often ridiculous statements in their journals. They have every opportunity to get correct information, but they neglect to do so, and many of them show a lamentable ignorance of mining matters when commenting editorially on such subjects.

The most important qualifications of a competent editor is a close acquaintance with the subjects of greatest importance to the community in which his journal is published. Yet, there are comparatively few editors in the coal regions who have even a superficial knowledge of the technicalities of coal mining, notwithstanding the industry is the source of all the prosperity of the towns in which they reside. It is a very easy matter for them to post themselves, and there is no excuse for their publishing inaccurate and misleading statements.

These sensational articles are mischievous in many ways. They perniciously affect the capital invested in coal mining, the labor employed therein, the value of real-estate in the mining communities, and the general business interests of the regions.

They affect capital by exciting the minds of the public against the operating interests, and make easy the work of mischievous demagogues who seek to further their own ends by injuring or ruining both capital and labor.

They affect the labor employed in the mines by making it appear that colliery employes are devoid of all morality, and are in general but one degree removed from the brute, when the actual fact is that the standard of morality in mining communities is superior to that of either manufacturing or agricultural communities, and the standard of intelligence among the miners is higher than that of most other classes of labor.

They affect the value of real-estate and business in the coal fields by making it appear that lawlessness prevails and that the working of the mines endangers the surface and all surface improvements.

Taken all in all, the business interests of the coal regions of the United States are seriously affected by these false and sensational publications, and it is the duty of every citizen of those regions to assist in remedying the matter. The editors of the local journals can assist in the work by making it a point to publish only correct reports of colliery happenings and news intelligently written up.

The colliery owners and colliery officials can assist by making it a point to give the newspapers full and correct reports of all important occurrences, and the general public can assist by calling sensational resident press agents to account for their work.

If all classes will combine to effect this result the prosperity of their communities will be enhanced, and capital and business will be attracted to the coal regions, instead of being scared away.

CERTIFICATED MINE FOREMEN.

THAT the employment of certificated mine foremen has been attended with increased safety in the coal mines of Pennsylvania can easily be proven by reference to the Mine Inspectors' reports. Yet there are men who, professing to be friends of the miners, advocate the abolishment of this section of the mine laws. The greater safety in mines due to the employment as mine foremen of such men as have by a careful examination proven themselves qualified to fill the position (many bosses hold service certificates) should ensure the perpetuity of the plan in Pennsylvania and its adoption in every other coal mining State in the Union.

Complaints are made by some that the examinations are too rigorous. We do not think they are. A successful mine boss is a man of broad views, and the more intimately he is acquainted with the sciences connected with mining the better he is equipped to manage the colliery with safety and economy. We wish it understood that we consider the theoretical portion of his education of fully as much importance as his practical knowledge or experience. Theory is merely some one else's practical experience recorded for the use of others, and the more of such theory a mine boss obtains the better is he qualified to fill his position.

The mine foreman who has no knowledge of mining, except that gleaned in his own narrow experience, does not amount to much. And the one who is familiar with theories and has had no practical experience, is wanting in the ability to make use of his knowledge. What is required in the successful mine foreman is a judicious combination of theory and practice. The object of the examinations is to prove that each candidate possesses these qualifications.

These examinations when the law went into effect in Pennsylvania, some five years ago, were comparatively simple. Since then they have been made more rigorous, and this is right.

To be a success the mine foreman should be familiar with the practice and theory of mine ventilation. That he knows that the simple formula

$$\text{“} p = \frac{k\,s\,v^2}{a} \text{”}$$

is so, is not enough. He should know *why* it is so. He should understand the laws of friction of air in mines; and to be able to calculate what current velocity or pressure he may require, he should thoroughly understand mensuration. His knowledge of the gases met with in coal mines should not cease with knowing that certain percentages of fire-damp in the air are explosive, and that certain percentages of other gases are poisonous. Neither should it end with a knowledge of their specific gravities. He should know all about the conditions governing the occurrence of gases in mines, and as it is impossible that any individual can obtain this knowledge by his own experience, a mine foreman must be a reader and a student to be qualified for the place. As well put a child in charge of a powder magazine, as a man who does not read, and in his ignorance professes to despise book learning, in charge of a gaseous colliery.

The mine foreman should understand not only the use of the various safety-lamps, but their construction and principles as well. Otherwise he will not know when a lamp is in safe condition or how to make it safe. He should have an elementary knowledge of geology, and the more he knows of the geology of the coal field he works in the better. He should understand mechanics, so as to be able to take advantage of every thing that will make the extraction of coal safer, and more economical. He should understand the principles involved in the construction and operation of steam boilers, and engines. His knowledge of pumps should be thorough. He cannot be too well versed in practical and theoretical mechanics. He should have a thorough knowledge of surveying, and should be able to read a mine map at a glance, and if necessary, bring the surveys up to date.

Some of our readers will say, "you would require a mine foreman to be not only a practical miner, but a mining engineer, a mechanical engineer, and chemist as well." We heartily wish he could be all four. We do not think that the examinations should be so strict as to compel the candidate to fully reach the standard outlined above, but we do think they should determine that he has an elementary knowledge of the branches mentioned. If he has this knowledge he will, as a rule, thirst for more, and will not cease his studying because he has a certificate. He will know that the little knowledge he possesses makes his work easier, and his services more valuable. He will realize that if he continues his studies he will know still more, and be able to grapple successfully with more serious obstacles, and thus be worth more to his employer and merit promotion and increase of salary. The most successful colliery officials are not those who have merely studied enough to secure certificates. They are those who keep on studying both books and the works of others. They do not expect to learn all from their own narrow experiences, and seek to profit by the experiences of others. The old saying, that "experience is a good teacher," is a true one, but it is not true of our individual experience only. We can learn more from the experience of others working in the same line as ourselves because there are more workers, and therefore more experiences to study. All that the student who is preparing himself for examination learns from books is the experience of others who have gone before, and with the advantage of their experience, and his own, he will be well equipped for his work. The mere possession of a State certificate of competency does not fit a man for successful mine management. There are other qualifications necessary, and without them no man can secure a position, or if he does, he will not hold it long. But this can be truthfully said: Every man of good habits and good judgment, who possesses the faculty of handling men, and who does not cease his studies, and observations, will eventually reach the desired goal, and be a success.

Some time ago we received the following letter from a subscriber in the Wyoming Valley: "Please stop my COLLIERY ENGINEER; I don't need it no more as I past the last examination." This man is not likely to be employed as a mine foreman. He has made the mistake of considering his mining education completed, when it has only commenced.

COMMENT AND NOTICE.

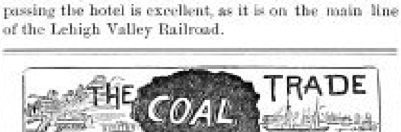
THE statement is frequently made that the use of safety-lamps is injurious to the eyes of the miners though till recently no corroborative evidence accompanied the statement. However, the matter has been practically tested in Great Britain, by Dr. J. Court, of Stavely, who investigated the matter on behalf of the Derbyshire miners, and his examination of a number of miners working with safety-lamps and an equal number using naked lights will throw considerable light upon the question. As nearly one-half the coal raised in the Midland district is worked by the use of safety-lamps, Dr. Court undertook to see 500 persons using the former and 500 using the latter. The examinations show that out of 524 persons using safety-lamps there were 164 afflicted with nystagmus, 127 had night blindness, and 61 photophobia. This clearly proves that there is a serious amount of disease, and in striking contrast with the disease found amongst the 573 miners using naked light, of whom only 32 had nystagmus, 1 had photophobia, and 12 night blindness. This difference is made greater still when it is borne in mind that out of these 32 cases of nystagmus 29 of the men had previously used safety-lamps, and the one man with photophobia and 11 of the cases of night blindness had also been employed in mines worked with the safety-lamps. In other words, of the 544 men who had always used naked lights, there were only 3 who had nystagmus, and they worked with candles. Amongst the torch-light men, 228 in number, there was not a single case. Dr. Court is of opinion that the insufficient light of the safety-lamps is the chief, if not the sole, cause of nystagmus, night blindness, and photophobia.

AT a recent meeting of the Lancashire Branch of the National Association of Colliery Managers, the chairman, Mr. J. H. Tonge, of Hulton Collieries, read an interesting paper on the effect of varying atmospheric pressures on gases in coal mines. He said, considering the effect of varying atmospheric pressure in mines, there appeared to be a divergence of opinion amongst mining engineers, and others whose attention had been directed to the subject, as to the different effects in a mine generating gas of a rising or falling barometer. Numerous experiments tended to prove that gas in the strata existed under very varying pressure. He thought they might, from experiments and from sudden outbursts with which most colliery managers were familiar, assume that this outward pressure of the gas depended almost entirely upon the nature of the strata. But what they had really to fear, when gas existed in the strata—was the removal of strata—be it coal, shale, mineral rock, or whatever might have formed the barrier—at a moment when some defective or open lamp stood directly in the path of the liberated gas. Under such circumstances the volumes of gas rushed forth at such a rate that it effectually refused to allow the pure air to mix with it. He would feel safe in saying it was probable that gas existed in the goaves of many collieries to such an extent that a sudden lowering of the barometer would mean an explosion unless—and this he thought a point well worthy of attention—the liberated gas could get to the upcast shaft without coming in contact with a naked light. He further believed that gas might exist in any of the mines—and did actually exist in some—under such conditions that nothing but the strict exclusion of naked lights from its path, nothing but the most perfect system of lighting, could ensure safety. The official who neglected or treated this question lightly deserved the severest censure; he who could improve and perfect their lighting system would deserve well of his country.

IT probably does not occur to the average reader of a technical paper that the expenses incident to its publication are much greater than those of ordinary newspapers, though the subscription price is less. If the leading technical papers of the country had only such an income as is derived from subscribers they would either degenerate into insignificance or cease publication. It is the advertising patronage that makes such journals profitable, and enables the publishers to furnish first class literature to their subscribers, by employing first-class talent. We are constantly receiving letters from all parts of the country commending and extolling this journal. These are very pleasant evidences that our efforts to make THE COLLIERY ENGINEER the leading mining journal of the world are appreciated. However, our friends can show their appreciation in another way, and a more effective one. Every advertiser in the journal, through his patronage, not only brings his goods to your attention, but he assists in building up the standard of the journal. Therefore, as long as his goods are as cheap and as of good or better quality than others he should have your patronage, and you should, when sending him either inquiries or orders, mention the fact that you saw his advertisement in THE COLLIERY ENGINEER. All our advertisers are substantial firms and are the leading firms in their li es in the country, and they are entitled to your patronage.

WE have received from Mr. Morgan G. Thomas, Inspector of the Third Mining District, of Iowa, advance sheets of his annual report, in which he very strongly sets forth the necessity of a geological survey of the State. Mr. Thomas shows in an intelligent manner the advantages that will accrue to all classes of the States' population by having the mineral resources of the State intelligently examined into and reported on. The coal resources of Iowa, alone, are far greater than many of its citizens know, and if the citizens of the State, who are most interested in its welfare, have no knowledge of the extent of their most plenteous mineral, capital and enterprise from other States can not be attracted, because strangers can not be expected to be familiar with conditions that are not known to the residents of the State. The same truth will apply to other minerals, and Mr. Thomas should have the support of every intelligent citizen of the State in his efforts to have a geological survey started and maintained. Another excellent suggestion that he makes in his report is the establishment of State mining schools. Iowa's mining interests are being rapidly developed, and they should be developed intelligently. The only way this can be done is by the application of skill and intelligence as well as brute force. The miners themselves cannot afford to maintain such schools, but the State can, and the State will profit by establishing them. More coal is lost by unskilled working each year in Iowa than would pay for the maintenance of a dozen such schools. As this coal represents a large portion of the States' wealth, it is evident that it will profit by the establishment of free mining schools as suggested by Mr. Thomas.

THE Fall Meeting of the American Institute of Mining Engineers will be held at Glen Summit, Luzerne Co., Pa., beginning October 6th. Aside from the regular attractions, both scientific and social, that render the meetings particularly enjoyable, the happy selection of beautiful Glen Summit, with its excellent hotel accommodations, will make this meeting particularly enjoyable. Glen Summit is on the top of the Wilkes-Barre Mountains. It overlooks the beautiful Wyoming Valley on one side, and on the other sides the wild mountain scenery is unsurpassed in America. At the time of the meeting the foliage will be very beautiful, and will vary in tints from the dark green of the massive evergreens to the brilliant scarlet and yellow of the maples and other varieties of mountain trees. The Glen Summit Hotel is one of the largest and most popular summer hotels in the country, and the natural attractions surrounding it are equal to those of any mountain resort in America. Its location is particularly convenient to Scranton, Wilkes-Barre, and all other points of interest in the Wyoming and Lackawanna Valleys, on one side, and to the principal points in the Lehigh region on the other side. The train service, passing the hotel is excellent, as it is on the main line of the Lehigh Valley Railroad.



THE ANTHRACITE TRADE.

Mr. C. D. Simpson Proposes Control of the Trade Which Will Control.

The Anthracite coal trade is very quiet, but prospects are very favorable for a good fall trade. The sales-agents of the large companies met on the 29th ult., and agreed to limit the tonnage for August to 3,000,000 tons, and there is good reason to believe that the coal producing interests will this month use every effort to keep the production down to these figures. In pursuance of this plan, the Philadelphia & Reading Coal and Iron Co. suspended operations at all its collieries on the 6th and 7th, and it will carry out this programme of shutting down on the last two days of the week until the market is in satisfactory shape. The other large companies will also do their share. The production for the week ending August 8th was 728,654 tons, and for the year to that date was 22,557,095 tons, an increase over last year to the same date of 2,860,200 tons. The determined effort at restriction which will now be made is a necessary one. But some method should be adopted to regulate the business. Mr. C. D. Simpson, of the firm of Simpson & Watkins, of this city, in a recent communication to *The Coal Trade Journal*, shows the great necessity for this and makes practical suggestions as follows:

"I have no faith in the theory that lower prices for hard coal would broaden the market enough to give us full time work at profitable prices, for within certain narrow limits I think that the consumption demand is definable, subject of course to such an advantage (advantage to Anthracite) as the coke strike which probably added something under a million tons to the demand this year. So even if tolls to tide-water were made $1, we should still need restriction during the first six months of the year. Of course a joint commission having charge not only of all coal mined but of routes and prices, would be of incalculable benefit to the whole trade, but such a radical change in methods is yet out of the question, the discussion should be confined to some simple plan at the start.

Even under our present theory each transportation interest knows its allotment whatever the gross tonnage for the year may be; why then should there be overproduction and forced sales early in the season? Can there be a feeling that prices are likely to decline later on? We know that dealers hesitate to buy at early spring prices having been taught by experience that prices are often if not usually lower in July and August than in April and May. Here then I put our first radical mistake. The matter should be arranged as practically to guarantee to buyers that spring prices would be the lowest of the season. If this were well understood large orders would be received early, mining, selling and transporting of coal would be more evenly distributed throughout the year, and the amount of coal now requiring expensive storage but then taken care of by dealers, would surprise all of us. But why is this not done now? I have talked with many in the trade and while individually they all agree on the main points, collectively they seem helpless, although something of this kind has been worked at since 1886. The simple thing to do as a remedy is to see that spring prices are actually *the lowest of the season and that these will gradually be advanced.* The sales-agents now spend part of their time in accusing each other of cutting prices. I suggest the employment of a clear-headed, honest, dignified man, not interested in mining but familiar with the trade, who shall make the allotment for each week's mining, after advising with representatives of each interest; this man's advice to be strictly followed. He would by means of his position be in touch with the whole trade and the best judge of the general situation. While I think there would be little occasion for such a thing, he might in addition investigate charges of price cutting so far as the interests of the trade at large might require it. *Agreement on tonnage* is the main point I would insist upon; agreement on price is secondary and might indeed be omitted altogether, if the former be lived up to. Supply and demand govern prices; we cannot get from under this law of all commerce, if we would. So if we take care of the spring prices by sufficient restriction, the later prices will take care of themselves."

Mr. Simpson in stating the Anthracite coal trade will prove most profitable when conducted on the principle of securing fair prices instead of relying for profits on a larger output secured by a policy of encouraging consumption with very low prices is not mere supposition. In the years 1877 and 1879 there was unlimited production and competition. Although the cost of mining coal those years, owing to the large production, was very considerably reduced, yet the prices fell off in far greater ratio, and the losses of all interested were so great that the companies gladly settled their differences and returned to the policy of restriction. Mr. Simpson is not theorizing. He is stating the results of experience. It has been proven that the capacity to produce Anthracite coal is greater than the markets can be made to absorb even when prices are so low as not to repay the cost of mining and transportation and that the trade can only be profitably conducted with restriction.

The trade is now supposed to be directed and managed but, it is so poorly controlled that buyers are not protected in the regulation of prices. Mr. Simpson calls attention to the greatest difficulty when he states that "dealers hesitate to buy at early spring prices having been taught by experience that prices are often if not usually lower in July and August than in April and May." His suggestion that matters be so arranged as to guarantee to buyers that spring prices will be the lowest of the season is eminently practical. In order to do this it will be necessary to have the whole trade in such control as to be able to regulate the output at beyond peradventure. This will require the strengthening of the arrangement among the coal companies by which the trade is now unsuccessfully regulated. The suggestions of Mr. Simpson's letter should receive the careful consideration of all interested in the business since there is not likely to be much money in mining Anthracite coal until they are carried into effect.

The Bituminous Trade.

The Bituminous coal trade is dull. Large quantities are being mined and shipped to markets to fill old yearly contracts. There is but little new business being done, but prices are fairly good. Consumers, as a rule, have large stocks on hand, having taken advantage of the low water freights that have prevailed for some time, not only on the coast but on the lakes as well. As a rule, harmony prevails in all regions, and there are no serious labor troubles to record in any of the American coal fields.

The Coke Trade.

The coke trade is quiet and prices still continue low. But 75% of the ovens in the Connellsville region were in blast during the past month, and production at these was restricted by running but four or five days a week. The *Connellsville Courier*, in its issue of the 7th inst., quotes prices as follows: furnace coke, $1.90; foundry coke, $2.30; crushed coke, $2.65; all f. o. b. cars at ovens, per ton of 2,000 lbs.

The new metal "Perfection Bronze," manufactured by the Eastwood Mfg. Co., of Belleville, N. J., has been proven by practical tests in the highly acidulated mine water of the Anthracite regions to be practically indestructible, and it is bound to become the favorite metal for pump rods, pump barrels, valves, etc., etc. The company manufacturing it is prepared to furnish it either in bulk or castings as desired, and we recommend those of our readers who are having trouble with their pumps or other machinery to correspond with the Eastwood Co.

ANTHRACITE COAL STATISTICS.

Statement of Anthracite coal shipments, for month of June, 1891, compared with same period last year. Compiled from returns furnished by the Mine Operators, by John H. Jones, Chief of Bureau of Anthracite Coal Statistics.

	June 1891.	June 1890.	Difference.		For Year 1891.	For Year 1890.	Difference.	
From Wyoming Region, - -	2,104,063·00	1,808,708·10	Inc.	295,354·10	9,584,252·11	7,855,732·00	Inc.	1,728,520·11
From Lehigh Region, - - -	584,100·03	571,199·06	Inc.	12,900·17	2,903,721·13	2,930,615·10	Dec.	26,893·17
From Schuylkill Region, - -	1,092,079·00	1,065,654·12	Inc.	26,424·08	5,477,119·07	4,579,605·08	Inc.	897,513·19
Total - - - - - - -	3,780,242·03	3,445,562·08	Inc.	334,679·15	17,965,093·11	15,365,952·18	Inc.	2,599,140·13

The stock of coal on hand at tide-water shipping points, June 30, 1891, was 678,144 tons; on May 31st, 1891, 692,874 tons; decrease, 14,730 tons.

CERTIFICATED MINE OFFICERS IN ILLINOIS.

The Law Recently Enacted Requiring Mine Foremen to Have Certificates of Competency.

An Act to provide for the Examination of mine managers, and to regulate their employment.

SECTION 1. *Be it enacted by the People of the State of Illinois, represented in the General Assembly*: That in order to secure greater efficiency in the management of coal mines, and a higher standard of qualifications in those who have immediate responsibility for the health and safety of persons employed in coal mines, it shall be unlawful, except as hereinafter provided, after the first day of January, 1892, for any person to assume or attempt to discharge the duties of mine manager, at any coal mine equipped for shipping coal by rail or water, or any mine whose output may be twenty-five or more tons per day, unless he shall hold such a certificate as to his qualification for that position as may be required by this act from the State Board of Mine Examiners: *Provided*, that the term mine manager is here intended to mean any person who is charged with the general direction of the underground work, or of both the underground and top work, of any coal mine, and who is commonly known and designated as mine boss, or foreman, or pit boss.

SEC. 2. The certificates provided for in the first section of this act may be either certificates of competency or certificates of service, and any person may acquire such certificate by appearing before the State Board of Examiners appointed by the commissioners of labor for the examination and inspection of mines, and submitting to such an examination as to his competency, or length of service, as may be prescribed by this act and the said examiners.

SEC. 3. Meetings of said boards shall be held at such times and places, and shall be conducted under such rules, conditions, and regulations as the members of said Boards may deemmost efficient for carrying into effect the spirit and intent of this act. Said Board shall, after each of its several meetings, make report of its action and of its term of service to the State Commissioners of Labor, and the sum of three dollars a day and traveling expenses for each day devoted to the service required by this act, which shall not exceed eighty days in all during any one year, shall be paid to each of the members of said board upon vouchers sworn to by them and approved by the Governor, and the Auditor of Public Accounts is hereby authorized to draw his warrant on the Treasurer, payable out of any money in the treasury not otherwise appropriated, in favor of the said members of the Board of Examiners for the amounts thus shown to be due them.

SEC. 4. Certificates of qualification or competency shall be conferred upon any citizen of the United States who shall submit to and satisfactorily pass such an examination as to his fitness for the duties and responsibilities of mine managers as said examiners shall provide; and certificates of service shall be conferred upon any citizen of the United States who shall present satisfactory evidence of having had at least four years' practical experience in coal mines, and of having served as mine manager continuously and satisfactorily, and for the same person or firm, for one year next preceding the passage of this act, but the holder of such certificate shall not be eligible to employment by any other person or firm until he shall also have obtained a certificate of competency upon examination. The certificates herein provided for shall be issued by the State Board of Examiners, and be registered in the office of the Commissioners of Labor at the capitol, where a record of all certificates issued shall be kept. Such certificates shall contain the full name, age, and place of birth of the recipient, and also the length and nature of his previous service in and about coal mines. All applicants for the certificates herein provided for shall, before being examined, pay to the Board the sum of one dollar each, and those who receive certificates shall pay an additional sum of two dollars each, all of which fees shall be accounted for and covered into the State treasury.

SEC. 5. After January 1, 1892, no owner, operator, or agent of any mine to which this act applies shall employ any mine manager who does not hold either the certificate of competency or service herein provided for, and if any accident shall occur in any mine in which a mine manager shall be employed who has no certificate of competency or service as required by this act, by which any miner shall be killed or injured, he or his heirs shall have right of action against such operator, owner, or agent, and shall recover the full value of the damages sustained: *Provided*, that in case no suitable or satisfactory certified mine manager can be obtained by any operator at the date herein specified, such operator may place any competent man in temporary charge of his mine to act as mine manager until such time as a suitable certified manager may be found: *Provided*, that the time be not more than three months from the date aforesaid. The said Board of Examiners shall be furnished by the Secretary of State with the necessary blanks, blank books, and stationery. Any violations of the provisions of this act shall be deemed a misdemeanor and be punished accordingly.

Approved June 18, 1891.

Mine Inspectors' Examination.

An examination for two Inspectors was held at Wilkes-Barre, Pa., during the week commencing August 3d, by the following Board of Examiners: Chairman, John B. Law, C. E., Pittston, Pa., L. O. Emmerich, C. E., Hazleton, Pa., Geo. Frye, Dunmore, Pa., Martin McCormick, Dunmore, Pa., and Lewis Harris, Wilkes-Barre, Pa. Mr. Andrew Bryden, of Pittston, Pa., was appointed Secretary by the Board. The positions to be filled were caused by the expiration of the term of Patrick Blewitt, and that created by the division of Mr. Blewitt's, or the First district, with the addition of several collieries from the Second district.

There were fourteen applicants, as follows: Anthony J. Gallagher, Wilkes-Barre; Patrick Blewitt, Scranton; Wm. E. Howell, Plymouth; Thomas Prothetoe, Dunmore; John T. McDonald, Forty Fort; Wm. H. Hoskins, Wilkes-Barre; Jenkin T. Reese, Scranton; Edward Roderick, Stockton; D. O. Pritchard, Nanticoke; Thomas S. Morgan, Scranton; E. W. Scharar, Scranton; Alexander Aikman, Scranton; David E. Jones, Glen Lyon; Anthony Ferd, Pittston.

Complimentary Banquet to Ex-Inspector King.

Mr. Austin King, who resigned the inspectorship of the Eighth Bituminous District of Pennsylvania, to accept the superintendency of the Leisenring No. 3 Shaft and coke plant of the H. C. Frick Coke Company, was tendered a banquet at the Passmore House, Philipsburg, Pa., on the evening of July 30th, by a number of the miners of his district. The occasion was a most enjoyable one and the speeches made were the sincere expressions of the good will of the miners of Mr. King's district. During the course of the evening Mr. R. A. Kinsloe, editor of *The Wage-Earner's Journal*, presented Mr. King, on behalf of the company assembled, the following address, which was handsomely printed on white satin:

AN ADDRESS TO AUSTIN KING,

LATE MINE INSPECTOR OF THE EIGHTH BITUMINOUS COAL DISTRICT OF PENNSYLVANIA, MADE AT A BANQUET GIVEN IN HIS HONOR, IN PHILIPSBURG, JULY 30, 1891, BY A NUMBER OF HIS APPRECIATIVE FRIENDS AMONG THE MINERS.

SIR:—You are this evening the guest of only a few of the thousands of miners, as well as others, who, had the opportunity been extended them, would have been present and given personal endorsement to the sentiments contained in this address. It is sometimes, and by some persons, held that to give the meed of praise to a deserving official or public servant is unnecessary, if not out of place, because the faithful official or public servant is self-satisfied with the consciousness of having performed his duty, and having done only his duty, no more or no less, is entitled to nothing further, except the material reward such service brings. That is, possibly, true from the standpoint of one who, seeking to know his duty, performs it without fear, favor, or affection, yet hardly true from the standpoint of those who have been the beneficiaries of his services. Your friends, gathered on this occasion, Mr. King, believe most heartily that in doing your duty, in accordance with your understanding of the several provisions of a not-at-all onerous law, are entitled to carry away with you some token of their esteem and appreciation for your uniform course in insisting that the law should be obeyed, no matter whether it affected this or that operator, or this or that boss, or this or that miner. In the performance of your various duties—no doubt often unpleasant—you were no respector of persons, and that you were not able in each instance to better the conditions under which the miners worked, was much more the fault of a weak and ambiguously-worded law than it was any shortcoming of yours. Had the law been more guardedly worded, the improvements—great and many as they have been—comparatively speaking, would have been more pronounced and more numerous. In the matter of air, alone, there is hardly a mine in which an improvement has not taken place under your administration, and on account of your watchfulness; and in the matter of accidents, that these have not been less frequent is largely owing to the persistence with which many miners disobeyed your very plain orders. For the miners to fail to make some public acknowledgement of the good things you have done for them, and indirectly for the operators, would, whatever you may say or think about, be a failure on our part to give you that encouragement for further faithfulness to which the conscientious workman in every sphere is entitled, as well as an encouragement to the others who may come after you, to acquit themselves as you have acquitted yourself—not to say this much would be a failure on our part to show the measure of appreciation that is due from us as a recognition of merit and worth wherever the same may be found. In the new field of labor to which you have been called, while we, here, feel and express our regret at your departure, we desire to offer you our best wishes for your success, feeling assured that in whatever field you may labor, the reward that always follows able, honest, and conscientious discharge of duty, together with genial, courteous intercourse with those whom you work, will be yours.

A Few Words About Painting.

There is a class of oils which, when thinly spread, in contact with the air undergo a certain chemical change called "drying." Linseed oil has this "drying" property in a high degree; hence its value in the preparation of oil paints. The drying property of the oil is increased by the addition of what are called "dryers;" they enable the oil to become more quickly converted into a tough, elastic solid. Too much dryer causes the paint to peel or blister. Paint properly spread should be in a thin layer, as the paint begins to dry first at the surface. Paint laid on by an unpracticed hand may require weeks to dry, whereas, if the coat had been properly applied, it would have dried in eight or ten hours. Paint too heavily laid on will show the want of skill in the hand that applied it by its "pitted" and wrinkled appearance.

The amount of paint required to cover a given surface will vary with the temperature at which it is applied, and will also be modified by the nature and character of the surface to be covered, and whether the surfaces are horizontal or vertical. Lastly, all other conditions being the same, the amount of paint required to cover any given surface will vary with the skill of the hand that applies the paint. This has been most strikingly illustrated in a large number of tests that we have caused to be made in order to determine the spreading power of Dixon's Graphite Paint, manufactured by the Jos. Dixon Crucible Co., Jersey City, N. J., in comparison with the lead and mineral paints. Innumerable tests, made by painters who have had no self interest in the matter whatever, have shown that when used side by side, and under conditions similar in every way, Dixon's Graphite Paint will cover three times more surface than any lead paint, and from two to three times more surface than any "mineral" or "metallic" paint. Twenty years' experience has demonstrated beyond question that a tin roof, well painted with Dixon's Graphite paint will not require repainting in ten to fifteen years. This makes it the most economical paint now in the market.

Lightning Enters a Mine.

Mr. M. W. Jenkins, of Sharon, Pa., who recently accepted the position of superintendent and mine foreman of the H. K. Wick Coal Mine, at Chestnut Ridge, Pa., had a singular experience with lightning during a storm on July 14th. Mr. Jenkins and Mr. McKnight were in the mine during some surveying, there being no miners at work. The former had his instrument in the center of the track while the latter was a short distance from him. They heard it thunder and knew there was a storm above. Suddenly a ball of fire came rolling along the rails, and when near Mr. Jenkins it jumped from the rail and exploded with a loud report, the fire going in every direction, a spark striking his right hand which benumbed the whole arm. Mr. McKnight had been standing with one heel near or against the rail, from which he received a severe shock. At the time the men were fifty feet under ground and two hundred feet from the shaft. On ascending they found that the engine house had been struck, and the engineer, Mr. Kennedy, stunned. Mr. Kennedy stated that when he rallied from the shock, which he thought was within two or three minutes, he found some clothing that had been hanging on the wall burned and the boards on fire, which he extinguished with a bucket of water.

The Evening Chronicle, that very lively Pottsville paper, is authority for the statement that Inspectors McMurtrie, of Ashland; Stein, of Shenandoah, and Gay, of Pottsville, held their regular weekly meeting at the latter city on Saturday. The boys are in the habit of meeting around and having confabs, and the statement would not attract unusual attention were it not for the fact that the receipt of the Shaw machines is given as the subject under discussion. "The machine is not to be taken into the mines," continues *The Chronicle*, "it remains in the office of the mine inspector. This official gathers the gas by means of rubber bags, which have a pumping apparatus attached." Such being the case, we don't wonder the inspectors met and talked it over. *The Black Diamond* knows these gentlemen very well. They are all three great, broad-shouldered, noble-hearted men, capable of lifting a baby with infinite tenderness or resenting an insult with ferocious severity; but when it comes to carrying bags of gas around the country the subject certainly requires careful consideration on their part. Oh! for another excursion! one of the features of which shall be a procession of mine inspectors, each with a well filled gas-bag. Oh! for a glimpse of the expression on Inspector Gay's face when he brings home his first charge.—*Black Diamond.*

BOOK REVIEW.

ELECTRIC TRANSMISSION HAND-BOOK, by F. B. Badt, Chicago, Electrician Publishing Co. This little book belongs to the Hand-Book series, which, owing to convenient shape and condensation of matter has been so favorably received during the past few years. Prof. Badt, the author, is a practical electrician and before locating in America was a First Lieutenant in the Royal Prussian artillery. He has made electricity a life study, and his *Electric Transmission Hand-Book* is a valuable contribution to technical literature. It is just such a book as has been needed by electrical students and all persons interested either directly or indirectly in the subject of electrical transmission of power, and we predict for it a large sale. It is neatly bound in cloth and sells at the reasonable price of one dollar. Orders will be promptly filled by THE COLLIERY ENGINEER CO.

HANDY LIST OF BOOKS ON MINES AND MINING.—A Reference Catalogue by H. E. Haferkorn. Milwaukee, H. E. Haferkorn; London, Gay and Bird. This is a convenient publication embracing an alphabetical reference catalogue, arranged under authors and subjects, and including analytical references to the contents of important works, together with a list of periodicals and annuals devoted to mines and mining. It is a reference book that will be found of great value to all persons interested in mining literature, as it contains a complete list, up to date, of all works on any branch of mining.

We have also received the following publications, which we are compelled to notice by title only:

U. S. COAST AND GEODETIC SURVEY.—Report 1889; Journal and Proceedings of The Royal Society of New South Wales; Proceedings of the U. S. Naval Institute, Volume XVII; School of Mines Quarterly, Columbia College, N. Y., April 1891; The Journal of the Franklin Institute, July 1891; Annals des Ponts et Chaussees, Paris, January to June, 1891, and Personnel 1891; Norsk Teknisk Tidsskrift, Kristiania, de Argang, 1 *ste* Hefte and 2 *det* Hefte; Foldtani Kozlony, Budapest, January to May 1891; Twenty-seventh Report of the Oberhessischen Gesellschaft fur Natur und Heilkunde; Bulletin de la Societe Scientifique Industrielle de Marseille; Journal of the Royal Institution, of Cornwall, Volume X, Parts 1 and 2; Proceedings of the Cleveland (England) Institution of Engineers, Session 1890-1891, No. 6; Journal of the British Society of Mining Students, Vol. XIII, No. 5; Transactions of The Mining Institute of Scotland, Vol. XIII, Part 1; Transactions of the American Institute of Electrical Engineers, June and July, 1891; Transactions of the Institution of Engineers and Shipbuilders in Scotland; Bulletin de la Societe Industrielle du Nord de la France.

MINING AS IT WAS,

As it is Now, and as It Ought to Be.

BY WM. GILLIE.

(Transactions of the Western Pennsylvania Central Mining Institute).

It is not the object of this paper to treat of the ancient history of mining, for I presume you are already acquainted with the rude appliances that were adopted for getting the mineral from the mines and the methods adopted of ventilating and lighting them.

But the reader of such history will no doubt be surprised as he reviews the primitive appliances that were brought forth from time to time, to meet the various difficulties that were ever presenting themselves before the pioneers of this great industry of coal mining.

Each of these innovations were brought forth by a brighter and clearer mind than that of his fellows, but the conservative spirit of the miner exerted itself then the same as it does now. So that it required no small amount of persuasive force in order to introduce any new method or appliance that would be of any practical benefit to them.

When mines became dangerous, and could no longer be worked on account of fire-damp being generated, a premium was offered to the miner that could work best in the dark, after which the weak phosphorescent light of fish skins, or the small intermittent spark of the steel mill was given them to overcome the difficulty, but these all failed to accomplish the purpose, and only added misery to the dangers that they were already surrounded with. Explosion followed explosion until Sir Humphrey Davy's attention was called to the matter and his aid solicited in order to prevent the great sacrifice of human life and destruction of property. He came to the rescue and conquered, for by his invention thousands of acres of coal were worked that could not have been operated and hundreds of lives have been saved by the use of the safety-lamp in gaseous mines. Various lamps have been presented to the mining world, each inventor claiming that his lamp possesses advantages that none other possesses, and that he has brought about the millennial dawn as far as the lighting of mines and the safety of the miner is concerned; but all these improvements of the safety-lamp are based on the principles of the Davy. When this great philosopher wrote to a friend on this subject, he said: "I never received so much pleasure from the result of any other of my chemical labors, for I trust the cause of humanity will gain something by it." The same conservative nature that possessed our predecessors in the art of mining, seems to be hereditary, for the miners, and officials now in the profession, seem to stick tenaciously to the old forms and customs of our forefathers. Certainly we have made great improvement of late years, and especially since the introduction of the present mining law; and notwithstanding the very serious accidents that have taken place of late, I don't hesitate in saying that the miners are more intelligent and a better class of managers and officers exist at our mines than there did a few years ago. The mines are better looked after and in a better sanitary condition than they once were, yet there is room for improvement and we ought not to be slow to take advantage of it. We should not foster and cherish any pet theory or system if a better can be adopted.

There is one particular point that I will try to bring out in this paper, and will be glad to hear the opinions of the gentlemen present on the subject, and that is the present system of ventilation, as is carried on in very many of the mines in working operation in Western Pennsylvania.

The system that I refer to is the wheel system, or of coursing the air from one end of the mine to the other, in one volume and in one continuous route. By this system the noxious gases are collected in the course and are passed from room to room and from the first miner to the man in the last working place, and how often have you heard the remark and seen the wan face that was once flushed with the vigor of health appealing for a room in the first of the air, because his system was wrecked, his constitution was weakened, and he was no longer able to fight and overcome the deadly poisonous gases that were passed on to him when he had to labor where he received the last of the air under this obnoxious system.

Another point in connection with the laying out of the mine is the driving the butt headings or entries so far without breaking off the face entries again. I think it would be much better if the mine was laid off in districts or sections, each district being separate and distinct from the succeeding district, a solid rib or pillar being left in between them, the breadth of such pillar depending on the character of the coal and the nature of the overlying strata. By this method of working, the mine will be better adapted for splitting the air current and giving to each district or section fresh air direct from the intake. Less trap-doors would be required and the continual danger and expense of attending and maintaining such doors would be considerably reduced. For who has not heard the remark after an accident had occurred that such a door had been left open by the carelessness of some employe of the mine, or where is the manager or official who has charge of a mine that is generating fire-damp whose heart has not been filled with awe, and consternation, when he thought of the possibility of a main door being left open, and the air current diverted from its course. Whereas if cross-overs or air-crossings were used wherever practical and possible, these dangers would be obviated, the expense would be lessened, and the position of the manager would be made more comfortable than it is at present in such a mine as I have described.

In addition to giving each district of the mine pure air and the other advantages that I have already named, we would get a greater quantity of air than we have at present with the same pressure and with the same amount of power expended, or if we have already sufficient air by the present system of ventilation, less power will be required when the air is split to produce that quantity. If gas is generated by this system of working and ventilation it can be confined to that district where it is being given off and handled with much more efficiency than at present, and should an accident occur (which may under the ablest management, and under the best conditions) the force would be expended in a great measure upon the district where it took place, and as a result the loss of life would not be so great, and the destruction of property considerably lessened. Instead of the dangerous gases being swept around from one place to another, increasing in volume and in force, they can by proper management be carried direct to the return airway where no naked lights ought to be. When I think of this subject I am surprised that it is not more generally adopted, for its simplicity and for its many practical advantages over the coursing system of ventilation. I do not wish you to infer that this is any new system, or that I claim to be the originator of such a method, for air-crossings were used 60 years ago, and a knowledge of splitting the air was known to a few at that time. Pillars and ribs can be extracted much safer, where the air current is divided, for a separate split can be put on to such ribs or a current can be brought after it has done its work in ventilating the rooms in a district and made to circulate through the pillars; but on no account should air after it has passed over a gob, or a place where ribs are drawn, be made to circulate through a district where the men work with naked lights and where the new workings are in operation. For it may become charged with gas and catch by the light of a miner or of a driver as he passes along, not thinking of the danger or of the result should such an accident take place.

Or what advantage is it in giving the men that are working the pillars, and drawing the ribs, safety-lamps, if we allow the foul air to pass directly on to some other place where a naked light is in use? There is nothing practical about it, nor is it safe to adopt such a course as the most of you know. I am rather inclined to think that many who hold certificates of competency to-day, had they ventilated their mine plans in such a manner before the examining Board would have been found wanting. If such knowledge is necessary to satisfy an examining board surely its practical application is necessary to protect life and property.

Old workings can be kept comparatively clear of gas by coursing the air through them as it passes to the upcast, after it has done its work in the interior of the mine, or a fresh current of air can be admitted in order to prevent such places from becoming a pent-up magazine, which only needs a fall over a large area, or a reduction in the pressure of the atmosphere to force it out, and foul the main roads and traveling ways.

Another thing necessary to make mining as it ought to be—safe, healthy, and pleasant—is to remove the dangers as far as practicable. Coal-dust is one of these dangers, at least we believe it to be, and think our knowledge is not without foundation, for this subject has produced surprise, and startled us from time to time, for now and then an explosion takes place, resulting either in loss of life or destruction to property, and can only be accounted for by the ignition of coal-dust. The law by which this danger arises is that if the small particles of a combustible substance, such as coal-dust, are scattered diffusively in a volume of air, and if the proportion of air and dust are such, that the oxygen can burn up the dust, and produce a volume of flame equal to the space occupied by the dust and air then an explosion will ensue if the air contains a very small percentage of gas. In kindling a fire it will be observed that the sticks burn freely when the interspaces are such that air can freely circulate through them, so with coal-dust, it is coal in a fine state of division, each particle presenting a comparatively large surface to the air and is therefore easily burnt.

Therefore let us try to remove this cause and the direful effect will cease. Mining as it ought to be needs close att-ntion by men of keen intellect, quick judgment, and possessing a disciplined and well-trained mind. Not to be trying this plan to see how it works, and adopting that to ascertain how it pans out, but to weigh the facts in the particular case and when once your inference has been drawn, be firm in your decision and act on it. And as we heard at our last meeting that discipline is an important element to make a successful manager, it is just as essential to make mining what it ought to be. While you are firm and decided, be kind and ready to impart that knowledge which you possess.

If a miner asks why it is necessary to fence off a place where gas has suddenly made its appearance do not deceive him by telling him there is nothing in there to do any damage, but rather tell him what is there, and the properties of such a gas, and the consequence of it becoming ignited, strive to stir a spirit of emulation among your employes to become conversant with the properties of the gases and the laws that govern the ventilation of mines; by so doing a better state of things will exist, fewer accidents will take place, and then we will have the science of mining placed on an elevated platform where it ought to be.

Electric Mining Machinery.

On our advertising pages is announced the formation of a new corporation under the title, H. Ward Leonard & Co., whose principal office will be in New York City, and whose business will be that of Electrical Engineering generally, with special attention paid to electrical motor appliances, the transmission of power, the installation of Central Station lighting and power plants, the concealed wiring of large office buildings, hotels, etc., and plants in which advantages can be obtained by a combination of apparatus of various companies, such as alternating current systems, storage batteries, arc lights, etc.

A feature of the business of this concern which is entirely novel, will be the supplying of expert information regarding engineering matters, the operation of different plants and upon the best methods and system of accounts in connection with the operation of electrical plants. Such information will be supplied by correspondence at a very moderate charge per annum.

This Company will be actively in business before September 1st. Their offices will probably be in the Columbia Building, No. 29 Broadway, New York City.

Bittenbender's Improved Mine Drills.

Owing to the great capital employed in coal mining in the United States and particularly in Pennsylvania competition has been sharp, and consequently inventive genius has been very active in producing labor-saving machinery and devices to lessen the cost of production. Naturally enough, the mine owners were first to seek the advantages which labor-saving devices offered, and having the capital to buy whatever was of practical value, inventors, as a rule, naturally concentrated their efforts on producing machinery that would commend itself to them, and but little attention was paid to inventions that would tend to lessen the labor and make work easier for the miner. In fact up to a very recent date nothing better than the long heavy iron bar with a steel bit was in use for hand drilling, and many of these cumbersome and inconvenient tools are still in use. But they will soon be superseded by the drilling machines, which, though costing but little more, render the work of the miner much easier and enables him to accomplish much more work per day. For about six years, Mr. Fred. T. Bittenbender, of Nanticoke, Pa., was employed as an engineer at a coal mine, and he paid particular attention to the methods in vogue among the miners at their daily work. The old method of drilling with the old bar drill struck him as slow and laborious, and he at once set his inventive genius and practical mechanical skill to work to endeavor to prodsce a tool that would be more practicable and lessen the labor. The result was the invention of the "Improved Coal and Rock Mining Drill," a machine which will drill five or six holes with the expenditure of less labor and time, than will be expended in drilling one hole by the old method.

The miners were quick to appreciate the invention and the demand for them became so great that Mr. Bittenbender decided to give up his position as engineer and engage actively in the manufacture of his drills. This was about six years ago, and the little blacksmith shop which then constituted his "factory," has now grown into a building 110 ft. long by 30 ft. wide, supplied with engines and machinery capable of turning out over 200 drills per month, and as the demand is continually increasing further enlargements must soon be made.

The "Improved Drill" is bound to become very popular, owing to the superior advantages it possesses. It is cheap, simple, durable, and easy to operate. Every machine that leaves the shop is accompanied by a written guarantee against destruction within three months, and as a matter of fact, Mr. Bittenbender states that they have had to repair scarcely any of the drills within the past three years. With such a record it is easy to see how this drill has made its own reputation, and when it is understood that the trade is not "drummed" its sales show that real merit must exist. These drills are now in use in all parts of the country.

The drill is so perfectly shown by an illustration in Mr. Bittenbender's advertisement on another page that a further description would be useless. We will only add that the feed bars are made with 6, 8, 10, 12, and 14 threads per inch, a range which thoroughly fits the drill for all grades of hardness in coal or rock.

PERSONALS

Mr. W. S. Gresly, M. E., of Erie, Pa., has been to Saginaw, Mich., on professional business in regard to improving the mode of mining and other matters connected with the Saginaw Bay Coal Company's mines at Sebewaing, Mich. This month he proceeds to the mines of the Shawmut Coal Company, Elk County, Pa., to advise on a Longwall system for a three feet vein, in connection with electric undercutting machines.

Mr. C. A. Byers, of Williamsport, Pa., has succeeded Mr. M. E. Taylor as general manager of the Elk Coal and Coke Company, at Glen Fisher, Pa., and the title of the company has been changed to the Fisher Coke Company.

Baird Halberstadt, E. M., of Pottsville, Pa., who has been appointed assistant geologist on the Geological Survey of Pennsylvania will complete a Bituminous Map of Pennsylvania similar to the map of the Anthracite region already issued by the survey. All of the mines will be located on the map, and in the report to accompany it there will be a short account of each mine, section of the bed worked, together with other valuable information.

Mr. Austin King, Inspector of the Eighth Bituminous District of Pennsylvania, resigned the position on the first inst. to accept the superintendency of the Leisenring No. 3 shaft of the H. C. Frick Coke Company. Mr. King has been succeeded as Mine Inspector by Mr. D. H. Thomas, of Bitumen, Pa.

Mr. Bernard Callaghan, of Leisenring, Pa., ex-Inspector of Mines, has been appointed superintendent of the Leisenring No. 2 plant of the H. C. Frick Coke Company

Mr. H. C. Zacharias, Assistant Engineer of the Philadelphia and Reading Coal and Iron Company in charge of the Shamokin District, resigned on the 1st inst. to accept the superintendency of the Silver Brook Coal Company's colliery at Silver Brook, Pa. Mr. Zacharias has been succeeded by his first assistant Mr. K. C. Farrow.

PRIMARY EDUCATIONAL DEPARTMENT

FOR CANDIDATES FOR

MINE FOREMEN'S CERTIFICATES

AND FOR

STUDENTS OF MINING.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the sciences related to mining and to learn how to answer the questions in ventilation, surveying, and mechanics which are asked at the examinations for mine foremen's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine foremen and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and many calculations are worked out at length for the benefit of those who are not familiar with figures.

PENMANSHIP.

In referring to Figures 12 and 13, we will call the letters 1, 2, 3, and 4, beginning at the left. Letter 1, Fig. 12, represents the letter B drawn on ideal principles, that is to say, in this letter all the laws of penmanship are fulfilled. Letter 2 is intended to illustrate how the principal curves in the letter are generated; it will be seen that the two bottom scrolls consist of ellipses having their major axes parallel to the mean axis of the stem of the letter. This is easy enough to comprehend, but the ellipse that lends most beauty to the construction of the letter B is the large upper ellipse. Now in constructing the letter B, few persons give this ellipse its right inclination, they

FIG. 12.

either droop the axis of the ellipse too much, as in Letter 3, or incline it upwards as in Letter 4. By reference to Letters 1 and 2, and especially Letter 2, the right inclination of each ellipse is clearly shown. By paying attention to Letter 2 any person may in a few minutes be able to execute it with majesty and grace.

In Letter 3 it will be observed the large bottom scroll of the stem is an outrage on the first law of penmanship, namely, that all strokes should be parallel. In Letter 4, however, the deformity entirely arises from giving the upper ellipse the wrong inclination.

In Letter 1, Fig. 13, the bottom ellipse of the letter B has the wrong inclination, or in other words, it is not parallel to the mean axis of the stem, hence the deformity that is offensive to the eye. In Letter 2 the bottom ellipse is inclined in an opposite direction to the major axis of the bottom ellipse of Letter 1, hence these wrong inclinations have given to Letters 1, 2, and

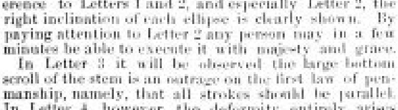


FIG. 13.

3, a positively uninviting appearance. In letters 2 and 3 the upper ellipses are a little too large, but in Letter 4 the ellipse becomes nearly a circle, and although the inclination of the major axis is correct, it nevertheless is a manifest deformity. Nothing is more important to a person in pursuit of knowledge than correct ideas of form, and nothing is more likely to refine and develop the observing faculties than a study of the letters of the alphabet as we are now presenting them.

ARITHMETIC.

It is important to be able to numerate or to operate with whole and decimal numbers, as rapidly as with whole numbers alone. We are afraid that to many beginners the strangeness of the language employed, beclouds the eyes of their mind more than the inherent difficulties of the subject; to speak of decimal fractions is to some people repulsive, and we honestly believe, that if our beautiful Saxon words had been compounded to express these terms and principles, the people of England would have been further advanced in elementary education than they are.

The word decimal means something relating to ten, therefore we might have said tenal fractions instead of decimal fractions, or fractions of tens or tenths. Perhaps the most accurate way of expressing what is here meant would have been to call them tenth fractions. Now the learner, to understand these fractions, cannot do better than to make use of his own hands and fingers. We have five fingers on each hand, or a total of ten fingers; now each single finger is one-tenth of the whole of our fingers and might be expressed as ·1 of our fingers; two of our fingers might be expressed as two-tenths, or ·2 of our fingers; three of our fingers might be expressed as three-tenths or ·3 of our fingers; and four fingers might be considered four-tenths of the fingers, or ·4. Operations with decimal fractions are performed in the same way as operations with ordinary whole numbers, the only difference arises out of the use of the decimal point. Now suppose a person to be required to add 333 to 22, he would certainly place the figures as

$$\begin{array}{r} 333 \\ 22 \\ \hline 355 \end{array}$$

Now let us suppose that instead of placing the figures as has been done in the example given, the operator was to place the figures representing 22 under the wrong figures representing 333, it would then be made to appear that 333 added to 22 were equal to a sum of 553, as below

$$\begin{array}{l} 333 \\ 22 \\ \hline 553 \end{array}$$

But say you, this is a mistake, you put the figures 22 in the wrong place. Most decidedly that has been done, and if the learner is acute enough to notice this false arrangement, he will be equally sharp enough to properly locate whole and decimal numbers for addition.

Supposing again we are going to add 33·3 to 2·2, now if no regard is paid to the value of the figures in relation to the decimal point, errors of the most startling kind must occur; for example, 33 is nothing more than 33 and 33·3 is 33 and a little more, that is to say, it is less than 34. Now 2·2 is only 2, and 2 tenths of another unit. Now, if these figures were properly located for addition, they would appear as follows:

$$\begin{array}{r} 33{\cdot}3 \\ 2{\cdot}2 \\ \hline 35{\cdot}5 \end{array}$$

But supposing now that fractions were added to whole numbers, what serious mistakes would occur

$$\begin{array}{l} 3\,3\,3 \\ 2\,2 \\ \hline 5\,5\,3 \end{array}$$

Now see what a mess this is, what is this 553? It really is nothing; because anybody's common sense can tell them if 33 be added to 2 the sum will be 35. Now add the two decimal parts together—two-tenths and three-tenths—and they will produce five-tenths; then when 33·3 is correctly added to 2·2 the result is 35 and a half, ·5 being five-tenths of 1.

To some of our advanced readers our explanation may appear somewhat playful, but in educating the judgment of a learner it is necessary that you should assume that he is beginning to learn from zero.

CHEMISTRY RELATING TO MINE VENTILATION.

An elementary body is one that is not reducible by any known process, into any other than the single or simple unity form of an element.

For example: Water is a compound body, and cannot be called an element; it is reducible into oxygen and hydrogen. Now oxygen and hydrogen are each of them elementary bodies, and therefore cannot be reduced.

The elementary bodies found in the gases of mines are five in number, and are as follows:

Oxygen.	Nitrogen.
Hydrogen.	Carbon.
Sulphur.	

Each of these elements can exist in a free state that is, uncombined with any other element.

For example: Sulphur can exist at ordinary temperatures as pure sulphur, which is a solid. Carbon can exist at all temperatures as a solid in a perfect vacuum. Nitrogen, hydrogen, and oxygen in a free state, are always found as gases.

Densities of the gases. Hydrogen is the lightest known element, and its specific gravity is always taken as unity, that is, if a cubic inch, a cubic foot, a gallon, or any other measure of capacity be taken, the one each measure of hydrogen would be one. Oxygen is sixteen times heavier than hydrogen, and its specific gravity is said to be sixteen.

The gases oxygen and nitrogen, and the vapors of sulphur and carbon are, volume for volume (at the same temperature), weighed against hydrogen, as follows:

Hydrogen, oxygen, nitrogen, sulphur, carbon (say one gallon of each).

Hydrogen	1
Oxygen	16
Nitrogen	14
Carbon	12
Sulphur	32

The elementary gases are, for expediency and brevity, designated in the language of chemistry by their respective initial letters, which are known as the symbols of the elementary gases.

Hydrogen	*H*
Oxygen	*O*
Nitrogen	*N*
Carbon	*C*
Sulphur	*S*

Combining proportions of the elementary gases. First. Water which is a liquid, and a gas as watery vapor. It is a chemical compound H_2O, that is, two volumes of hydrogen combined with one volume of oxygen.

Second. Carbon dioxide (commonly known as carbonic acid) is a chemical compound CO_2, that is, one volume of carbon (as gas) combined with two volumes of oxygen.

Third. Carbon monoxide (commonly known as carbonic oxide), is a chemical compound $C\,O$, that is, one volume of carbon (as gas) combined with one volume of oxygen.

Fourth. Methyl hydride (commonly known as marsh gas, fire-damp, and light carbureted hydrogen), is a gas, and is a chemical compound $C\,H_4$ that is, one volume of carbon (as gas) combined with 4 volumes of hydrogen.

Fifth. Hydrogen sulphide (commonly known as sulphureted hydrogen), is a chemical compound H_2S, that is, two volumes of hydrogen, combined with one volume of sulphur (as gas).

Atmospheric air is not a chemical compound, but a mechanical mixture of two elementary gases and three compound gases, the latter three in small quantities, viz., the elementary gases, nitrogen and oxygen, and the compound gases, watery vapor, carbon dioxide, and ammonia.

The quantities of the compound gases, carbon dioxide and ammonia, are very small (carbon dioxide 4 in 10,000 parts, and ammonia 1, in 1,000,000 parts), and may be here neglected, but not so with water gas or watery vapor, which plays a most important part in mine ventilation, as will be shown further on.

The relative values or "weights" of nitrogen and oxygen in atmospheric air are in 100 parts.

Nitrogen, 77 parts.
Oxygen, 23 parts.

Atoms and Molecules.—An atom is assumed by the chemist to be the ultimate indivisible condition of an elementary body, consequently two or more atoms combined would be a condition of divisibility; this condition of divisibility is called a molecule.

Relative weights, specific gravities, and absolute weights of the gases.—Relative weight is a term used in chemistry whereby it is shown that the specific gravity of a compound gas is not the mean or average weight of the constituent atoms in the molecule, but a weight resulting from the condensation of a group of atoms into a volume equal to the volume of two atoms of hydrogen. For example: Carbon dioxide is CO_2. Now here we have three atoms, and if no condensation resulted, the molecular weight would be

$$\frac{C+O+O}{3} = \frac{12+16+16}{3} = 14\tfrac{2}{3}.$$

The true relative weight, however, is

$$\frac{C+O+O}{2} = \frac{12+16+16}{2} = \frac{44}{2} = 22$$

relative weight.

From this we get the general law at once simple and easy to deduce. All the compound gases found in mines have a relative weight, which is found by dividing the sum of the weights of the constituent atoms by two.

$$H = 1,\ O = 16,\ N = 14,\ C = 12,\ S = 32.$$

Methyl hydride $= CH_4$.

$$\frac{C+H+H+H+H}{2} = \frac{12+1+1+1\times1}{2}$$

$= \frac{16}{2} = 8$, relative weight.

Hydrogen sulphide $= H_2\,S$.

$$\frac{H+H+S}{2} = \frac{1+1+32}{2} = \frac{34}{2} = 17\text{, relative weight.}$$

Carbon monoxide $= C\,O$.

$$\frac{C+O}{2} = \frac{12+16}{2} = \frac{28}{2} = 14\text{, relative weight.}$$

Nitric oxide $= N\ O$.

$$\frac{N+O}{2} = \frac{14+16}{2} = \frac{30}{2} = 15\text{, relative weight.}$$

Watery Vapor $= H_2\,O$.

$$\frac{H+H+O}{2} = \frac{1+1+16}{2} = \frac{18}{2} = 9,$$

relative weight.

To atmospheric air the above law does not apply, as air is a mechanical mixture.

The proportions of nitrogen and oxygen being by weight as previously shown, nitrogen 77, oxygen 23, and as $N = 14$ and $O = 16$, it follows that the specific gravity of air when weighed against hydrogen is

$$\frac{79 \times 14}{100} + \frac{21 \times 16}{100} = 14{\cdot}42.$$

which means that $\frac{77}{100} \times 14$ added to $\frac{23}{100} \times 16$ will give the specific gravity of air.

Note then, we find that in mine ventilation we have to deal with five elementary bodies: nitrogen, oxygen, hydrogen, carbon, sulphur, and seven compound gases, viz.:

Carbon Monoxide,	Methyl Hydride,
Carbon Dioxide,	Watery Vapor,
Hydride of Ethyl,	Hydrogen Sulphide,
Nitric Oxide,	

and one mechanical mixture, atmospheric air.

The specific gravities of gases are found by weighing them in equal volumes against hydrogen, thus $H = 1$, then

Carbon Monoxide	= 14	Watery Vapor	= 9
Methyl Hydride	= 8	Carbon Dioxide	= 22
Hydride of Ethyl	= 15	Hydrogen Sulphide	= 17
Nitric Oxide	= 15		

Atmospheric Air = 14·42.

The absolute weights of the gases may be found by a simple proportion, the weight of a given volume of air being known.

THE COMPOSITION AND CLASSIFICATION OF COAL.

Q. 1. What is coal ?

A. Coal is mineralized vegetable matter.

Q. 2. What is coal composed of ?

A. Coal differs very much in its composition, so far as the proportions of its constituents are concerned, but the essential elements are the same in all cases, namely, carbon, hydrogen, and small quantities of nitrogen, oxygen, sulphur, silica, lime, and alumina.

Q. 3. How may the constituents of coal be classified, so far as their solidity and fluidity is concerned ?

A. The constituent of coal, when burnt, assume two forms, first the solid, as coke or cinder; second, volatile matter, such as the gases and oils that are expelled by heat.

Q. 4. How may the constituents of coal be classified according to their value in the fuel ?

A. They may be classified under three heads—first, carbon and hydrogen, which supply heat and light; second, the constituents that reduce the value of coal, such as sulphur and nitrogen; third, the worthless constituents such as the silica, oxides of iron, magnesia, lime, and alumina, all the latter constitute the ash.

Q. 5. What is the average percentage of combustible matter, injurious or destructive matter, and ash in coal?

A. The proportions vary so much in different varieties that only an average can be given; carbon and hydrogen may be taken at 92 per cent., sulphur at 1 per cent., and ash at 7.

Q. 6. How may coals be classified according to their appearance when broken ?

A. They may be classified as indefinite in cleavage, such as lignite coal; cuboidal, as the Bituminous coal; and conchoidal, as the Anthracite, and some varieties of cannel coal.

Q. 7. How may coal be classified according to their relative age ?

A. They may be classified according to their relative ages, as lignite or brown woody coal, such as are found at the bottoms of peat bogs, or interstratified with the latest or newest rock formations, as found in all parts of the world. Lignite, by age, slowly changes into Bituminous coal, and cannel coal appears to be of the same age as the Bituminous seams.

Anthracite coal cannot be said to be older than the oldest Bituminous coals, because the same seam, as found in South Wales, will change from a Bituminous coal at the rise near the outcrop, to an Anthracite coal where it dips beneath a thicker cover of the rocks.

Graphite is the oldest variety of mineralized vegetable matter known, and is found interstratified with the oldest rocks, such as the Silurian group and groups of even greater age, such as the Laurentian, in Canada.

Q. 8. How may coals be classified according to their mode of burning?

A. They may be classified as flaming and non-flaming, Lignite, Bituminous, and Cannel coals, all belong to the flaming varieties, giving off much smoke. There is only one non-flaming variety, that is Anthracite.

Q. 9. How may coals be classified according to their commercial uses ?

A. They may be classified as household coals, gas coals, and steam coals.

Q. 10. How may coals be classified with regard to their condition when subjected to a high temperature ?

A. They may under these conditions, be classified as caking and non-caking.

Q. 11. How do you account for some Bituminous coals being non-caking ?

A. The non-caking variety seem to contain oils that are easily volatilized by heat, and contain a small percentage of tar, pitch, or resinous matter; the coking variety appears to be made up of mineralized vegetable matter that was originally very rich in solid resin.

Q. 12. Can non-caking coals be made to cake by artificial treatment ?

A. Yes; non-caking coals if broken into slack by a disintegrator, and mixed with about 5 per cent. of finely ground pitch, will cake in a coke oven.

Q. 13. Is lignite coal of much commercial value?

A. As a general rule it must be said that lignite is of comparatively little commercial value for two reasons, first, it contains a high percentage of water and neutralizes the heat which is largely consumed in converting the water into steam; second, in proportion to its weight it generally contains a higher percentage of ash than other coals.

Q. 14. What reason can you assign for the percentage of ash in lignite being greater than that found in ordinary Bituminous coal ?

A. Lignite, so far as we know, is found in the temperate regions of the earth where climatic conditions have not been favorable for a rich and rapid development of woody tissue, at the period of the formation of the seam. The rich coal seams afford abundant evidence of being composed of the remains of vegetable matter, which flourished during the period of its growth, in a warm moist climate. There, however, can be no doubt that some seams of lignite, characteristic of tropical regions, will be as rich as the best Bituminous coals, but climatic conditions render them at present inaccessible to civilized men.

Q. 15. How do you account for the cuboidal structure of Bituminous coals ?

A. The cuboidal structure of Bituminous coals is the result of planes of fracture in the coal at right angles to each other.

Q. 16. How do you account for the horizontal planes of fracture in Bituminous coal ?

A. The horizontal planes of fracture in Bituminous coal coincide with the planes of stratification; the coal has been increased in thickness by leaves or sheets sometimes called lamina. During the growth of a great peat bog there would prevail storms and tempests just as now; heavy rainfalls would develop water torrents carrying with them in suspension small particles of earthy matter, which deposited on the vegetable matter as a thin layer, made partings or partitions by which the coal has been split into leaves or sheets; in short, these partings have produced stratification. Sometimes storms had raged of a more violent character, and the flowing waters had carried into the bog an enormous quantity of earthy matter, and made partings varying from an eighth of an inch to an inch and more in thickness, and these partings are now known to the miner as bands in the seams.

MECHANICS IN MINING.

It is very important to understand with great clearness the relationship of circular and square measure. Suppose a square to measure 12 inches on each of its four sides, and a circle to measure 12 inches in diameter. Now it is clear that the space enclosed by the four sides of the square must be larger than the space enclosed by the circumference of the circle; consequently we speak of the contained spaces as 144 square inches for the square, and 144 circular inches for the circle. From this it must be clear that the value of a circular inch is less than that of a square inch in the proportion of 1 to ·7854; that is to say, if a square be 1 foot on every side, the four sides will enclose a square foot, or, if a square be 1 inch on every side, the figure will enclose a square inch. In the same way a circle 1 foot in diameter may be called a circular foot; that is to say, the circumference of the circle encloses a space equal to ·7854 of a square foot. The same contrast may be applied to square miles or square anything else.

Another matter must be carefully noticed, viz.: If the square be equal in square inches to the area enclosed by a square whose side is 12, 144 circular inches will be the area enclosed in circular measure by the circumference of a circle whose diameter is 12; but 144 circular inches are less in value than 144 square inches in the proportion of 1 to ·7854; therefore $144 \times {\cdot}7854 = 113{\cdot}0976$ square inches. From this we conclude that the square of the diameter of any circle is equal to its area in circular measure, and the circular can be converted into square measure by multiplying by ·7854. As a knowledge of circular relationship constantly is required we hope we have made the matter plain.

Q. What is the area in square measure of a circle whose diameter is 13?

A. We first find the area of a square whose sides are 13 inches, and multiply the result by ·7854, thus

$$13 \times 13 = 169 \times {\cdot}7854 = 132{\cdot}7326.$$

Q. The bucket of a pumping set is 15 inches in diameter, the length of the stroke is 5 feet; how many cubic inches of water does the pump lift in one stroke?

A. The square inches of the end of the bucket are found by squaring the diameter 15″ and multiplying the result by ·7854, thus $15 \times 15 \times {\cdot}7854 = 176{\cdot}715$ sq. inches. The length of the stroke is 5 feet or 60 inches, which multiplied by 176·715 sq. in. will give the number of cubic inches in the bucket, or the cubic inches of water the pump will lift in one stroke. Thus

$$176{\cdot}715 \times 60 = 10{,}602{\cdot}9.$$

Q. How many cubic feet are there in 10,602·9 cubic inches?

A. There are 1,728 cubic inches in one foot, and $10{,}602{\cdot}9 \div 1{,}728 = 6{\cdot}1359 +$ cu. ft.

Q. How many gallons are there in 10,602·9 cubic inches?

A. 45·9 gallons, there being 231 cubic inches in the standard U. S. gallon.

Q. How many square feet of rubbing surface are there in a circular shaft 18 feet in diameter, and 1,500 feet deep?

A. The circumference of the shaft is in this case called the perimeter. Now the perimeter in feet, multiplied by the depth of the shaft in feet, will be equal to the rubbing surface demanded. The diameter in feet multiplied by 3·1416 gives the circumference, or perimeter of the circle in feet, thus $18 \times 3{\cdot}1416 = 56{\cdot}5488$ linear feet, and $56{\cdot}5488 \times 1{,}500 = 84{,}823{\cdot}2$ square feet of rubbing surface.

Q. Suppose a brattice to be introduced in the former question, and that the brattice is 15 feet wide, how much will this increase the rubbing surface of the air?

A. As the air will rub on both sides of this brattice, the rubbing surface due to it will be found as follows: $2 \times 15 \times 1{,}500 = 45{,}000$, the rubbing surface due to the brattice; but the total rubbing surface due both to the shaft and the brattice will be $45{,}000 + 84{,}823{\cdot}2 = 129{,}823{\cdot}2$ square feet of rubbing surface.

Q. How many thousand bricks will be required to line a 14-foot shaft for a depth of 780 feet, the brick on the inside face or small side being 4 inches by 9 inches, the joints being made with ⅛ of an inch of cement?

A. First, find the square feet in the inside surface of the walling, as follows: $14 \times 3{\cdot}1416 \times 780 = 34{,}306{\cdot}272$ square feet. Now each brick will measure on the face $9\frac{1}{8} \times 4\frac{1}{8}$, that is allowing for cement in the joints, and the area of the face of each brick will be found in square feet as follows:

$$9\tfrac{1}{8} = \frac{73}{8};\ 4\tfrac{1}{8} = \frac{33}{8},\ \text{then}$$

$$\frac{73}{8} \times \frac{33}{8} \times \frac{1}{144} = \frac{2{,}409}{9{,}216} \text{ or } \frac{803}{3{,}072} \text{ sq. ft.}$$

Now, if this fraction of a square foot be divided into the surface of the shaft in square feet, the result will be the answer required:

$$34{,}306{\cdot}272 \div \frac{803}{3{,}072} = 131{,}244 \text{ bricks to line the}$$

shaft in question.

Q. A circular shaft is 16 feet in diameter, and during the course of sinking, from some cause the shaft feeder has flooded the shaft with water to a depth of 312 feet; how many gallons and cubic feet of water are there in the shaft?

A. To find the cubic feet of water in this shaft, we square its diameter 16, and multiply the result by ·7854, or

$$16 \times 16 \times {\cdot}7854 = 201{\cdot}0624$$

the square feet in the area of the section of the shaft. Now if the area of the section be multiplied by the depth of the shaft in feet, the result will be the volume of water in the shaft in cubic feet, that is to say

$$201{\cdot}0624 \times 312 = 62{,}731{\cdot}4688$$

cubic feet of water, which multiplied by 1,728 gives cubic inches thus

$$62{,}731{\cdot}4688 \times 1{,}728 = 108{,}399{,}978{\cdot}0864$$

and this divided by 231 the number of cubic inches in a standard United States gallon gives the required number of gallons, thus

$$108{,}399{,}978{\cdot}0864 \div 231 = 469{,}264 \text{ gallons.}$$

Q. How long would a pump be in pumping the shaft in the former question dry, supposing no feeder continued to run into it, the pump being 12 inches in diameter, and having a 5 feet stroke and making 6 strokes per minute?

A. If we knew the number of gallons the pump could lift per minute, we would only require to divide the gallons of water in the shaft, by the number of gallons the pump could lift per minute. Now in solving this question, we require first to find the gallons the pump can lift per minute. This can be determined in different ways. For example:

$$12 \times 12 \times {\cdot}7854 = 113{\cdot}0976 \text{ square inches.}$$

in the area of section of the pump. Now if the area of the section of the pump be multiplied by the length of the stroke in inches, the result will be the cubic inches of water lifted in one stroke as

$$113{\cdot}0976 \times 60 = 6{,}785{\cdot}856 \text{ cubic inches.}$$

Now, if the cubic inches be multiplied by the number of strokes per minute, the result will be, the cubic inches of water lifted per minute, which is equal to

$$6{,}785{\cdot}856 \times 6 = 40{,}715{\cdot}136 \text{ cubic inches per minute.}$$

Now, there are 231 cubic inches in a gallon, therefore,

$$\frac{40{,}715{\cdot}136}{231} = 176{\cdot}256 \text{ gallons per minute.}$$

But as no pump could lift this theoretical quantity an allowance of 10 per cent. ought to be made for leakage due to the bucket and the valves, therefore,

$$176{\cdot}256 \times {\cdot}9 = 158{\cdot}63 = \text{quantity actually}$$

lifted by the pump per minute. Now, if the total number of gallons in the shaft be divided by what the pump can actually lift per minute, the result will be the time in which the shaft without a feeder would be emptied, therefore,

$$\frac{469{,}264}{158{\cdot}63} = 2958{\cdot}2 \text{ minutes or } 49\tfrac{1}{3} \text{ hours.}$$

Answer required.

The same question can be answered by finding the cubic feet the pump can lift per minute, as follows: The diameter being 1 foot, then,

$$1 \times 1 \times {\cdot}7854 \times 5 \times 6 \times {\cdot}90 = 21{\cdot}2058$$

cubic feet the pump will lift in one minute. Now, if the cubic feet of water in the shaft be divided by the cubic feet of water the pump can lift per minute, the result will be the time in minutes the pump will clear the shaft,

$$\frac{62{,}731{\cdot}4688}{21{\cdot}2058} = 2958{\cdot}2 \text{ minutes.}$$

as before, or $49\frac{1}{3}$ hours.

How many cubic feet, cubic yards, and gallons of water are there in a 14 feet shaft, with the water 468 feet up the shaft?

A. We will first find the cubic feet by squaring the diameter, multiplying the result by ·7854, and this result by the depth 468 feet, thus

$$14 \times 14 \times {\cdot}7854 \times 468 = 72{,}043 \text{ cu. ft.}$$

Now 27 cu. ft. make one cu. yd., then

$$72{,}043 \div 27 = 2{,}668 \text{ cu. yds.}$$

To find the number of gallons we reduce the cubic feet to inches and divide by 231, thus

$$72{,}043 \times 1{,}728 \div 231 = 538{,}919 \text{ gallons.}$$

Q. There are 3,500 cubic yards of water in a shaft, the depth of the water being 480 feet, what is the diameter of the shaft?

A. There are 27 cubic feet in a cubic yard, consequently $3{,}500 \times 27 = 94{,}500$ cubic feet. Now 94,500 cubic feet divided by the depth of the shaft in feet, which is 480, will give the sectional area of the shaft in square feet, or

$$\frac{94{,}500}{480} = 196{\cdot}875 \text{ square feet.}$$

Now to convert square feet into circular feet

$$\frac{196{\cdot}875}{{\cdot}7854} = 250{\cdot}6684 \text{ circular feet.}$$

Now the square root of the circular feet will be equal to the diameter of the shaft or $\sqrt{250{\cdot}6684} = 15{\cdot}83$ feet, the diameter of the shaft.

Q. What are the contents in cubic feet and gallons, of a cylindrical boiler with hemispherical or egg ends, the total length is 40 feet and the diameter 5 feet?

A. The area of the circular section of the boiler will be found as follows: $5 \times 5 \times {\cdot}7854 = 19{\cdot}635$ square feet. The contents of the cylindrical portion will be found as follows: $19{\cdot}635 \times 35 = 687{\cdot}225$ cubic feet. Now if the two hemispherical ends be conceived to jointly make a sphere, then the cube of the diameter of the sphere, which is 125, multiplied by one-sixth of pi, or 3·1416 the result will be the contents of the sphere—thus

$$\frac{3{\cdot}1416 \times 125}{6} = {\cdot}5236 \times 125 = 65{\cdot}45.$$

Now if the contents of the sphere be added to the contents of the cylinder we have the contents of the boiler, or $65{\cdot}45 + 687{\cdot}225 = 752{\cdot}675$ cubic feet, or 5,630·4 gallons. There are 6·25 gallons in a cubic foot, therefore,

$$752{\cdot}675 \times 6{\cdot}25 = 4{,}704{\cdot}21875 \text{ gallons.}$$

Q. Suppose the boiler in the previous question to be built into its seat in such a way that half of its surface will constitute the heating surface for the action of the find how many square feet of heating surface will this represent?

A. To find the heating surface of the cylindrical portion proceed as follows: Multiply the circumference of the cylindrical portion by half the length of the cylinder, or the length of the cylinder by half the circumference, and the product will be the heating surface of the cylindrical portion, then

$$\frac{3{\cdot}1416 \times 5 \times 35}{2} = 274{\cdot}89$$

square feet of heating surface due to the cylindrical portion of the boiler.

Now if we calculate the two ends as a complete sphere, the half of the surface of the sphere will be the portion exposed to the heat of the fire. The surface of a sphere is equal to the surface of a hollow cylinder, whose length and diameter are equal to the diameter of the given sphere, consequently the surface of the sphere is found as follows:

$$\frac{5 \times 5 \times 3{\cdot}1416}{2} = 39{\cdot}27.$$

Now if half the surface of the sphere be added to half the surface of the cylinder the total will be the heating surface of the boiler, thus $274{\cdot}89 + 39{\cdot}27 = 314{\cdot}16$ square feet of heating of the boiler.

Q. Theoretically 9 square feet of heating surface generates steam capable of doing the work of one horse power. About collieries where coal is used extravagantly or wastefully, 6 square feet of heating surface is made to do the work of one horse pow r, but let the equivalent of a horse power in this case be 9 feet, what then is the equivalent horse power of the boiler in the previous question?

A.

$$\frac{314{\cdot}16}{9} = 34{\cdot}9 \text{ horse power.}$$

EXAMINATION QUESTIONS ANSWERED.

QUESTION 33.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

A mine employing 250 men and 10 mules is ventilated by two splits, each split receives the same quantity of air, what size would the airways have to be to pass the quantity of air required by law, the velocity being 5 ft. per second, allowing 500 cubic feet for each mule? What is the total quantity passing in the mine, the mine being located in the Connellsville Coke Region?

ANSWER.—The mine law requires a minimum of 100 cu. ft. per minute for each person employed, and as much more as the circumstances may require. As, in this region there is considerable gas evolved the minimum amount is not enough, and at least 200 cu. ft. should be furnished per employe. Then for the 250 men, there will be 250×200 or 50,000 cu. ft. required. Adding to this, the 500×10 or 5,000 cubic feet required for each mule, we have a total of 55,000 cu. ft. required, or 27,500 cu. ft. in each split.

A velocity of 5 ft. per second is equal to 300 ft. per minute. To pass this each airway will have to be

$$\frac{27{,}500}{300} \text{ or } 91{\cdot}66 \text{ sq. ft. area.}$$

Therefore, if square, the airway must be $\sqrt{91{\cdot}66} = 9{\cdot}6$ ft. square.

QUESTION 34.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

If the mine described in the preceding question was ventilated by furnace power producing a pressure of 4 lbs. per square foot, what would be the length of the motive column in feet, the weight of a cubic foot of air at the inlet to be 0·0686 lbs.?

ANSWER.—As the power produces a pressure of 4 lbs. per square foot, that represents a difference in pressure of 4 lbs. between the column of air in the downcast, and the column in the upcast, then as a cubic foot of air in the downcast weighs 0·0686 lbs., and as the motive column is the length of a column of air in the downcast shaft which would be equal in weight to the difference in weight of the air in the downcast and upcast shafts, we find its length by dividing 4 by 0·0686, which gives us 58·3 ft. as the length of the motive column.

QUESTION 35.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

Where and how should safety-lamps be used?

ANSWER.—Safety-lamps should be used by a competent fire-boss every morning, not more than three hours before the workmen enter the mine, to examine all accessible portions of the mine for fire-damp. They should be used by the workmen in all places where dangerous accumulations of gas are likely to occur. They should only be used by men of enough intelligence to under-stand their use, and should be kept locked when in use.

QUESTION 36.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

The units of work producing ventilation is 165,000; what is the horse power?

ANSWER.—The units of work represent the foot-pounds applied to circulate air, and 33,000 foot-pounds equal one horse power. Therefore $165{,}000 \div 33{,}000 = 5$ horse power.

QUESTION 37.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

How does a furnace produce ventilation, and in what class of mines are they most effective, and why? Show how to find the ventilating pressure arising from the use of furnace ventilation.

ANSWER.—A furnace produces ventilation by expanding the air in the upcast, and rendering it lighter than the cooler air in the downcast. If we suppose we have two shafts of equal depth sunk to a coal bed, with a communication between them at bottom by means of an underground channel, and the shafts and channel be filled with air of the same density and temperature, there would be no circulation and the air would remain stagnant. By imparting heat, however, to one of the shafts, the equilibrium will be destroyed; the effect will be to expand the air in the warmed shaft and render it lighter than that in the other, and, consequently cause a current down the colder shaft, along the drift, and up the warmer shaft; if the heat be continuously imparted, as in the case of a furnace, a constant current will be the result. Furnaces are most effective in deep mines. It is reckoned that the quantity of air produced by furnace ventilation, is as the square root of the difference between the temperature of the downcast and upcast shafts, and also as the square root of the depth from the surface, so the higher the temperature and the greater the depth at which the furnace is placed, the greater will be the quantity of air it will put in circulation.

The ventilating pressure arising from the use of furnace ventilation is found by ascertaining the difference in weight between the columns of air in the downcast and upcast shafts. The column of air in the downcast, which would represent the difference in weight between the air in the two shaf.s, is called the "motive column." Or, if the difference per square foot in the downcast and upcast be multiplied by the quantity of air passing, and divided by 33,000, we will get the horse power.

Thus, if the difference of pressure per square foot between the two shafts amounts to 4 lbs., and the quantity of air passing is 55,000 cubic feet per minute, the ventilating power is

$$\frac{4 \times 55{,}000}{33{,}000} = 6{\cdot}66 \text{ H. P.}$$

Again, if the temperature of the downcast be 50 degrees, and the temperature of the upcast be raised from 75 degrees to 150 degrees it will double the quantity. For we find that at first the difference in temperature is 25 degrees, and afterwards it is 100 degrees. Therefore, as the amount of ventilation effected is as the square root of the difference between the temperatures of the downcast and upcast we have

$$\sqrt{100} \div \sqrt{25} \text{ or } 10 \div 5 = 2.$$

To find the weight of the air in the two shafts, we use the following formula:

$$W = \frac{1{\cdot}3253 \times B}{459 + t}$$

where B = the height in inches of the barometer, and t = the temperature by Fahrenheit's thermometer. This rule is arrived at from the fact of 459 cu. ft. of air at 0 degrees Fahr. weighing 39·76 lbs. when the pressure is 30 in. of mercury, of the density due to 32 degrees, the weight being only $\frac{1}{30}$ of this or 1·3253 lbs. when the pressure is only 1 inch, and 459 ft. of air at 0 degrees expanding exactly one cubic foot for each degree of heat added. Then to find the difference of pressure per square foot in the two shafts of a mine, we proceed as follows:

Suppose the average temperature of the air in the downcast is 44 degrees, upcast 200 degrees, barometric pressure half way down say, 30½ in.; depth of shafts, 700 ft.

(1). In the downcast, the weight of one cubic foot =

$$\frac{1{\cdot}3253 \times 30\tfrac{1}{2}}{459 + 44} = {\cdot}08036 \text{ lb. and } 700 \times {\cdot}08036 = 56{\cdot}25 \text{ lbs.}$$

as total pressure per square foot.

(2). In the upcast, the weight of one cubic foot =

$$\frac{1{\cdot}3253 \times 30\tfrac{1}{2}}{459 + 200} = {\cdot}06138 \text{ and } 700 \times {\cdot}06138 = 42{\cdot}966 \text{ lbs}$$

as the total pressure per square foot. The difference of pressure is $56{\cdot}25 - 42{\cdot}966 = 13{\cdot}284$ lbs. or the pressure per square foot producing ventilation.

QUESTION 38.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania on October 28, 29, 30, and 31, 1889.

When an aircourse is of irregular form how do you determine the area?

ANSWER.—Divide it into a number of triangles, or parallelograms and triangles, and find the area of each of these simple figures. Then add these areas together for the total area of the airway.

The areas of the parallelograms = the base multiplied by the perpendicular height. The area of triangles is found by either multiplying the base by one-half of the altitude, or add the lengths of the three sides together, divide the sum by two; from the half sum subtract each side separately; multiply the half sum and three remainders continuously together, and take the square root of the product.

QUESTION 39.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

A mine makes 200 gallons of water per minute, said water being caught in a sump 200 feet perpendicular below the surface, and also located 2,000 feet from mouth of slope, the slope dipping 1 in 10, would you discharge the water up through a drill-hole perpendicular or up the slope, considering expenditure of power only, and what sized pump would you use, and what make of pump would you prefer?

ANSWER.—The vertical lift, via the slope would be

$$\frac{2{,}000}{10} \text{ or } 200 \text{ ft.,}$$

the same as by the drill-hole, and as by using the drill-hole, I would only have $\frac{1}{10}$ as long a pipe line, and consequently only $\frac{1}{10}$ the rubbing surface to cause friction, I would discharge the water through the drill-hole.

Regarding size of pump, we will assume that we have an average effective steam pressure of 40 lbs. per square inch, and the pumps would work 100 ft. per minute.

Then we have the formula:

$$D = \sqrt{\frac{G}{{\cdot}034\ L\ N}}$$

D = diameter of pump in inches.
G = number of gallons to be delivered per minute.
L = length of stroke in feet.
N = number of strokes per minute.
LN = speed of pump per minute.

Then as we have 200 gallons per minute, and we would use a double-acting piston pump each pump would have to handle 100 gallons per minute. Then

$$D = \sqrt{\frac{100}{{\cdot}034 \times 100}} = 5\tfrac{1}{2} \text{ inches nearly.}$$

As this formula gives the net diameter of the pump plunger; it is usual to increase the area of the plunger ¼ to allow for leakage etc.

Then the area of the pump plunger should be

$$5{\cdot}5 \times 5{\cdot}5 \times {\cdot}7854 = 23{\cdot}76 \text{ sq. in.}$$

and $23{\cdot}76 \times 1{\cdot}25 = 29{\cdot}7$ in. as area of each cylinder. Then as the area of a circle equals the square of the diameter multiplied by ·7854, we find the square of the diameter is

$$\frac{29{\cdot}7}{{\cdot}7854} = 37{\cdot}82 -.$$

Then $\sqrt{37{\cdot}82} = 6{\cdot}15 -$. Therefore the diameter of the pump cylinder should be 6·15 inches, or say 6¼ inches. Now, as to the steam end, the area of the 6¼ inch water cylinder is $6{\cdot}25 \times 6{\cdot}25 \times {\cdot}7854$ or 30·68 — inches. Then the pressure on each water piston due to a head of 200 ft. of water is equal to $200 \times {\cdot}434 \times 30{\cdot}68 = 2663{\cdot}02$ lbs. (See p. 102, COLLIERY ENGINEER POCKET-BOOK). Now as the effective steam pressure is 40 lbs. per inch, the theoretical area of the piston to balance this weight should be

$$\frac{2663{\cdot}02}{40} \text{ or } 66{\cdot}57 \text{ sq. inches.}$$

In practice we add one-half for resistance, and therefore the area of each steam piston should be $66{\cdot}57 \times 1{\cdot}5$ or 99·86 sq. in., and the diameters should be

$$\sqrt{\frac{99{\cdot}86}{{\cdot}7854}} \text{ or } 11{\cdot}28 \text{ in.,}$$

say 11¼ inches.

I would th refore use any standard duplex pump with 11¼ in. steam cylinders and 6¼ in. water cylinders, that was advertised in the columns of THE COLLIERY ENGINEER.

QUESTION 41.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October, 28, 29, 30, and 31, 1889.

A mine generating explosive gas has not been entered for some time, what means would you take to enable workmen to descend, and suppose furnace ventilation was proposed? Describe fully the method you would adopt in lighting the furnace and clearing the mine of fire-damp.

ANSWER.—I would allow no workman to descend until a competent fire-boss had examined the mine and ascertained how far he could enter with safety. I would then allow only enough men to enter to repair bratties, doors, etc., and would pick only cool-headed men that were perfectly familiar with the safety-lamp and working in gas for this purpose. I would restore ventilation as rapidly as possible and would not allow the regular working force to descend until the fire-boss had reported the whole mine in a safe condition. If furnace ventilation was used I would first endeavor to secure a fairly good current of fresh air through the mine by the temporary use of a steam-jet in the upcast or a waterfall in the downcast, and if the mine was a large one ventilated by several splits, I would shut off all but one from the current, until I had first cleared all gas out of that split with either the steam-jet or waterfall, and second had my furnace lighted and the air in the upcast shaft heated to a temperature sufficiently high to create a current strong enough to dilute and carry off the gas in all splits if the mine was in its normal condition. I would then divide the current and allow a portion of it to sweep through another split. When this had been cleared, I would add another split, until I had, upon careful examination, found the entire mine free of gas. As my furnace would work in connection with a dumb drift, the lighting of it, and the clearing of the mine of explosive gases, would thus be rendered a safe operation.

QUESTION 42.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

Describe the dangerous gases found in coal mines how they are produced, the dangers attending the presence of each and how each may be detected.

ANSWER.—This question was fully answered in our issue of December last, page 105.

MECHANICAL NOTES

An Ancient Lock.

An Egyptian lock has been found which was in use more than 4,000 years ago. The old Egyptian lock was not made of metal, like those we use nowadays, but of wood, and the key that opened it was wooden, too. On one side of the door to which it was fastened there was a staple, and into this staple fitted a wooden bolt that was fixed to the door itself. When this bolt was pushed into the staple as far as it would go, three pins in the upper part of the staple dropped into holes in the bolt and held it in its place, so that it could not be moved back again until the pins were lifted. The key was a straight piece of wood, at the end of which were three pegs the same distance apart as the pins which held the bolt firm. When the key was pushed into the bolt through a hole made to receive it, the pegs came into such a position that they were able to lift the pins that fixed the bolt, and when these were lifted, the bolt could be lifted out of the staple. The most modern locks work on a similar principle.—*Metal and Iron Journal.*

The Tool and Handle in One Piece.

The difficulty in making an effective strong joint between a tool and its handle has long been felt, and the disadvantages thus involved are well understood, not only in respect to looseness in the joint but to the positive lack of power. But the invention of the Mannesmann process for the production of tubes direct from metal blocks, would now appear to have rendered both possible and desirable the making of a tool combined with its handle; that is, by means of that process, tubes are produced having solid portions at one or more points of their lengths, and these tubular rods may be made in any convenient lengths, with solid portions at regular or irregular distances apart, so that by cutting through such solid portions the rod can, of course, be divided up to a corresponding number of blanks for tools. By cutting such bars through at convenient points, as the size or length will show to be best, each section will consist of a hollow part, which may be suitably shaped or bent to form the handle, and the solid part, which can be shaped into the tool head by forging or stamping. Various tools are so formed, and it is obvious that they possess a greater degree of strength and durability than tools of which the handles form a separate piece.

A New Rotary Engine.

In a new construction of rotary engine it is claimed that the motive power is utilized to the greatest possible advantage. In this arrangement the frame supports a cylinder made in the shape of a ring having an annular recess, closed at one side by a ring-shaped head, while the outer edge of a piston extends centrally into this recess on the inner side of the cylinder, the piston being made in the shape of a wheel on a shaft turning in suitable bearings of the frame. The wheel-shaped piston has recesses or bucket, in its periphery against which the steam is tangentially directed through angularly arranged inlet ports in the cylinder. The outer ends of these ports are connected by short branch pipes with a pipe extending almost entirely around the cylinder, this latter pipe being also connected at one end with the steam supply source and closed at its other end. The series of inlet ports follow each other at equal distances around the cylinder, and following them is an exhaust port connecting with a pipe leading to the outside. By this arrangement all but one of the buckets in the periphery of the piston are kept constantly filled with live steam, each discharging as it reaches the exhaust port. To insure the steam-tight rotation of the piston in the annular recess of the cylinder, packing rings are provided, to be pressed against the sides of the cylinder by set-screws at suitable distances apart in each outer side of the cylinder.

Maxim's Flying Machine.

Mr. Hiram Maxim, well known for his many ingenious inventions, who is, moreover, a very practical and successful mechanic, has for some time past devoted considerable study to the subject of aerial navigation. His practical experiments in this direction, which have been many and various, appear to have crystallized into the form of a machine which might be called a steam kite. The experimental device consists of a thin sheet or kite 4 feet wide and 13 feet long, which is propelled by a screw capable of 2,500 revolutions per minute. According to information given by Mr. Maxim this machine, when properly inclined and pushed forward by the screw at the rate of 30 miles per hour, will maintain itself in the air; if the forward speed is increased to 35 miles per hour, it begins to ascend; at 90 miles its rising power is quite strong.

Mr. Maxim says he has already expended $45,000 on these tests, and is now at work on a large machine of silk and steel, with a plane 110 feet by 40 feet, with two wooden screws 18 feet in diameter. A petroleum condensing engine will furnish the power. In his previous experiments he found that one horse power would carry 133 pounds 75 miles per hour. He had proved that the screw would lift forty times as much on the propelled plane as it could push. A motor he says has been built, weighing 1,800 pounds, which pushes 1,000 pounds, and will consequently lift 40,000 pounds. The estimated weight of his engines, generator, condenser, water supply (2 gallons), petroleum (40 pounds per hour) and two men is about 5,000 pounds. Thus with a steam kite weighing in all 6,800 pounds he calculates on having an ascending power equal to 40,000 pounds, or 23,200 pounds more than the dead weight, say eleven tons. It is devoutly to be hoped that Mr. Maxim will soon be able to demonstrate the success of his great passenger kite.—*Scientific American.*

How an Axe is Made.

The first step in the operation of making an axe, is the formation of the axe-head without the blade. The glowing flat iron bars are withdrawn from the furnace and are taken to a powerful and somewhat complicated machine, which performs upon them four distinct operations—shaping the metal to form the upper and lower part of the axe, then the eye, and finally doubling the piece over so that the whole can be welded together. A workman stands by, seizing the partially-fashioned pieces one after another with a pair of tongs, and hammering the lower edges together. Next the iron is put in a powerful natural-gas furnace and heated to a white heat. Taken out, it goes under a tilt-hammer and is welded together in a second. This done, one blow from the "drop" and the poll of the axe is completed and firmly welded.

When the axe leaves the drop, there is some superfluous metal still adhering to the edges and forming what is technically known as a "fin." To get rid of this fin, the axe is again heated in a furnace, and then taken in hand by a sawyer, who trims the ends and edges. The operator has a glass in front of him to protect his eyes from the sparks which fly off as the hot metal is pressed against the rapidly-revolving saw. The iron part of the axe is now complete.

The steel for the blade, after being heated, is cut by machinery and shaped with a die. It is then ready for welding. A groove is cut in the edge of the iron, the steel for the blade inserted, and the whole firmly welded by machine hammers. Next comes the operation of tempering. The steel portion of the axe is heated by being inserted in pots of molten lead, the blade only being immersed. It is then cooled by dipping in water, and goes to the hands of the inspector. An axe is subject to rigid tests before it is pronounced perfect. The steel must be of the required temper, the weight of all axes of the same sizes must be uniform, all must be ground alike, and in various other ways conform to an established standard. The inspector who tests the quality of the steel, does so by hammering the blade and striking the edge to ascertain whether it be too brittle or not. An axe that breaks during the test is thrown aside to be made over.

Before the material of an axe is in the proper shape, it has been heated five times, including the tempering process, and the axe, when completed, has passed through the hands of about forty workmen, each of whom has done something toward perfecting it. After passing inspection, the axes go to the grinding department, and from that to the polishers, who finish them upon emery wheels.—*The Manufacturer and Builder.*

ELECTRICAL PROGRESS

Electricity and Industry.

In the census taken ten years ago, a department was devoted to the subject of power used in manufactures, but its reports and tables dealt only with steam and water power, and made no mention of electricity. During the ten years that have intervened, the application of electricity to industrial purposes has been wonderfully rapid. About two years ago, *Electric Power*, a New York journal, printed a list of 150 industries to which the electric motor had actually been applied in this country, and one of the editors expresses the opinion that if a list were now prepared with equal completeness, it would show that the electric motor has found employment in connection with nearly 300 branches of productive industry. The electric motor has been successfully used to run the sewing machines of girls employed in glove making in their own homes, and with the reported result of enabling each worker to accomplish more and better work in less time, and under conditions more favorable to health and causing less fatigue.

With these facts before us, the introduction of electricity as a power applicable to a great variety of industries, and available in the private house and at the individual work-bench, is no longer a dream or a prophecy, but an actual realization, of which the possible future development and industrial influences cannot be foretold. One of the principal articles of belief of the cheerful economic creed so ably propagated by Mr. Edward Atkinson, is that natural forces are constantly tending to a distribution of population more favorable to individual welfare. That where men have been too much isolated on great farms and sparsely settled tracts of land, the tendency toward higher cultivation of smaller areas, is operating to bring them into closer and better relations with the world, and that, on the other hand, where population has become too closely concentrated, in crowded cities and towns and over-crowded tenements, the development of rapid transit is operating to secure a distribution over a larger area, and to correct the evils incidental to a congestion of population at industrial centers.

In the latter direction, nothing could be more efficacious than the gradual adoption, in many industries and at many manufacturing centers, of a form of power peculiarly suited to such distribution, as would do away with the necessity for crowding hundreds of operatives together in the work-rooms of great factories. Such a change could be made to bring with it an amelioration of many of the conditions which now occasion most complaint, and to secure for a great mass of workers, more wholesome and cheerful surroundings, less crowded and better lighted and ventilated. Such a change seems like a dream of a return to the days of the hand-loom and spinning-wheel, and its possibility is an answer to much of the sentimental lamentation constantly heard about the changes which time and development have wrought in the condition of the toiling masses. Progress in the application of electricity to the employments of men, is but one of innumerable evidences that an improvement in social and industrial conditions is to be sought in the higher development of mechanical invention, and in the advancement of science, rather than in vain regrets for the simpler life of the irrevocable past.—*N. Y. Commercial Bulletin.*

Underground Wires.

The greatest sufferers by the burial of the wires are the telephone companies whose system connect with the long distance lines. A short length of underground cable has little or no effect on telephonic transmission, but when a few miles of underground cable are joined on to several hundred miles of overhead line, the effect is very marked, the speech becoming muffled, thick, and indistinct. All cities ought to make allowance for this apparently insuperable difficulty, and allow the wires of the long distance system to be carried overhead. For local telephone work, underground wires work admirably. The telephone system of New York from the Battery to the Harlem River is entirely underground, and there are to-day under the streets of New York considerably more than 20,000 miles of wire used for telephonic communication.

The type of underground cable now in general use should have a very long life. The lead covering is practically indestructible; if laid in iron pipes it cannot be affected even by galvanic action, because iron is electro-positive to lead, and the iron would be attacked. As the insulating material is hermetically sealed within the lead covering, it is safe from deterioration as long as the lead remains sound. So that unless it is found that the insulating materials deteriorate by reason of the action of the current, the depreciation on underground cables of this class should be placed at a very low figure. In contrast, the depreciation of overhead lines is very considerable, especially in towns where the wires are exposed to the action of smoke and gases besides the influence of extremes of weather.

In large towns and cities the underground system is among the established order of things, while freedom must be conceded for overhead wires in the open country and on restricted routes.—*Herbert Laws Webb, in The Engineering Magazine for August.*

A Novel Electrical Bell.

The *Journal des Applications Electriques* for last month describes a novel form of electric bell, in which the vibrations are maintained, not by hammering, but by means of synchronically intermittent electro-magnetic attractions. The bell or gong itself, which is made of steel, carries upon its outer edge a very small plate of platinum; and this plate, when the apparatus is at rest, just touches another platinum contact, that is attached to a fixed spring. Within the bell, and almost touching its edge, is a short fixed electro-magnet, and this is put into electrical circuit with the platinum contact pieces. Now, when the current is passed, it is obvious that the steel bell will be successively attracted and released with great rapidity; similarly to the contact breaker of a Ruhmkorff coil. The amplitude of its vibrations will, of course, depend on the strength of the current, and upon the adjustment of the spring contact. The bell is so placed as that when in full vibration it does not quite touch the face of the bar magnet. Hence there is practically nothing to interfere with its vibration; and the disagreeable clashing of the ordinary electric hammer is replaced by a pure musical note. When the bell is mounted in a resonant box, it can be heard distinctly from a long distance, and the arrangement is highly recommended by our contemporary for adaption to orchestral music.

A New Application of Electricity in the Purification of Water.

Two new methods of softening water for industrial purposes have been recently proposed by M. Lahovski. One of these involves purely chemical reactions, and need not be noticed here; the other introduces an ingenious application of electricity.

Hydrated oxide lead is placed in a filter press which is traversed by the water to be purified, and this produces an effluent showing only one or, at most, two degrees of hardness. In this way all the carbonates, sulphates, and chlorides are precipitated.

Now, in order to work this process economically, it is necessary to produce the hydrated oxide of lead cheaply, and the following method has been devised by Villon for this purpose:

Sodium nitrate is dissolved in water, and the solution is placed in a vat divided into two compartments by a diaphragm; lead electrodes of large surface are placed in the solution, and the current from a dynamo then passed through. The sodium nitrate is decomposed, caustic soda being formed in the negative compartment and nitric acid at the positive pole, from which it dissolves a certain quantity of lead forming lead nitrate.

After the current has been passing through the liquid for a certain time, the solutions that result from the various decompositions are run from the two compartments into a second vat, and then mixed mechanically by means of an agitator. The soda precipitates hydrated oxide of lead, and itself forms sodium nitrate; the liquid is then filtered, and the sodium nitrate solution which runs through the filter is again subject to electrolysis.

When the hydrated oxide of lead has been in use for some time it is then replaced by fresh oxide; the proper time for replacing the contents of the filter press is indicated by the degree of hardness of the water.—*Electrical Review*, London.

Electricity vs. Steam Railways.

While electricity may not yet be able to take the place of steam as an economical motive power for railway trains, it is demonstrating its ability, when properly managed, of cutting into the business of existing steam railways. The illustration of this is to be found in the passenger travel between St. Paul and Minneapolis. Until recently the steam railroads have controlled this business, and, with the exception of the fares charged, have given a fairly satisfactory service but an electric road is now running between the two cities connecting with the street lines of both, and in the half year which it has so far served the public it has taken such a large portion of the patronage from the steam railway that the latter will probably withdraw from competition for the local passenger traffic between the two cities. The reason for this is plain. The steam railroads charged 30 cents for a single trip of ten miles, and 50 cents for a round trip, while the electric road has been put on a paying basis while charging but 20 cents per round trip. In addition to this difference in fares, the electric road runs its cars more frequently and gives transfers to other street railways in either city. The electric company is making preparations to handle a very extensive traffic and will soon be able to run trains under one minute headway. The 30-horse power motors first used will be replaced by new ones of 50-horse power, and the cars will be run at higher speed than at first. Similar conditions of travel in other places will doubtless be met in the same way, and before railroad men realize it, electric railways will be running, the character of whose traffic will bear a very strong resemblance to that of steam railways. In this growth the fact may be developed that a comparison between steam and electricity will not always lead to the results obtained in the experiments thus far made.—*Metal and Iron Journal.*

An Electric House at the World's Fair.

Some months ago we made the remark that there appeared to be no limit to the possibilities of electricity. We can now add that if men like Mr. Edison have their way there never will be. One of the wonders promised for the Chicago Exhibition is an electric home. A miniature home, worked entirely by electricity, will be shown with bells and lights, and doors and windows with burglar alarms, which will immediately illuminate the entire dwelling in the event of an attempted ingress. The rooms are to be warmed by electric radiators and cooled by electric fans. The cooking will be done in an electric range at the top of the house, and the food will be lowered to the dining-room by an electric dumb-waiter, and the dishes will be afterwards washed by an electric dish-washer, in which a child can wash 10,000 dishes a day without breaking them. If these little matters can be accomplished we shall quite believe the promises that are made, that the washing and ironing of linen, and the scrubbing of floors and the cleaning of windows will also be performed by electricity. We shall think none the less of this wonderful power if it does not fully accomplish all that is claimed for it. But if Edison has pledged himself to the programme, it certainly will be accomplished.—*Colliery Manager.*

The Suez Canal Too Small.

"The most important deduction," says the *Engineer*, "to be obtained from the annual report of M. Ferdinand de Lesseps to the shareholders in the Suez Canal is that the facilities of the waterway are rapidly falling behind the enormous increase of traffic, and that before long probably even the relief afforded by the recent diminution in the time required for transit, will be found insufficient. The report shows that during the year no less than 3,389 vessels passed through the canal, giving a total receipt of £2,637,000. The principal work carried on in the period covered by the report has been the widening of the maritime canal by 15 metres. This work has been carried from the tenth mile, from Port Said to the fifteenth, and it is intended during the present year to carry it as far as the twenty-second mile. The other widening works also in course of execution have been continued vigorously, and the new basin at Port Said has been excavated to its full width for a length of 300 m. The crowding of the canal is so severely felt that the engineers have determined to abolish the supply of stores, etc., by water to the stations of the company between Port Said and Ismaila. The boats and barges at present employed will therefore be displaced in favor of a steam tramway, which is now in active construction. The Egyptian government has entered into negotiations with the company for the employment of this tramway as a public line for the transport of passengers and merchandise. One other noteworthy feature of the report is the statement that the development in the petroleum commerce of Port Said has rendered it necessary to undertake the construction of an isolated dock at that place for the accommodation of this traffic. At the annual meeting of the company in Paris the whole of the resolutions presented by the committee of management were approved, and MM. Chabrieres-Arles, Boucard, Guichard, and Lord Brassey were elected directors."

The Romans as Engineers.

The Romans were the first great engineers, and in their own particular manner have never been excelled. Their genius was more of an engineering quality than architectural, and it is in this department they erected their most successful structures. Architecturally, though of wonderful variety and imposing magnitude Roman art was rich, too great a combination of diverse elements to be thoroughly artistic and in keeping with refined taste. The barbaric Etruscan element in the Roman character which found visible expression in their gladiatorial and bloody shows, was too strongly rooted to be eradicated even in the centuries of independent Roman existence. The many lands which Roman conquerors placed under their city's sway made them familiar with a great variety of architectural forms they did not hesitate to avail themselves of, and the result was a combination, wonderfully rich and impressive, but often violating the canons of architectural art. Measured by the faultless standard of the Greek, its immediate predecessor and the model it most closely followed, Roman art leaves much to be desired from the æsthetic standpoint. But however unsatisfactory the Romans were in architectural design, and it must not be forgotten that after all it is the purist who chiefly finds fault with them, they more than made up as constructive builders. Construction was the Romans' chief point of excellence, and they brought to this work a native genius and an insight into engineering requirements of a very high order.—*Barr Ferree, in the Engineering Magazine for August.*

The Suwanee and the Mississippi.

One of the latest proposed improvements in our national waterways is the connecting of the Suwanee River with the Mississippi. The estimated distance is 500 miles, and depth of water *en route* 9 to 12 feet at mean low water. The establishment of this connection with the diversion of traffic by the opening of the Florida canal would add to the commercial facilities of all the country tributary to the water courses, and would also be of vital importance as a means of coast defence. All obstacles are said to be removable in our present advance in engineering science and mechanical appliances. The distance from the Suwanee River to St. Marks is from 70 to 90 miles, according to the route selected, the one being a direct and the other a dredged line. From St. Marks to the Mississippi the water line is almost continuous, but requiring improvement. The Ocleckony and Crooked Rivers require straightening and the removal of sundry bars, which are not supposed to be difficult, and are entirely practicable. In St. George's Sound, near Apalachicola, an oyster bar needs to be removed, and then the Apalachicola River is reached with 12 feet of water on the bar. The distance from St. Marks, Florida, to Apalachicola, Fla., by the coast line, is about 61 miles; by the Ocleckony and Crooked Rivers, about 10 miles longer. From the Apalachicola River to the Mississippi the distance is about 400 miles, and it will require about 30 miles—possibly less—of canaling to make land-locked connection between the two rivers. This project is in unison with the spirit of modern enterprise, and though at present but a proposition, may be accepted as a possible future fact.—*The Age of Steel.*

The Era of Canals.

The American canal was inaugurated in the beginning of the present century. They were made for purposes of inland transport, and were in coincidence with the exigencies of the situation. Railways were immature, both in construction and service, and with the blind guess at natural advantages that is in every historic case the pioneer of better facilities, the utilization of waterways and the artificial corrections of geography were generally crude and temporary efforts. These canals were from 6 to 7 feet deep, and traversed the course of drainage up hill and down for some hundreds of miles. The canal barge furnished the modest navy, and the horse and mule the moving power. For a time these canals served their purpose, till the iron horse and the railway track relieved them of business and future service. To-day circumstances are changed and under new conditions of industrial development the ship canal is a stately sequence to the slow-going barge and the cumbersome lock. We are improving on geography. Where nature made an isthmus a Lesseps, a Menocal and a Miller are using science and a dredger to make a canal. Increasing population, rapid industrial development and the necessities of international commerce are making rapid transit an economic necessity.

The Suez Canal was in response to commercial exigencies; the Panama abortion was on the same line, and the Nicaragua is in coincidence with the same commercial necessity. The movement is not local, but general. The necessity is cosmopolitan. Germany connects the North Sea with the Baltic; Greece digs a channel across the Isthmus of Corinth; England leads the Mersey from Liverpool to Manchester, and proposes a deep cut through the peninsula of Malacca to shorten the ocean voyage between India and China. All these attempts converge in a reconstruction of international relationships, and practically illustrate what we have repeatedly stated in *The Age of Steel*, that the industrial and commercial affinities of nations are really the pivot on which swings the destiny of the human race.

In a home sense we are helping to fill out the divine programme. We have joined the Chesapeake with the Delaware, and have made the Great Lakes a chain of inland seas. It is but a question of time when ocean steamers can load at Chicago and discharge their cargoes in Liverpool, and New York have an unbroken waterway to Lake Michigan. Florida will yet be an island, and the vessels of the Gulf Stream pass through its everglades and orange groves. In short, modern engineering and commercial necessity will add the ship canal to the triumphs of civilization and the service of international commerce.

The Future Railway Map.

Railways are rapidly changing international relationships and the character of nations. Isolation and the prejudices it engenders is going, as feudalism and slavery have gone, into the ash-pit of history. Nations now are neighbors, and notwithstanding all political jingoism to the contrary, it is becoming an economic and historic fact that as we shorten distances and develop commerce we reduce the possibilities of misunderstanding and rupture. In this kind of evangelization the railroad has been one of the most vital and important factors. It has done much, and is destined to do more. The steel rail will yet be a planetary institution. It is annexing the globe, and when complete will radiate from the equator to the poles. It is just 24,000 miles round the waist of Mother Earth, and when the Bessemer girdle is complete some 20,000 miles can be traveled in a palace car. From New York and other Eastern points we can travel to San Francisco, thence to Alaska, can cross what will be but an ocean ferry to Siberia, and on to China and India. The gorges of Afghanistan will pass in panoramic grandeur before the traveler as he glides along to Russia in Europe; Berlin, Paris and London will be scheduled in the same time-table, and an Atlantic trip of five days will see the cosmopolitan American in sight of the Hudson. It is simply a question of time, and in less than two decades will probably be an historic fact. The Siberian railway is being pushed with vigor, and the American link, missing in Alaska, will, without a doubt, be supplied in a few years, and the railway map of the planet be complete.—*The Age of Steel.*

Romance of the Sky.

By the increased power of telescopes, the number of stars within our ken has been increased from 2,000, the number which may be seen in both hemispheres by the naked eye, to probably about 80,000,000. The star nearest to the earth, α Centauri, is about 275,000 times as far from us as the sun is, and Sirius is about twice as far away as that; if, however, we could view these bodies at an equal distance, α Centauri would appear nearly twice as bright as our sun, and Sirius 40 times as bright.

Star 61, Cygni, has a velocity of not less than 30 miles a second, or 3,000,000 miles a day. So far, then, we find that the stars are at different distances; that they are of different sizes, and that, instead of being fixed, they are all in movement.

Such bodies are masses of glowing gas, the materials of which are, for the most part, precisely the same as those of which our earth is built up, the great difference between such stars and the earth at the present time being that they are hot, while the earth is cold.

The sun is so hot at present that its outer atmosphere, instead of being composed of cool oxygen and nitrogen and water vapor, as happens with our own, consists of brightly shining hydrogen gas and iron vapor chiefly. The iron is not solid and it is not molten, but exists as iron steam at, perhaps, a distance of 200,000 miles above the shining orb that we see and call the sun. This, I think, may be taken as a fair indication that the sun is a very hot body, especially when we remember that as its center is approached, the temperature must always increase.

I have said this much about the sun, because it is very natural to ask whether all stars are like the sun. It used to be thought that they were, but I, for one, do not think that this is so. When we come to examine the bodies which shine in the sky, those dim patches of gray light called ne'ulæ, as well as many of the stars themselves, the prism tells us that the light which they send to us is very different from the light sent to us by the sun and by other stars, the light of which is exactly like sunlight.

A great deal of work recently done shows that probably many stars, instead of being like the sun, are built up, as the comets are, of enormous clouds or swarms of little bodies, some of them, perhaps, no bigger than grains of dust, the different quantities and qualities of the light given out depending upon the motions of these little particles and the average distance between them.

So, when we have a great many of these little masses closely packed together and moving rapidly, they will have an opportunity to strike one another and thus produce light and heat in a greater degree than can happen in those other so-called "stars," where the dust is sparser and the motion less rapid.

This is an idea which has lately been suggested, and I refer to it here because it appears to make clear a great many points on which children even of a larger growth have long been puzzled.

In this way, we pass from what we see in the heavens as patches of milk-white light, called nebulæ, to other bodies even hotter than our sun, and when the stage is reached in which we see specks of light merely, and deal with "stars," properly so called, we get a hot body which increases in temperature as all the little particles arrive at the center, until the motion of all of them has been changed into heat, and a ball of vapor results, very, very, hot.

As soon as the supply of heat ceases, the mass begins to cool. Our sun is such a cooling mass. The cooling goes on until at last a body such as our own earth is formed. This is why it is that the chemical composition of the sun and earth are so similar.

If this is what really happens we can easily explain the colors of all the stars. Each stage of heat in a star has its own special color. It is true that sometimes very nearly the same color is produced at two different stages of heat; but aside from this, we know that very white stars are at the condition of their greatest heat, and that yellow stars are cooler, though some are old, some young; and that very red, but especially blood-red stars, are tottering on the verge of invisibility, having run through all their changes.—*Norman Lockyer.*

The Improvement of Predictions.

The principal problem which the new Weather Bureau will try and solve will be the improvement of the predictions. If this can be done, the financial loss due to miscalculations regarding frosts, rainfall, droughts, and great storms will be much lessened as related to agricultural, marine, and commercial interests. Professor Harrington believes that the forecasts of local rain can be improved by greatly extending the number of local stations, and that observations taken high in the air will greatly aid the advancement of weather science. He is at present actively engaged in establishing local centers of weather prediction, it being part of his plan to especially emphasize the importance of local indications. It has been discovered during recent years, while carrying forward the signal service work, that the predictions at Washington for the country in general were not equal to the special predictions made at local centers. This was shown in the excellent results achieved by Sergeant E. B. Dunn, of New York, and J. W. Smith, of Boston. The admirable local predictions made by Mr. H. H. Clayton, of the Blue Hill Observatory—Mr. A. Lawrence Rotch, director—near Boston, Massachusetts, also emphasize the importance of these local stations. Washington is merely the executive office. New York and Boston are the most important stations for observation, owing to their vast marine and commercial interests and the widely diffused suburban population affected by the local weather forecasts for these cities. The investigation of local storms by the New England Meteorological Society—Professor William M. Davis, director—has shown that a line of rain a few miles in width but many hundred miles in length may steadily advance over an immense extent of territory. It is clear that when the Weather Bureau has increased the number of local centers of weather prediction the approach of rain will be announced with such an improvement in the verifications that the results will be of great value.

Under the Earth.

The workmen in the deepest mines of Europe swelter in almost intolerable heat, and yet they have never penetrated over one seven-thousandth part of the distance from the surface to the center of the earth. In the lower levels of some of the Comstock mines the men fought scalding water and could labor only three or four hours at a time until the Sutro Tunnel pierced the mines and drew off some of the terrible heat, which had stood at 120 degrees. The deepest boring ever made, that at Sperenberg, near Berlin, penetrates only 4,172 feet, about 1,000 feet deeper than the famous artesian well at St. Louis. While borings and mines reveal to us only a few secrets relating solely to the temperature and constitution of the earth for a few thousand feet below the surface, we are able, by means of volcanoes, to form some notion of what is going on at greater depths. There have been many theories about the causes of volcanoes, but it is now generally held that though they are produced by the intense heat of the interior of earth, they are not directly connected with the molten mass that lies many miles below the immediate source of volcanic energy. Every body knows that many rocks are formed on the floor of the ocean, and it has been found that a twentieth to a seventh of their weight is made up of imprisoned water. Now, these rocks are buried in time under overlaying strata which serve as a blanket to keep in the enormous heat of the interior. This heat turns the water into superheated steam, which melts the hardest rocks, and when the steam finds a fissure in the strata above it breaks through to the surface with terrific energy, and we have a volcano. We find that these outpourings that have lain countless ages many thousands of feet below the surface are well adapted to serve the purposes of man. Many a vineyard flourishes on the volcanic ashes from Vesuvius, and volcanic mud has clothed the hills of New Zealand with fine forests and its plains with luxuriant verdure. The most wonderful display of the results of volcanic energy is seen in the northwestern corner of our own land, a region of lofty forests and of great fertility.—*Goldthwaite's Geographical Magazine.*

A Useful Invention.

One of the most ingenious and at the same time practically useful among the automatic machines which have been introduced of late is a device which forms, fills, weighs, and seals packages in those establishments where large quantities of goods, such as fine-cut tobacco, soda, starch, &c., are constantly put up. The operation by which this result is accomplished, though decidedly novel, is not at all complex in any particular, the machine consisting merely of a series of forming blocks, receptacles, folders, gummers, and feeders, all working in mutual harmony, so that the packages are smoothly and continuously produced. The forming blocks successively size the paper, which instantly afterward is wrapped around them, folded and gummed at the end; the paper sacks are then plunged into receptacles filled with the commodity for which they are intended, finally folded on top and sealed.—*New York Sun.*

USEFUL INFORMATION

Kauri Gum and "Swaggers."

Kauri gum is an amber-like fossil resin, which is used as a base, instead of gum-mastic, for fine varnishes. Kauri gum digging is one of the industries peculiar to New Zealand. In former ages vast forests of the Kauri pine must have been burnt in the north part of the North Island, and the resin melted down into the ground and became deposited in lumps. These lumps vary in size from a thimble to an anchor, and can be dug up by any one able to handle a spade. Gum land is considered worthless for any other purpose, but as it yields to the value of nearly two millions a year for export, and the supply seems inexhaustible, it has an unquestioned worth of its own. As no apprenticeship is needed to make a gum-digger, and no capital but a shovel, the unemployed take to it when they have nothing better to do; waifs and strays also, because of the element of uncertainty in it that appeals to the gambling instinct. The regular army of labor looks down on the work, and classes the workers with the "sundowners," or "swaggers," who roam over the country in search of employment, terribly afraid lest they may find it. To run as little risk as possible, they take care not to appear at farmsteading or station till a little before sundown, sauntering then into the yard, swag or red blanket rolled into a pack on their back, requesting, in humble or insolent tones as may be, food and a night's lodging. The request is always granted, as the farmer or squatter has no wish to quarrel with men whose friends may drop accidentally a lighted match near his ricks on a dark night. They may be told to chop a little wood or do some chores in the morning, in exchange for their supper; but as a rule they feel that this implies a reflection on the hospitality of their entertainers, and before the household is astir, they have folded their swag and silently stolen away. It is only fair to add that I have heard of this class of the population not at first-hand. The "swagger" has probably a different story to tell from the squatter. So, doubtless, has the Kauri gum digger; but neither had I the good fortune to fall in with any member of that interesting profession. It is difficult to understand why in a country like New Zealand there should be so many tramps, but it is unnecessary to enter on social questions at present.—*From "New Zealand," by G. M. Grant, in Harper's Magazine for August.*

Increase of Suicide.

There seems no doubt that a notable increase of cases of suicide is in progress among civilized nations. Comparative statistics are hard to obtain and are often open to question, but that the present century has witnessed a steadily increasing proclivity to suicide in Europe seems indisputable. A recent writer computes the suicides of Europe at sixty thousand annually, and believes that while this number represents the recognized cases of suicide, we should require to double it in order to reach the true figure, and to include secret or unrecognized cases. Germany affords the largest relative proportion of cases, France and England follow next in this order, while Spain, Ireland, and Portugal are very little given to suicide. The Slavonic race is the least suicidal in Europe. As a general rule, suicide is relatively more frequent among the civilized and cultured than among the ignorant and barbarous. The list of notable suicides is a long one, and includes men in the very front rank of literature, science, art, politics, and war.

The causes of suicide are numerous and obscure. Probably no question opens up more diverse or more abstruse problems in sociology than the inquiry into the reasons that tend to make men weary of life. Racial idiosyncrasy (itself a very obscure subject, and capable, no doubt, of further analysis), degree and quality of the civilization attained, type of intellectual development, religion, the severity of the struggle for existence, disease—all these play their part in determining whether a larger or a smaller proportion of persons of unstable brains will elect "to bear the ills they have" or "fly to others that they know not of." Alcoholism is alleged to be the chief obvious cause of suicide in Northern Europe; but before we can admit this doctrine we should require to investigate the causes of alcoholism itself, to determine how far it is itself a symptom of nervous instability, or an index of misery, over-pressure or boredom. No error in sociological inquiry has been more wide-spread or pernicious than the tendency to accept alcoholism as an ultimate fact, requiring no further explanation or analysis, and to trace to the fact of alcoholism all the deplorable evils which follow in its train, without regard to the predisposing causes or the associated conditions. The same hereditary or racial peculiarities that incline one individual to alcoholism *minus* suicide, may incline another to alcoholism *plus* suicide.

It is very striking that absolute want and destitution do not seem to be frequent causes of suicide. The abjectly poor and the utterly ignorant do not in any considerable numbers seek to terminate their misery by self-destruction. To incline to suicide there would seem to be required a sharp disparity between either the present and the past social condition of the individual or between his desires and his attainments. The hereditary or chronic pauper, however miserable his state, rarely thinks of violently terminating his sufferings, probably because he has become accustomed to them, or has only a vague realization of the difference between what is and what might be. On the other hand, the man who has fallen from comfort and social consideration to utter need is in danger, because he vividly realizes the contrast between the present and the past. Somewhat parallel is the fact that it is the more intellectually gifted races that are most prone to seek refuge in suicide. The intellectual German or the sprightly Frenchman inclines to self destruction, whereas the phlegmatic Slav has no such inclination.

It is in this connection that the very unwelcome fact of the tendency of education and culture to increase the proclivity to suicide finds its explanation. Education, while immeasurably increasing the usefulness and enlarging the enjoyments of the individual, also multiplies his wants, and if those wants cannot be reasonably satisfied, irritation and unrest ensue and may predispose to suicide. We must recognize this fact, and it need occasion no surprise. The man whose mind has been expanded by science, art, or letters cannot be satisfied, like ignorant Hodge, with a hunk of bread and cheese, a pipe, and a quart pot. The former has aspirations which cannot be stilled without danger, and the gratification of which may be beneficial, not only to himself, but to his fellows. The enormous benefit of education is that the new wants which it creates are in the main intellectual, and that their legitimate satisfaction tends to wean the individual from the gratification of the senses. The conclusion to be drawn is, not that the perils of education outweigh or even seriously detract from its advantages, but that as education spreads, adequate provision must be made for the satisfaction of those new wants which this spread involves.

We are apt to attribute the growing tendency to suicide to the nervous wear and tear of an age of over-pressure, to the railway, the steamboat, the post, the telegraph. This has become one of the commonplaces of the day, but it is only one side of the question. Suicide is common in stagnant China, whether from religion, misery, boredom or that weariness of life which seems one of the inevitable concomitants of an ancient civilization. There is under-pressure as well as over-pressure. Legitimate and normal development is foreign to both.

We have mentioned religion, and no account of suicide could be at all adequate which neglected this essential factor. Every classical scholar knows how profound is the difference between the ancient and the modern mind on this subject, and this difference is due mainly at least to the teachings of Christianity. The ancient Greek and Roman saw nothing wicked, but rather everything meritorious, in voluntarily terminating a life which had been robbed of all happiness and value by domestic, personal or national calamity. Aristotle, Demosthenes, Cato, Seneca, and Hannibal sought refuge in suicide from overwhelming misfortune, and their example, so far from being condemned by heathen writers, was held up to admiration and imitation. Christianity, however, from the first put its darkest stigma on self-murder, and contributed powerfully to the dissemination of that sentiment of horror which now surrounds—probably very salutarily—the subject of suicide.—*Lancet.*

As to Thermometers.

The aperture in the tube of a thermometer is smaller than the finest hair. Though it appears to be round, it is not; if it were, the mercury could not be easily seen. It is, therefore, made flat, and then the glass magnifies it so that it seems to be quite large. To bring it out still more distinctly, a maker of Boston recently conceived the idea of backing the tube with a thin film of white sizing. This device is now generally adopted by the foreign makers.

Mercury is generally used in thermometers because it is more regular in its contraction and expansion. It is, indeed, impossible to make a spirit thermometer that will be as trustworthy as one in which mercury is used. In a mercurial thermometer the degree marks are all the same distance apart, because the expansion under all conditions is uniform; but in a spirit thermometer the degrees are wider apart at the top, because the expansion increases at a greater ratio after a certain temperature is reached. Though not so trustworthy, spirit thermometers are necessary, as mercury freezes at forty degrees below zero. Spirits of wine is generally used, and is colored red, so that it will be more visible to the eye.

In a correct thermometer, the scale is graduated to the requirements of the tube to which it is fitted, so that every correct thermometer must have a special scale of its own. That is to say, it wouldn't do to put the tube of one thermometer in the frame of another. Of course, in the very cheap grades of thermometers such accurate adjustments are not made, and, therefore, their records are only approximately correct. The best thermometer tube made will cost about five dollars; but a thermometer may be made to cost almost any price, according to the way in which it is mounted.

As every one knows, the Fahrenheit scale is that most commonly used in this country. Fahrenheit arbitrarily assumed a limit of cold which he termed zero. This makes the freezing point thirty-two degrees above zero and the boiling point two hundred and twelve degrees above zero. As a matter of fact, however, in northern latitudes the temperature in winter frequently falls below the zero point, so that there is no scientific reason why the zero point in the Fahrenheit scale should be where it is. A much more scientific scale is that known as the centigrade, which marks the point at which water freezes as zero, and divides the space between that and the point at which water boils into one hundred degrees. In the Reaumur scale zero marks the freezing point and eighty above zero the boiling point. Many self-registering thermometers are now used. These instruments mark the highest or lowest temperature reached, as the case may be, so that one may return at night feeling assured that the weather can play no pranks without his learning of them.—*Scientific American.*

The Value of Education.

The assertion of Charles A. Dana, in his speech on Horace Greeley, that he was a man of no education at all, except what he had acquired himself, and that this was a great disadvantage to him, has elicited considerable discussion pro and con. Mr. Dana recognized Greeley's remarkable abilities, and a fair construction of his language is that the subject of the oration could have made his abilities of far greater effect if he had started with the advantages of college training. Nevertheless such a sweeping declaration as, "there is no greater misfortune for a man of extraordinary talent than to be educated by himself, because he is of necessity a very poor schoolmaster," warrants some of the sarcastic retorts taking "the remarkably successful career of Greeley as an illustration of the disadvantages of self-education." The fact is that a great deal of dispute about the advantages or disadvantages of self-education is necessarily befogged by an uncertainty of terms. Taking the word in its broadest sense, all men who have earned eminence in any sphere of effort are self-educated. Whether in political or social philosophy, scientific investigation or commercial effort, every successful man knows he has gained his greatest knowledge and his most complete grasp of details of his special work by the thorough lessons of practical experience. If a man is not self-educated in the sense of learning for himself the lessons of life, the judgment of human nature and the complete mastery of the details of his special line of effort, he will never amount to much, whether he goes through college or not. Of course this is not the kind of education in dispute, but it is important in this discussion as showing what the training of colleges and books must have reference to. But the discussion of the value of college training must depend on the kind of education that obtains there. The college teaches its student that it will at best only give him a groundwork for beginning the greater education of practical experience. If it trains him in habits of mind that will digest the lessons of life most advantageously, and impresses him with the seeming paradox that the object of education is to teach us that at best we know comparatively nothing, then Mr. Dana is right in saying that even a man like Greeley would have been better off if he had started in life with that advantage. But if the preliminary education starts the graduate into actual life with an idea that the comprehension of the digamma, or theoretical familiarity with conic sections, places him on a plane of mental superiority above men who have learned the lessons of actual work, then Mr. Dana's critics are right. The first thing a student who has received such an education has to do is to unlearn his lessons, and it sometimes takes him all his life to do it.—*Pittsburgh Dispatch.*

HOW TO LIVE

The Value of Walking to Health.

Few things, if any, are so effectual in building up and sustaining the physical organization as walking, if resolutely and judiciously followed. It is a perfect exercise. It taxes the entire system. When you walk properly every member and muscle, every nerve and fiber has something to do. The arms swing backward and forward, keeping step, as it were, with the legs; the chest expands and contracts as the lungs fill and discharge; the drummer boy pulse beats a tune for the march; the legs curve and straighten; the feet rise and fall, while the head rides over all—but not as a dead head. Every sense it has is employed, every faculty alert. The nostrils expand to quaff the breeze; the ear turn to every sound; the eyes roll in their sockets, sweeping from left to right, from earth to sky; the brain is at work through all its parts. Progress under such conditions is the very eloquence of physical motion. What is the effect? The flesh is solidified; the lungs grow strong and sound; the chest enlarges; the limbs are rounded out; the tendons swell and toughen; the figure rises in height and dignity, and is clothed with grace and suppleness. Hunters, who walk much, are tall and straight, while sailors, who scarcely walk at all, are low and squat. The whole man is developed, not the body merely. The mind is broadened by the contemplation of creation's works, the soul is enlarged, the imagination brightened, the spirits cheered, the temper sweetened. The moral forces are strengthened equally with the physical. A loftier reverential feeling is awakened, if not a profound religious sentiment. No one who rightly walks the fields and groves, or climbs the heights beneath the heavenly dome, with its blazing sun by day and its moon and countless stars by night, but is irresistibly drawn toward the Infinite, as he "looks through Nature up to Nature's God."—*A Sexagenarian, in Belford's.*

The Summer Sea.

Commend us, at this sultry season, to a quiet spot on the margin of the sea. The fashionable bathing-places are delightful, no doubt, to persons who would consider it undignified to shake hands with the sea-gods except in kid gloves; but those who love the ocean for itself prefer to enjoy its buffets and its breezes where there is more elbow-room and less ceremony. When one reflects that the Atlantic sea-board extends from latitude forty-four almost to the edge of the northern tropic, it seems absurd that multitudes professedly in search of health and ease should consent to be penned up, season after season, like sheep in shearing-time, in five or six pet localities not a whit superior in natural advantages to hundreds of others that may be found within convenient distances of the great centers of population. But if the world of fashion were disintegrated, the fragments would be of small account; it is only when massed together that its gorgeous splendors provoke the envy which is so dear to its votaries.

Sea-air is somewhat too pungent for weak or unsound lungs; but where there is no pulmonary disability or disease, it is the finest invigorant in the world. And how gloriously the Atlantic bath supplements the Atlantic breeze. *Elixir vitæ* passes into the system through every pore. The circulation is quickened and a salutary chemical change is wrought in the blood itself.

Nothing in nature presents such an endless variety of forms and phases as the sea. The earth changes its aspect only with the seasons, but the ocean is more changeful even than the clouds. Its lights and shadows shift momently, and of all its myriads of acrobatic billows, no two perform their somersaults alike. How glorious to stand on the yellow beach and see, rank on rank, the white knights of Neptune, with foam-plumes streaming from their emerald helms, come charging in! What is the shock of armies to the collision between raging sea and rock-bound shore! What are all the trumpets that ever pealed defiance in the field to the shout of the multitudinous waves as they dash themselves against the gray ramparts that have baffled their onset since time began! "Calm or convulsed," the sea is a perpetual poem.—*New York Ledger.*

Hot Weather Suggestions.

At the opening of the heated term a few good resolutions should be made. Among the first should be one to cultivate tranquility of mind. Nothing more conduces to comfort of body. In hot weather a fiery argument is almost as productive of a raised physical temperature as is a brisk walk in the blazing sun. Moreover, its effects are less rapidly dissipated, for it is easier to sit down and get cool after bodily exertion than it is to so subdue the perturbed mind that it will not cause a series of "hot flushes" for possibly hours after a vehement discussion.

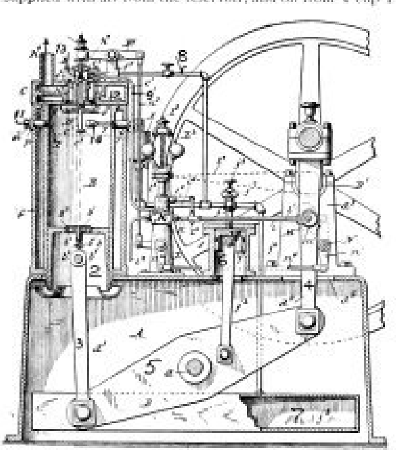
The same rule that applies to undue exercise of the tongue and temper should be observed in intellectual pursuits conducted in the dog days. Do not attempt to shirk steady work in this line, but let all you do be done methodically not spasmodically. Adherence to the German motto, "Without haste, without rest," relentless as it seems, is really less wearying than a series of violent efforts resulting in a fatigue which can be relieved only by utter repose.

So much for the mental attitude in hot weather. The bodily condition is of equal importance. Many people seem to think that ease in summer can only be obtained by laziness, that employment of any sort is the mortal enemy of *bien-être*, and so devote the whole of the long days to what is expressively termed "loafing." What wonder if for them the weeks drag drearily, and that they hail the return of shortened days and frosty nights as a release from ennui?

There is no better way to keep cool than to have some regular occupation, be it never so trivial, that will serve to divert the mind from the bodily condition. No matter what this employment may be, whether the charge of certain branches of housework, the doing of the family mending, the conducting of a course of reading, the studying of a language or a science—whatever it is, let it be made a duty, and followed conscientiously.

OIL ENGINE.

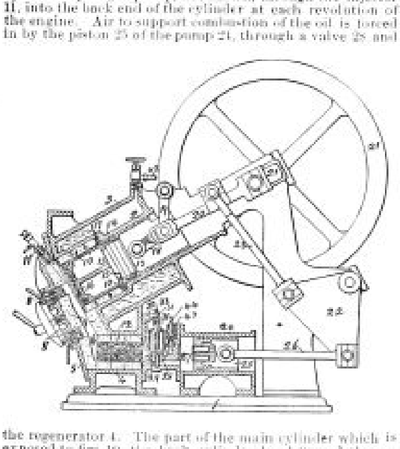
No. 432,260. George B. Brayton, Boston, Mass. *Patented July 15, 1890.* This engine burns a fine spray of oil, in a chamber full of compressed air, and the resulting expansion furnishes the power. The working cylinder B, is vertical, and the long piston 2 is connected to the main crank by the rods 3 and 4, and beam 5. An air pump 6, driven by a rod from the main beam 5, compresses air and stores it in a reservoir 7. A small plunger pump K, on the governor stand, is worked by an eccentric on a shaft M below the main crank shaft. Shaft M is driven by gearing at one half the speed of the main shaft. In this pump the usual clack valves for supply and discharge are not used, and their place is supplied by a small slide valve driven by another eccentric on shaft M. The connection between the plunger of the pump K and its eccentric rod is loose, to permit great lost motion. The governor moves a tapering key up and down between them, varying the lost motion and consequently the stroke of the plunger—thus regulating the amount of oil forced into the working cylinder, through the pipe 9. A burner 10 is kept constantly glowing in the top end of the cylinder, to fire the charges as they come in. This burner is a small metal shell filled partly with asbestos and loose spirals of platinum wires, and is supplied with air from the reservoir, and oil from a cup I.



This burner is lit by a torch inserted through a window 11 in the side of the cylinder, when starting engine, and remains incandescent as long as the engine runs. The inlet valve 13 and exhaust valve 12 in the top of the cylinder are operated by the lever F, which is moved by suitable rods and a cam on the shaft M. When valve 13 rises it allows a gust of compressed air to blow the oil supplied by pipe 9 down the hanging tube to the deflector shown at its lower end, which throws it upward toward the cylinder head in fine spray, past the burner 10 which fires it. This occurs when the piston is near the top of its stroke and the air in the cylinder is greatly compressed. The instantaneous heating of this body of air produces a powerful pressure which drives the piston B downward. As it rises the exhaust valve 12 is opened and the spent air and gases are expelled. During the next downstroke the valves 12 and 13 remain closed, and the cylinder fills with fresh air through the poppet valve in the piston. As it rises again it compresses the entrapped air, and at the top of the stroke another charge of oil spray is blown in and fired as before. It will be seen that the engine is independent of gas works, and can be used anywhere that oil can be procured, and produces no dust, no ashes, or danger of explosion.

HEAT ENGINE.

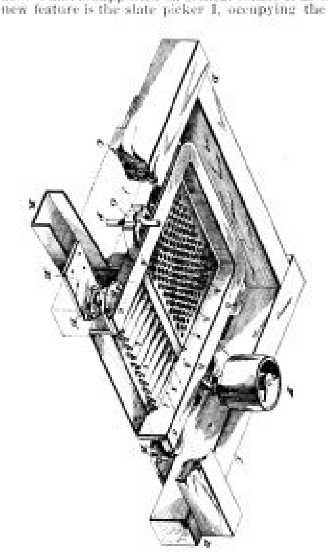
No. 436,781. James Hargreaves, Farnworth, England. *Patented Sept. 23, 1890.* Oil or other liquid is forced by a small plunger-pump, not shown, through the injector 11, into the back end of the cylinder at each revolution of the engine. Air to support combustion of the oil is forced in by the piston 25 of the pump 24, through a valve 28 and



the regenerator 4. The part of the main cylinder which is exposed to fire 10, the back cylinder head 9, and the regenerator 4, are all lined with non-metallic refractory lining, which is kept at a high temperature by the flame. The piston is composed of two parts, a shell 16, which is in contact with fire, and the piston proper 13, which is provided with packing rings 14. The lining of the cylinder is made to fit the piston shell 16 as closely as possible without touching it. The regenerator 4 is filled with small spiral pieces of refractory material, which absorb heat from the burnt gases as they are pushed out by the main piston, through the exhaust-valve 29, and give it out again to the air pushed through the valve 28 by the air pump piston 25. The amount of oil injected at 11 is governed by a common centrifugal governor. The main cylinder is provided with a jacket 3, and the space between them is filled with water. Owing to the high temperature of the cylinder the water is made into steam, and it passes out by the pipe 42 to a valve 44. At each stroke of the engine this valve is opened and the steam blows into the regenerator along with the air driven in by the air pump. There is no explosion in the cylinder as in common gas engine, but a very rapid combustion, which greatly expands the air and products of combustion, and produces pressure upon the piston. The lining of the cylinder head quickly becomes red hot, and ignites and gasifies the injected oil, and no firing burner is needed after the engine is started.

SLATE PICKER.

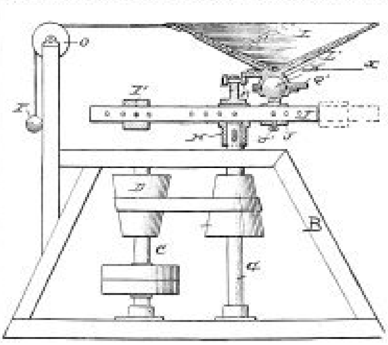
No. 450,482. Eckley B. Coxe, Drifton, Pa. *Patented April 14, 1891.* The screen frame A and screen plate H is the same as that previously described in The Colliery Engineer for January, 1891. The screen is shaken by the cranks G G and is supported on conical rollers E as before. The new feature is the slate picker I, occupying the front



half of the pan. It is composed of a series of parallel bars *i* set with their top surfaces inclined, and the edge of each bar lapping under the next, but leaving a narrow slot between them. The flat pieces of slate either pass through these slots, or are caught by them and prevented from passing off into the next screen with the coal. The slate which passes through passes off by the trough K.

ORE CONCENTRATOR.

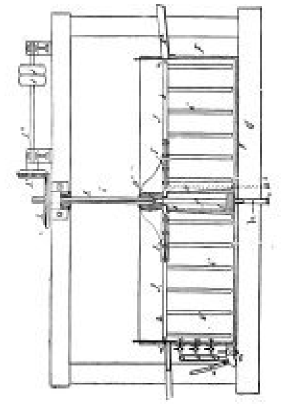
No. 450,013. Walter J. Hammond and John Gordon, Rio De Janeiro, Brazil. *Patented April 7, 1891.* The construction of this ore concentrator is based on the fact that if particles of ore are placed in a vessel containing water and the vessel is revolved, its center of gyration lying between the center of gravity and the outside edge of the vessel, they



will arrange themselves in the order of their specific gravity. Water in motion will lift and carry substances of much greater specific gravity than its own, the velocity of the water determining how heavy a body can be carried. The motion of the particles in the vessel among themselves is greatly facilitated by turning the vessel at the same time that it is rotated on its own axis. On the upper end of the shaft G is secured a carrier H, on which is held adjustably a horizontally extending bar I, carrying at one end a counterbalancing weight I^{3}, and supporting at its other end a sleeve J, held adjustably on the bar I by a set screw J^{1}. On the top of the sleeve J is a ball K carrying a vessel L, having the shape of an inverted cone, shown in figure. The outer edge of this vessel L extends beyond the axis of the shaft G, so that the latter is located between the outer edge of the vessel and its axis which is in the center of the ball-joint K L^{1}. A rope N is connected by one end with the outer edge of the vessel L, the said rope passing over a pulley O to a weight P. Now, when the shaft G is rotated from the main driving shaft C the vessel L revolves and at the same time it is turned on its own axis by being connected with the rope N, carrying the weight P, so that the vessel turns once on its own axis while revolving once. The belt is shifted on the cones to impart a faster or slower rotary motion to the vessel L while revolving as above described. It will be seen that the sleeve J, supporting the vessel on the bar I, can be adjusted on the latter, so as to increase or diminish the distance between the axis of the vessel, and the axis of the shaft G, said distance never being greater than the distance between the outer edge of the vessel and its own axis.

SETTLING AND AMALGAMATING PAN.

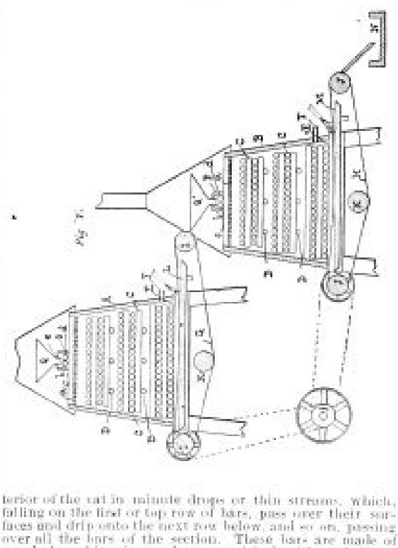
No. 440,552. William A. Merralls, Kansas City, Mo. *Patented March 31, 1891.* This pan is provided with a revolving stirrer J which is turned by gearing L L^{1} as shown. The stirrer is lifted out of the pan, and lowered down to its work as gradually as desired, by means of steam or water pressure in the cylinder H. The center spider I, of the stirrer, turns freely on the top end of the piston rod f^{1}, and by regulating the pressure applied through the pipe *h*, the stirrer can be made to operate at any depth. Instead of the



stirrer shown, settler plow shoes, or mullers can be used equally well. In case of accident—say at the moment of a belt breaking—by one turn of the cock in the pipe *h*, the spider and its adjuncts can be raised out of the quickly settling pulp, and thus the danger of its becoming stuck in the mass avoided, and as compared with the old styles of pans operated, say by right and left hand screw, with which much time and labor are consumed in turning the screw for the purpose of raising and lowering the spider and its adjuncts, this invention is a great improvement.

LIXIVIATION APPARATUS.

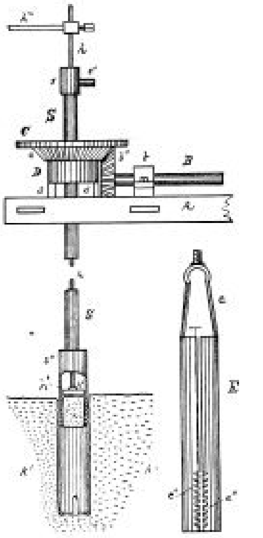
No. 449,814. Samuel W. Cragg, Baltimore, Md. *Patented April 7, 1891.* The gold and silver bearing ore if ground or pulverized and subjected to a chloridizing roasting. It is then introduced into the hopper of the vat A, from which it passes to the trough O. On entering the said trough it is divided into two streams, one falling in front of each of the pipes *c* and *d*. At the same time leaching water is admitted into the trough from an elevated tank (not shown) through the said pipes, and meeting with the finely ground ore carries it in opposite directions in the trough. The effect of these reverse currents is to thoroughly mix the ore and the water. The pulp thus formed overflows the sides of the trough or through the aperture *e* and falls on the wooden grating *a* and passes through it into the interior of the vat in minute drops or thin streams, which, falling on the first or top row of bars, pass over their surfaces and drip onto the next row below, and so on, passing over all the bars of the section. These bars are made of wood, dry white pine, and are varnished with asphaltum. It then falls through a current of atmospheric air circulat-



ing between the sections and strikes the first row of bars of the second section, and, passing over these bars, drips from one row to the next one below, and so on, from one section to the next one under it until it falls on the filter. The passage of the pulp over these round surfaces, which are separated from each other, greatly facilitates the breaking up of the chlorides and the salts of the base metals. All the globules of gas formed in the water are broken and all deleterious gases generated by the decomposition of the chlorides or salts of the base metals—such, for example, as sulphureted hydrogen—which would precipitate gold, are diluted by the currents of air circulating in the vat and are carried off. The pulp drips onto the endless cloth or apron G, which is carried forward by the horizontal rollers I, around which it is stretched. Both aprons G and H are driven continuously forward by belting as shown. There is thus a continual renewal of the filter surface under the vat, and as a very small quantity of pulp not exceeding a sixteenth of an inch in thickness, is deposited at any one place on the cloth, the liquor is soon filtered and passes into the trough L. As the filter-cloth carrying the pulp passes out from under the vat A the pulp may be sprayed with water to wash out any of the leaching water or soluble salts remaining in it. This wash water is also collected in the trough. As the apron G advances and passes over the roller L the pulp falls or is scraped off into the hopper Q, from which it passes through the mixer P into the second vat B, where it is treated in a similar manner, with a solution of sodium or calcium hyposulphites supplied from an elevated tank, not shown. The tailings are sluiced away in the trough N. Each tank is covered by a hood and has a pipe to carry off the gases liberated below.

CORE DRILLING APPARATUS.

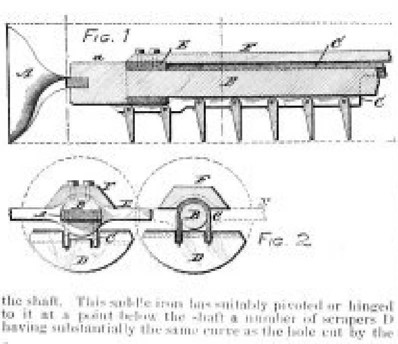
No. 450,656. Moses Beal, Elyria, Ohio. *Patented April 21, 1891.* The drill employed is a steel tube S[11], with teeth at its lower end. It is attached to a tubular drill-rod S in the usual manner and is rotated by the bevel gears C and D[11], by power applied to the shaft B. Water is supplied to the drill through the tube S and stuffing-box *s* as usual. To keep the core from breaking, a rod *h* runs down inside the drill-rod S and ends in a point which engages the top end of the core. The rod carries a loose collar h^1 which touches the inside of the drill, and is centered by it. The



core is steadied by the point of the rod *h*, and prevented from fouling with the drill—thus securing long sections of unbroken core. The extractor E is a sheet-metal tube open on one side, of somewhat smaller diameter than the core, and is provided with teeth e^{11} bent inward. It is easily forced over the core, but as soon as force is applied to lift it, the teeth e^{11} take hold and tear the core loose, and retain it within the tube, and it is raised to the surface. The loose collar h^1 has large notches in its edge to pass the water and borings.

SCRAPER FOR COAL-DRILLING MACHINES.

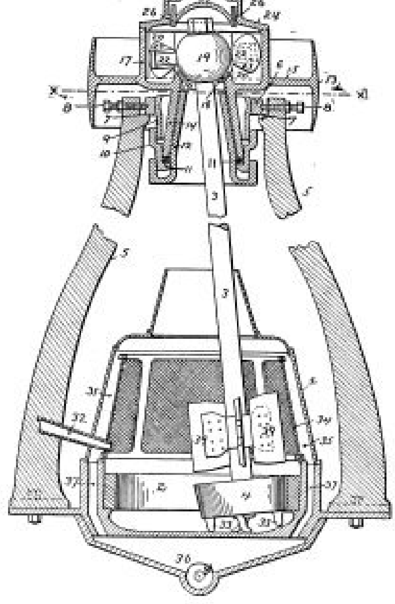
No. 448,829. Horace B. Wyman, Dover, N. H. *Patented March 24, 1891.* This scraper is designed to clear away the chips from machines which use a gang of drills for undercutting coal. The drill-shaft B has a saddle C, which rests upon said shaft and is of such shape as to partly inclose the shaft back of the drill and extends down below



the shaft. This saddle iron has suitably pivoted or hinged to it at a point below the shaft a number of scrapers D having substantially the same curve as the hole cut by the drill, said scrapers being free to swing on their hinged connections in the path of the drill, and not to one side. The saddle C, as before mentioned, rests upon the drill-shaft B and is reciprocated lengthwise with the shaft by the usual mechanism, and the scrapers being directly below the shaft and on the same line therewith, the cuttings will be cleaned from the path of the drill. When two or more drills are used, they are connected together by a suitable frame, the front end of the frame being shown at E, Fig. 2 of the drawings, the drill shafts passing through holes in the end of the frame, as more clearly shown in Fig. 1. To this frame at its front end is bolted a shield F to prevent the coal-dust from falling on the saddle and working in between it and the drill-shaft. When two or more drills are used, they are so placed with relation to each other that the cutting-path of one drill laps into the cutting-path of the adjoining drill, as shown in dotted lines, Fig. 2, of the drawings, thereby removing the partition between the two drills and making a continuous mortise in the coal, of a length equal to the space occupied by the gang of drills used.

GRINDING MILL.

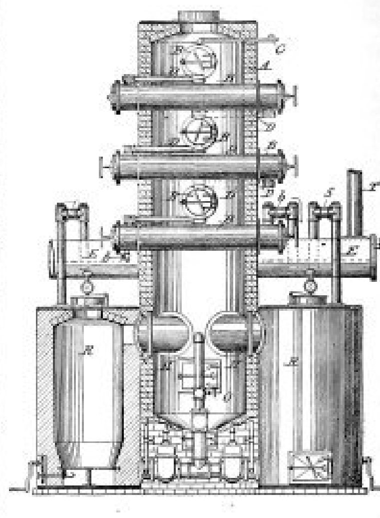
No. 449,118. Edwin C. Griffin, West Newton, Mass. *Patented March 31, 1891.* The ore is ground between the ring die 2 and the gyrating roll 4. The roll is thrown out and held against the die by centrifugal force. The ore is fed into the grinding chamber by the spout 32, and is stirred up and thrown against the die by scrapers 33 on the bottom of the roll. Fan wings 39, attached to the roll shaft 3, blow the finely ground stuff through the screens 34 into the casing 35, and from there it passes down holes 37 to a conveyor 36. The roll shaft is supported by a circular bearing ring 18 under the ball 19 which is fast to the shaft 3. The ring rests on the hub 14 of the pulley 13 and turns with it. The ball has two trunnions 22 provided with gibs or brasses 23 which



play in vertical grooves 20 in the enlarged upper part 17 of the pulley hub. This arrangement makes a universal joint, and permits the shaft to stand at any angle. The roll is turned positively by the pulley, at the same time that it is swung around against the whole face of the die. The pulley turns on a hollow bearing 12, which is screwed onto the collar 10. This collar carries washers 11 which afford a bearing for the lower end of the pulley hub, and it is adjustable by screwing it upon the sleeve 9, which has trunnions 6 resting on the lugs 7 of the main frame. Set-screws 8 serve to center the sleeve and shaft bearing. The suction produced by the fan blades below draws the dust and grit away from the bearings.

GAS APPARATUS OPERATED BY WASTE HEAT.

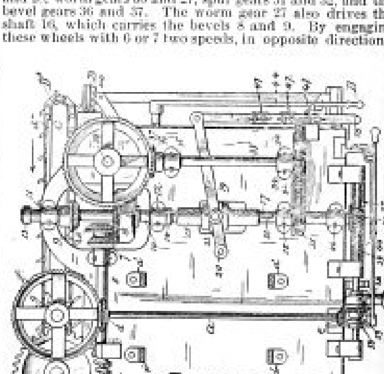
No. 437,315. John McKay, Titusville, Penna. *Patented Sept. 30, 1890.* The main flue A receives the waste heat from furnaces of any kind—or as shown in the drawing, from the generators R, of a water gas producer. Across the flue or hollow interior of these stack retorts B are arranged alternately at right angles to each other. An oil-pipe C extends in through the wall of said stack and supplies the uppermost of said retorts. The ends of the latter extend through the wall of the stack and allow connecting pipes D to be conveniently attached. Every retort, except the lowest, is connected by one of these pipes to the retort next below. In every instance the connecting pipe D is wholly outside of said stack. The lowest retort discharges gas through a pipe *b* at one end, and liquid with other residual material through a pipe b^1 at the other end. The oil in descending from the uppermost retort to the lowest is exposed, of course, to successive increments of temperature, and by the arrangement and connections of said retorts is compelled to travel in a circuitous course, repeatedly crossing the blast of the products of combustion, each time nearer to the source of heat. The gas which finally issues through the pipe *b* contains nearly all the volatile elements of the oil. There is no loss on the way by the oil coming suddenly in contact with an incandescent surface and being charred to an unserviceable form of carbon. The heat, though quite sufficient, increases so gradually that the oil is not injured thereby, and in each transition from one retort to another through a pipe D outside of the stack the oil is necessarily somewhat cooled by way of neutralizing any excess of heating action. It has been found in practice essential to vaporize the oil by gradual increase of heat in order to secure the greatest yield. It has further been found impracticable to have all the vaporizing surfaces and con-

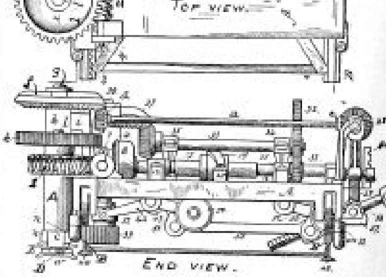


nections within the stack, as the smaller connections are liable to clog up, thus lessening the yield and causing considerable delay. The gas thus produced may be used by itself or employed for enriching coal gas, or, as illustrated in Fig. 3, for carbureting water-gas.

COAL CUTTING MACHINE.

No. 450,971. James H. McEwen and Burr E. Cartwright, Ridgway, Penna. *Patented April 21, 1891.* The cutters are attached to an endless chain D^1 which runs around an arm C, and is driven by a sprocket-wheel E on the lower end of the vertical shaft *l*. An electric motor, not shown, rests on the pads a^1 shown on the top view, and turns the shaft *a*. The motion is conveyed to the shaft *l* and cutter chain by the bevel gears *d* and *f*, and by a spur pinion (not seen) on the shaft *g* which drives the gear *k*. The machine runs on two rails B B, of any desired length. The front rail is provided with a rack which is engaged by the pinion 39 on the lower end of shaft 38. Motion is conveyed to it from the motor shaft *a*, by bevel gears *e* and 28, worm gears 30 and 27, spur gears 31 and 32, and the bevel gears 36 and 37. The worm gear 27 also drives the shaft 16, which carries the bevels 8 and 9. By engaging these wheels with 6 or 7 two speeds, in opposite directions,





can be given to the worm 2 which turns the worm wheel 1. The cutter bar C is attached to a long hub or sleeve which runs through the boss A on the main frame. The wheel 1 is keyed on the top end of this sleeve, and by turning the worm 2 the cutter bar and chain is swung around as desired. In starting work, the machine is placed on the rails B B close to the face, with the cutter bar in the position shown. The motor is started, and the bevels 6 and 9 are thrown into gear by the handle 18 and lever 19. The cutter chain is swung slowly against the face and it cuts its way into the coal until it stands at a right angle to the tracks. The lever 19 is moved to middle position leaving the worm 2 idle. The feed-gears 31 32 are now started and the whole machine feeds forward along the rails B B to any desired distance. When the end of the cut is reached, the gears 7 and 8 are engaged and the cutter bar is rapidly swung out of the cut.

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Coal and Metal Mining and Kindred Interests.

VOL. XII.—NO. 2. SCRANTON, PA., SEPTEMBER, 1891. WITH WHICH IS COMBINED THE MINING HERALD.

AN ELEMENTARY TREATISE ON THE PRINCIPLES OF COAL-MINING.

For the Use of Candidates for Mine-Foremen's Certificates, Mining Students, Mine-Foremen, Mine-Superintendents, Mining-Engineers, etc.

BY A. A. ATKINSON, DURHAM, ENG.

The last series finished with a paper by the late Mr. T. J. Taylor, and the following is another unpublished paper by the same gentleman, and it has some reference to the former one:

1. It has been shown that there are two distinct conditions of the existence of fire-damp in mines; one consisting of liberated gas, the emission of which is influenced by the state of the barometer; the other, and really dangerous condition, consisting of gas of a tension greatly superior to that of the atmosphere.

2. The receptacles of the fire-damp are the cellular tissues of the coal, and the cavities which are found to a greater or less extent in mines, more particularly along the lines of disturbance and fracture of the strata.

3. The emission of gas from the cellular tissue of the coal is slow and gradual, and such is the usual and manageable form of issue; it being neither by this form of its emission, nor by that of the liberated gas, that the great explosions of the mines of the North of England have been occasioned.

4. In the mines of class three, described in the first paper (the deeper mines with fire-damp at a great tension), a state of high tension is not casual nor accidental; but it is the natural condition in which fire-damp subsists, provided there are no means of spontaneous drainage. The cavities mentioned under head two, are filled with gas, the minimum tension of which is 4½ atmospheres, but the actual tension probably much greater; and when the intervening strata are compact enough to act, entirely or partially, as a dam, or when the rate of excavation is faster than that of drainage, the gas of these reservoirs will be discharged into the mine in a state, the tension of which has an indication in the displacement from the face of a block of coal of six tons at Jarrow, in 1830, and one of eleven tons at Walker, in 1845.

5. There are numerous ascertained instances of the discharge of high pressure gas into mines, and other cases in which it was obvious that such issue had been the cause of explosion; but in the majority of cases it is difficult to discover the source of issue when explosion ensues, and as no living witness remains of the fact, a peculiar degree of obscurity generally hangs over the immediate cause of these accidents.

6. Cases are cited in which air currents of 4·39 and 6½ feet per second were quite inadequate to dilute a stream of gas; and it is further shown by calculation from experiment, that our existing ventilating agencies are extremely feeble in comparison with the antagonist they have to contend against; and that if we were enabled to increase even tenfold the efficiency of these agencies, the ventilation would still be quite inadequate to meet the danger.

7. The cases of heavy explosions in the North of England have occurred, without a proved exception, in the whole mine, where the ventilation is the most perfect, but where the occurrence of eruptions of gas is most likely to be met with.

8. While good ventilation is, and will continue, essential for removing the ordinary and manageable gaseous products; and while it may be looked to as a security against the gases of mines of the first and second classes (first paper) it is yet manifest from the premises that we require some further means of protection, in the case of mines classed under the third head (the deeper mines); and though further research may lead to yet undiscovered measures of safety we are yet bound, in the meantime, to use the means in our power, and already devised, as a safeguard against explosions in those mines.

9. These means consist of the universal employment of the safety-lamp in the mines of the third class. Without giving a preference to any particular lamp, the experience of above thirty years in the mines of the North of England, has proved the principle of the Davy lamp to be an inestimable boon.

10. The expense of lighting mines with safety-lamps is, on the whole, less than that of lighting with candles; and though it is desirable to exclude naked lights as much as possible, yet the use of explosives, under proper regulations, is not inconsistent with that of safety-lamps.

11. With the safety-lamp exclusively in use throughout the mines of the third class, it is a legitimate conclusion that we should, in future, be as free from explosions in the whole mine as we now are in the pillar districts.

In the occurrence of an explosion of fire-damp the high temperature to which the explosive gases are raised, causes them to immediately assume a volume nearly double of that which they occupied before explosion; it checks the circulation of the air through the mine, and often destroys all obstacles opposed to its expansion. Immediately afterwards, the greater part of the water-vapor or steam condenses, and forms a relative vacuum, into which the atmospheric air rushes, and restores the equilibrium of pressure. These phenomena ensue so rapidly, that the workmen feel the shock and immediately experience the passage of the flame.

The following tables show the complete combustion of 100 cubic feet of fire-damp, and the resulting products:

MIXTURE BEFORE EXPLOSION.

		By Volume.		By Weight.	
		Cubic Feet.	Per Cent.	Pounds.	Per Cent.
Air.	Nitrogen...	740	71·15	56·03	72·21
	Oxygen...	200	19·23	17·85	22·23
	Total.....	940	90·38	73·88	94·12
Fire-damp..........		100	9·62	4·18	5·88
	Total.....	1040	100·00	80·36	100·00

MIXTURE AFTER EXPLOSION.

	By Volume.		By Weight.	
	Cubic Feet.	Per Cent.	Cubic Feet.	Per Cent.
Nitrogen	740	71·15	56·03	72·21
Carbonic Acid Gas..	100	9·62	12·29	15·29
Water-vapor(steam)	200	19·23	10·04	12·50
Total	1040	100·00	80·36	100·00

If the mixture of air and fire-damp is not in the proportion to cause an explosion, its ignition may not be attended with danger, and may only produce a flash. But the most terrible cause of destruction to life is the after-damp, which may spread through the whole mine, and kill more victims by its poisonous effects than the explosion itself.

If in the mixture to be exploded, there is present any excess of air or fire-damp, above the quantity necessary to ensure the complete combustion, the excess will remain in an unchanged state after the explosion, and be mixed with the after-damp. But there can never be such an excess of air before explosion as to render the after-damp fit to breathe, because the limits are such that, if there is an excess of air, no explosion can take place.

The following tables show the products of the extreme cases of explosion, with an excess of either gas:

MIXTURE BEFORE EXPLOSION.

		Excess of Air.		Excess of Fire-damp.	
		Cubic Feet.	Per Cent.	Cubic Feet.	Per Cent.
Air,	Oxygen	298	19·86	85	17·00
	Nitrogen	1102	73·47	315	63·00
	Total	1400	93·33	400	80·00
Fire-damp		100	6·67	100	20·00
	Total	1500	100·00	500	100·00

MIXTURE AFTER EXPLOSION.

	Excess of Air.		Excess of Fire-damp.	
	Cubic Feet.	Per Cent.	Cubic Feet.	Per Cent.
Oxygen	98	6·53	.....	.....
Nitrogen	1102	73·47	315·0	63·0
Carbonic Acid Gas	100	6·67	42·5	8·5
Water Vapor.........	200	13·33	85·0	17·0
Fire-Damp	.....	.....	57·5	11·5
Total	1500	100·00	500·00	100·00

Either of the damps resulting from the explosion of the above mixtures of fire-damp and air, are wholly unfit for and incapable of supporting life and combustion. As the water-vapor produced by the explosion, is almost wholly condensed in a very short time, it leaves as a residue, at the most of only 98 parts of oxygen to 1,202 parts of nitrogen and carbonic acid gas, or say 7·54 per cent. of oxygen. Relatively, the after-damp resulting from the explosion of a mixture containing an excess of fire-damp is much more poisonous and injurious in its effects than that resulting from an excess of air; but they are both incapable of supporting life or combustion.

The following are some short and clear instructions for the recovery of suffocated persons:

ASPHYXIA.

Miners are exposed to asphyxia when the circulation of the air is not sufficiently active, when the substance exhales a quantity of deleterious gases, when they imprudently penetrate into old and abandoned workings, and when there is an explosion, or when the air is deprived of its oxygen.

The symptoms of asphyxia, always easily known, are sudden cessation of the respiration, of the pulsations of the heart, and of the action of the senses; the countenance is swollen and marked with reddish spots, the eyes are protruded, the features distorted, and the face is often livid.

It is necessary to succor an asphyxiated person with the greatest promptitude, and to continue the remedies with perseverance as long as there is not a certainty of death.

The best and first remedy to employ, and in which the greatest confidence ought to be placed, is the renewal of the air necessary for respiration.

1st. Promptly withdraw the asphyxiated person from the deleterious place, and expose him to pure air.

2d. Loosen the clothes round the neck and chest, and dash cold water on the face and chest.

3d. Endeavor to make him swallow, if it be possible, cold water acidulated with vinegar.

4th. Clysters should be given, two-thirds of cold water, and one of vinegar; to be followed with others of a strong solution of common salt, or of senna and epsom salts.

5th. Attempts should be made to irritate the pituitary membrane, with the feathered end of a quill, which should be gently moved in the nostrils of the insensible person, or to stimulate it with a bottle of volatile alkali placed under the nose.

6th. Introduce air into the lungs by blowing with the nozzle of a bellows into one of the nostrils and compressing the other with the fingers.

7th. If these means do not produce the effects expected, the body of the asphyxiated person remaining warm, as that generally occurs for a long time, it will be necessary to seek the aid of Doctor Sylvestor's method of producing artificial respiration, as follows: Place the patient on his back, on a flat surface, inclined a little upwards from the feet; raise and support the head and shoulders on a small firm cushion or folded article of dress placed under the shoulder blades. Draw forward the patient's tongue and keep it projecting beyond the lips; an elastic band over the tongue and under the chin will answer this purpose, or a piece of string or tape may be tied round them, or by raising the lower jaw the teeth may be made to retain the tongue in that position. Remove all tight clothing from about the neck and chest, especially the braces. Then standing at the patient's head, grasp the arms just above the elbows, and draw the arms gently and steadily upwards above the head, and keep them stretched upwards for two seconds (by this means air is drawn into the lungs). Then turn down the patient's arms and press them gently and firmly for two seconds against the sides of the chest (by this means air is pressed out of the lungs). Repeat these measures alternately, deliberately, and perseveringly, about 15 times a minute, until a spontaneous effort to respire is perceived; immediately upon which cease to imitate the movements of breathing, and proceed to induce circulation and warmth.

8th. To promote warmth and circulation rub the limbs upwards with firm, grasping pressure and energy, using handkerchiefs, flannels, etc. Apply hot flannels, bottles of hot water, heated bricks, etc., to the pit of the stomach, the arm-pits, between the thighs, and to the soles of the feet.

9th. On the restoration of life a teaspoonful of warm water should be given; and then, if the power of swallowing has returned, small quantities of wine, warm brandy and water, or coffee, should be given.

10th. These remedies should be promptly applied, and, as death does not certainly appear for a long time, they ought only to be discontinued when it is clearly confirmed. Absence of the pulsation of the heart is not a sure sign of death, neither is the want of respiration.

The following are some definitions and technical explanations of some of the leading phenomena in connection with mining ventilation, and may prove useful to any who have an examination to pass on the subject:

NATURAL VENTILATION.

Natural ventilation is ventilation taking place without the aid of artificial means; it is due in a coal pit to the increasing heat of the earth as we descend. This natural heat rarefies the air in the pit, which thus becomes (in winter especially) lighter than the atmosphere. This warm air finding itself at the bottom of one of the shafts, gradually ascends, and causes to flow down the other shaft a slow current of cold air; this alters the barometric balance of the column of air in the two shafts, and a slight current is established, passing through the galleries and workings, which is liable to be reversed, or stopped by the slightest disturbance; in fact, it is trusting the ventilation of a pit to the caprice of the winds.

FURNACE VENTILATION.

In furnace ventilation, a furnace is placed at the bottom of the upcast, which heats and rarefies the air, thus increasing the difference of weight in the two columns in the upcast and downcast shafts. This of course acts in assistance of the natural warmth of the earth; this kind of ventilation is much less liable to disturbance from atmospheric changes, although far from exempt from their influence.

THE STEAM-JET SYSTEM OF VENTILATION.

The steam-jet acts in a manner totally different. It is a mechanical force applied to propel the air through the shaft. When a jet of high pressure steam is blown into an atmosphere at a state of rest, it produces a violent disturbance in that fluid. The particles of steam are in rapid motion; and since the first law of motion is, that a body in motion continues to move for ever or until stopped by something else, when stopped it communicates its force to the body stopping it. The force of the jet of steam is expended on the air on which it strikes and through which it passes; and this force is applied to the air as fully as if it were applied to a piston in a steam engine. Thus by this method we have the steam power applied directly to the object we require to move, avoiding all the friction of an engine. The force thus obtained is used in forcing the air up or down the pit, or both, according to the requirements, and is under more perfect control, and is a more powerful agent when properly employed than the furnace; the furnace not producing above three inches of disturbance of the water-gauge level, the jet has been shown to produce fifteen inches of mercury, which is equal to 15 feet of the water gauge. It requires no machinery, but a simple pipe in connection with the steam.

SPLITTING THE AIR.

Splitting the air is to divide the original trunk or column of air into separate branches, proportioned to the extent and nature of each particular working district. It is arranged by doors and stoppings sufficient to admit and regulate the quantities supposed necessary for each. Some of these splits, or branches, run a course of only a mile or two, or perhaps less, and others as far as perhaps eight or ten miles. They are "coursed" in the working places up and down the boards or workings, and are directed against the face of the works in each working place by "brattices," which take the air close up against the solid coal, or by allowing it to fall short of the coal by shortening the brattices. These currents dilute and sweep away any fire damp that may come off and keep the mine safe and healthy. The air used to be "coursed" up to the year 1813, through the whole passages and galleries of a mine, as if through a tortuous pipe. From the time of its entrance to its exit, it sometimes ran thirty miles, carrying all the impurities of the mine with it. In that year Wm. Buddle introduced "splitting the air," by dividing it into several great streams that swept each particular district, as just stated. It requires judicious management to direct proper quantities to each of these districts, for while the more splitting is practiced, the stream will be fresher and purer; yet when done to a very great extent, the small columns become so weakened as, like small streamlets of water, scarcely to be able to struggle forward and do their work amidst the obstructions and difficulties in their courses. This is the present mode of carrying air through the workings. The doors, stoppings, and regulators act as valves, and, like those in the vessels of the vital fluid of the body, they direct, curb, and regulate the vital fluid (*i. e.* the air currents), in the mines.

Upon this internal machinery, in addition to a full and healthy supply of air at its source, the entire safety of the mine depends. If any part of it falls into disorder or is neglected, congestion and accumulation in some district takes place; this diseased locality being then accidentally, or negligently touched by flame, bursts forth in its whole mass into instant explosion.

Thus abundance of air well directed is the source of life and safety to a mine.

FURNACE LIMIT.

The quantity of heat generated by the furnace is directly as the fuel that can be consumed in a given time. The amount of rarefaction or power of the upcast will always be directly as the temperature of the column of air passing up in a given time, which temperature will vary in proportion to the quantity. The amount of heat of the furnace is a constant quantity, which will be spread over a more or less quantity of air. The power of the upcast rises in "an arithmetical ratio;" the friction or drag of a current of air through the workings of a coal mine, offers a resistance equal to the squares of its velocity. Now it is manifest there will soon be a point where the resistance overtakes the power. The power being as an arithmetical ratio; while the resistance increases in a geometrical ratio, the "furnace limit" will be the point where these two powers balance each other. This limit coincides in practice much earlier than would appear on calculation, which seems never to have been noticed. This element is the resistance offered to the air going through a mine by the "vena contracta." It amounts to a serious quantity in the workings of an ordinary coal mine. This amount of extra resistance, added to the friction arising from the rate of current, adds considerably to the rate of increase of the drag. I believe it is to Mr. Goldsworthy Gurney we are indebted for pointing out this important fact for the first time.

NATURAL BRATTICE.

The resistance or drag of a current of air passing through the workings of a coal mine is, as stated before, as the square of its velocity. When this resistance is so great that the proper quantity of air cannot come through the galleries of a mine to fill the exhaustion produced at the bottom of the upcast shaft, it will come down through the shaft itself, as the easiest channel. It will come down on one side, leaving room on the other for the hot air to ascend; the stationary particles of air between the two moving currents forming an imaginary aerial plate; this plate has been called "the natural brattice."

FURNACE PARADOXES.

The amount of resistance of currents of air coming through the workings increase as the squares of their velocity; the power of exhaustion by the upcast shaft is *directly* as its temperature. If the quantity of air passing through a mine be reduced by increased friction or obstruction, that smaller quantity of air will be raised to a higher temperature by the furnace in the upcast shaft, and the exhaustion arising from its increased temperature will produce a greater amount of "force." The water-gauge is a measure of this force of exhaustion or power of the furnace. Under the above circumstances the water-gauge will rise and indicate a *greater power*, while the *amount* of ventilation is reduced. This is a seeming fallacy; it is not a fallacy; therefore, is called the "Furnace Paradox."

THE WATER-GAUGE.

The water-gauge is a tube of glass bent in the form of the letter U, one end of which communicates with the upcast and the other with the downcast or intakes by a pipe; it contains a little water at the bottom of the bend, and is an indicator of the *amount of power*; its extent of break of level in the two legs is a measure of the actual *force* which is necessary to overcome the "drag of a mine." When this force is known, its rise or fall indicates whether proper ventilation is going on in the extreme workings, or not; thus if the air comes through the workings by a shorter passage than it ought to do, the water-gauge will immediately fall. In an explosion, occasioned by leaving a door open between the downcast and upcast shafts, the water-gauge would have pointed it out. If the water-gauge rises above its working point, it shows obstruction existing somewhere in the workings. If it stands at its working point, it shows that ventilation is going right. It is a most useful instrument; it is a measure of the actual power required for ventilation, and in the possession of a practical man, will tell him nearly where, and how, ventilation is going on by simple inspection. In connection with the anemometer, the water-gauge is most valuable.

GAS DRIFTS.

A system of gas drifts along the *rise* of the coal deposit, intersecting its cleavages, banks, and interstices, and taken to the upcast shaft, might be, and in some cases has proved to be a practical and scientific means of removing the light carbureted hydrogen gas from the coal, without permitting it to descend into the workings.

EFFECT OF SEASONS ON FURNACE VENTILATION.

In winter the atmosphere is colder than the air of a coal mine; consequently the air in the mine forms of itself a natural upcast, and a certain amount of disturbance, or power, is thus produced. In summer, when the temperature of the air equals that in the mine, this power will cease; this generally occurs in spring; ventilation often ceases in naturally ventilated mines, and an explosion may follow in consequence. If a furnace be used for ventilation its power in winter is increased by the weight of the cold air in the downcast; but in summer this weight is taken off. In case no extra care and watchfulness are taken to meet the change, disagreeable results may ensue at this season of the year. If the furnace at its maximum power in the winter, with this assistance, is but just sufficient to prevent the fire-damp arriving at its explosive point, it will be unable to do it in summer, when its power is thus weakened.

THE BAROMETER.

This instrument is useful to show any change of weight of the atmosphere.

THE DIFFERENTIAL BAROMETER.

This is more delicate in its movement than an ordinary barometer; it may be made almost to any ratio of delicacy. It would show a change taking place in the weight of the atmosphere long before it could be seen in the ordinary barometer, and therefore be more valuable in a coal pit. On the fall of the barometer fire-damp issues out of the goaves and recesses of the coal in larger quantities than usual, so that ventilation requires to be increased under such circumstances. The barometer is said to be more useful in a coal pit than in a ship. It indicates impending storms, or change of weather; and the more delicate it is the better. The index of the differential barometer can be made to range easily from 50 to 100 times through a greater space than the ordinary mercurial level; and therefore slight changes in the weight of the atmosphere can be read off by this instrument, which are inappreciable in the common barometers.

THE ANEMOMETER.

The anemometer is a valuable instrument for measuring the *quantity* of ventilation; it shows the exact rate of currents and registers them by an index like a gas meter; by this instrument the *actual quantity* of air passing may be known; and at the same time by the water-gauge, the *absolute force* or *power* required to move or pass that quantity may be known; so that by these two instruments the amount, power, and probable state of ventilation may be ascertained.

[TO BE CONTINUED.]

THE PRINCIPLES AND PRACTICE OF COAL MINING ON THE PILLAR SYSTEMS.*

BY W. S. GRESLEY, M. E.

[Written for the Colliery Engineer].

Fig. 31 is a plan of a couple of breasts in an Anthracite seam of a tender nature and with a bad top, where the pitch is such that the coal after being mined will slide of its own weight to the gangway. Narrow headings or "chutes" are worked up (in the bottom benches of the seam) at right angles to the gangway and an air heading a few yards above it, to the full height of the lift, say 270 to 300 ft., holed through for air about every 60 ft., and with a sheet-iron trough or spout about 4 ft. wide, laid on bottom between the props. When the full distance has been attained the places are widened out on one side and worked backwards down hill, as shown in cut, the coal rushing down the iron chute to the wooden platform at foot where it is shoveled into cars. The miners get up and down the places behind the props. Half-inch plate-glass has been used in place of sheet-iron for floors of coal chutes in the mines containing acid waters which destroy iron very rapidly. The floors of many Anthracite seams are, however, often nearly as smooth and slippery as glass or sheet-iron. For preventing too much leakage of air between the gangways and headings above wooden brattices or canvas checks are erected in the lower part of the chutes just above the platforms with a trap door in them (if of wood) for men to pass through.

Figs. 32 and 32a are illustrative of another Anthracite mining method, or rather a variety, in detail of breast-work. It is devised to meet the difficulty of dealing with the falling top-slate, bony-coal, or other refuse made in mining, by keeping the same in the mine where the pitch is heavy (shown 45° here). As the plan, Fig. 32, shows, the coal is thrown down the timbered manways or side-chutes, and the separated refuse and fallen top accumulates and is cast into the gob or space between the coal-chutes, suitable timber platforms being fixed at intervals as the work goes on near the face for the miners to stand upon. The system has its special dangers as well as advantages which will be apparent to every practical mining man. The direction of the ventilation is shown. The profile, Fig. 32a, is taken on lines A B C D, Fig. 32.

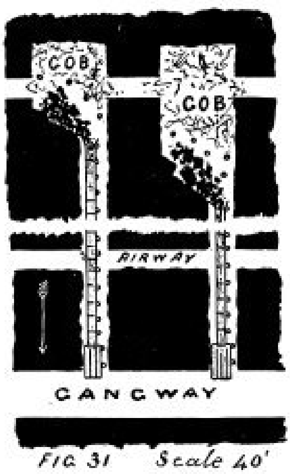


FIG 31 Scale 40'

Fig. 33 requires but little explanation. It is a profile up the center of an Anthracite mine breast where the pitch becomes too steep for the mule to take the wagon to the face and yet not steep enough for the coal to slide of itself in sheet-iron chutes to gangway. The plan illustrated is to use small cars called "buggies" (they hold about ¾ of a ton) in manner shown, *i. e.*, to chute or dump the coal several times from one level to another until the gangway is reached, the refuse being employed for carrying the buggy-track upon from dump to dump. Where refuse is scarce timber trestles may be used. The very frequent and rapid changes of dip or pitch of Anthracite seams in Pennsylvania may be such that in one single lift of say 300 ft. from gangway to gangway (see Figs. 15, 16, and 19,) nearly all the different modes of mining a breast may come into play one after another. At starting, for instance, the coal may be nearly flat, but commence rising a few yards in and the pitch increase more and more until verticality may be approached; or *vice versa*.

Fig. 34. Plan and cross-section showing a method of working a thick heavy-pitching coal seam on the plan of close stowing or complete packing as the coal is cut out and taken away. It has been successfully applied to very soft semi-Bituminous coals in China, and probably in other quarters besides. The preliminary or opening up work consists in sinking shafts, or making slopes on the vein or veins, and driving tunnels to intersect them; cross sections of the latter being shown on plan at T T. Gangways G G, both illustrations, are then driven to form "lifts" with chutes R R driven full pitch connecting them for air, etc. In the drawings given it will be seen that the second or lower of the two lifts is being worked. Between and above tunnels T T large solid pillars are left to protect them and other openings. I I are inclined planes connecting the upper or middle gangway with the surface, and these are used for taking stone, etc., from quarry or other convenient source into the mine by gravity, for filling the gob up solid in manner to be described. On each side of shaft or tunnel pillars a heading is driven parallel with and a few yards above the bottom gangway or water level, and when through from chute to chute, and batteries and loading places, etc., have been fixed, then regular coal digging commences on the high side and is carried on regularly and methodically up the pitch as shown in figure, the refuse for filling the excavations being dumped at upper gangway down every alternate chute marked R R. From the bottom of these chutes the rubbish is taken and spread layer upon layer as each skip or slice of coal is cut away and removed. The coal is drawn off through timbered or rock-built spouts or chutes in center of each panel or stall-face, as at E. Access for men to working places is had through the ladderways or manways previously put through for the purpose; the coal-chutes being made where the manways were driven. When the upper gangway is worked nearly up to, the faces are stopped, leaving the "chain pillar" stumps to be got out the last thing before abandoning the lifts. In this way of working many advantages are derived, which, briefly stated, are these: (*a*) The coal seam is thoroughly proved before the bulk of the coal is mined. (*b*) Nearly all the seam is worked and sent out. (*c*) Refuse in the coal is kept in the stalls and not run out with the coal. (*d*) Squeezes or crushes cannot take place, because every place is completely filled up solid as the work advances. (*e*) Practically there are no "fast ends," and every advantage can be taken of the cleat or cleavage-places to save labor and produce the maximum quantity of lump. (*f*) Suits thin as well as thick seams. (*g*) Overlying seams are not injured by working beneath them, and the surface is kept intact. (*h*) All the coal may be taken out beneath important buildings on surface, rivers, etc., without fear of damage, etc. The length of the stalls or working faces, *i. e.*, between each rock chute R R is, of course, set out to suit the conditions of each seam; and the distance one stall or room advances in front of its neighbor may be regulated at will of the superintendent. The coal is removed from the place where it is cut to the dump either in small mine wagons, in barrows, or slid down sheet-iron on a suitable grade and shoveled into chutes. It seems probable that this system of coal-mining, or modifications of it, will come much more into use in the future in localities likely to favor its adoption. The leading feature of it lies in substituting or replacing the coal, as taken out, with material put in compact and solid from floor to roof as the work advances.

[TO BE CONTINUED.]

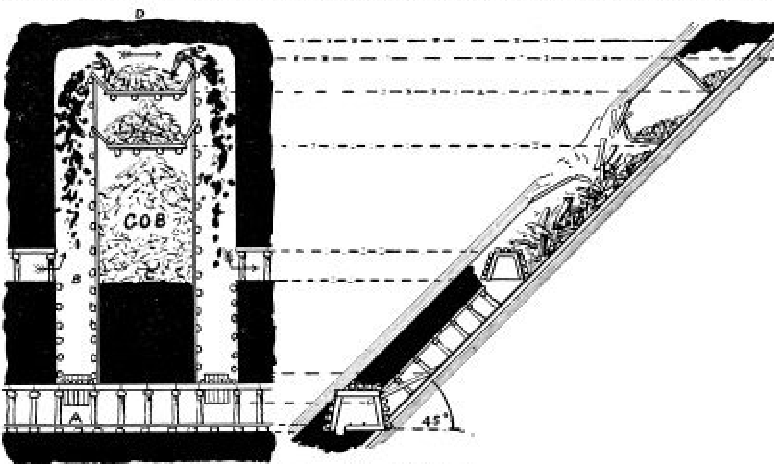


FIG 32 Scale 20' FIG 32.a

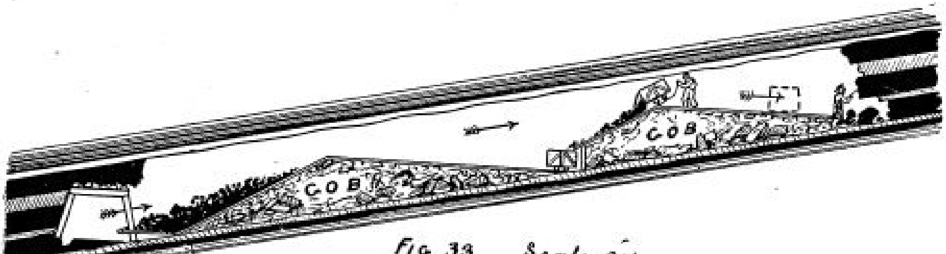


FIG 33 Scale 20'

*Commenced in No. 8, Vol. XI., *i. e.*, the issue of March, 1891. Back numbers may be had by addressing The Colliery Engineer Co., Coal Exchange, Scranton, Pa.

THE DURATION OF THE ENGLISH COAL SUPPLY.

An Abstract of the Address of President Henry Hall, Inspector of Mines, in the Transactions of the Manchester Geological Society, Volume XX., by J. H., Mining Institute of Scotland.

Twenty years have passed since the Royal Commission reported on the coal supply of the country. How far has the estimate then made been verified by experience during these years? The main questions the Commission had to consider were (1) The available quantity of coal, and (2) The rate of consumption. The report fixed the quantity of coal available in the known coal-fields, at depths not exceeding 4,000 ft. (which the Commission considered the limit of practicable working), at 90,207 millions tons. In addition to this quantity, it was estimated that 56,273 millons of tons, covered by Permian rocks, lie above the 4000 ft. limit, making a total of 146,480 million tons. The quantity of coal between 4,000 and 6,000 ft. deep is estimated at 29,000 millions of tons. The Commission considered the question of the possible existence of coal under the Cretaceous rocks of south-eastern England, where it was recently reported that the coal measures had been pierced by a bore-hole, and came to the conclusion that the evidence was not sufficient to justify any credit for coal therein being taken in the report. It is obviously the more difficult problem to estimate the duration of the estimated coal supply. Two bases of calculation were used by the Commissioners—first, that the consumption would bear a fixed relation to the population, which was estimated at about 4½ tons per head per annum. On this assumption, they estimated that the 146,736 millions of tons would last for 360 years. The second method was to allow an annual increase in production of three million tons, being the average rate of increase during the preceding fourteen years. On this basis, the coal would be exhausted in 276 years.

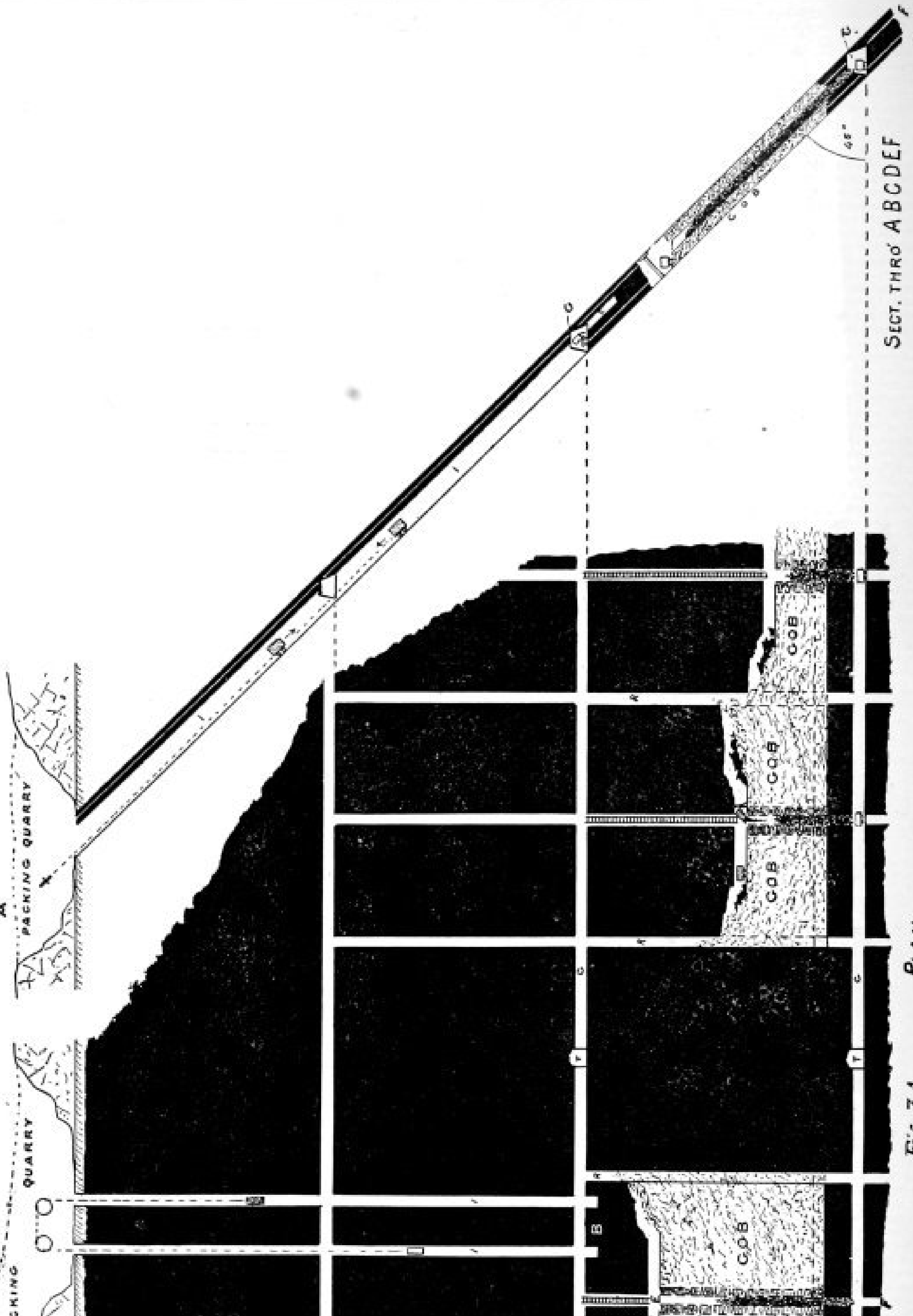
Taking the first method of calculation, Mr. Hall calculates that the consumption estimated by the Commissioners for 1891 is 10 per cent. less than the actual consumption in 1888. According to the second method the output of 1888 was estimated at 164 million tons, and the production was really 170 million tons—a difference of only rather more than 3 per cent. During the past ten years, the annual increase in production has been, on the average, four million tons in place of three-and-a-half millions—the average of fourteen years immediately prior to 1869. If this rate of increase be continued, the 276 years of the Commissioners will be reduced to 240. All these calculations are based on the assumption that workings may be carried to a depth of 4,000 ft., where the estimated natural temperature is 116° Fahrenheit. This, Mr. Hall believes, ought to be 130°, and he places the reduction of natural temperature possible by ventilation at 15°, against 7° mentioned in the report of the Commission, and so makes the probable temperature of the workings at 4,000 ft. 115°. Now, workmen complain of heat where temperature rises above 80°, and the conclusion reached is that, with our present appliances, coal can only be worked at great expense, if at all, at greater depths than that which gives a natural temperature of 100°.

It may fairly be questioned whether any considerable quantity of coal can be got from beneath permian rocks, and consequently the available supply is reduced to 90,207 million tons, if coal worked beneath the permian be set against what may be found unworkable at depths less than 4,000 feet, and on this assumption there will be no more coal workable in 171 years from the present time.

From particulars furnished by certain mine owners, it appears that the cost of coal in 1889 has been only 9d. per ton above the cost in 1869, while the costs in 1879 and 1869 are about equal. The difference in the former case is probably due to increased cost in labor.

AMMONITE.

Recently a series of experiments with a new explosive (Ammonite) were made at Risca, Wales, under the auspices of Sir George Elliot, M. P., and The Miners' Safety Explosive Company, Limited. The *South Wales Daily News* describes the experiments as follows: "A large section of a boiler was mounted on a gravel bed near the Risca Artillery shed. The boiler was 16 feet by 5 feet, and each end was closed by a heavy tarpaulin sheet, such as are used in collieries. Coal gas was admitted into this from a 2-inch main, and the bottom of the boiler was strewn to the depth of several inches with coal-dust. The dust was agitated by a flapper, worked by a chain, which mixed it well with the gas and the air into what ought to have been a terribly fiery condition. A small aperture in the middle of the boiler, also closed by a colliery sheet, was provided that the mass might be tested with a safety-lamp. When this had been done the cartridge of ammonite, buried in the 6 inches of coal-dust in the bottom of the boiler, was fired by electricity from an adjacent building. The spectators had all withdrawn to a safe spot on the sloping hill side, and witnessed again and again the sheets fly from either end as the explosion took place. In all nearly a dozen exhibitions were given with the boiler, and in these the explosive energy was varied by the use of dynamite, securite, stonite, and tonite. Then, after a half a dozen experiments, the coal-dust was cleared out, and the cartridge merely tamped, or covered with small coal, and gas introduced to the proper admixture. The last shot was with carbonite—an explosive used at the wish of one of the visitors. This gave the nearest approach to ammon-



THE PRINCIPLES AND PRACTICE OF COAL MINING ON THE PILLAR SYSTEMS.

ite, namely, no flame as far as could be seen. Dynamite gave lurid red tongues of flame from either end of the boiler, fringed with black, carbon-laden smoke. Tonite was even more fiery in the moment of its discharge than dynamite, and the sheets were ignited, and also the rope used to fasten them on to the ends. Ammonite showed to great advantage, and no appearance of flame could be detected in the smoke and dust which belched forth from the ends. In each instance the test of the safety-lamp was applied to the mixture in the boiler to prove that it had arrived at the explosive point. The experiments were considered to be conclusive and satisfactory. Then the value of ammonite in withstanding concussion was illustrated. A 60-lb. steel block was suspended over an anvil and dropped through guides from heights varying from 8 ft. to 23 ft. Dynamite, tonite, stonite, carbonite, gelignite, and the most recent of all, arthurite, all exploded; but although the height of the fall was increased from 10 ft. to 23 ft., ammonite declined to explode either in the cartridge or placed as loose powder on the anvil. Arthurite also did not explode the first time the hammer fell, but this was owing to the weight becoming hitched. When raised a second time on the arthurite, a faint explosion took place. This series of experiments was held to be conclusive and satisfactory, and here ammonite clearly scored. In some other experiments, however, where a lighted fuse was used, fire certainly was generated—whether from the fuse itself, from the cartridges of ammonite, or from the concussion causing sparks to fly from stones or pebbles, it is not allowable to say, seeing that doctors differ. The presence of fire was distinctly evident to several gentlemen when two stockades of sleepers were cut down by a line of ammonite cartridges. Probably better results would have been obtained had the cartridges been fired by an electric spark. The other experiment included the destruction of a section of railway by four 6-ounce cartridges, the smashing of two wrought-iron plates ⅝″ and ¾″ thick, respectively, by 6-ounce and 8-ounce cartridges, the exploding of a bundle of cartridges under water creating a good sized geyser, firing bullets at ammonite, immersing it in ice, burning it in a brazier, and firing 16 ounces of gunpowder, surrounded by a case of ammonite cartridges without exploding them. Proof up to the hilt was afforded when the fragments of the cartridges were collected together and fired in the approved fashion to create a big concussion, which shook the ground, loosened the plaster of the walls, and reverberated like respectably loud thunder amidst the neighboring hills."

Subsidence Due to Coal Working.

(From the Journal of the British Society of Mining Students.)

In a communication to The British Society of Mining Students, Mr. W. S. Gresley, of Erie, Pa., writes as follows regarding the subsidence due to coal working in the Anthracite regions of Pennsylvania:

"Now, in the Anthracite regions of Pennsylvania, the character of the coal measures is so peculiar, both in hardness and position, that the effects of working out the coal seams are peculiar and very different from those of ordinary coal fields.

"Where you have a seam, say 40 feet thick, outcropping at an angle of 70° to 80°, the working away of the coal in chambers or narrow stalls in the mine below will very frequently cause the whole seam and surface over it at the outcrop, to run in, form 'caves,' or 'crop falls,' as they are termed, and leave great yawning chasms all along the hill sides. I measured one that was 150 feet wide the other day, there having been 55 feet thick of coal run in from it. On another occasion the spot was pointed out to me where a miner's house and two men in it went down bodily with one of these 'caves-in,' and were lost.

"I was informed by a Mining Engineer of reputation, that at 600 feet deep, 50 feet thick of the 'Mammoth' seam on a dip of 25° were taken clean out, and the surface went down about 8 feet.

"At another colliery I was told that taking out 12 feet of Anthracite in one seam, at 150 feet to 200 feet deep, only lowered the surface 8 inches as proved by railway tracks on top.

"It is the opinion of many mine superintendents in this Anthracite field, that the clearing out of a seam, say 7 feet thick at 200 feet below another workable seam, will not affect the latter or the surface above in the least. These gentlemen claim, that the fall of the roof and strata above, take place in such a manner that the broken rocks, &c., soon fill up the excavations and 'choke themselves' as the saying is. But, notwithstanding, the binds are about as hard as roofing slates, the sandstones as strong as granite, fire-clay so hard it won't soften with water or 'weather' on top—the coal almost as hard as plate-glass; and that very thick beds of compact quartz conglomerate are interstratified with the other measures; so that the fallen roof, &c., can't become much compressed by top weight; there is something in what they say, though I can hardly believe that no surface subsidence goes on even in the case of the thinner seam workings. The wild and rough character of the mining regions of course makes it difficult and unnecessary to find out what subsidence does take place."

A new plummet for use in deep shafts is described in the *Lehigh Quarterly*. It consists of a vertical core 12 in. long, with eight radiating flanges, 9 in. high by 3 in. wide, of ¼ in. metal. At the bottom there is a circular disc acting as a web. This bob weighs 20 lbs., and has a surface area of about 630 square inches. An ordinary bob of equal weight would have a surface area of about 90 square inches. In an ordinary dry shaft 500 ft. deep this form of plumb-bob will settle, under usual conditions, in about one hour, instead of five or six hours as with the older form.

PREVENTION OF ACCIDENTS IN MINES.

A Prize Essay on Practical Means to Ensure Safety in Coal Mines.

BY AUSTIN KING, PHILIPSBURG, PA.

[Shortly after the disastrous explosion at the Mammoth Mine, the *Pittsburgh Times* offered a prize of $100 for the best essay on the above subject. The judges were Messrs. M. P. Kane, John F. Farrell, and Thos. Lynch. Of the 272 essays submitted, they considered that of Mr. King, the best, on the grounds that the ideas suggested were cheap, certain, and practicable.]

The services of a superintendent and of a mine boss should be secured, both of whom are possessed of a practical and theoretical knowledge of mining in all the phases likely to be presented or circumstances likely to occur in the particular coal field operated in; and combined with this they should be men of integrity, sobriety, tact, and executive ability, to enable them to manage successfully any difficulty that might arise in the operation of the mines, whether it was one of engineering of mines—other than professional work—or one of handling or dealing with men and enforcing obedience to such rules and regulations as the best practice and theory suggested for their personal safety and safety of the property. The superintendent should be a man of superior attainments, if possible, to the mining boss, so that should an unusual occurrence arise in the mine he could, if unable to cope with it alone, seek his superintendent's counsel and implicitly rely on his judgment when he gave instructions relating to it.

The mine boss in a gaseous mine should pay special attention to the reports of the fire bosses and note in his travels through the workings whether the places showed evidence of the regular visits of the fire boss, whose duty it was to daily examine them. He should also give particular attention to any violations by those under him of the regulations or laws governing the working of the mine, and administer the proper penalties for such violations as had been prescribed by the mine rules, or deemed advisable by consultation with the superintendent or mine inspector of the district when not already provided for. He should be unceasing in his vigilance and endeavor to foresee any possible danger, and thus be prepared to prevent rather than remedy the evil.

ACCIDENTS IN SHAFTS.

Prevention of accidents in shafts should be guarded against by the use of the different safety appliances now prescribed by law, (1) such as safety-gates at top landings, safety-catches on cages and good cover overhead on them, good ropes and chains, and in addition (2) by timbering shaft from top to bottom with timber of suitable size, strength and durability; (3) by using a reversible fan for ventilating purposes and making the hoisting shaft the upcast so that ice could not form in it. If ice formed in downcast or fan shaft, the fan could be reversed long enough to thaw it out; (4) by careful daily examination of hoisting machinery, and of ropes, and by shortening the latter at proper intervals so as to remove that part of rope bearing most strain, because resting on the pulley and by daily examination of clevices and bridal chains and the annealing of same at proper intervals; (5) by prohibiting the carrying of mining tools on cages by persons ascending or descending; (6) by the construction of safety-blocks so arranged that cars could not be pushed into shaft accidentally; (7) by keeping copy or code of signals printed in large type in engine-room and top and bottom of shaft, and so placed as to be always in full view of persons required to use them, and by employing no person at top or bottom of shaft who did not understand English "as she is spoken;" (8) by refusing to employ any person as hoisting engineer unless well and favorably known; (9) by using an automatic steam brake on winding drum, safety-hooks and catches fixed to head frame to prevent over-winding.

ACCIDENTS IN SLOPES.

There are but few slopes in Bituminous coal mines of Pennsylvania where persons are lowered into or hoisted out of slopes; but where this is done, (1) the same careful examination of ropes and chains and hoisting machinery, as suggested, for shafts; (2) and in addition, persons should be carefully lowered and raised, the tracks should be kept clean and in good order; (3) roof and timbers should be regularly and properly inspected by mine boss; (4) whitewashed shelter holes, not exceeding thirty feet apart, should be provided for the use of those whose labor required their presence on the slope; (5) the same precautions as to signals and safety-blocks should be adopted as at shafts. Where persons are not lowered into or hoisted out of slope mines a separate traveling way should be provided, which should be well drained and free from all steam or discharge pipes.

ACCIDENTS IN DRIFT OPENINGS.

These may be guarded against (1) by compelling inspection of roof and sides in all hauling roads and pillars if known to be weak—at least three times a week; (2) by providing a separate traveling way where hauling is done by machinery or inclined planes are used. Where this is not feasible, white-washed shelter holes should be provided every thirty feet. Where mules or horses are used for hauling purposes shelter holes should be provided at distances not exceeding sixty feet apart; the shelter holes in both cases to be made in the rib regardless of the distance of the rib from the track; (3) by refusing to permit the use of a steam locomotive where it was necessary for persons to travel into or out of a mine.

ACCIDENTS WHILE WORKING.

Having gone over the accidents likely to occur, to persons going into or out of the mine we will now consider the dangers persons are exposed to when working in mines, which for our purpose may be generally classed under six heads, namely: (1) Falls of roof and coal; (2) injuries by mine wagons; (3) explosions of fire-damp; (4) miscellaneous accidents; (5) explosions of coal-dust; (6) drowning by water.

A list of fatal accidents which have occurred in the Bituminous coal mines of Pennsylvania, and which were compiled from the reports of the inspectors of mines for the years of 1884 to 1889 inclusive, is here given to assist us in forming a correct idea regarding their number and the causes producing them:

Character of Accident.	Number.	Per Cent.
Falls of roof and coal	340	64·2
Mine wagons	74	14·1
Fire-damp explosions	51	9·7
Miscellaneous causes	46	8·7
Dust explosions	17	3·2
Total	528	99·9

If we only take the accidents that happened in districts in which fire-damp is generated, and also leave out the number killed at Kettle Creek explosion, which was attributed to coal-dust, the list will appear as follows:

Character of Accident.	Number.	Per Cent.
Falls of roof and coal	227	61·68
Mine wagons	56	15·22
Fire-damp explosions	51	13·84
Miscellaneous causes	34	9·24
Total	368	99·98

EXPLOSIONS OF GAS.

We will consider first the explosions of fire-damp in mines, because this form of accident is particularly dreaded on account of the large number almost instantly killed by them. The cause of fire-damp explosions, or explosions of any kind, should receive greater attention and consideration than any other for the reason that no matter how intelligent, careful, or circumspect a man or number of men may be who work in a mine generating explosive gases (and when such gas may be present in such quantities during working hours in working places, roads, and airways as to be ignitable) they are always liable to be the victims of some foolish or overt act that would cost them their lives, and as the strength of the weakest link in a chain measures the strength of the whole chain, so their safety is measured by the probable misconduct of some ignorant, vicious, or semi-idiotic person who cannot realize the awful consequences of his misbehavior.

To avoid such disasters, (1) ample means of ventilation should be furnished, always preferring it in the form of a fan, which should be placed at a safe and convenient point; (2) the work should be laid off in separate ventilation districts, giving each district a separate current of air and having a separate return therefrom to bottom of upcast, said return to be maintained solely for that purpose and only to be traveled by mine officials for inspection purposes. The objects attainable by this method of ventilation would be to increase the total volume of air circulating in mine to insure purity of air current (as far as practicable in mines) on its entrance to each particular district and to limit the extent of an explosion, should one occur afterward; (3) the overcast or air bridges should be constructed in the natural strata if the material was suitable for this work; if too expensive to construct in this way, then they should be constructed of iron in segments which should be of a known or calculated strength so as to resist being collapsed or blown out in case of an explosion; (4) no crosscuts should be made in main heading pillars or boundary pillars of a ventilation district, except at such points as were necessary for hauling purposes; the headings should be aired as they advanced from cross-heading to cross-heading, or from flat to flat, by means of incombustible brattice put up for that purpose. This precaution would greatly reduce the number of stoppings to maintain air-tight, or to be blown out (in case of an explosion) and would thus greatly facilitate a rescue under such circumstances. By a judicious use of this brattice in cross or flat headings the number of stoppings in them would be reduced one-half or more, with the before mentioned advantage, and with little or no extra cost where pillars are large and yardage is paid for cross-cuts.

Next the services of one or more fire bosses should be secured, whose qualifications should come up to the following standard: He should possess a good practical knowledge of mine gases—and especially of fire-damp—know their composition and specific gravities in order to be able to know where, under ordinary circumstances, to find them, to be able to form a good idea of the amount of air required to dilute any explosive gases he might encounter in his daily examinations; should be acquainted with the method of ventilation used in the mine and the direction of and distance traveled by any explosive gases that might be generated in his examination district or in the mine. He should be a total abstainer from all intoxicating drink, should not be shortsighted or color-blind, should be cool and courageous under all circumstances connected with his duties.

The fire bosses should be provided with a type of safety-lamp that would combine sensitiveness in testing with the quality of resisting the passage of flame through the gauze in currents passing at high velocities. It should also be provided with a shut-off to aid in extinguishing the flame in case a large body of gas was suddenly encountered. There should also be a small key fixed to the side of safety-lamp, near the top to unlock a device fixed to roof of working place by a small wooden plug driven in a hole one inch in diameter bored in the roof with a small auger. The device would consist of an ordinary clock face, say four inches in diameter, with a circle on the outside on which the numbers 1 to 31 inclusive were marked and three pointers. After the workman entered his room or heading he could see that the fire boss had been there (the cover being open) from the position of the pointers on the dial. If the fire boss had examined the place on March 20 at 3.30 in the morning the long pointer on the dial would be over the figure 20, the hour finger between the letters 4 and 5, indicating at minute finger at letter indicating six as on an ordinary clock face. The object to be attained by this is to furnish absolute proof that the fire boss' safety-lamp has been in such a position that if any gas was near the roof he could not help seeing it. This device could be moved forward as the work advanced, according as the coal seam inclined or the condition of the roof might suggest. The fire boss could, under ordinary circumstances, make the examination and fix figures of dial in 30 seconds (the dial should always be placed in the highest point practicable in the working place.) He should not be required to travel between places to be examined faster than two miles per hour. After an examination of the working places and also of those not worked in for the time being that are in any way contiguous to them or are ventilated by any air current that may afterwards pass in any place that may be worked or traveled in by workmen in the mine and all has been found safe, the fire boss should remain at the "station" and should see that no lamp passed him that did not satisfy him as to its safety.

No men should be hired to work in a mine generating explosive gases who did not possess some practical knowledge of the use of the safety-lamp. If men were needed and men possessed of this practical knowledge could be had, pains should be taken by those in charge of mines to explain to them the reason why the light was so guarded and try to impress on their minds the great danger of tampering in any way with the lamp, and the awful things that might happen to themselves and fellow workmen if the lamp was handled or damaged in such a way as to make the passing of the flame through the gauze possible and also show them how to shield their lamp in air traveling at a high velocity. The lamps furnished to workmen should be examined and tested before giving to workmen to enter the mine, and should be able to withstand safely a strong current of air and at the same time give a light equal to the Clanny. No common Davy, Clanny, or Stephenson (Geordie) lamp, or lamps of like character should be allowed to be taken into the mine, because they have been proven time and again to be unsafe and unreliable. Blasting should also be prohibited in any portion of the mine where fire-damp existed or was likely to be liberated by the blast or in the vicinity of gobs and falls that were not easily accessible to examination for the detection of gas, or where coal dust was deposited in any material quantity on the floor and sides as the flame of the shot might be propagated by it into inaccessible portions of mine. Tamping shots with coal should also be prohibited for the same reason. The laws forbidding the taking of matches, fuse, smoking pipes or any other combustible material into mines where safety-lamps are used, or the propping open of or doing damage to any door, regulator, or overcast used to direct the air currents in the mine, or tampering in any way with any safety-lamp, removing danger signals, etc., should be fearlessly and rigidly enforced.

ACCIDENTS BY FALLS OF ROOFS.

The best preventative for this class of accidents would be to (1) employ special or selected workmen to work or timber places where roof is "full" of slips, seams, or cracks, men known for the care exercised by them in their daily work; (2) to provide ample and suitable timber, proper caps and collars, which should be delivered on short notice to where it was required; (3) to compel workmen by rigid enforcement of rules to properly set their timber and keep it propped sufficiently close to the face of working place to secure safety under all ordinary circumstances and to withdraw the workmen from place if it shows signs of any approaching cave-in; (4) where drawing props is a necessity, either from an economical standpoint or to avoid squeezes or creeps, the work should be performed by one thoroughly acquainted with the character of the work and nature of the roof, and he should be provided with a "timber-bar" and chain to draw post in very dangerous positions.

ACCIDENTS BY FALLS OF COAL.

The accidents under this head may be prevented very materially (1) by increased vigilance on the part of the miner in looking for smooths, slips, and crevices in the coal, but where undercutting is required; (2) coal-cutting machinery should be put in to perform that labor. If this could be done in all coal seams the accidents under this head would be reduced fully 80 per cent. Where machinery cannot, with profit, be so used, miners should be compelled to set sprags to coal face at a distance not exceeding seven feet apart, whether it appears necessary or not, and the mine boss or mine inspector, if able to prove negligence in this respect (or in properly posting and securing his working place) should make complaint at once to the nearest justice of the peace—who should be given jurisdiction in such cases—and fined the sum of from $5 to $25; the fines so paid to be turned over to the miners' hospital fund of the district in which the misdemeanor was committed. Observation shows that about 50 per cent. of the accidents from falls are owing to carelessness or indifference on the part of the persons injured.

ACCIDENTS FROM MINE WAGONS.

These may be very largely prevented by the adoption or putting into practice the suggestions made with reference to drift openings, together with the provision (where condition of roof will permit) that the headings, or hauling roads be made sufficiently wide, so that with tracks placed to one side of the center there would be two to three feet of space between the loaded cars and one side of heading all along. The hauling roads should always be made wide enough to allow a driver to pass a moving trip of cars safely to put on or take off brakes or for the use of sprags, where the grade requires it; then having roads properly cleaned and well drained there would be little or no inducement to ride on or between cars. No persons should be permitted to ride on cars on any incline unless special provisions have been made for that purpose.

DEATHS FROM DROWNING.

Deaths from drowning by holing into old or abandoned workings containing large bodies of water have fortunately been small in number, but the danger is a fast increasing one from the fact that mines are being worked deeper each succeeding year, and that lakes of water, many acres in extent, surround some coal properties and overlie others. This is all the more alarming when we consider that in many cases no maps of these water-filled workings are to be had and if some maps are preserved their accuracy is not to be trusted or relied on, because there is good reason to believe that working places were advanced more or less after the survey had been made or probably some portion filled with water at the time and not on the map at all. To provide against disasters a large margin should be allowed for the correctness of the maps of old workings that contained either water or gas in dangerous quantities. A law should also be enacted compelling engineers of mines, mining engineers, and mine surveyors to sign and date maps or portions of maps made by them, after their surveys, and hold them responsible for any loss of life or property that was occasioned by any defect or inaccuracies proven as theirs. This would give a stimulus to intelligent, accurate engineering, and would relegate botches or barnacles of the profession.

ACCIDENTS FROM DUST EXPLOSIONS.

A comparatively newly discovered or newly demonstrated cause of explosion has made itself manifest in our Bituminous coal mines. I refer to that of coal-dust. It was the chief agent of destruction in the Kettle Creek explosion, and in that case the mining world was furnished the best proof of its deadly character when once raised and ignited, for at this mine no fire-damp was ever seen before or since, and had only been opened a few months, and had a score or so of working places. [These facts are merely cited for the benefit of your readers should it be my good fortune to merit the publication of them.] That coal-dust caused the death of a large number of persons at Mammoth was everywhere apparent to the rescuers and to the experts who visited the scene afterward. This source of danger is present in all dry, or partly dry mines, and should be guarded against by the prohibition of blasting in localities where dust has accumulated in dangerous quantities until the dust has been removed and the place and vicinity thoroughly moistened by sprinkling water thereon. Sprinkling should also be regularly practiced on roads where dust accumulates.

MINE FIRES.

These may be prevented by prohibiting naked lights from being taken into stable or feed rooms or where timber is very tinder-like, by keeping pump rooms and cabins in pits clear of all oily waste, and where cars are oiled at bottom of pit some absorbent should be used and the floors cleared from time to time and fresh absorbents scattered on floor of mine. Sand or gravel is suitable for this purpose. Where a place is in danger of being set on fire from ignition of gas blowers by shots, as near clay veins, for example, holes should be drilled ahead and the gas allowed to drain off. If the necessity of driving the heading will not permit this delay, then the place should be driven through the danger point by picks. Only such brattice as is incombustible should be allowed to be used in mines.

NATURAL GAS PIPE LINES.

The location of these lines should be accurately determined and plotted on mine maps of mines over which they pass. The strata under them should be left intact by leaving ample pillars of coal in for support.

OIL AND GAS WELLS.

The General Assembly should authorize the appointment of a competent corps of engineers to survey and accurately locate the position of all oil, gas, or salt wells, as far as can be ascertained from deeds, leases, or information gathered from other sources, that have been drilled in the coal measures of the State. The maps should be drawn to a scale not exceeding 400 feet to one inch, and they should be deposited with the recorder of the respective counties represented on them as public documents, so that ready reference may be made to them at any time. Mine managers can thus guard against striking them unawares and prevent the mine from being deluged by water or gas.

In conclusion, I would say that the greatest preventative of accidents in mines is the use of ordinary caution on the part of workmen and the rigid enforcement of rules, and the infliction of due punishment by the mine officials. This last may seem harsh, but my experience of 30 years in mines only serves to strengthen my opinion as to its necessity. It is much better to suspend or discharge a man for violation of rules providing for his safety than carry him home on a stretcher, crippled perhaps for life, or dead. Operators, too, should give their subordinate officials a standing order to do all possible to avoid accidents and see that their mines were well ventilated. When not entirely taken up with other business they should visit the mines in person, enter them and see that their workmen are cared for as he desires they should be.

SINKING THROUGH WET GRAVEL AND QUICKSAND NEAR NORWAY, MICH.

BY WILLIAM KELLY, VULCAN, MICH.

[Cleveland Meeting, June 1891. American Institute of Mining Engineers.]

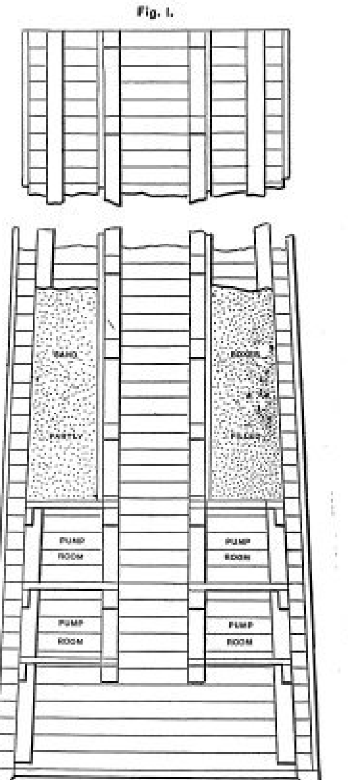
An extensive swamp covers a large part of the town-site of Norway and adjacent land. Through this swamp run two parallel ore formations. In the north one is the Aragon Mine. The south one passes into the swamp on the Harrison property. On the edge of the swamp, about 1,000 feet from the Aragon Mine, a diamond drill, in the fall of 1889, located the ore-bearing formation and a probable ore body. To explore further and develop this ore, the Penn Iron Mining Company proposed, in the Spring of 1890, to sink a shaft.

The drill had shown the depth of the glacial drift to be more than 60 feet. A test pit near the location of the proposed shaft had struck, at a depth of 20 feet, an amount of water which a 200 gallon pump was unable to lower. At the Aragon, a few years before a shaft had been sunk to hard pan with great difficulty and many delays by the usual method of driving laths.

Under the conditions it was decided to sink a caisson or drop shaft. Two 40-horse power boilers, a Lidgerwood engine with 4-foot drum, and a good derrick were set up; and two No. 10 Knowles pumps rated at 400 gallons a minute, were brought on the ground. The pumps had been purchased for another purpose, and, being brass-lined, were not well suited for the work intended, but they were available.

The dimensions adopted for the top of the shaft were 6 feet by 13 feet inside. To give sufficient space for pumps and working, and to aid the shaft to settle, it was made 4 feet larger each way at the bottom. The shaft was divided, to within 12 feet of the bottom, into three compartments, the middle one uniformly 4 feet wide. This compartment was used for hoisting, a ladder-way and pipes. The pumps were placed one

Fig. 1.



LONGITUDINAL SECTION.

Scale ⅛ in. to 1 foot.

HARRISON SHAFT.

in each end-compartment. Above the pumps the end-compartments were planked up to be filled with sand to increase the weight. A ventilation box was put in one corner. The bottom of the shaft was left unobstructed for working purposes, and sufficiently high to allow two additional pumps to be put in under the first. (See Fig. 1).

The bottom pieces, made of oak and constituting what is called the shoe (see A A Fig. 4), were 15 inches square, but the bottom inside was beveled off to 6 inches. Above the shoe, white pine timbers (B B), 12 inches square, framed in sets, were laid close and bolted together and to the shoe with eight 5-foot bolts. The successive sets were reduced 1 inch in length and width, until at 48 feet above the bottom their dimensions corresponded with the top. Corner posts, 12 inches square, of unequal lengths so as to break joints, were bolted to every other side piece and end piece. The bolts, being put in from the inside and having the nuts countersunk, were easily unscrewed and recovered when the corner posts were removed. Like the corner posts, side posts (D D) were put in, one at each corner of the middle compartment. Twelve-inch dividers (E) were used every 5 feet.

After the ground had been leveled the timbers were built up and bolted as far as the derrick and bucket would permit, nearly 30 feet. The seams were then carefully caulked outside, and 3-inch planks (C) in unequal lengths were spiked on, to protect the caulking and timbers and to strengthen the shaft. A shaft of this character is liable to be pulled apart if not very strong.

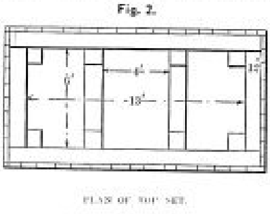
Steam hose was used at first to connect the pipe on the ground, coming from the boilers, with the pipes in the shaft. But afterwards lengths of pipe with double elbows were substituted. Two lines of steam pipe from the ground to the pumps were necessary, in order that one could be used while the the other was being altered in building the shaft up.

The shaft erected, the pumps in place, and everything ready, ground inside the shaft was broken Monday morning, June 2, 1890. As the top was dry the buckets came up fast, and by next morning the shaft had gone down 6 feet. On Friday, the fifth day, at 15 feet, the pumps had to be started. The first week's work resulted in 18 feet sunk. During the first three days of the second week 9 feet more were sunk. It was now evident that both our pumps had to run fast to keep the water out, and if one should break down or the water should increase, we would be drowned out. Therefore, before sinking the pumps below the water-level, we stopped to get more power.

Two portable boilers of 35 and 100 horse power respectively were bought, delivered, and connected, and two No. 10 Cameron pumps without air-chambers were placed 4 feet under the Knowles pumps. During the stop the shaft was built up again as high as possible. We lost thus 15 working days, but started afresh Monday, June 30th, with doubled power. During the next three days we sunk 7 feet. Then the Knowles pumps gave out. Eight days of sand and gravel had completely worn out the brass linings. It was necessary to take out the linings and put in larger pistons, which repairs consumed two days.

On Saturday, July 5th, we started again, and to the end of the following week we sunk 16 feet in 7 work-

Fig. 2.



PLAN OF TOP SET.

Scale 1/8 in. to 1 foot.

HARRISON SHAFT.

ing days, during which time everything went well. The pumps were kept busy; three running constantly and the Knowles pumps often making 100 strokes a minute. The quantity of water was estimated at 1,500 gallons a minute. During the week the sand boxes were filled to keep the shaft down to the bottom of the excavation. The sand and gravel came in under the shoe, and the surface about the shaft settled into a large pit which continually grew larger.

July 12th, the shaft was down 50 feet, and it became necessary again to build it higher. This took 3 days. A drill in the bottom gave us some encouragement, as at 10 feet it struck something hard. During the next 3 days we sunk 7 feet and found hard pan in a corner of the shaft. At this point the shaft did not settle regularly. Sometimes it would hang, and then it would drop with a great inrush of sand and water, even when the ground was out a foot or more from under the shoe. To increase still farther the weight of the shaft 30 tons of rails were laid on the top; and props had to be placed against the shaft at different times to keep it straight. It took 18 days to go through the 14 feet of hard pan; but parts of two days were spent in weighting the shaft and one day by an accident which bade fair to stop proceedings summarily.

Some difficulty with the water supply of the boilers cut down the steam pressure so low as to stop the pumps, and before steam was raised again they were completely drowned and could not be reached. An anxious quarter of an hour was passed before first one, then another, and then a third pump started of their own accord under water.

The ledge was struck August 7th, and two days later the slates were exposed all across the shaft. Four days more were spent getting the shaft down 2 feet further into solid rock.

The time spent in sinking may be summarized as follows:

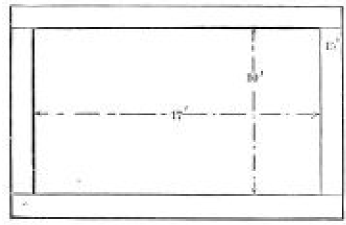
4 days sinking 15 feet above water-level;
17 days sinking 42 feet through wet gravel and quicksand;
16 days sinking 14 feet through hard pan;
4 days sinking 2 feet in slates; making a total of
41 days sinking 73 feet.
To this must be added:
6 days required to build up the shaft and
2 days weighting the shaft with rails; making a total of
49 days, or one day over eight weeks actual working time. In addition to this we lost
12 days in increasing our power and
2 in repairing pumps; making the time consumed
63 days, or ten and a half weeks.

We now, August 14th, had the shaft down firmly in the ledge; but the most delicate part of the operation was still to come, namely, stopping the flow of water.

Before that could be done, however, many things were necessary.

The rails had to be removed from the top and the sand from the boxes, the pipes changed and the shaft built up to the surface. There was now a sink-hole about the shaft, 65 feet in diameter and 20 feet deep,

Fig. 3.



PLAN OF SHOE.

Scale 1/8 in. to 1 foot.

HARRISON SHAFT.

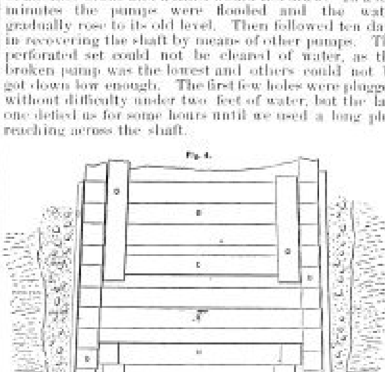
and the top of the shaft was about 6 feet below the original surface level. The shaft was but little out of plumb, the top set having to be raised 2 inches at one end to level it. The corner posts were taken out, the bolt-holes plugged and the shaft caulked on the inside. This work took 8 days.

The next 14 days were spent in sinking 11 feet further into the ledge. It was unsafe to make heavy blasts, and the pumps, after their severe strain with lengthened suctions were barely equal to their task. The bulk of the water from under the shoe was gathered together by troughs of boards and clay, but still water was falling everywhere.

The work of sealing up the bottom of the drop-shaft was now undertaken. A set, 6 feet by 13 feet inside, of 12-inch square timber, was carefully placed in line with the top set of the shaft, about 6½ feet below the shoe. This was thoroughly blocked against the rock all around with wedges. Six sets (F F) of the same size were placed on top of the first and each bolted to the next. Behind the sets as they were built up, was put a thin layer of clay over the wedges and then concrete of equal parts of sand and Hilton cement. The middle of the top set (G) was about opposite the bottom of the shoe. Through this set, twenty 2-inch holes had been bored. Behind the holes a layer of gravel and broken stone, 4 inches deep, was laid, leaving a free passage for the water. Upon this perforated set were put three other sets (H H) of increasing inside dimensions, so that the top set was against and bolted to the drop shaft. The space behind these sets was filled with concrete as before. This timbering and cementing in such a flood of water was a tedious process and took 18 days.

It was all done, and we were ready to plug up the holes, when the pumps failed. One had been removed to make room for lowering the timbers. The piston-rod of another broke and a third would not draw. In a few minutes the pumps were flooded and the water gradually rose to its old level. Then followed ten days in recovering the shaft by means of other pumps. The perforated set could not be cleared of water, as the broken pump was the lowest and others could not be got down low enough. The first few holes were plugged without difficulty under two feet of water, but the last one defied us for some hours until we used a long plug reaching across the shaft.

Fig. 4.



CROSS SECTION, SHOWING METHOD OF CLOSING THE BOTTOM.

Scale 1/6½ in. to 1 foot.

HARRISON SHAFT.

The result was entirely satisfactory. The water at once fell to about 200 gallons a minute. After the pumps and side posts had been removed and the interior had been thoroughly caulked, the water was decreased to about 90 gallons. After the shaft had been sunk farther and bearers put in, a small station was cut at one end and the water was gathered to a No. 8 Cameron pump. Below this the shaft was sunk with a No. 4 Cameron which now works about an hour and a half a day.

The time taken for sealing up the bottom may be summarized as follows:

8 days to alter shaft after it rested;
14 days to sink 11 feet in slates;
18 days to timber and cement;
16 days to remove pumps, caulk, and arrange shaft for regular sinking; making a total of 56 days.
To this we must add:
10 days lost by failure of pumps; making a total of
66 days or eleven weeks.

This makes the total of both periods of the work 129 days, or 5 months. At the end of this time, November 1st, the shaft was 84 feet deep and in shape for sinking in the regular way.

SINKING APPLIANCES AT LLANBRADACH.

By W. Galloway, in the Proceedings of the South Wales Institute of Engineers, Vol. XVI., Abstracted by J. H., of the Mining Institute of Scotland.

The shaft sunk by the Cardiff Steam Coal Collieries Company (Limited), at Llanbradach, was put down for the purpose of ascertaining the exact depth to the coal, and to gain such information as to pumping requirements, &c., as would enable the engineers to determine with some degree of certainty the fittings of the future colliery. It is also intended to form the upcast when the winding shaft has been sunk. It was known that a considerable thickness of the Pennant sand-stone series, which is invariably found heavily watered, required to be passed through, and surrounding collieries have heavy pumping fittings. The absence of any means of determining the probable quantity of water to be dealt with in sinking led to special provision for winding the water to the surface. The contract provided for certain allowances whenever the water exceeded 4,000 gallons per hour, whether pumps were provided, or not. The largest quantity met with was 7,500 gallons an hour in the shaft bottom. Down to a depth of 135 yards the total growth was 9,000 gallons an hour, of which 5,000 gallons was walled out by brick and cement walling. It would have been impossible to proceed with the sinking without pumps had it been necessary to fill the water into the kettle by the ordinary means of bailing. This bailing the author says he has long regarded as a disgrace to the art of mining, and so he devised what he calls the "Pneumatic Water Barrel." It consists of a cylindrical vessel of sheet-iron, 4 feet 2 inches in diameter, and 8 feet deep, closed at the top by an air-tight man-hole door. The bottom is 5 inches above the lower edge of the cylinder, and has a circular hole in it 18 inches in diameter. This hole is closed by a faced valve of cast-iron, mounted with a sheet of leather, capped and tightly clasped by an iron hoop. The valve is attached to a spindle by a ball and socket joint, by which it is kept in position, but allowed a certain amount of play so that it may readily accommodate itself to its seat. The cylinder is thus an air-tight vessel, the interior of which has communication with the exterior atmosphere only by means of a pipe, extending from close to the top of the cylinder in the inside, to the outside of the vessel half-way down. The outside end of the pipe is fitted with an instantaneous coupling identical with that used on the vacuum railway brake. In use the pneumatic water-barrel is lowered into the shaft till its lower edge is under water in the shaft bottom. The interior is put into communication with a condenser air-pump on the surface by attaching a flexible tube connected to the vacuum pipes in the shaft to the instantaneous coupling of the barrel. A vacuum equivalent to 20 to 22 inches of mercury is thus obtained inside the barrel, and the water rushes in through the bottom valve. A glass gauge tube on the outside of the vessel shows when it is full. The tube is detached, and the signal given to raise the barrel. When it reaches the surface a bogie is run under it, and it is lowered on a conical block of wood, which raises the valve, and the water escapes. With 7,500 gallons of water an hour thus raised, the rate of sinking was 4 yards a week. When the growth was only 500 gallons an hour, the progress attained was 6½ yards per week.

Two winding engines were erected and used in sinking—the principal engine for winding water and material from the shaft bottom, and an auxiliary for lowering walling material, and latterly used to raise the water collected by a cistern, first at 135 yards, and afterwards at 190 yards deep. The latter engine was a compound one, built to the specification of the author, who wished to try experimentally a contrivance he had desired to meet the difficulties already experienced in applying compound engines to winding. His solution is to introduce a reducing valve between the feed pipe of the high-pressure cylinder and the pipe connecting the high and low pressure cylinders with the object of maintaining the pressure in this connecting pipe when the engine is standing about equal to the average pressure therein when the engine is at work. The result has been entirely satisfactory. The guide ropes in the shaft are used to suspend the walling stage, which is always in the shaft, thus affording protection to the sinkers, and permitting the winding of water through a central opening 6 feet 6 inches square, while walling is going on. This stage is double the walling stage proper, having a roof 10 feet above it. The guide ropes are bound on drums of a steam crab, and can be wound or unwound simultaneously or separately.

ENGINEERING PHOTOGRAPHY.

A Paper Read Before the Lancashire Branch of the National Association of Colliery Managers, Eng.

BY MR. T. HOUSE, OF WIGAN.

I think it will perhaps be better to offer some explanation, and to describe the reason why it became necessary to introduce engineering photography. As an example take an engineering establishment where it is first necessary and essential at the commencement of an undertaking, say in a mechanical arrangement, to make a general drawing showing such arrangement in its entirety, thereby enabling the designer to assemble such mechanism to the best advantage for accomplishing the desired objects. Now from this general drawing the details for pattern, smiths, turning, fitting and erecting shops are got out on a larger scale so as to facilitate the manufacture and manipulation of the several parts of the mechanism forming such arrangement. And taking into consideration that the different parts or details of such arrangement must all be in a state of progress at the same time, it is requisite that a general drawing should be in the hands of the foreman of each department at the very commencement of the operation of manufacture, thereby enabling him to see at once if necessary for what part of the arrangement the details that he has in hand are for. A general drawing has to be kept in the drawing office for the draughtsman's reference, and perhaps a similar drawing to be sent to the customer for whom we are making the arrangement, so as to enable the necessary provisions being made for the erection of such arrangements, say such as excavations, foundations, framework, &c. Taking these circumstances into consideration, it is apparent that necessity compels us to have a multiplicity of these drawings, which would take, say in the case of a pit heapstead, with tipping, shaking, sorting, and picking arrangements, with all necessary provision made for reception of same, a considerable length of time to complete, say a drawing in the first place, and six *fac simile* tracings on either paper or cloth. These six tracings would take one man from three weeks to a month to complete, as much care having to be taken in one as in the other. Now it became apparent from this, that there was a considerable amount of expense incurred in the multiplicity of drawings as here described, which might be curtailed by a more rapid production of copies from any drawing. These remarks of course, not only apply to engineering establishments, but to colliery surveying, architects, and others who also require to have a multiplicity of copies from the same drawing. Now, to make a multiplicity of drawings or copies from any drawings the cheapest, most accurate, and most rapid method is undoubtedly by means of photography, of which there are several processes. Six effective and invaluable processes I will here enumerate: First, F. P., Ferro Prussiate Process, which produces white lines on blue ground, requring nothing but a developing bath of cold or tepid water. Second, Rolland Rapide, Ferro Prussiate Process, printing in any light. Third, B. L. process (invented by a French chemist, Prof. Pellet), known as the Cyanotype process, and produces blue lines on white ground under any conditions of weather during daylight, requiring two acid baths. Fourth, Ferric Cyanide process, produces blue lines on white ground, requiring one acid bath only. Fifth, B. W., black white produces black lines on white ground, requiring one acid bath only. Sixth process, Black Cyanotype process, black lines on white ground under any conditions during daylight, requiring three acid baths. Of the processes enumerated, the three principal ones at present in vogue in engineering and other establishments are the F. P., Ferro Prussiate, the L. B. blue line, requiring one acid bath only, and the B. W., black white, requiring one acid bath only, or namely the first, fourth, and fifth enumerated. These three processes being mostly in demand, I purpose explaining the mode of procedure and manipulation of these three processes fully, which, I think, will be sufficient and quite within the scope of this paper. Perhaps I had better here mention, for the benefit of the uninitiated, that it is still necessary to make a pencil drawing of the subject arrangement we desire to photograph, from which we make a tracing on either clear tracing paper or cloth. Those papers with bluish-white lines are preferable, and give the best results. Yellowish-tinted papers or cloths should therefore be avoided. The lines on the tracing should be made of well-rubbed Indian ink, with a little Prussian blue added. This latter takes out the brownish cast. Center and dimension lines, of course, should be dotted or broken, and made with either raw or burnt sienna, as these latter colors always give the best results. This tracing is called the negative, from which an *ad infinitum* number of copies can be made. The negative is made in precisely the same way for all the processes. Printing is done in every respect in the same way as the ordinary photographic silver-print, the tracing forming the negative. The papers on which we take the impression or copy from the negatives are called sensitised papers, having a chemical solution on the prepared surface. Sensitised papers for any of the processes can be bought from whole-sale producers, who have special mechanical appliances for the sensitising of papers, consequently their purchase from manufacturers will come in cheaper for consumers than if they bought paper made and put on their own solutions. As an illustration of the mode of sensitising paper in a primitive way, I will describe the preparation of paper for the F. P. Ferro Prussiate process, as was in vogue at engineering establishments who made their own for the particular process. Sensitising solution: (*a*) Citrate of iron and ammonia 100 grains, water 1 oz.; (*b*) red prussiate of potash, 70 grains, water, 1 oz. These solutions will keep indefinitely before mixing, but when mixed they should be used at once or left in the dark. Preparing the paper: Mix equal quantities of *a* and *b*, and apply to one side of paper with a sponge. The sponge should be well filled with the solution, which should be liberally applied to the paper for about two minutes. Then squeeze out the sponge and wipe off all the solution from the surface of the paper, care being taken to use the sponge lightly and judiciously, without abrasing the surface. The paper, which is now of a bright yellow color on the prepared side, should be hung up to dry in the dark. Manipulation of the F. P. Process: The sensitised paper should be cut rather larger than the negative tracing. The tracing is now placed face downwards in the printing frame; on the back of this is placed the sensitised paper; prepared side next to tracing, folds being carefully avoided. A piece of felt, pad, or cloth covreing is placed on both, for equalizingthe pressure. The hinged crossbars are now pressed down upon an intervening board, the board receiving the pressure of the crossbar springs, the crossbars being secured at the free ends by catches. It is essential that the tracing be in uniform contact with the glass. The printing frame is taken out of doors and the glass turned towards the direction of the sun so that a clear light falls upon the printing frame glass, intervening shadows to be avoided. The frame is left out until the margin of the sensitised paper shows a grey metallic color. Exposure: The fuller the exposure the darker the blue tint of the copy when completed. When the fine lines on the tracing appear blue on the copy, the exposure will be sufficient. If the lines appear yellow the exposure should be continued. Under exposure results in a light milky blue background. Over exposure results in the lines being indistinct and of a bluish-white color. Time of exposure: In clear sunshine, 4 to 15 minutes, in fair weather 15 to 30 minutes, in dull weather up to one hour, and even more. Developing: After sufficient exposure the copy is taken out of the frame and immersed in a basin or trough of cold or tepid water, and left there until the blue lines come out perfectly white. Copies should be fully immersed, and if several are washed together the water should be changed once or twice. After a final rinsing in clear water the paper is hung up over a roller to dry, or, if necessary, dried by blotting paper. All the operations should be executed in a darkish or subdued light, and except when exposed to the action of the sun in the printing frame no direct daylight should fall upon the paper, as it is apt to disfigure the copy by producing a yellowish brown cast. Corrections or additions in white can be made with a drawing, etching, or quill pen dipped in a solution of 40 grains of carbonate of potash to one ounce of water, or by means of an acid ink specially prepared. After using this solution or ink the line put in should be dried by blotting paper, or the lines will spread and become blurred and unsightly. A white line may be taken out by going over with a small camel hair brush dipped in the sensitising solution, exposing to the sun and washing as before. This process is about the oldest extant, and is much in use, and it can be safely claimed for this process that it is the easier to manipulate than any other process, as only two distinct operations are necessary, namely, exposure and development. Cost of Ferro Prussiate outfit, £5 10s. Printing frame glass view 40 by 27, superior water bath 42 by 30 foot, roll of 32 inches, sensitised paper. Cost includes carriage. As supplied by J. Halden and Co., Manchester. Manipulation of B. L. Blue Line process (blue lines on white ground): One chemical bath only required. Exposure is made in exactly the same manner as the Ferro Prussiate, great care being taken to shield the paper from the light before it is in the printing frame, the cutting and framing to be done of course in a subdued light. Sufficiency of exposure is led up to by various changes in the appearance of the sensitised paper. When the lines appear a distinct yellow on gray ground exposure is complete, withdraw from frame, and float on salt developing bath. The time of exposure depends on intensity of light available. In bright sunshine from one to two minutes, in fair weather from three to six minutes, in dull weather from ten to twenty minutes, and even more. Development: It is necessary before taking the print to the bath to turn up the edges all the way round for about half an inch from face to back. This forms a kind of tray, thereby preventing the developing solution from getting on the back, which would disfigure its appearance. The print is then floated on the developing bath, with its face down upon same, and to ensure the whole of the surface being in contact with the solution a dry, soft brush should be applied with slight pressure over the entire back of it, or the print may be drawn and agitated across the surface of the developing solution, the print to be raised from time to time for purposes of examination during the progress of development. The drawing will, in a minute or two, appear in distinct bluish-green lines on a ground of yellowish green. Washing: The photo is now laid face upwards in a trough of clean water, and a brush or soft sponge passed gently over it until the lines stand out well and clear, dark-blue lines on white ground, and every other trace of blue has disappeared. Then leave the photo for about five minutes in the water trough to soak, and renew the water once or twice as may be required, after which it is taken out and hung up over a roller to dry. Care should be taken that no finger marks are made on the photo, and that the surface of the paper is not cracked or broken. Spots and stains can be removed and corrections made in the drawing when necessary by blue solving. Bath consists of equal parts of red and yellow prussiate of potash, 10 P. C. solution dissolved in tepid water. It will be seen that only three distinct operations are necessary by this process, viz.: exposure, development, and washing, and is undoubtedly a great improvement over the other B. L. process, No. 3, enumerated. As for that process five distinct operations are necessary, namely: First exposure in printing frame to light. Second, floating of copy on yellow prussiate solution (development). Third, immersion of copy in first water tray. Fourth, immersion in acidulated bath of either sulphuric or hydrochloric acid (bleaching). Fifth, brushing and flushing in second water tray, and finally drying. It will therefore be seen the B. L. process (one acid bath) has dispensed with a somewhat tedious manipulation that was necessary formerly for the production of a blue line on white ground photo drawing. A recommendable feature of this process over the Ferro Prussiate is that coloring is permissible. Cost of Blue line process outfit £8 8s. to print copies 40 inches by 27 inches, which outfit includes printing frame, glass view 40 inches by 27 inches; lined bath for salts, 42 inches by 30 inches, water bath 42 feet by 30 feet; felt roll of 30 inches. Blue line paper, developing salts ½ pound mixed blue solving. B. W. Black White Process, producing black lines on white ground (one acid bath only required). Manipulation: Exposure as other processes. The point of sufficient exposure is led up to by various changes in the appearance of the sensitised surface. Its color before exposure is yellow. Under exposure the color gradually fades. Exposure is sufficient when the sensitised paper is white under the blank parts of the tracing, and the lines appear yellow on the prepared paper. Development: After taking from the frame, immerse the print in a gutta percha lined bath containing acid and water until the yellow lines become black. The print is then taken out, and immersed and rinsed in a bath of clean water. The print can be gently brushed to get rid of the superficial mucilage, and should be washed copiously with clean water to remove all traces of the chemical solution, or the print may be left to soak in the clean water bath for about ten minutes. If the print be hung up before a thorough washing, the acid on the lines will run and smear the copy. After a thorough washing the print is hung up to dry. Contents of acid bath should be three-quarters of an ounce of acid to one gallon of warm water. The acid is a mixture of gallic and oxalic acids with a little alum. It is essential in this process that the exposure should be well watched, as the paper is very sensitive; a little over exposure results in the lines being taken out, and in other cases left ragged. Under exposure results in a back ground of more or less violet hue or tint. Time necessary for exposure similar to B. L. process. The B. W. process, as compared with most processes, is very modern, being perfected in France about 1880. The simplicity of manipulation necessary, the clearness and utility of its results, and its very moderate cost, have placed this process far in advance of all others. The following advantages can be safely claimed: First, it is the nearest approach that can be got in appearance to an ordinary or original drawing, the only difference being that we should perhaps draw center lines in red and dimension lines in blue. In the photo., of course, these lines would appear black. Second, copies can be colored and treated in every respect like an ordinary drawing. This latter facility can not be over estimated, as for instance, in large drawings on a small scale, the great assemblage and intersection of lines make the drawing to one unaccustomed to dealing with them very intricate, but when colored in the various colors known as different materials, it makes the drawing easier to understand and more explicit throughout. As far as coloring is concerned, this can be done in the B. L. process, but the appearance is not near so good as in the process last described. It may be added that the great value of this process has been recognized, and its adoption accomplished by the leading engineers in Great Britain, Australia, the Continent, and the United States of America. Cost of B. W. outfit, £8 15s. 0d. Printing frame glass view 40 inches by 27 inches, lined bath for acid 42 inches by 30 inches, water bath, felt, roll of B. W. paper 30 inches wide, B. W. acid ½ pound (as supplied by J. Halden and Co., Manchester). Of course the cost of any of the outfits will vary a little, and be subject to fluctuation in cost of material. Hints that should be known: Sensitised papers should be kept in a dry dark place, where the sensitising will remain good for several months. The contents of acid baths will, when kept covered, last for a fortnight's operations. The liquid should be an inch and a half deep in the bath. There should always be a good supply of water, which should be led into the trays or baths by india-rubber tubes, about one inch diameter, the overflow, or emptying pipe, to run into a drain, when the supply pipe can be regulated in accordance with the discharge, thereby enabling fresh water to be constantly running into the washing trays or baths. Copies should be laid to dry across semi-circular rollers, about three inches diameter, in preference to suspending them from horizontal boards by wooden pegs. Copies should not be dried by steaming before a fierce fire. It turns the copies yellowish and renders the paper brittle. Chemical stains can be removed from the hands by a very weak dilution of caustic potash. When a pair of india-rubber gloves or finger stalls are used these stains are avoided. The zinc baths to be occasionally scoured with fine sand, and a weak solution of caustic potash, or soda. The gutta-percha lined trays should never be allowed to remain empty; if not in use they should be filled with water.

A considerable number of questions were asked Mr. House, and were satisfactorily answered. Mr. Mehers proposed a vote of thanks to Mr. House for his valuable paper, which had been an intellectual treat. Mr. Broome, in seconding, said the association was made the more valuable when they had such papers read before it. The paper combined both the theoretical and the practical, and the information contained in it was all the more valuable coming as it did from the head draughtsman of a well known and active firm in Wigan. The motion was heartily passed and acknowledged, and, a similar compliment having been paid to the chairman, the meeting terminated.

Correspondence

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to "E. R. S.," of Winburne, Pa., whose question appeared in the June issue:

In an airway of the following dimensions what quantity of air in cubic feet per minute will be obtained when there is a water-gauge of 1·85 inches; 6′ × 8′ × 1,000′, 9′ × 3½′ × 1,100′, 5′ × 7′ × 1,500′, 3′ × 8′ × 1,550′?

This question may be answered in several different ways of which I submit two.

First, by finding the relative amount of pressure absorbed by each section of the airway and then finding the quantity that the pressures will pass in their several sections.

The relative pressure is found thus:

$$\text{formula}: \frac{s}{a^3} = \text{relative pressure},$$

because $k\,s\,q^2 = p\,a^3$, and as the same quantity must pass through each section, k and q will cancel and we will have

$$\frac{s}{a^3} = \frac{p\,a^3}{a^3} = p.$$

$$\text{First section } \frac{28{,}000}{48^3} = \cdot2532 = \text{relative pressure.}$$

$$\text{Second section } \frac{27{,}500}{31\tfrac{1}{2}^3} = \cdot8830 = \text{relative pressure.}$$

$$\text{Third section } \frac{36{,}000}{35^3} = \cdot8396 = \text{relative pressure.}$$

$$\text{Fourth section } \frac{34{,}100}{24^3} = 2\cdot4667 = \text{relative pressure.}$$

$$4\cdot4425$$

W. G., 1·85 × 5·2 = 9·62 = the sum of the pressures due to each section.

Then

4·4425 : ·2532 :: 9·62 : ·548 true pressure.
4·4425 : ·8830 :: 9·62 : 1·912 true pressure.
4·4425 : ·8396 :: 9·62 : 1·818 true pressure.
4·4425 : 2·4667 :: 9·62 : 5·341 true pressure.
9·619

Then by the formula:

$$a\sqrt{\frac{p\,a}{k\,s}} = q.$$

$$\text{First section } \sqrt{\frac{48 \times \cdot548}{\cdot0217 \times 28{,}000}} \times \overset{a}{48} = \overset{\text{Quantity.}}{9{,}987}$$

$$\text{Second section } \sqrt{\frac{31\tfrac{1}{2} \times 1\cdot912}{\cdot0217 \times 27{,}500}} \times 31\tfrac{1}{2} = 9{,}988$$

$$\text{Third section } \sqrt{\frac{35 \times 1\cdot818}{\cdot0217 \times 36{,}000}} \times 35 = 9{,}989$$

$$\text{Fourth section } \sqrt{\frac{24 \times 5\cdot341}{\cdot0217 \times 34{,}100}} \times 24 = 9{,}984$$

So the quantity passing is nearly 10,000 cubic feet per minute.

Second, in airways passing equal quantities, s will vary as their areas cubed; now let us assume that an airway 20 feet area is to pass the same quantity as the airway given in the question, then s for

				s	s'
First section	= 48³	: 20³	:: 28,000	:	2,025·47
Second section	= 31½³	: 20³	:: 27,500	:	7,038·67
Third section	= 35³	: 20³	:: 36,000	:	6,717·20
Fourth section	= 24³	: 20³	:: 34,100	:	19,733·8
Rubbing surface of assumed airway,					35,515·14

Then

$$\sqrt{\frac{p\,a}{k\,s}} \times a = q = \sqrt{\frac{9\cdot62 \times 20}{\cdot0217 \times 35{,}515\cdot14}} \times 20 =$$

9,992, quantity passing. The slight difference is due to the fractions.

The answer given by "S. U. P.," in your August issue, is too great a quantity as it would require a pressure of more than 16 lbs. to pass 12,962 cubic feet of air per minute in the airway given in the question.

Yours, etc.,
T. S. C.

Gardner, Ill., August 24th.

Certificated Mine Foremen.

Editor Colliery Engineer:

SIR: In the August number of your invaluable mining journal, I find some well considered editorial remarks touching "Certificated Mine Foremen." There is no such thing as perfection, and objections can be raised to the operation and results of Certificated Mine Bosses; but that the advantages greatly outweigh the disadvantages of this system must be admitted by every one desiring to see increased safety in subterranean mining.

At the summer meeting of the Ohio Institute of Mining Engineers, in 1890, and again during the last winter's meeting of the Institute, I called attention to the necessity of such a law for the coal mines of Ohio. To my astonishment, the Chief Inspector of Mines, Mr. Hazeltine, and several of his assistants, set up a vigorous opposition to such a scheme, Mr. Hazeltine asserting as the results of *his* experience that the more illiterate a mine boss was, the better boss he made.

I was glad to see some discussion follow my article in THE COLLIERY ENGINEER on this subject, and hope to see it thoroughly ventilated by some of your able correspondents.

In my opinion, mine bosses and mine inspectors should be required to undergo examination and receive certificates of competency previous to assuming their duties.

I feel proud of the success of my old friend, Mr. Austin King. He is an example of what an intelligent miner can do for himself if given a chance. By the way Mr. Hazeltine quoted Mr. King as opposed to mine inspectors and mine bosses being examined, if Mr. King thinks so now, he has changed his opinion since he left Ohio.

I trust my friend, Mr. Hazeltine, will take no offence in my quoting him in this letter. The question is one of public interest to mining, in which he and I have always agreed, except as to this matter.

Wishing THE COLLIERY ENGINEER increased success.

Fraternally yours,
ANDREW ROY.

Glen Roy, O., August 24th.

Mechanics.

Editor Colliery Engineer:

SIR:—Will some of your readers kindly answer the following question:

On an incline rising 1 in 10, the loads weighing 12,000 pounds, and the empties 3,000 pounds, the drums, ropes, and sheaves 5,000 pounds; the friction of the cars equal 1% of their weight, and the friction for drums, ropes, and sheaves $\frac{1}{10}$ of their weight. When they are being let down by a brake, it takes 4 minutes to run 300′, now what is the amount of friction applied by the brake?

Yours, etc.,
J. T. G.

Braidwood, Ill., August 25th.

Blasting.

Editor Colliery Engineer:

SIR:—I wish some of your correspondents would answer the following question:

There is a blast-hole charged with powder and tamped ready for firing. The needle is withdrawn and from the hole or orifice molded by the needle there issues fire-damp. When this fire-damp or gas is ignited at the mouth of the needle will it explode the powder at the end of the hole? State reasons, whether the answer is in affirmative or negative.

Yours, etc.,
JOHN KANE.

Coal Bluff, Indiana, August 15th.

Pumping.

Editor Colliery Engineer:

SIR:—Permit me to send you a few lines in reply to "Tyro's" article, in your last issue, regarding "Pumping:"

The volume of water discharged by a pump is ascertained by multiplying the cubical contents of the pump by the number of strokes per minute, the cubical contents being the product of the sectional area of the pump and the length of stroke. We have therefore the following formula:

$$\underbrace{D^2 \times \cdot7854}_{\text{Area}} \times S \times N = \text{cubic inches or feet where}$$

all quantities are in inches or in feet. If we wish to obtain gallons discharged the formula becomes

$$\frac{D^2 \times \cdot7854 \times L \times N}{231} = D^2 \times L \times N\ \cdot0034 =$$

gallons.

The example given works out therefore as follows:

8² × 60 inches × 30 × ·0034 = 391·68 gallons per minute, instead of 32·64 as stated.

One of Keuffel & Esser Co.'s (New York) $2.50 pump indicators gives this result at a glance without any computation whatever.

Yours, etc.,
WM. COX.

Bay View Hotel, Tompkinsville,
Staten Island, N. Y., July 21st.

Correction.

Editor Colliery Engineer:

SIR:—In my answer to Mr. Arthur Crossland's question in the August issue, where I said the quantity of air should not be less than 100,000 cubic feet per minute, I should have said 150,000 cubic feet.

Yours, etc.,
JOSEPH CAIN.

Whitwell, Marion Co., Tenn., August 22d.

Examination Question.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to question by J. W. S.:

[The solution sent in is similar to that of "A. B.," which was inserted in the August issue.—ED.]

Yours, etc.,
F. B.

Maccan, N. S., August 2d.

Pumping.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to J. T. Rogers' question in the August issue:

The receiver and 3″ T should be connected by a 4″ pipe instead of a 3″ pipe to give proper results, as to carrying capacity to both slopes at same time, and the 6″ pipe for intermediate, 1,800′ is quite right as it offers less resistance to flow of air. Nothing would be gained by using two 3″ pipes from 6″ pipe to the pump, unless a pipe giving corresponding area is used direct from receiver.

Yours, etc.,
J. EDWARD SLATER.

S. Norwalk, Conn., August 20th.

Examination Question.

Editor Colliery Engineer:

SIR:—I submit the following in answer to question by "J. W. S.," of Westville, Picton Co., N. S., in your July issue:

5·2 ÷ ·0763 (weight of a cubic foot of air at 62° F. and 30″ barometer) = 68·15′, the motive column that will produce 5·2 lbs. pressure; and 68·15 ÷ 400 = ·1703. Then

459° + 40° = 499 × ·1703 = 84·98° + 40° = 124·98° F., the temperature in the upcast.

By the following formula we can prove the work.

$$M = D\,\frac{T - t}{459 + t}$$

M = motive column.
D = depth of shaft.
T = temperature in upcast.
t = temperature in downcast, then

$$\frac{124\cdot98^\circ - 40^\circ}{459^\circ + 40^\circ} = \cdot1703 \times 400 = 68\cdot12 \times \cdot0763 =$$

5·197556 lbs., or 5·2 lbs. nearly.

Yours, etc.,
H. L. D. W.

Lethbridge, N. W. T. Canada, August 1st.

Mechanics and Surveying.

Editor Colliery Engineer:

SIR:—I send the following solutions in reply to Samuel Lewis, of Scranton, Pa., whose questions appeared in the July issue:

(1). What is the reason for reducing the column pipe of an engine? In a given case the diameter of the engine is 10″ and of column pipe 8″. There is a short reducer set in the column near the pump, what is this for, and what is gained by it?

The diameter of the water cylinder equals 10″, and of the column pipe 8″, which under ordinary circumstances may be considered a fairly practical size. The relative capacities or areas are 10″² and 8″², or the mean areas are

pump = 78·54.
pipe = 50·2656.

The area of the piston rod must be deducted from one stroke, or one-half from each stroke. We will assume it to be a 3″ rod, then the area is 7·068″.

78·5 − 3·5 = 75, then under ordinary circumstances a pump may be expected to give about ·85 per cent. of efficiency, which would reduce the relative capacity of the water cylinder to about 63·75, then the area of pipe being 50·25, the flow of the water in the pipe would have a speed of 63·75, while the piston moves 50·25, then the piston must stop at the end of each stroke, so it may be seen that the pump, if not working at full power, can do the work. However, a 9″ pipe would have an area of 63·6, and to obtain the best possible results large pipes are required, for the friction is increased as the square of the speed, and directly as the length of the pipe.

(2). In answer to his second question, I would say that the inner branch of the siphon remains full and the outer branch will be emptied at about half the rate of flow when working, for as the water runs out air will force its way in at the end of discharge, and will occupy about half the area.

Yours, etc.,
F. B.

Maccan, N. S., August 1st.

Ventilation.

Editor Colliery Engineer:

SIR:—I submit the following in answer to S. U. P., of Red Bank, Pa.:

(1). The velocity is found by dividing the volume by the area of the shaft, thus

43,982·4 ÷ 87·9648 = 500′ per minute, the velocity.

(2). The formula used in finding the pressure is

$$P = \frac{K\,S\,V^2}{a}, \text{ substituting their values}$$

we have

$$\frac{\cdot0000000217 \times 24111\cdot552 \times 500^2}{87\cdot9648} = 10\cdot6764 \text{ lbs.}$$

pressure per foot, and 10·6764 ÷ 5·2 = 2·0531 inches W. G.

Yours, etc.,
LEWIS C. HUGHES.

Avoca, Pa., August 20th.

Algebra.

Editor Colliery Engineer:

SIR:—In answer to question by "A. B. C.," of Pittston, Pa., in your August issue, I would say that I find the value of x to be 2, and of y to be 5.

Yours, etc.,
SUBSCRIBER.

Connellsville, Pa., August 19th.

Siphon.

Editor Colliery Engineer :

SIR:—I send the following in reply to "Miner," of Elizabeth, Pa.:

Can a siphon have too much fall for its lift, and why?

I have good reasons to believe that it can, as I had an opportunity to test the matter some time since. A siphon was laid in a mine, the length of the pipe from inlet to summit being 300′; vertical height 12′, and the discharge 35′ below the summit. For an experiment I added enough pipe to the discharge to make it 35′ below the inlet, or 47′ below the summit and found that the siphon would cut off, or stop flowing in three or four hours, while I knew it to run a week or ten days continually before the fall was increased. When the fall was reduced the siphon worked as well as ever.

Now, I may be wrong in my surmise, but the most satisfactory solution I could arrive at for the difficulty was this: In a siphon we have only the atmospheric pressure of 14·7 lbs. per square inch to overcome the friction of the pipe, and to lift the water, or rather force it to the summit. In order to create a vacuum we must have the discharge lower than the inlet. From inlet to summit we have two forces to overcome, *i. e.*, friction and weight, or force of gravity, while in the discharge there is only friction, the force of gravity assisting the flow, the atmospheric pressure being overbalanced before the siphon will flow. Now, as the velocity increases, friction increases also requiring more power, also there are more pounds to be lifted. As the fall is increased we get more weight, or pressure, and this increases the velocity until the friction due to increased velocity will eventually absorb the atmospheric pressure, and the water will run away from the summit faster than it can be forced to summit from inlet.

The above may not be the correct explanation of a fact, but it is a fact that a siphon may have too much fall for its lift, as I have proved by experiment.

Yours, etc.,
S. U. P.

Red Bank, Pa., August 22d.

Ventilation and Mining.

Editor Colliery Engineer:

SIR:—I submit the following in answer to the three questions asked by "A. L. G.," of Audenried, Pa., in your August issue:

(1). In the formula given

A = the major axis, or 16′
a = the minor axis, or 8′

Substituting these values in the given formula, it becomes

$$\frac{\frac{\sqrt{256+64}}{2} + \frac{16+8}{2}}{2} \times 3{\cdot}1416.$$

Collecting we have

256 + 64 = 320 ÷ 2 = 160, and $\sqrt{160}$ = 12·6491 +.
16 + 8 = 24 ÷ 2 = 12, and 12·6491 + 12 = 24·6491, and this divided by 2 = 12·32455 × 3·1416 = 38·71980628′ = perimeter of the ellipse.

(2). In opening out a roadway for a turnout, it would probably be necessary to double the length of the collars. The condition of roof, etc., being the same, the new collar would have to support twice the weight. In the "Colliery Engineer Pocket-Book," page 22, I find this example: If a collar 6 feet long, 8″ diameter, supports a certain weight, what must be the diameter of a collar 12′ long to support the same weight? The answer given is

$\sqrt[3]{6} : \sqrt[3]{12} :: 8'' : x$, or 10″ +.

That question calls for the support of the same weight, but we have to provide for double the weight, consequently

6 : 12 :: 10³ : 2000, and $\sqrt[3]{2000}$ = 12·6″ diameter of collar to support twice the weight.

(3.) Pressure varies as the square of the velocity, therefore a velocity of 1 in the 9′ × 9′ airway means a velocity of 1·125 in the 12′ × 6′ airway. Then

1² : 1·125² :: 10 : x, or 12·65625 = new pressure.

Yours, etc.,
J. V.

Punxsutawney, Pa., August 24th.

[Answers to the above questions similar as regards the principles used were received from J. T. G., of Braidwood, Ill., August 25th, and David P. Brown, of Adelaide, Pa., August 27th.—ED.]

Ventilation and Mining.

Editor Colliery Engineer :

SIR:—Please insert the following in answer to "A. L. G.," of Audenried, Pa.:

(1). In the formula let A = 14, and a = 8, then it becomes

$$\frac{\sqrt{\frac{14^2+8^2}{2}} + \frac{14+8}{2}}{2} \times 3{\cdot}1416 = 35{\cdot}185 +, \text{ perimeter.}$$

(2). We will assume the collars to be 7′ between the notches, and 10″ in diameter, then for the double track or turnout they would be 14′ between the notches. The diameter required for the collars over the double track under similar conditions would be found thus

$$\frac{2 \times 10^3}{1} = 2{,}000, \text{ and}$$

$\sqrt[3]{2{,}000}$ = 12·5″ the diameter, if the weight were the same; but where the width of the place is doubled, if the top follows the same law, the weight will also be doubled. This would cause the roof to weaken and the average weight upon the timber to increase as the width, the same as the resistance of the timber decreases. Therefore we would conclude that a 14′ collar would have to support double the weight of a 7′ collar, because the space was doubled. By this assumption the 14′ collar would have to be 4 times as strong; twice as strong for the double length, and twice more for the double weight. If the 7′ collar is 10″ in diameter then the 14′ collar should be

1 : 4 :: 10³ : 4,000 ; $\sqrt[3]{4{,}000}$ = 15·8″,

or nearly 16″ in diameter.

(3). According to the conditions of the question $q = q$, that is $a\,v = a\,v$, or

$$a\sqrt{\frac{P\,a}{K\,s}} = a\sqrt{\frac{P\,a}{K\,s}} \text{ and as } s = s, \text{ we have}$$

$a\sqrt{P\,a} = a\sqrt{P\,a}$, or squaring both sides of the equation $P\,a^3 = P\,a^3$, whence

$$P = \frac{P\,a^3}{a^3},$$

substituting the given values we have

$$P = \frac{10 \times 81^3}{72^3} = 14{\cdot}22 \text{ lbs.},$$

therefore the pressure required is 14·22 lbs. per sq. ft.

Yours, etc.,
P.

Whitney, Pa., Aug. 29th.

Ventilation.

Editor Colliery Engineer :

SIR:—Please publish the two following questions in your next issue:

(1). An airway 8′ × 8′ × 1000′ is passing 40,000 cu. ft., of air, what diameter should a circular airway 1200′ long be to pass one-half the quantity, the pressure remaining the same?

(2). A mine is ventilated by natural ventilation passing 10,000 cubic feet of air per minute with a pressure of 5·5 pounds, the temperature in the downcast being 42°. The air current is reversed by erecting a furnace at bottom of the downcast producing 14,000 cubic feet of air per minute, what is the effect on the pressure and temperature?

Yours, etc.,
A. B.

Hanna City, Ill., August 22d.

Ventilation.

Editor Colliery Engineer :

SIR:—Please insert the following in answer to "S. U. P.," of Red Bank, Pa.:

(1). The velocity is found by dividing the quantity of air passing by the area, thus

43982·4 ÷ 95·0334 = 462·80091′ the velocity.

(2). The pressure is found by the formula

$P = \frac{K\,S\,V^2}{a}$, substituting their values and multiplying we have

96·37399 ÷ 95·0334 = 1·014106 lbs., pressure, and 1·014106 ÷ 5·2 = 0·19502 = water gauge.

Yours, etc.,
I. E. J.

Moosic, Pa., August 27th.

Efficiency of Fans.

Editor Colliery Engineer :

SIR:—A fan 16′ in diameter, which is making 130 revolutions per minute, gives a water-gauge of 3·2″, what is the fan's efficiency?

Yours, etc.,
M.

Braidwood, Ill., August 27th.

Ventilation.

Editor Colliery Engineer :

SIR:—I submit the following in reply to "S. U. P.," of Red Bank, Pa.

(1). Let
a = semi-major axis.
b = semi-minor axis.
π = 3·1416.
Then

$\pi \times a \times b$ = 87·9648 area, and
43982·4 ÷ 87·9648 = 500′ velocity.

(2). We can find the perimeter by the formula

$$\frac{\frac{\sqrt{14^2+8^2}}{2} + \frac{14+8}{2}}{2} \times 3{\cdot}1416, \text{ which is } 35{\cdot}29$$

nearly, then

35·29 × 600 = 21,674, or s.

And by the formula

$\frac{K\,S\,V^2}{a}$ = w. g. = ·257055″ +, or 1·33669 lbs.

Yours, etc.,
J. V.

Punxsutawney, Pa., August 24th.

Examination Questions.

Editor Colliery Engineer :

SIR:—Will you kindly publish the following questions for answer in your valuable journal:

(1). Suppose we increase the wires of the gauze of a safety-lamp three times their usual thickness, what effect, if any, would it have on the safety of a Davy lamp?

What kind of oil would you prefer to use in safety-lamps, and state the reasons why?

(2). How would you proceed to develop a field of coal 1,000 acres in extent lying 500′ below the surface, the coal-bed being 4′ thick with an inclination of 1 in 300 west to east. The output to equal 1,200 tons per day. Give a description of all necessary appliances required, also the number of men necessary to produce this output continually. Assuming 250 gallons of water to accumulate per minute, what size of pump would be required to keep it emptied out?

(3). Is there any safe practical method of detecting explosive gas in mines other than by the use of the safety-lamp? Explain fully.

(4). A furnace at the bottom of a shaft 400′ deep produces 15,000 cu. ft. of air per minute with 5·2 lbs. pressure per sq. ft. The temperature in the downcast shaft is 40° F., what is the temperature in the upcast shaft, which is 450′ deep.

Yours, etc.,
M.

Mansfield, Pa., August 28th.

Mining.

Editor Colliery Engineer:

SIR:—Will any of your readers kindly give plan and directions how to erect a door in a 4½′ vein to be opened by mules traveling both ways.?

Yours, etc.,
SUBSCRIBER.

Lehigh, Ind. Ty., August 28th.

Ventilation.

Editor Colliery Engineer :

SIR:—Will you please insert the following questions in your next issue for some of your able correspondents to answer:

A mine (drift opening) is ventilated by furnace. The outside temperature is 41° F., and the upcast shaft, which is 100′ in depth, has a temperature of 191° F., the dimensions of the underground airway are 7′ × 9′ × 4,000′.

(1). Using Atkinson's co-efficient of friction what will be the volume of air obtained under the above conditions?

(2). What will be the length of the motive column; (show method and formula by which length is ascertained)?

(3). What horse power will be expended by the furnace in producing this volume of air?

(4). Suppose the length of the airway is increased to 9,000′, what would be the quantity obtained, the area and pressure remaining the same?

(5). What will be the horse power expended, when the length is increased? Explain cause of difference in horse power, if any?

Yours, etc.,
S. U. P.

Red Bank, Pa., August 22d.

Ventilation.

Editor Colliery Engineer :

SIR:—I send the following in answer to question (1) submitted by "A. L. G.," of Audenried, Pa., in your last issue:

The formula referred to is simply this: To half the sum of the two diameters add the square root of half the sum of their squares, multiplying the last sum by 1·5708, which is half of 3·1416; the product will be the perimeter.

For example, suppose an elliptical shaft, the diameters of which are 8′ and 14′ respectively, then

8 + 14 ÷ 2 = 11, or half the sum of the two diameters. And

8² + 14² ÷ 2 = 130, half the square of the two diameters, then

$\sqrt{130}$ = 11·4 + the square root of half the sum. Whence

11 + 11·4 × 1·5708 = 35·18592′ the perimeter required.

Another formula is to multiply the sum of the two diameters by 1·5708, and the product will be the perimeter nearly, thus

8 + 14 × 1·5708 = 34·5576′, perimeter.

Yours, etc.,
Avoca, Pa., Aug., 20th. LEWIS P. HUGHES.

Measuration and Mining.

Editor Colliery Engineer :

SIR:—I submit the following in answer to questions 1, 3, and 4, asked by "Miner," of Philipsburg, Pa., in your August issue:

(1). The inside measurements of a pit car are length, 6′ 6″; depth, 2′ 6″; the bottom section 1′ in height, and 3′ 2″ in width; the top measurement of upper section is 4′ in width, how many bushels of coal will it contain, computing 2,688 cubic inches to the bushel?

First, we will find the cubical contents of the bottom section of the car, reducing the measurements in feet to inches, we have

Length = 78″; width = 38″, and depth 12″ then,
78″ × 38″ × 12″ = 35,568 cu. ins,

and for top section

Width = 48″; bottom width 38″, and depth = 18″, or 30″ — 12″ = 18″. The average width of top section is found thus

48″ + 38″ ÷ 2 = 43″, then
43″ × 78″ × 18″ = 60,372 cu. inches.

Adding this to cubical contents of bottom section we have

35,568 + 60,372 = 95,940 cu. ins., and
95,940 ÷ 2,688 = 35·7 bushels nearly.

(3). In a mine generating a large amount of fire-damp, where the coal vein dips 10′ in every 100′, what ventilating apparatus would be best, and where would you erect the same?

I would select a Guibal fan; split the current so as to ventilate each district from the downcast, having the foul air pass direct to the upcast. I would, if possible, place the fan so as to have the outlet on a rise from the downcast, by doing so the gas would be more easily removed if the ventilation is ascensional than when the current is forced down the dip. The gas being lighter than air, will rise, and the air inside being lighter than on the outside especially in Winter, it would be more easily directed to the rise than to the dip. As to whether the fan should be a blower or an exhaust, I would be guided by circumstances and in any case make it reversible so that in case of fire in either shaft the fan can be reversed, and the smoke drawn out until the men can be gotten out safely. Another advantage to be gained would be in case the fan exhausts it could be reversed at night to clear the downcast of ice in the winter time.

(4). If a mine generated 200 cubic feet of fire-damp per minute, and 1,000 cubic feet of black-damp, there being 120 persons employed, how much air would be required to keep the workings in a healthy condition?

Two hundred cubic feet of fire-damp per minute may be diluted and rendered harmless by having say, 4,000 cubic ft. of air in circulation, this would be in a proportion of 1 in 20, as the mine gives off 1,000 cu. ft. of black-damp per minute, and a mixture of 7% of black-damp will render fire-damp non-explosive. The 200 cu. ft. given off in this case is not explosive as 1,000 cu. ft. of black-damp would "damp" 14,285 cu. ft. of gas, but since a mixture of 8% of black-damp is dangerous to breathe, and 10% will extinguish lights, it will require a volume of 10,000 cu. ft. of air to bring the mixture to the point where a light will be extinguished, and 12,500 cu. ft. to make the mixture 8% damp, then in order to make the air safe it would require at least 50,000 cu. ft. of air and then there would be 2% of damp.

According to law 120 men would require 12,000 cu. ft. of air, and, say, 8 mules allowing 500 cu. ft. for each mule, which would make

$8 \times 500 = 4{,}000$ cu. ft., or 16,000 cu. ft. in all if only a normal amount of gas was given off, but in this case it will be necessary to have at least 50,000 cu. ft.

Yours, etc.,
S. U. P.

Red Bank, Pa., Aug. 22d.

Ventilation.

Editor Colliery Engineer:

SIR:—I submit the following in answer to question by S. M. Roberts, in your August issue:

The length of the box is 841·868′ +, and is found as follows:

Since the area and rubbing surface are given, we must find the perimeter and divide the rubbing surface by it, the quotient will be the length, thus—

$\sqrt{28{\cdot}5714} = 5{\cdot}34525' =$ one side of the box; $5{\cdot}34525 \times 4 = 21{\cdot}381 =$ perimeter, then $18000 \div 21{\cdot}381 = 841{\cdot}868'$.

I have worked this out as a separate airway.

Yours, etc.,
L. P. H.

Avoca, Pa., August 27th.

A Well Managed Mine.

A friend who recently visited Blue Creek Mines Slope No. 5, of the DeBardeleben Coal and Iron Company, at Adger, Ala., sends us the following:

The work of sinking Slope No. 5 was started four years ago under the superintendence of Mr. L. W. Johns, the present superintendent. In June, of this year, the mine was the largest producer in Alabama, having shipped 19,567 tons in 21½ days. The slope is 1,000 ft. long, with an average dip of 14°, to the basin, which at this point is 100 ft. wide. When the slope had reached the basin, Mr. Johns employed Mr. James Hillhouse Sr. as inside superintendent, and in doing so he secured a most competent official.

Mr. Hillhouse started six headings, two six hundred feet from the top of the mine, one east, and one west, and 4 in the basin, 2 east and 2 west, each of which are now over 4,000 ft. long. A slope was driven up the pitch on the other side of the basin 1,500 ft. Four headings were started from this slope, at distances of 300 ft. and 600 ft. from the bottom. The coal from these headings is run down to the foot of the main slope by gravity, the loaded cars hoisting the empties. Owing to the basin widening and dipping to the west, Mr. Hillhouse has driven a slope down the center of it, and the coal from it is hoisted by a pair of engines and landed at the bottom of the main slope. Every thing is so well planned and conducted that things run "like clock work."

The ventilation is effected by two 15 ft. fans and is excellent, the mine being probably one of the best ventilated in the State, and Mr. Hillhouse deserves credit for and is justly proud of this fact.

Mr. James Hillhouse, Jr. son of the Inside Superintendent, who has just completed a course of mining engineering at the State University, is employed as Mine Boss and Assistant Engineer, and as he has worked in all capacities from a slate picker in Pennsylvania up to his present position, he has before him a bright future and will probably become one of the leading colliery officials of the State.

A United States Association of Government Geologists to be Formed.

A meeting was held at the Colombian University, Washington, D. C., on the 28th ult., which promises to result in the formation of an association for the advancement of geological work, and especially of official geological work. This is an official organization of the directors of the State and National Geological Surveys.

There were present at this meeting Maj. J. W. Powell, director of the United States Geological Survey; Prof. James Hall, State Geologist of New York; Prof. J. M. Safford, State Geologist of Tennessee; Prof. J. W. Spencer, State Geologist of Georgia; Prof. E. A. Smith, State Geologist of Alabama; Prof. J. A. Holmes, State Geologist of North Carolina; Mr. Arthur Winslow, State Geologist of Missouri; Mr. E. T. Dumble, State Geologist of Texas; Prof. J. Lindahl, State Geologist of Illinois. Maj. Powell was elected chairman of the meeting. Mr. Winslow was elected secretary. After a few preliminary remarks in explanation of the reasons for calling the meeting, Mr. Winslow read a paper suggesting a plan of organization and explaining the objects of and the results to be derived from such an official association. As prominent among the important objects of the Association the following may be cited:

1. The determination of the proper objects of public geologic work.
2. The improvement of methods.
3. The unification of methods.
4. The establishment of the proper relative spheres and functions of national and state surveys.
5. Co-operation in works of common interest and the prevention of duplication of work.
6. The elevation of the standard of public geologic work and the sustenance of an appreciation of its value.
7. The inauguration of surveys by States not having such at present to co-operate with the other state surveys and with the national survey.

As an immediate result of this meeting a committee of six was elected to consider the matter of organization, with the power to frame a constitution and by-laws, to be reported to the association at a time and place to be selected by the committee. This committee consists of Maj. J. W. Powell, Director of the United States Geological Survey, Chairman; Prof. E. A. Smith, State Geologist of Alabama; Prof. J. A. Holmes, State Geologist of North Carolina; Dr. J. C. Branner, State Geologist of Arkansas; Mr. Arthur Winslow, State Geologist of Missouri, and Prof. W. H. Winchell, State Geologist of Minnesota.

It is a matter of sincere congratulation that the Association, whose organization has been an oft-mooted question, is now in a fair condition to become an established fact; that it will serve as an invaluable agent in securing harmony and efficiency in the important public work will be readily appreciated.

Mining Classes.

An evening class, which has for its object the training of candidates for the next competitive examination for Mine Foremen's Certificates, under the new Anthracite Mine Law of Pennsylvania, is commencing in Wilkes-Barre, Pa., under the supervision of Mr. Alexander Dick, M. E., English Government Certificated Colliery Manager. Mr. Dick has conducted similar classes with success in Great Britain, and he expresses his determination to use all efforts in obtaining a good percentage of successful students at the forthcoming examination. The great benefits to be derived from such a class have never before been offered to the miners of this district, and as it is to be hoped that the opportunity may be embraced right now we strongly advise all whose ambitions rise above a "breast of work" in the mine to place themselves in immediate communication with him.

As will be seen by our advertising columns, Mr. Dick is also starting correspondence classes, a method of teaching which has been adopted in England and Scotland with great success. As we understand the *modus operandi*, any pupil can by means of these classes be placed in direct contact with the teacher, no matter how far away he may be residing, and now that the States of Alabama and Illinois have followed the lead of Pennsylvania in making competitive examinations compulsory, such a class is sure to prove of immense advantage to mining students, as we have no doubt the other mining states will, in course of time, follow suit.

Low Rate Harvest Excursions.

The Missouri Pacific Railway and Iron Mountain Route will run a series of low rate Harvest Excursions to Southwest Missouri, Kansas, Arkansas, Texas, and all points West and Southwest, August 25th, September 15th and 29th. Tickets good for thirty days to return with stopover privileges for the inspection of land. Further information furnished by any of the company's agents or H. C. Townsend, General Passenger and Ticket Agent, St. Louis, Mo.

Messrs. Crawford and McCrimmon, of Brazil, Indiana, report that their mine fans are meeting with great success wherever introduced. They are so constructed that they can be readily changed from the exhaust to forcing fans or *vice versa*. They are now in use in every important American coal field, and are giving great satisfaction. Besides the construction of improved fans and fan engines, Messrs. Crawford and McCrimmon manufacture general mine machinery. Their Deluge mine pumps, hoisting and haulage engines, and stationary engines for all purposes are built on correct principles from best materials and the strongest proof of their excellence lies in the fact that whenever the purchaser of a Crawford and McCrimmon fan, engine, or pump, found it necessary to enlarge his plant, he invariably patronized the firm. Their prices are reasonable, and they will cheerfully furnish estimates on all kinds of mining machinery.

During a recent visit to the Clearfield region, we particularly noticed the large number of Beagle Mine Hames in use at the collieries, and as the general agent for the hames carries an advertisement with us, we asked several prominent colliery officials how they liked them. The answer was invariably "first rate. They are the best hames we have ever had." We therefore advise our readers to write for prices and information to George Wise, General Agent, Jeddo, Pa.

Water Supply for Collieries and Coke Plants.

The development of the various coal fields always has more or less effect on the sources from which the water supply is drawn, and unless the fountain-head is outside of the coal measures, the extensive underground workings tap and drain the springs. After the water once enters the mine and flows along in contact with the minerals, it takes up foreign substances both by dissolving them, and by being fed by small streams or droppers strongly impregnated with them. This renders the mine water unfit for use in boilers, or in fact for any other use where it comes in contact with iron. It not only eats out the pipe, but it soon destroys the machinery with which it comes in contact.

Therefore the water supply for steam raising purposes must, if possible, be obtained from points far enough removed from the center of mining operations to ensure a constant and ample supply. If possible, the water necessary for other purposes, such as washing coal, and cooling coke, should also be drawn from sources uncontaminated by mineral acids. This is necessary to ensure long life to the pipe lines, and to valves both of which are as a rule expensive.

The expense of bringing a sufficient water supply to the point of utilization is in many instances much more expensive than it would be if the colliery owners and superintendents would, instead of using metal pipes, use first-class guaranteed wooden water-pipes.

Although wooden water-pipes are of earliest origin, their advantages and usefulness for this purpose have only recently been appreciated by colliery officials. They are now largely used in the Anthracite regions, where, owing to large steam plants, a great deal of water is daily converted into steam. They have been found to last longer than iron pipe, are easier laid, as they are more flexible, and cost much less. The trench does not have to be dug with so smooth a bottom and irregularity in alignment does not effect the joints.

In a recent conversation with Mr. Frank T. Wyckoff, of the Wyckoff Pipe Co., of Williamsport Pa., he informed us that his company turned their pipes directly from the log, and made a specialty of extra strong pipe which they guaranteed. Their pipe is made extra thick and the demand for it for all purposes, where the water head does not exceed two or three hundred feet is enormous. Their total sales from January 1, 1891, to date have been over half a million feet, and of this amount, over 50,000 ft., or about ten miles, have been for colliery use.

When once used the merit of the pipe manufactured by the Wyckoff Pipe Co. becomes so firmly established that subsequent orders always follow, and we advise our readers to look into and test it in a practical way. Inquiries addressed to the company at Williamsport, Pa., will always receive careful and courteous attention.

Merit Appreciated.

The new type heavy hoisting engine which the Lidgerwood Manufacturing Company, lately placed upon the market, has received a flattering reception. Thirteen of them have already been sold in less than a year. The following endorsement from the president of the Vermont Marble Co., Proctor, Vt., Fletcher D. Proctor, son of the present Secretary of War, is notable:

July 31st, 1891.

LIDGERWOOD MANUFACTURING CO.,
New York, N. Y.

Gentlemen:—The two drum hoisting engine which you sent us last spring, is a success, and we do not hesitate to recommend it for what you claim for it. It runs two derricks with one engine, hoisting twenty ton blocks, without any trouble, 152 feet in a minute and a half. This with a steam pressure of about 60 pounds, 300 feet away from the engine, and I am satisfied that with a stronger pressure it would hoist this weight in from a minute to a minute and a quarter. The workmanship of the engine and power is perfect, and we can heartily recommend it.

Very truly yours,
(Signed) VERMONT MARBLE CO.
Fletcher D. Proctor, Pres.

Firemen's Tournament at Atlantic City, N. J.—Half Rates via Pennsylvania Railroad.

The Firemen's Tournament to be held at Atlantic City on September 29th, 30th, October 1st and 2d, promises to be one of the most interesting events of its kind ever held in this country. Invitations have been sent to all the prominent fire companies of the East to be present and enter the lists, and the number of entries already registered assures a brilliant success. The programme of events is a most elaborate one and includes everything that pertains to the firemen's art. Hose races, team races, steamer trials, prize drills, and other firemen contests, together with concerts, torch-light procession, and a grand parade. Beside this, the arrangements for the entertainment of the visitors are very elaborate.

For the better accommodation of visitors and contestants the Pennsylvania Railroad Company will sell excursion tickets to Atlantic City from all principal stations on its system at a single fare for the round trip. The tickets will be sold September 25th to October 2d, valid for return until October 6th, 1891. The facilities presented by the Pennsylvania Railroad for reaching Atlantic City quickly and comfortably are too well known to need comment.

THE Jeffrey Mfg. Co., of Columbus, Ohio, have in the hands of the printers, a revised Illustrated Catalogue and Price-List, showing all the chain links and specialties manufactured by them. A wrought chain is one of the latest additions to their already large list of chains. This Company has the largest line of chain links, from which to select, of any manufacturer in the world, and their list should be consulted by dealers and users of such machinery in general.

The Colliery Engineer.

AN ILLUSTRATED JOURNAL OF

Coal and Metal Mining and Kindred Interests.

ESTABLISHED 1881, INCORPORATED 1889.

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THOS. J. FOSTER,
RUFUS J. FOSTER, MINING ENGINEER, } EDITORS.

THE COLLIERY ENGINEER COMPANY, PUBLISHERS.

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THE COLLIERY ENGINEER COMPANY,
Coal Exchange,
Scranton, Pa.

Cable Address—"Retsof, Scranton."

Vol. XII. September, 1891. No. 2.

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THE FIRE-BOSSES MUST HAVE THE SAME CERTIFICATES AS MINE FOREMEN.

ON the 24th ult., Hon. Fred. W. Gunster, Assistant Law Judge of Lackawanna County, handed down an opinion in the case, which Inspector of Mines Patrick Blewitt, and Mr. William Connell, Chairman of the late Commission to revise the Anthracite Mine Law, had submitted to secure a legal interpretation of the provisions of the new Anthracite Mine Act in regard to the qualifications of persons who perform the duties of fire-boss. Judge Gunster decides that they must have certificates of qualification the same as the mine foremen. The opinion in full is as follows:

The defendants are the owners of a coal mine in this district over which the plaintiff is Mine Inspector. They have a mine foreman and also a qualified fire-boss. At times when the mine foreman cannot personally carry out the provisions of the act of assembly entitled "An Act to provide for the health and safety of persons employed in and about the Anthracite coal mines of Pennsylvania and for the protection and preservation of the property connected therewith." Approved June 2d, 1891. They require the fire-boss to perform the duties prescribed by Rule 5, of article XII of said Act. The question presented for consideration is whether these duties may be performed by a fire-boss, who has qualified as such by filing a certificate of experience as requested by Section 9 of Article VIII, but who is not registered as a holder of a certificate of qualification as mine foreman or assistant mine foreman prescribed by Section 4 of Article VIII of said Act. Rule 5 referred to is as follows:

"In mines generating explosive gases, the mine foreman or his assistant shall make a careful examination every morning of all working places and traveling roads, and all other places which might endanger the safety of the workmen, before the workmen shall enter the mine, and such examination shall be made with a safety-lamp within three (3) hours at most, before time for commencing work, and a workman shall not enter the mine or his working place until the said mine or part thereof, and working place are reported to be safe. Every report shall be recorded without delay in a book which shall be kept at the colliery for the purpose and shall be signed by the person making the examination."

These duties are among the most important if not the most important to be performed in the Anthracite coal mines. They call for a high order of intelligence and skill and it is only necessary to mention them to realize the importance of ascertaining by whom they may be performed.

The practical difficulty in answering the question lies in determining who are intended in the term "mine foreman or his assistant" used in the rule. It is contended on the part of the defendant that a fire-boss who has filed a proper certificate of experience is not prohibited from acting as mine foreman or assistant mine foreman, and that even if he is prohibited from so doing, the mine foreman, whenever he cannot personally carry out the provisions of the Act of the Assembly, may be authorized by the owner of the mine to employ competent persons to act as his assistants, and that if he employs the fire-boss as assistant he is such an assistant as is contemplated by Rule 5. There are isolated portions of the Act which seem to give color to this contention, but we do not think it can be sustained. The faults chiefly relied on by the defendants are Sections 1 and 9, Article 8, and Rule 2, Article 12. They are as follows:

Section 1. Article 8—"It shall not be lawful, neither shall it be permitted for any person or persons to act as mine foreman or assistant mine foreman of any coal mines or colliery unless they are registered as a holder of a certificate of qualification or service under this act."

Section 9. Article 8—"And no person shall be permitted to act as fire-boss in any coal mine or colliery, except he has had five years practical experience in mines as a miner, three of which he shall have as a miner wherein noxious and explosive gases are evolved, and the said fire-boss shall certify to the same before entering upon his duties before an Alderman, Justice of the Peace or other person authorized to administer oaths, and a copy of said deposition shall be filed with the District Inspector of Mines wherein said person is employed."

Rule 2. Article 12—"Whenever a mine foreman can not personally carry out the provisions of this Act so far as they pertain to him, the owner, operator, or superintendent shall authorize him to employ a sufficient number of competent persons to act as his assistants who shall be subject to his order."

The words, "or service under this act," contained in Section 1 certainly tend to confuse, but we do not see how they can be construed as applicable to a fire-boss. If they can, then a fire-boss can act as mine foreman without further qualifications. Strictly speaking there is no such thing as a certificate of service recognized by this act though the certificate of practical experience which a fire-boss is required to file, is something similar to it. But fire bosses are not registered and their certificates are not recorded, while mine foremen and assistant mine foremen are registered and their certificates recorded in the office of the Secretary of Internal Affairs. The words were evidently inadvertently copied by the scrivenor from the Act of 1885, in which they are used in connection with mine foremen, who were granted certificates of service in case they had acted at any mine as mine foreman under said act for at least one year prior to July 1, 1886, Act June 30, 1885, Article 8, Section 4.

This is the more apparent from the fact that the position and qualifications of a fire boss do not appear to be mentioned in the Act of 1885, while under its provisions there were certificates of qualification and certificates of service for mine foremen. But what seems to me as conclusive upon the question before me is the fact that an assistant mine foreman is put upon the same basis as a mine foreman by the act of 1891. He must pass the same examination, give satisfactory evidence of the same amount of practical experience as a miner and of good conduct, capability and sobriety and be registered as a holder of a certificate of qualification. Unless he complies with these requirements the command is absolute that it shall not be lawful, neither shall he be permitted to act as assistant mine foreman. This was not so under the act of 1885. Neither the position of assistant mine foreman, the qualifications for it nor its duties are mentioned in it. It is true that Rule 2 of the act of 1885, authorizing the mine foreman to appoint assistants in certain cases is identical in language with Rule 2 of the act of 1891, but the act of 1891 has in it a new element and must be construed with that element in it, and in the light of antecedent legislation and experience. The command that no person shall be permitted to act as assistant mine foreman unless he is registered, and a holder of a certificate of qualification, is without qualification. It was put into the act for a purpose, and that purpose obviously was to secure greater safety to health and life and property. It would be of no avail if the mine foreman whenever he cannot personally attend to his duties, could appoint anyone whom he thought competent, to assist him whether such assistant was qualified or registered, or not.

We are of the opinion that the fire-boss or person who performs the duties prescribed by Rule 5, Article 12, of the Act of June 2, 1891, is required to be registered, and the holder of a certificate of qualification prescribed by Section 4, Article 8, of said act, and in accordance with the terms of the case stated, direct judgment to be entered in favor of the plaintiff for the sum of six cents and costs.

This opinion is a clear explanation of the provisions of the Act and if appealed from will not be reversed. What was intended by the framers of the law was a certificate of qualification for mine foremen and assistant mine foremen secured by passing an examination and a certificate of experience for fire-bosses, but the Committee failed to change Rule 5 of Article XII which provides that the examinations for gas must be made by the mine foremen or their assistants. The new law provides for fire-bosses who must file a certificate of experience before they can serve, but it says that the duties of the fire-bosses shall be performed by the foremen or assistant foremen who must have certificates of qualification secured by passing an examination. Judge Gunster decides that the fire-bosses cannot make the examinations for gas because in doing so they are performing the duties of the assistant foremen which must be performed by persons holding certificates of qualification. It was not the intention of the Committee that the law should have this effect, but through the failure to change Rule 5 of Article XII so as to permit the fire-bosses to make the examinations for gas the law has this effect and since it cannot be altered it must be obeyed.

To avoid, if possible, the necessity of requiring the fire-bosses to stand the same examination as the mine foremen, a consultation was had, we understand, by a committee with the representative of the Attorney-General, and as the result of that conference at a joint meeting of members of the different Examining Boards of the Anthracite districts held at Hazelton, June 29th, the following resolutions were adopted:

"*Whereas*, It is the opinion of the Attorney-General of the Commonwealth of Pennsylvania 'That the persons now holding Certificates of Service or Qualification as Mine Foremen under the Act of June 30, 1885, must qualify under the Act of June 2d, 1891.

"*Resolved*, That all persons now holding Certificates of Qualification or of Service under the Act of June 30, 1885, shall be entitled to receive Certificates of Qualification under the Act of June 2, 1891, provided the Board of Examiners are satisfied that applicant are competent.

"*Resolved*, That all persons now holding the position of Assistant Mine Foreman or Fire-Boss, or who desire to fill the said position, shall, upon presenting an affidavit certifying that he has had five years practical experience as a miner, three of which as a miner in a gaseous mine, be entitled to have a Certificate of Qualification as Assistant Mine Foreman.

"*Resolved*, That the Examination of Applicants for Certificates shall be held Monday and Tuesday July 6th and 7th, 1891."

We understand the Examining Boards with the exception of that of the former First District (Inspector Blewitt's) have acted in accordance with these resolutions and that certificates of qualification as assistant mine foremen have been recommended for persons who have filed an affidavit certifying that they have had the necessary experience. In Inspector Williams' District 179 persons were recommended for certificates as assistant mine foremen, the blanks for that purpose having been furnished by the Secretary of Internal Affairs. In Inspector Blewitt's District applicants for assistant mine foremen's certificates were examined on the same questions as were asked the candidates for mine foremen's certificates, but they were not required to make as many points to pass the examination. Eight of the applicants will be recommended for assistant mine foremen's certificates. In the light of Judge Gunster's decision, however, neither of these courses is legal. The Judge holds that the act does not contemplate two classes of certificates and that the fire-bosses and assistant foremen must have the same certificates as the mine foremen.

There are over five hundred fire-bosses in the Anthracite collieries, very few of whom have certificates of qualification and all who have not are illegally filling their positions. There are probably five hundred persons who have certificates of qualification obtained by passing the examinations since the Act of 1885 went into effect, who are not now filling positions either as bosses or fire-bosses. It is a question, however, if all the fire-bosses who are illegally performing their duties were removed whether it would be possible to fill their places with competent persons legally qualified. A fire-boss to efficiently perform his duties must possess good sight and hearing, be a close observer, have good judgment and have had experience in making examinations, and he must also have a thorough knowledge of the workings, methods of ventilation, etc., of the colliery in which he is employed. This information cannot be picked up in a day and these qualities are not possessed by all, and in consequence many operators and superintendents will be loath to discharge their fire-bosses and to fill their places with inexperienced men, notwithstanding the latter may have certificates and are qualified legally to fill the positions. How this difficulty is to be gotten over it is not easy to see. It will not be safe to discharge the fire-bosses and fill their places with men who are strangers to the workings. The best plan will be to give the fire-bosses an opportunity to obtain certificates.

The assistant bosses and fire-bosses should have all the knowledge of the art of mining and the sciences related to it that is required of persons who pass our present examinations for mine foremen. A number of the most destructive accidents that have occurred can be traced directly to the incompetency or carelessness of fire-bosses. It is a fact that there are more persons killed in proportion to the number of tons of coal produced and the number of employes in the Anthracite mines of Pennsylvania than in any other coal district in the world. Some of the conditions attending mining here make the occupation more dangerous than elsewhere, such as the large amount of powder used in getting the coal and the greater thickness of the seams, but there are also conditions which are more favorable here than in other mining districts. There has never been a great explosion in which the whole mine was involved and a great many lives lost for the reason probably that our dusts are not as explosive as Bituminous dusts are. To reduce the number of accidents in Anthracite collieries better education as to the phenomena attending the occupation among both mine officers and miners and stricter discipline is needed and any legal requirements which will increase the knowledge of the fire bosses will be beneficial in the end, although it may cause some inconvenience now.

Any person can pass an examination if he will try. The next examination may not be held until next June and by that time if the fire-bosses will apply themselves they can qualify to obtain certificates. When the fact is taken into consideration that the law has been passed with provisions (not intended by the Committee or the Legislature) we think no one will object to giving the fire-bosses an opportunity to qualify for their positions. If they cannot qualify after having had an opportunity to prepare for the examination then they will have to be removed, and amongst those who have certificates of qualification now a sufficient number can be found competent and willing to fill the places that will thus become vacant.

The standard of the examinations should not be lowered, however, to enable the fire bosses to pass. The main thing to find out in a candidate who presents himself for examination is, does he understand the principles involved. It is not so important that he be a good penman or an expert figurer if he has the intelligence to understand the principles which underlie the phenomena which he encounters, but that he has this knowledge should be insisted upon and no person should be given a certificate who does not possess it. We think any intelligent miner or fire-boss who will apply himself during the next nine months can learn everything that it is necessary for him to know to pass an examination to obtain a certificate of qualification and the standard of the examination need not be lowered to enable him to do this.

COAL AND IRON AT THE CHICAGO EXPOSITION.

ONE of the largest and most interesting departments of the World's Columbian Exposition, will be that of Mines and Mining. Here will be grouped in an artistic manner all the mineral products of the earth's strata. Everything useful or beautiful, from coal and iron to the precious metals and finest gems will be shown. The whole world will contribute to make the display a grand one, but America, with her wonderful mineral resources, must lead all other nations.

How extensive the mineral exhibit from other countries will be cannot be estimated as yet, but the exhibit of this country, not only as a whole, but of each state and section, will be most complete. Chief Skiff, of the department of Mines and Mining, is working hard to secure an exhibit that will surpass in size, grandeur, and utility, anything heretofore attempted.

Most of the matter so far published relating to the exhibit in this department has been concerning the precious metals, gems, and rare collections of minerals, and this has led many to believe that the baser metals and minerals were to be neglected. Such an inference is entirely wrong. The management realize their great industrial importance, and it has been determined to organize a sub-department to take special charge of the coal and iron exhibit, and later, a similar subdepartment to take charge of the copper and lead exhibits.

The coal industry of the United States is of gigantic proportions, involving the investment of many millions of capital, and the subsistence of probably a million and a half of people. The census bulletins recently issued, show the production of coal in the United States, in 1889, to have been over 140,000,000 tons, the value of which at the mines was over $150,000,000. Twenty-nine of the States and Territories are coal producing. Large as is our present annual production, it is small in comparison with the possibilities. Our coal resources are practically inexhaustible, and many large fields have not as yet been developed. Vast areas of coal measures, thousands of miles in extent, are distributed over our national area, and in the West and South the coal mining industry is rapidly increasing in importance.

The exhibit of coal at the Exposition, will of course be qualitative, rather than quantitive. Not only will the different varieties of coal, which the different localities produce, be shown, but chemical analyses of each, and the results of physical tests determining their economic value, and adaptability to various uses, will be shown. The coal resources of the different States and sections will be shown by geological maps and drawings, showing configuration, stratification, etc., which will make apparent at a glance, the extent and accessibility of the various beds.

So, too, as regards iron. The most strenuous efforts will be made to have an exhibit worthy of that great branch of industry. This country is now the first nation in the world in iron production, having recently forged ahead of Great Britain, its only real competitor. Our production of pig iron now exceeds 10,000,000 tons annually, or nearly four times what it was ten years ago, and the production of steel now aggregates about 5,000,000 tons a year, a growth of nearly 300 per cent. in the decade. The development of the iron resources of the Southern States has been especially great and rapid. The display at the Exposition will be prepared and collected under the fullest appreciation of the magnitude and importance of the iron industry. There will be shown all the many varieties of ores, with full data as to the location and extent of their beds, the analysis of each ore, and, so far as possible, the different processes of treatment in the manufacture of iron and steel.

Another exhibit which will be very extensive and varied will be that of building stone. Granite, limestone, marble, sandstone and bluestone, in scores of varieties, and scores of colors, will be shown by the finest specimens procurable. Nearly every State has quarries of native material of excellent quality. From one to half a dozen of the twenty or more recognized varieties of granite, for example, are quarried in twenty-eight States, Massachusetts, Maine, California, and Connecticut being the largest producers. The value of the granite output in 1889, was $14,464,095, an increase of more than $9,000,000 over that of 1880. Limestone is quarried in almost every State, Pennsylvania and Illinois taking the lead. The value of the output in 1889 was $19,095,179. This is exclusive of the output of marble, which, as is well known, is a species of limestone, the quarrying of which in a number of the States is an important and extensive industry. Sandstone, including bluestone, was quarried in 1889, to the value of $11,758,081, nearly every State being a producer. The exhibit of building stone, Chief Skiff intends, will be given the importance it justly demands. Thousands of specimens, many of them highly polished, and very beautiful, will be shown, and accompanying each will be the results of tests made to determine strength, durability, and other merits as construction material. The exhibit, which will be made in the Mines and Mining department, will, it is believed, mean very much in the matter of rapid development of newly discovered mines and quarries, and the attraction of capital to many which, through lack of it, have been but little worked.

COMMENT AND NOTICE.

THE United States is entering on what promises to be the most prosperous year in the history of the Nation. The crop situations here and in Europe are such as to assure this. Our crops are the largest ever known, and far exceed the most sanguine estimates, while those of Europe are remarkably small. It is practically settled that Europe will need to import between two and three hundred million bushels of wheat from America. Our production this year has been so great that this large amount can be spared without enhancing the price of breadstuffs at home. The farmer will reap his profits from the greatly increased production of his land and Europe's necessities. The mining and manufacturing interests will be benefited by an increased demand for their productions from the agricultural classes, and from the enhancement of the volume of general business incident to a largely increased export trade. The surplus of wheat alone in the United States and Canada will this year aggregate fully 200,000,000 bushels. It assures a revival of prosperity in which all classes of people will share. But in order to realize all that is possible from the splendid opportunity, it is necessary that all schemes which may have an effect to obstruct the natural course of trade be avoided. Under natural conditions great prosperity is assured. Speculation cannot entirely spoil the prosperous future, but it can materially lessen its value, and all efforts to corner the grain market should be deprecated. Prosperity to the agricultural interests means prosperity to all interests.

THE number of accidents in Northern England is proportionately less than in other portions of Great Britain or than in this country. The reason is believed to be because of the deputy over-man system as carried out in that section of England. The deputies set all the timber, the miners not being permitted to do this work. As the setting of the timber is the special duty of this class of sub-officers it is performed, and as a consequence the number of deaths and injuries from falls of sides and roof in these collieries is less than in others. Then it is contended that the presence of the deputies in the workings greatly assists in the maintaining of discipline and discipline is the most important means of preventing accidents.

MR. F. M. WARDELL, Inspector of Mines for the Yorkshire and Lincolnshire (England), districts, relates these facts in relation to an explosion of coal-dust which took place on the surface, where gas did not contribute in the smallest degree to producing the results:

"The crank shaft of a slack crusher vertical engine broke, and it was necessary to hang a pair of rope blocks near the roof of the engine house in order to raise the fly-wheel sufficiently to admit of the removal of the shaft. A man was sent to the top of the engine-house to fix the blocks, and in order to place a plank from which they were to be fixed perpendicularly above the fly-wheel, he commenced to turn it over. This plank had not been touched for several months, and had become heavily loaded with very fine coal-dust from the crusher underneath. A fitter was, at the time standing on the engine, and other men were present on the floor of the engine house. They all had ordinary torch-flaming lamps. The dust, on the plank being moved, fell on to these lamps, and an explosion immediately followed, the men being seriously burned. The explosion was of a violent character, and blew the slates from the roof of the engine house.

MR. W. B. SCOTT, Inspector of Mines for the South Staffordshire District, of England, makes the following practical suggestions in his annual report:

"There would appear to be an opportunity for county councils of those counties in which mining is carried on, and for town councils of county boroughs within whose bounds the same industry flourishes, to apply a portion of the grant which they have received for the purposes of technical education to the support of a peripatetic lecturer, who could visit the local centers in the county or borough, or in a group of counties and boroughs, and there deliver lectures upon mining. This would be a great boon and convenience to those students, and to the practical workers who are striving to rise from the ranks, who find it difficult from expense and want of time to gain the necessary theoretical part of their training."

We would suggest to the leaders of the Knights of Labor that if they desire to secure legislation which will be of great advantage to the miners of the State they should direct their efforts to securing the establishment of schools for the instruction of miners in the dangers attending their occupation and how to avoid them. The State should maintain night schools for the benefit of those miners who wish to improve themselves, and it should also maintain a central college, the same as the State Agricultural College, which the students of night schools could attend to thoroughly inform themselves in the sciences related to mining. If legislation authorizing such a system of night schools and a State College cannot be obtained perhaps the passage of a law can be secured to provide for traveling lecturers as suggested by Inspector Scott. The men must be educated as to the dangers they meet in their toil and as to the best means to avoid them, and strict discipline must be enforced before any considerable reduction in the number of accidents can occur.

MR. ARTHUR WINSLOW, State Geologist, of Missouri, reports that during the month of July the survey under his charge have been studying the occurrences and distribution of coal in Carroll, Chariton Howard, Monroe, Buchanan, Nodaway, Gentry, and Daviess Counties. Work on the iron ores was begun during the latter part of the month and inspection was made in Callaway and Wayne Counties. Zinc and lead were examined and were reported upon in Newton, McDonald, Barry, and Lawrence Counties. An estimate is being made for the survey of the total amount and value of the mineral products of the State up to the present date.

OUR "PRIMARY EDUCATIONAL DEPARTMENT."

The following is an extract from a letter received from Mr. John Kane, of Coal Bluff, Vigo County, Indiana. Mr. Kane saw the advertisement of THE COLLIERY ENGINEER in *The National Labor Tribune*, and having sent for and examined a sample copy he became a subscriber. Mr. Kane writes: "Your Primary Educational Department is peculiarly adapted to the needs of the uneducated miner. There is by far too much space wasted on practical miners in articles couched in language and signs which, to them is so much hieroglyphic matter. The result is that men who are thirsting for such knowledge as is contained in the articles turn away from them discouraged and disappointed because they lack the training to understand the technical terms and signs employed. The articles referred to are oftentime full of valuable information and are perfectly in place for persons who have had educational advantages.

"I hope you will continue your Primary Educational Department and that each number will sustain the reputation of the preceding one. The result will be, if the merits of your journal are generally made known, a higher grade of efficiency among the miners of the country, thus making the occupation less hazardous than when the knowledge of the sciences related to mining was confined to a few, such as mine inspectors and others whose visits to any particular mine are at intervals so far removed as oftentimes to be of little or no value."

CERTIFICATED MINE FOREMEN.

The last issue of *The Coal Trade Journal* contains a communication from a correspondent who signs "S. T. Z." In speaking of the Pennsylvania law requiring certificated mine foremen he says: "It is a well-known fact that the examinations as required by law are a veritable farce, for instead of increasing the efficiency of the employes, it is openly stated that a poorer class of men are in these positions than was the case before the radical reform was inaugurated."

Such a statement could only emanate from a man of the densest ignorance concerning the conditions existing in Pennsylvania coal mines. Since 1886, when the law requiring certificated mine foremen went into effect, there has been 20·7 per cent. more coal mined per fatality than during the preceding sixteen years, though mine inspection was provided for by law during that period. The ratio of fatalities per 1,000 employes, previous to the advent of certificated mine foremen, was 21·5 per cent. greater than it has been since. These figures can be verified by the official reports of the various mine inspectors. In contrasting these results it must also be borne in mind that the dangers incident to coal mining have increased in recent years owing to the workings reaching greater depths, and the fact that an ordinary colliery to-day produces fully twice as much coal as it would twenty years ago. This necessitates the greater use of machinery, and greater liability to accidents from that source.

As we write, the General Mining Superintendent of one of the large Anthracite companies is in our office, and we asked him the following question: "Major, how does the present certificated mine foreman compare, as regards efficiency, with the old-time mine foreman?" His answer was: "There is no comparison between them. The mine foreman of to-day is infinitely more competent."

The statistics of the mine inspectors and the opinions of operators and superintendents both conclusively prove that "S. T. Z.," either knows nothing of the subject on which he writes, or he is a disappointed candidate who failed to pass an examination.

The Anthracite Trade.

The Anthracite coal trade has improved slightly since our last issue, and a gradually increasing demand is perceptible in all prominent markets. This improvement will be more marked during the ensuing month and the close of September promises to show a really active market and well maintained prices. Restriction was rigorously enforced during August and the production was kept down to the agreed amount of 3,000,000 tons. The companies are firm in their determination to improve the condition of the market by restriction, and buyers are beginning to realize that they must speedily lay in their winter stocks or pay much higher prices for coal in the three last months of the year. The companies have seen that strict adherence to the policy of restriction during August has materially improved the trade conditions, and unless something entirely unlooked for at present intervenes, harmonious action will be the rule, and the trade for the balance of the year will be on a firm basis and prices will be well maintained.

The sales-agents held a meeting on the 27th ult., and adopted the proposal made at the previous meeting, to limit the production for September to 2,500,000 tons.

The Bituminous Trade.

The Bituminous trade is gradually brightening, due to the near approach of fall and winter weather. Pittsburgh operators consider prospects for the balance of the year good, and are jubilant over another rise in the price of natural gas which will naturally force more local consumers to return to coal. The outlook at western and southern markets is good. In some markets, notably Chicago, stocks are large and prices easy, but the general impression among dealers is that the fall trade will be very active and that fairly good prices will be obtained. The stocks on hand at Buffalo are light, and the demand is also. The outlook for the ensuing month, however, is favorable for increased business and slightly better prices. Large shipments are being made to New England on old orders, owing to prevailing low freight rates. Coal is freely offered in the Boston market at very low prices, particularly coal of inferior reputation. The New York market is fairly active. The demand for standard varieties is good, but inferior varieties are being offered at prices that vary from fairly good to ridiculously low.

The Coke Trade.

The coke trade is steady and the prospects for the future are good. The conditions existing in the iron trade always influence coke, and as the iron trade is steady, the coke trade is also. The Connellsville operators, who practically control the trade, have wisely adhered to a policy of restriction that keeps the markets in good shape. Prices for Connellsville coke are firm, as follows: Furnace coke, $1.90; foundry coke, $2.30; crushed coke, $2.65; all f. o. b. cars at ovens.

In its issue of the 28th ult., *The Connellsville Courier* says:

"The coke trade dropped off a few points last week. Production was restricted about 7,000 tons and shipments were scaled down accordingly. The number of ovens in blast, however, remains about the same. Better times and better trade are anticipated very shortly, and the operators expect to have use for all the ovens now fired. Hence they are keeping them hot rather than blowing them out. The iron trade journals predict a more active demand next month. Cars continue in good supply and labor is plenty.

Consolidation of Asbestos Firms.

For several years The Chalmers-Spence Co., manufacturers of steam pipe covering, have advertised in this journal, and have done an extensive business among American collieries. This business was invariably satisfactory to all concerned as their work and goods always gave the greatest satisfaction. In order to increase and improve the quality of asbestos products, and to decrease costs, this company has in conjunction with the H. W. Johns Mfg. Co., Asbestos Packing Co., Shields & Brown Co., and Chas. W. Trainer & Co., formed a consolidation under the corporate name of the H. W. Johns Manufacturing Co. The officers of The Chalmers-Spence Co. will take a leading part in the management of the new company, and the services of the principle agents and salesmen will be retained. This consolidation is bound to be of advantage to both the consolidating concerns and purchasers of their products, and we particularly desire to call the attention of our readers to the change in the advertisement of The Chalmers-Spence Co., which is now signed by the H. W. Johns Mfg. Co. The Philadelphia branch has been removed from 24 Strawberry Street, to 170 and 172 North Fourth Street.

An Improved Fuse-Cap Fastener.

Mr. N. W. Moody, of Fresno, Fresno County, Cal., has recently patented a device which is especially designed as an improved implement for fastening the caps on fuse employed in exploding giant powder. The pliers are formed of two similar parts, connected by the pivotal rivet, each part having a cheek with notches, at the sides of which are cutting edges for cutting the fuse. The curved jaws beyond the cheek pieces, when closed, form a circular aperture, around which the jaws are beveled, one jaw having a tongue which fits in a groove in the other jaw. The pliers are employed for contracting the end of the cap on the fuse firmly and absolutely water-tight, thus avoiding the dangerous operation of digging out wet and unexploded loads. Miners who have used implements of this class will appreciate the improvements in the one designed by Mr. Moody. The instrument crimps the cap on the end of the fuse firmly. The fuse-cutter is simple and efficient. This implement is neatly gotten up of the finest cast-steel and nickel-plated. It is small and light, but strong and well adapted for its purpose.

It is well known that numbers of miners are killed annually in the United States and elsewhere while going through the dangerous operation of digging out wet and unexploded loads, to say nothing of those losing an eye or a limb in the same way. Accidents of this nature could be avoided, and the handling of Giant Powder made comparatively safe, by the use of an instrument such as this invented by Mr. Moody. Mining companies would also relieve themselves from the liability of damage suits were the use of such an instrument adopted by them. Another item of interest and benefit to mining companies is the time saved in preparing the cap and fuse for use. Instead of taking time to use soap and a string or tar, after the usual effort to fasten the cap to the fuse, this implement enables the miner to cut the fuse and fasten the cap on firmly, and absolutely water-tight; and this is done in a few seconds, which means no loss of time at all. Any one familiar with blasting operations can appreciate the advantages of this implement.

MINE FOREMEN'S EXAMINATION.

A List of the Successful Candidates.

The following is a complete list, by districts, of the applicants who passed the mine foremen's examination held in the Anthracite regions of Pennsylvania, on July 6th and 7th, 1891:

First District, Patrick Blewitt, Inspector—Matthew Gray, Michael J. Murray, and P. S. Malia, Dunmore; Richard Williams, Peckville; W. H. Walters, Olyphant.

Second, District, H. McDonald, Inspector—Thomas Smiles, Jr., John Joyce, Thos. O'Brien, Gilbert S. Jones, John Bone, Alexander McCormick, Patrick Eagan, Gottlieb Smaltz, Pittston; Hugh McCutchen and Daniel A. Sullivan, Miners Mills; Michael Gilboy, Duryea.

Third District, G. M. Williams, Inspector—John Arnott, Nanticoke; Enoch I. Jones, Wilkes-Barre; Henry D. Hughes, and A. Casewell, Larksville; Daniel B. Lewis, James Roberts, Thomas H. Picton, John H. Evans, and David W. Morris, Plymouth; Wm. F. Rees, Alden.

Fourth District, John M. Lewis, Inspector—Stephen Cairns and Geo. W. Meneeley, Sandy Run, Luzerne County; James Lawson, Freeland, Luzerne County; Tobias Seiwell, Oneida, Schuylkill County; Isaac M. Davies, Lansford, Carbon County.

Fifth District, Wm. Stein, Inspector—Thomas Whittaker, Yatesville; Benjamin Williams, Silver Brook; Henry F. Javins, Shenandoah; Charles Harlor, Raven Run; George Richardson, Maple Dale; Thomas D. James, Wm. Penn; John Conway, Suffolk; Lawrence Murphy, Lost Creek; John Schwint, Shenandoah; Edward J. McDonald, Colorado; Patrick Fenton, Buck Mountain; F. H. McCormick, Shenandoah; Samual Platt, Wiggans; Richard Rosby, Gilberton; John Garvey, Gilberton; Stephen Gervill, Mahanoy City; Thomas T. Williams, Audenried; Thomas Beddow, Mahanoy City; David Jones, St. Nicholas.

Sixth District, William McMurtrie, Inspector—Valentine Kline, Mt. Carmel; James Daily, Locust Gap; Henry Achman, Locust Gap; J. C. Brown, Shamokin; Charles Gallagher, Centralia; John Phillips, Williamstown; Nicholas Brecker, Locust Dale; John E. Davis, Ashland; John Mainey, Shamokin; F. W. Luckenbill, Shamokin; Evan Jenkins, Centralia; Robert Ansty, Locust Gap; Henry Carl, Locust Gap; James Finley, Shamokin; Henry Welker, Shamokin; Thomas Ramage, Green Ridge; William Krab, Locust Dale.

Seventh District, Samuel Gay, Inspector—Lewis Minnbach, Tremont; George Young, New Boston; Charles Forney, St. Clair; James Flemming, Donaldson; W. F. Jones, Minersville; John Conville, Branchdale; Michael Murphy, Heckscherville; Patrick Conville, Tower City; Andrew Gantley, Branchdale; William Beverage, Swatara; Joseph H. Zimmerman, Pottsville; Thomas M. Brennan, Heckscherville; John Kelly, Minersville; James Reese, Morea; David Griffith, St. Clair; Eli Snyder, St. Clair; James Tracey, Forestville.

Mining Lamps.

Mining lamps are small things and are not expensive, yet they are as great an improvement over candles as any other modern appliance is over the appliances used around collieries forty or fifty years ago.

Though simple in construction and cheap in price, they are not always of a uniform standard of excellence. Therefore, it is well, when ordering mining lamps, as in other specialties, to know that you are dealing with a responsible manufacturer, and one who is not ashamed to stamp his name on his products.

The stamp of "T. F. Leonard, Scranton, Pa.," on a mine lamp, ensures the purchaser that he is getting a lamp that is perfect in construction and made of the best material. All Mr. Leonard's lamps are seamless. They have stood the test of years, and are regarded as standard lamps wherever used. They are made with either single or double spouts, and with either single or double hooks. His facilities for manufacturing them are such that large numbers are turned out daily and none but best materials are used in their construction. His prices, owing to improved machinery and convenient shops, are as low as any other makers, and we advise our readers to write him for circulars and prices.

The Stratton Separator.

Manufacturers and steam users generally will be interested in the following communication:

PURDUE UNIVERSITY, La Fayette, Indiana.

THE STRATTON SEPARATOR CO.,
32 Cortlandt Street, New York.

GENTLEMEN: We have been using for about a year one of your 4-inch separators in connection with the compound engine in our Engineering Laboratory.

Steam for this engine is supplied by boilers located 380 feet away, and notwithstanding the long length of pipe through which it is thus required to pass, it was never found, *by repeated calorimeter tests*, to contain as much as 3% of moisture when it passes out of the separator, regardless of the amount of water previously held by the steam.

Very truly yours,
WM. F. M. GOSS,
Professor Experimental Engineering.

MR. JAMES F. BEATTIE, formerly of the Newburgh Orrel Coal and Coke Co., of Newburgh, Preston Co., W. Va., has accepted the Superintendency of the Gaston and Barnsville Mines and Coke Works, at Fairmont, W. Va.

ANTHRACITE COAL STATISTICS.

Statement of Anthracite coal shipments, for month of July, 1891, compared with same period last year Compiled from returns furnished by the Mine Operators, by John H. Jones, Chief of Bureau of Anthracite Coal Statistics.

	JULY 1891.	JULY 1890.	DIFFERENCE.		FOR YEAR 1891.	FOR YEAR 1890.	DIFFERENCE.	
From Wyoming Region, - - -	2,024,941·18	1,738,124·07	Inc.	286,817·11	11,609,194·09	9,613,856·07	Inc.	1,995,338·02
From Lehigh Region, - - -	569,487·12	532,843·18	Inc.	36,643·14	3,473,200·05	3,463,452·08	Inc.	9,747·17
From Schuylkill Region, - - -	1,196,910·00	1,019,110·13	Inc.	177,799·07	6,674,029·07	5,598,716·01	Inc.	1,075,313·06
Total - - - - - - -	3,791,339·10	3,310,078·18	Inc.	481,260·12	21,756,433·01	18,676,031·16	Inc.	3,080,401·05

The stock of coal on hand at tide-water shipping points, July 31st, 1891, was 703,634 tons; on June 30th, 1891, 678,144 tons; increase, 25,490 tons.

NEW MINING COMPANIES.

Names and Post-Office Addresses of the New Mining Companies Incorporated in the United States Since our Last Issue.

Osceola Consolidated Mining Co.,	San Francisco, Cal.
Crescent Coal Company,	What Cheer, Iowa.
Vernon Mining Company,	Nevada, Mo.
Motor Mining Company,	Helena, Mont.
The United States Mine Equipment Co.,	Chicago, Ill.
Algoma Nickel Company,	Chicago, Ill.
Essex Iron Company,	15 Cedar St., New York N. Y.
The Heckla Consolidated Gold Mining Company,	Gold Park, Eagle Co., Colo.
The Peck Montana Company,	Chicago, Ill.
Dutton Phosphate Company,	Gainesville, Fla.
Williamson Mining and Mfg. Co.,	Williamson, W. Va.
The Southeastern Georgia Timber Land Company,	Philadelphia, Pa.
The Atcheson Coke Company,	Dunbar, Fayette Co., Pa.
The Great Western Consolidated Mining Company,	Great Falls, Mont.
The Kentucky and Texas Mining and Investment Company,	Denver, Colo.
Lacoochee Phosphate Company,	Lacoochee, Pasco Co., Fla.
Eureka Block Coal Company,	Chicago, Ill.
The Summit Mining and Milling Co.,	Neihart, Mont.
Granite Hill Mining Company,	Barker, Mont.
New England Mining Company,	Portland, Me.
The St. Helene Phosphate Company,	Portland, Me.
The Empire Mining and Reduction Co.,	Silverton, Colo.
The South American Mining and Milling Company,	Denver, Colo.
The La Veta Coal Company,	Denver, Colo.
Cayuga Lake Salt Company,	Ludlowville, N. Y.
Gulf Stream Phosphate Company,	Tallahassee, Fla.
Chenango Mining Company,	Joplin, Mo.
Tyler Mining Company of Oregon,	Wardner, Idaho.
Crevasse Mountain Mining Company,	Helena, Mont.
Enterprise Company,	New York, N. Y.
Castle Cattle and Coke Company,	Castle, Mont.
The Tuerto Mountain Copper and Gold Company,	Santa Fe, N. M.
Minneapolis & Webb City Mining Co.,	Minneapolis, Minn.
The Inter-State Mining Company,	Weir City, Kans.
Oatka Dairy Salt Company,	Warsaw, N. Y.
Running Wolf Mining and Milling Co.,	Great Falls, Mont.
Standard Mining Company,	Helena, Mont.
Michigan Iron Mining Company,	Ashland, Wis.
Santiago Mining & Milling Company,	Oakland, Cal.
The Shoal Creek Mining Company,	Galena, Kans.
The Mountain State Mfg. and Mining Company,	Terra Alta, W. Va.
The Cinnibar King Mining Company,	Healdsburg, Cal.
Wenona Iron Company,	Duluth, Minn.
Wabigon Iron Company,	Duluth, Minn.
Minawa Iron Company,	Duluth, Minn.
Nibiru Iron Company,	Duluth, Minn.
Missosh Iron Company,	Duluth, Minn.
Monitor Coal Company,	Centreville, Iowa.
The Jeannette Mining Company,	Bonner's Ferry, Idaho.
Security Mining Company,	Great Falls, Mont.
Weser Mining Company,	Helena, Mont.
Archdale Phosphate Mining Company,	Charleston, S. C.
Fire Center Gold Mining Company,	Milwaukee, Wis.
The American Silica Sand Company,	Cleveland, Ohio.
The Commercial Mining and Milling Company,	Denver, Col.
Great Falls Mining Company,	Monarch, Mont.
The Cliff Mining Company,	Missoula, Mont.
World's Fair Mining & Developing Co.,	Helena, Mont.
The Trusdell and Grimes Rock Salt Company,	Lyons, Kans.
The Bluff Spring Mining Company,	East St. Louis, Ill.
The Columbia Mining Company,	Denver, Colo.
Green Mountain Mining Company,	Chicago, Ill.
The Happy Coal Co., of Centerville, Ia.,	Centerville, Iowa.
Russellville Coal and Mining Company of Russellville, Ark.,	Russellville, Ark.
Boston and Idaho Silver Mining Co.,	Portland, Me.
Eureka Phosphate Company,	Ocala, Fla.
The "Agnes C." Mining Company,	Manitou, Colo.
East Side Land Company,	Goshen, Va.
Muhlenberg Coal and Land Company,	Louisville, Ky.
La Pierre Phosphate Company,	Charleston, W. Va.
Republican Mining Co. (of Washington),	Wardner, Idaho.

H. WARD LEONARD & CO.

Mr. H. Ward Leonard, the General Manager of the Light and Power Department and also of the Intelligence Department of the Edison General Electric Company, resigned upon August 5, in order to start an independent electrical engineering business under the above title. The new concern will be an incorporated company under the laws of the State of New Jersey. Mr. Leonard will take with him several well-tried assistants who have been associated with him in the past, some of them as far back as 1885. Among those who will thus be connected with the Company are Mr. A. St. C. Vanse, Mr. E. H. Harrison, Mr. C. H. Bloomer, and Mr. August Monning.

The Company will operate specially in a field which is full of promise for the future, and is at present inadequately occupied, namely, the transmission of power by electricity and the application of electric motors to the operation of special machinery, such as is not at present operated by electric motors, or whose operation is subject to improvement by careful attention to the requirements of the case.

Mr. Leonard's experience since 1883, when he became a member of Mr. Edison's first electrical engineering staff, has brought him into contact with every branch of electric light and power work. He has held positions from the lowest to the highest in the exploiting parts of the business, as well as in the constructing and in the operation of every kind of electric light and power plants, and it is not, therefore, altogether surprising that he should feel willing to resign his office with the Edison Company to take up a line of work which promises so well for one having such an exceptional experience as he has been fortunate enough to have.

H. Ward Leonard & Co. will have one important feature of their business which will be entirely unique, namely, an electrical intelligence department. To any isolated plant, the Company offers at a very moderate subscription price ($25 a year) the privilege of corresponding upon any electrical subject of practical interest and thus an isolated plant will be able to secure expert information as to its own plant and the best methods of operating it, and about any new electrical apparatus or methods and the principles underlying various devices, and the prices thereof. For central station companies, whose queries would go further into steam engineering and methods of distribution and would also cover business questions as to relations with consumers, systems of accounts, etc., the annual subscription charge for this electrical intelligence will be $50.00.

The scheme strikes us as an excellent one and we have no doubt that any plant will get several times the value of the subscription price by placing before this Company the matters upon which it desires information, data, and statistics. As Mr. Leonard created and developed the Intelligence Department of the Edison General Electric Company, he has had the broadest possible experience in this line since information of every character issued to those in the Edison Company has been issued by the Intelligence Department of that Company. In case expert judgement of the Company be desired as to the comparative merit of various competing apparatus or methods, such expert judgment will be given by special arrangement, although the Company prefers to merely supply full information under the subscription arrangement and allows the purchaser to form his own conclusions.

H. Ward Leonard & Company will do no manufacturing and will do no supply business, neither will they under any circumstances, act as the selling agents of any concern, directly or indirectly.

They will, however, act for the purchaser, either as Consulting Engineers, Supervising Engineers, Inspectors, or Purchasing Agent. When acting in this way they will make the following charges, based upon the contract price:

For making preliminary plans, designs, distributions, and estimates,	1%
For making final plans and specifications,	1%
For drawing and executing contract on the behalf of the purchaser,	1%
For supervising an installation made by another contractor,	3%
For inspecting and reporting on the work of another contractor,	1%
For acting on the behalf of the purchaser in making a settlement with another contractor	1%
For acting as the agent of the purchaser from the beginning to the final settlement of a contract, including the making of estimate plans, determinations, specifications, contract, supervising the installation, final inspection and report, and final settlement,	5%

It will be seen from the complete schedule given above, that the purchaser will be able to obtain the services of this Company for any portion of the work, and under terms which are so reasonable that there can be no question in the minds of those familiar with the subject, that any purchaser contemplating the installation of an electric plant would not only save a great deal of his own time, and be spared a great deal of annoyance, but would actually effect a very material saving in retaining the services of a concern such as this to represent the interest of the purchaser.

The various parent companies will also, no doubt, welcome the advent in the electrical field, of an electrical engineering concern of this order whose experience and ability is undoubted, and who are free from prejudice and have no affiliations of any kind with any of the various electrical concerns. Any parent electrical company can refer a prospective purchaser to such a concern as this, with confidence that any opinions given by it to the purchaser will be based on the honest judgment of those thoroughly competent to judge any practical electrical question.

H. Ward Leonard & Company will make a specialty of the transmission of power and the application of electric motors to such uses as necessitate the application of a wide experience in both mechanical and electrical engineering. Such applications of electric motors as are met with in elevators, pumps, hoists, mine tramways, printing presses, etc., are those which this Company feels itself especially qualified to undertake under guarantee of perfectly satisfactory results.

The Sterling Water Safety-Boilers.

The Sterling Company, manufacturers of the Sterling Water Tube Safety-Boilers only four months ago completed their shops at Barberton, Ohio. That the Sterling boilers possess great merit is evidenced by the rapidity with which they are being introduced. The Company has already furnished boilers to the amount of 25,000 horse-power. A plant of three boilers aggregating 450 horse-power has been furnished to the Compania Metalurgica Mexicana, San Luis, Potosi, Mexico, and one of three boilers aggregating 550 horse-power to the Acadia Coal Co., Stellarton, N. S.

BOOK REVIEW.

We have received from the publishers Messrs. Funk and Wagnalls, of New York, the prospectus and some advance pages of "The Standard Dictionary of the English Language." It promises to be the most convenient dictionary yet published. It will be slightly larger than the unabridged Webster or Worcester dictionaries, and will contain nearly 4,000 illustrations. Its various departments have been edited by the leading specialists of America and in many important points it differs widely from the plans of other dictionaries. For example: (1). The "locating" of the verifying quotations; that is, the giving in each instance not only the name of the author, but also the name of the book and the number of the page where the quotation can be found; to thus "locate" 50,000 quotations is of itself a herculean task. (2). The use, in the pronunciation of words, of The Scientific Alphabet, adopted by The American Philological Association. (3). The placing of the etymology after the definition. (4). The placing of the most important current definition first, and the obsolescent and obsolete meaning last, that is, the substitution of the order of usage for the Historic Order usually followed in dictionaries. (5). In the case of disputed pronunciation the giving of the pronunciations preferred by other dictionaries, as well as the pronunciation which we prefer. (6). The giving of 50,000 vocabulary words more than are to be found in any other single volume dictionary in England or America, (no new word is admitted to a vocabulary place, unless it has been passed upon by the able men in charge of this department, namely, Julius H. Seelye, of Amherst College; Edward S. Sheldon, of Harvard University; Edward Everett Hale, Charles A. Dana, and Howard Crosby.) (7). The indication by the use of upper and lower case initial letters, as to whether words in the vocabulary are to be written as proper names or common names, etc., etc. The list price of the dictionary, when issued will be $10.00. It will be bound in heavy sheep, and a special discount will be allowed to advance subscribers.

New Anthracite Inspectors.

Messrs. Patrick Blewitt, present Inspector of the First Anthracite District, and Edward Roderick, of Stockton, Pa., were recommended for appointment as Inspectors of the Second and First Districts respectively, by the Board of Examiners, who held the examination at Wilkes-Barre, Pa., on the 3d and 4th ult.

ANTHRACITE MINE INSPECTORS' EXAMINATIONS.

Opinion of the Attorney-General Regarding the Publishing of the Questions and Answers.

OFFICE OF ATTORNEY-GENERAL,
Harrisburg, Aug. 28, 1891.

JOHN B. LAW, ESQ.,
Chairman Board of Examiners,
Pittston, Pa.

Dear Sir:—In answer to your letter of August 24th, inquiring as to the meaning of that clause of Section 5, Article II., of the Anthracite Mine Law of 1891, which requires the examiners to report to the Secretary of the Commonwealth and to publish in the local newspapers "the names of the applicants, the questions asked and answers thereto, etc.," I have to say:

The clause referred to is general and comprehensive in its character, and while it restricts the recommendation of the examiners to such candidates as shall have answered ninety per centum of the questions, and to such applicants "as they find qualified for the office," no such restriction is contained in the directions regarding the matter to be transmitted to the Secretary of the Commonwealth. The language of the Act is "the names of the applicants, the questions asked and answers thereto shall be sent to the Secretary of the Commonwealth, and published in at least two local newspapers, daily or weekly." The purpose of this provision seems to afford the public and the executive authorities an opportunity of knowing in what manner the examiners shall have performed their duty, and as to whether or not a fair and proper judgement was made upon the merits of the various applicants. I am therefore of the opinion that the answers of all the applicants should be published and transmitted to the Secretary of the Commonwealth.

Very truly yours,
(Signed) W. U. HENSEL,
Attorney-General.

A Successful Electric Haulage Plant.

Mr. James T. Gardiner, consulting engineer of the Pleasant Valley Coal Co., of Salt Lake City, Utah, in a recent letter regarding the haulage plant at the Castle Gate Mine, says:

"We have for the past year, at the Castle Gate Mine, in Utah, used a hoist or haulage drum, operated by electricity. The drum was made by the Lidgerwood Manufacturing Company, of New York, and the electric motor, and the electrical equipment was furnished by Thomson-Van Depoele Electric Mining Co., together with all the electrical apparatus for the power station.

"Trains of sixteen large pit cars run out of the mine by gravity, dragging the tail-rope after them. The empty trains are hauled back into the mine by the haulage drum located nearly 2,000 feet from the chute in the interior of the mine. The operation of this apparatus has proved so satisfactory and so economical that, by my advice, the company has ordered two more electric hoists of more powerful type.

"In every way the electrical apparatus has been satisfactory to the company, so satisfactory, that for the Winter Quarters Mine, operated by the same company, we have ordered an electric locomotive and the equipment of nearly two miles of underground railway with the Thomson-Van Depoele system.

"I take pleasure in testifying both to the excellent quality of the materials and machinery that have been furnished the Pleasant Valley Coal Company and to the economical working of electric haulage in coal mines where the conditions are adapted to the use of this power, and where the power is properly applied.

"I have been so well satisfied with the results of the application of electric power to the mines of the Pleasant Valley Coal Company that I am expecting to apply it to the mines of other companies where favorable conditions exist."

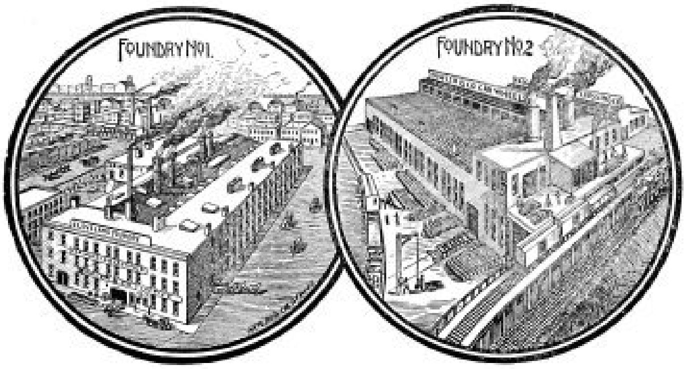
We have received from the Wm. Powell Co., of Cincinnati Ohio, a very handsome catalogue which illustrates and describes the many varieties of valves, (for steam or water), lubricators, steam whistles, gauge-cocks, etc., etc. The book is handsomely bound in cloth, and should be on the desk of every colliery and coke plant superintendent. The articles illustrated and described have won a national reputation for excellence, and as the book contains much valuable information, we would advise our readers to write to The Wm. Powell Co., 50 to 54 Plum St. Cincinnati, for a copy. It will be cheerfully sent you.

Messrs. J. & J. B. Milholland, of Pittsburgh, who make a specialty of endless and tail-rope haulage machinery, and who, as builders and designers of such machinery, have won a national reputation for excellence of machinery, combined with reasonable prices, inform us that their business is booming, and at present they have orders on their books for five new haulage plants.

THE MANUFACTURE OF CHILLED CAR WHEELS.

Messrs. Bowler & Co., of Cleveland, Ohio, rank among the leading manufacturing firms of Cleveland, Ohio, and the reputation of the car, engine, truck, and mining wheels manufactured by them, has been won by the use of only the best grade of materials and excellent workmanship. The illustration given below shows Foundries Nos. 1 and 2, and furnishes the reader an idea of the firm's capacity.

The foundry erected expressly for the casting of car wheels is one of the most complete establishments of the kind in the world, constructed from original designs, equipped upon the most liberal scale in every department, and provided with all practical modern improvements and facilities. The building is 140 x 200 feet in dimensions, one end facing Bessemer Avenue and the other the New York, Pennsylvania, and Ohio Railway.



The sidings are a special feature which deserve mention. The track running to one end of the building is raised to a charging platform forty-eight feet in width and twenty feet above the level of the molding floor. Here the raw material of every kind is received, and delivered directly to the pile from which it is to be used in charging the cupolas, two in number. It has storage capacity for 500 tons of the various grades of charcoal iron used, and several carloads of coke. Upon this platform is a thousand-pound hammer, with a drop of fifteen feet, for breaking old wheels. Its capacity is at least thirty wheels an hour—a vast improvement over the old-time sledge-hammer. Another spur runs on a lower level to the other end of the building to receive the finished product. The floor plan is entirely novel. Beginning at the south end (underneath the platform mentioned above), the middle portion is occupied by two cupolas, one 5 feet in diameter, with a capacity of 125 wheels per day, and the other 6½ feet in diameter, with a daily capacity of 300 wheels. A large Roots blower furnishes blast, and by an ingenious application of mercury in a U-shaped tube, the blast can be exactly determined.

In the engine room, adjoining the cupolas, is a 100 h. p. Lord, Bowler & Co., engine, which drives the blower and shafting that propels the cranes. In the room adjoining is the department for turning up axles, boring wheels, and putting them on axles. To the left of the cupolas is the sand bin, and next adjoining this are the core ovens. There are three ovens, 10 feet square, each holding 100 cores.

In the middle portion of the shop, of course, are the molding floors. A central shaft, running the entire length of the building, conveys the power by belts and gears to sixteen cranes, each surrounded by a molding floor, the total capacity being about 320 wheels per day. On either side of the room are overhead tramways, by which the wheels are run to the cooling or annealing pits at the further end. Over these pits is a traveling crane running across the shop and propelled by means of a cable and drum. After remaining in the pits three or four days, for the purpose of securing slow and even contraction, the wheels are removed and cleaned up ready for shipment. The chill is, of course, secured on the original castings by contact of the molten metal with a cold iron ring.

N. P. Bowler established this house in 1863. A year later Wm. Bowler and Thomas Maher were admitted, and in 1870 Mr. C. A. Brayton became a partner, the firm adopting the style of Bowler, Maher & Brayton. The two last named retired in 1880, whereupon Mr. W. W. Balkwill was admitted, and the style changed to Bowler & Co.

PACKING.

The packing question is one which is eternally agitating the mind of every engineer. There are good packings and poor ones, and packings adapted for special places, but you seldom, if ever find one line of packings which can be so manufactured as to do good service in all places. The Garlock Packing Company, whose main office and factory is at Palmyra, N. Y., manufacture the Elastic Ring, Sectional, Spiral, and Special Water Packings, and by using good judgment the purchaser can always obtain from the list, a packing which will exactly suit the special place where he wishes to apply it.

This packing has a world-wide reputation, but probably the greatest reward which comes to the inventor is the substantial business which he has been able to work up. The Elastic Ring packing is made in rings (as also the Sectional and Special Water Packing) and is subjected to a perfect lubricating process. Where the rods are true and smooth and the box and glands properly beveled it is well to adopt the Elastic Ring. The word "Elastic" explains the nature of the packing very well. It readily expands when steam is applied, and needs no attention except that the bolts should be screwed up with the fingers only very slightly. Should it leak water when starting, do not tighten for it will stop when it gets heated through. After properly applying it should be left alone.

The Sectional Ring Packing is especially adapted for rods out of line, cut rods, flat bottom stuffing boxes, rods working in ammonia or in acidulated water, and places that are very difficult to keep tight. This packing is positively automatic and is subjected to the same lubricating process as the elastic ring.

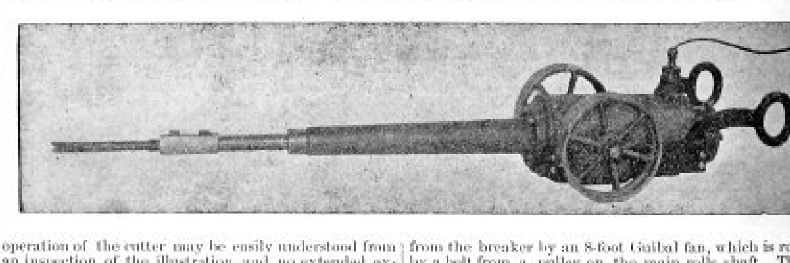
The Garlock Spiral Packing can be applied in places where the Elastic Ring or Sectional are used. Its chief advantage is in its being put up for a stock packing so as to be kept by dealers or large concerns. Consumers having a number of glands of the same size will find the Spiral Packing a very handy article. It is made of the same material as the other packings and thoroughly lubricated.

Probably the greatest improvement in packings made in many years has been that of the Garlock Special Water Packing, which will not only hold water successfully but is especially adapted for the most difficult places, generally speaking. The other kinds of Garlock Packings worked as well as any other packings in water and the Sectional Packing will hold very many difficult places, but the Special Water Packing the company guarantees to suit every time. They are introducing this packing with great success in places which no other packing would hold. The packing is made in two sections and works automatically. The company are anxious to put a set in with every company having any trouble anywhere whatever. The Garlock Packing Co. has three (3) factories respectively situated at Palmyra, N. Y., Rome, Ga., and Omaha, Neb. They have offices in all of the principal cities, and will be glad to correspond with anyone about the packing question. See advertisement.

A SOLENOID COAL CUTTER.

In some grades of coal it is found desirable to make the undercut with a machine concentrating its power upon a single reciprocating shaft, carrying a chisel at its extremity. This type of cutter or drill is very compact and is controlled by one man, the direction of the blow being varied as occasion demands. Several machines of this type, operated by steam or compressed air, are on the market, and while in many ways satisfactory, the application of electricity as the motive power possesses many decided advantages.

The illustration shows the Van Depoele Solenoid Coal Cutter, manufactured by the Thomson-Van Depoele Electric Mining Co., of Boston. The type shown is the present standard form, though modifications can be made to suit special requirements. The operation of the cutter may be easily understood from an inspection of the illustration, and no extended explanation is required. The direction of the blow is determined by the operator, who sits on the floor facing the breast, his feet resting against the wheels, and his hands grasping the handles at the rear of the cylinder, thus obtaining a double leverage, by which the machine, being almost exactly balanced, is easily turned on its points of support.



A simple switching device turns the current on or off, as desired, while lights, pumping apparatus, electric ventilators, etc., may be run on the same system of wires which supply power to the coal cutter, if desired.

The weight of the apparatus is a little over 700 pounds, the number of strokes usually from 300 to 350 per minute, although the rapidity of the blow can be varied at pleasure. The stroke is from five to six and one-half inches. The tension guide can be furnished in different lengths, according to the depth of undercut desired.

Steel Roofing.

A representative of this journal recently called at the office of the Canton Steel Roofing Company, of Canton, Ohio, and in reply to his question as to the business they were doing, he was told: "Our business has increased 58 per cent. during the first half of the current year. We have been compelled to enlarge our buildings and put in a great deal of new special machinery of our own invention. We now manufacture more steel roofing than any other firm in the world, and our competitors all admit that we manufacture a larger variety of goods than any other house in this line, and that we have the best systematized plant and use only best materials. We are holding all our old customers, and are rapidly extending our business in new fields."

Such a satisfactory state of affairs can only be attained by furnishing first-class roofing and siding at reasonable prices, and we congratulate the Canton Company on its success.

A Successful Young Coal Company.

The Langcliffe Coal Company started operations at the Langcliffe Colliery, near Avoca, Pa., in December 1889, and under the efficient management of Mr. Wm. T. Smyth, this colliery, which was previously designated as a "dead horse," has been made a large producer of coal of excellent quality.

When old operations on the land worked were suspended a few years ago, Mr. Thos. H. Phillips, then superintendent of the Lehigh and Wilkes-Barre Coal Co., recognized the value of the coal which former operators thought worthless, and secured an advantageous lease on it. He then sublet it to a party who in turn sold out to the Langcliffe Coal Co., the present operators.

The success of the Langcliffe Company lies chiefly in having as a superintendent, Mr. Smyth, whose ability as a practical miner is recognized as equal to that of any other man in America. His excellent underground management and his labor-saving and economical methods of cleaning and handling the coal have made the colliery. His associates in the company are men of broad views and experience, and therefore second his efforts to make the colliery a phenomenally successful one.

The veins worked are locally known as the Red Ash, 7 feet thick, which corresponds in geological position with the Buck Mountain vein in the lower Anthracite regions, and the Checker vein, 6 feet thick, which lies in nearly the same position as the bottom split of the Mammoth vein in the Middle Coal Field. The former vein is opened by a shaft 150 feet deep which was sunk by the old operators. The latter vein is worked from a drift opening. The Red Ash vein was overlaid by another vein, worked years ago, and in some places the strata between them runs only from 18 inches to 3 feet thick. Where this is the case the coal is worked on the Longwall retreating plan. Where the strata between the two veins is thick enough, and this is the case most generally, the method of working adopted is the pillar system.

The Langcliffe Co. leases in all about 700 acres of land, but owns the few acres on which the improvements are located, in fee simple. The tracks under the breaker were laid by the company, and they own them to the switches, where they connect with the New Jersey Central, Lehigh Valley, and Delaware and Hudson Railroads. This enables them to ship over any of the roads mentioned or over the Erie and Wyoming, Ontario and Western, or Pennsylvania R. R., without lateral tolls.

The present breaker which has a capacity of 900 tons per day is "one-sided," and so arranged that another side of like capacity can be added. It is a very conveniently-arranged structure, and while no space is wasted, it is very roomy. Machinery is used to do all that machinery can effectually do in the way of handling and cleaning the coal, and this machinery is so arranged that there is absolute safety for the employes engaged in the breaker. The dust is drawn from the breaker by an 8-foot Guibal fan, which is run by a belt from a pulley on the main rolls shaft. The atmosphere in the various rooms of the breaker is therefore much healthier and clearer than in the old time breakers. The cleaning of the coal is done so effectually that nothing but absolute waste goes to bank. The six boilers used to generate steam are heated with the refuse from the slate-pickers, which makes a good fuel, but is unsalable. Mr. Smyth, in reply to our question as to what percentage of the coal in the vein was brought to the surface said that he was confident that counting final robbing, he would get out 90% of it. Labor is economized at every point, and no coal is wasted.

Since the colliery was started there has been but one accident, and that was to a Hun, who was so ignorant as to disregard all cautions, and who was therefore a victim to his own carelessness.

PRIMARY EDUCATIONAL DEPARTMENT

FOR CANDIDATES FOR

MINE FOREMEN'S CERTIFICATES

AND FOR

STUDENTS OF MINING.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the sciences related to mining and to learn how to answer the questions in ventilation, surveying, and mechanics which are asked at the examinations for mine foremen's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine foremen and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and many calculations are worked out at length for the benefit of those who are not familiar with figures.

PENMANSHIP.

It will be seen the whole of th letters of the alphabet depend primarily for their correct construction upon the four laws of penmanship given in our first lesson, and we repeat them again: First, all strokes should be parallel; second, all strokes should be proportionate in distance; third, all lines should be proportionate in size; and fourth, all curves should be elliptical; and it must be clear to the mind of everyone that the least digression from these simple laws develops a deformity inexpressibly painful to the eye and the feelings.

In Fig. 14 (as before we will refer to the letters by numbering them from left to right) the first letter C satisfies the requirements of the four simple rules and is pleasing to the eye; the second letter illustrates the elements out of which the letter is constructed; the third letter is a deformity arising out of the imperfect

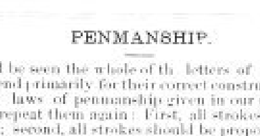


Fig. 14.

development of the upper loop, which is too short in the major axis; the fourth letter is not imperfect in the upper loop but very imperfect in the bottom scroll; first, the ellipses that ought to have developed it are too short in the major axis, and the fine hair stroke terminating the scroll is not parallel to the stem of the letter.

In Fig. 15 the first letter the bottom scroll is too large, and the upper loop too small. In the second letter the upper loop is too large both in the major and minor axes, andthe termination of the bottom scroll is an out-

Fig. 15.

rage on parallelism. In the third letter the upper loop is too long, and is an evident deformity; in the fourth letter the upper loop is developed out of an ellipse out of all proportion to the magnitude of the letter.

In Fig. 16 we have the letter D as it ought to be rendered in letter 1; in letter 2 we have the development of the letter, and it will be seen that to write this

Fig. 16.

letter with beauty and grace, the large ellipse ought to have its major axis inclined something after the order of the large ellipse of the letter B.

In Fig. 17 the first letter not only has the large ellipse the wrong inclination, but the hair stroke of the inner scroll is a violation of the first rule of penmanship, namely, that all strokes shall be parallel. In the second letter the large ellipse is inclined at the wrong angle, so much so that it makes an angle of 90° with what ought to be the true inclination of the major axis. The same occurs with the third letter, but the terminating scroll is a violation of the third rule, namely, all strokes shall be proportionate in size.

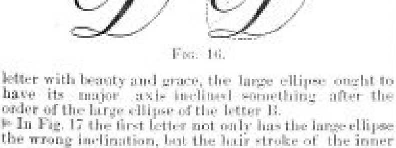


Fig. 17.

The study of these letters teaches more lessons than one, not only the necessary symmetry in writing, but it excites the observing faculties in noticing what is beautiful, proportionate, and harmonious in the development of all figures that are represented by lines.

CHEMISTRY RELATING TO MINE VENTILATION.

[CONTINUED.]

Proper Names of Gases.—The student must learn to give the compound gases their modern names, instead of using such obsolete terms as "carbonic acid gas" for there is not and cannot be, such a gas; this gas only manifests acid properties when dissolved in water.

CHEMICAL NAMES.	TECHNICAL NAMES.
Methyl Hydride.	Light Carbureted Hydrogen.
Hydride of Ethyl.	Silver Gas.
Carbon Monoxide.	Carbonic Oxide.
Carbon Dioxide.	Carbonic Acid.
Hydrogen Sulphide.	Sulphureted Hydrogen.
Nitric Oxide.	Nitric Oxide.
Water Gas.	Watery Vapor.

The Chemical and Physiological Action of the Simple and Compound Gases.—Hydrogen is the lightest known body and if atmospheric air be taken at 14·42 specific gravity, hydrogen is 1; consequently hydrogen is 14·42 times lighter than air. It is a colorless, tasteless, and invisible gas without smell; it cannot burn of itself; no amount of heat will alter it further than cause it to expand into a larger volume. It will not support life, and only destroys it by suffocation. If two volumes of this gas are mixed with one volume of oxygen gas, and a light be applied to the mixture, it explodes with terrible violence.

Oxygen is a colorless, invisible gas, without taste or smell, and is a little heavier than air in the proportion of 14·42 to 16, or, air being 1, oxygen is $\frac{16}{14.42} = 1\frac{1.58}{14.42}$. It exists in a free state in the atmosphere, and is the most active chemical element known, forming nearly one-half of the entire globe. It actively supports life and combustion, and at a suitable temperature all the known elements excepting fluorine will burn in it, forming oxides.

Nitrogen is a colorless, invisible gas, without odor or taste, and is slightly lighter than air in the proportion of air 1, nitrogen $\frac{14}{14.42}$. It forms nearly four-fifths of the atmosphere, and neither supports life or combustion after the manner of oxygen although it forms a part of the animal tissues. It extinguishes life not as a poison, but by suffocation.

Carbon dioxide = CO_2. The weight of air being 1, carbon dioxide is $\frac{22}{14.42} = 1\frac{7.58}{14.42}$, or nearly $1\frac{1}{2}$ times the weight of air. It is a colorless, inodorous, and invisible gas, and has a slightly acid taste. When breathed into the lungs its first physiological effects are manifested in the extremities, so that a man will fall paralyzed in his legs before mental consciousness is lost. Being a heavy gas it can be poured from one vessel to another like water; this can be proved by pouring it on the flame of a candle. It is known in mining as "choke damp," and is frequently found in old wells, is exhaled by men and animals, and is produced wherever carbon is burnt in air, as in coal gas, the oil of lamps and coal or coke fires. It will not support, but extinguishes flame. Carbon dioxide is soluble in water, one cubic foot of water at 32° F., absorbs 1·797 cubic feet of this gas at all pressures, so that such gas at a high pressure will be very soluble in water. The volume of the gas absorbed is inversely as the temperature, so much so that at boiling point all the gas is expelled from the water. At 68° F. each cubic foot of water is capable of absorbing ·901 of a cubic foot of gas. At the average temperature of 60° F. water will absorb a volume equal to its own of this gas.

The law of absorption is by weight directly as the pressure, and inversely as the temperature.

This gas is destructive to life, producing suffocation, and will not support combustion.

Methyl hydride, CH_4. The weight of air being 1, this gas is $\frac{8}{14.42}$, or little more than half the weight of air. When pure it is invisible, colorless, tasteless, and inodorous; but as found in mines it is seldom pure.

When mixed with twice its volume of oxygen or ten times its volume of air, it explodes when ignited with great violence. It burns with a bluish yellow flame, emitting very little light. It is known as "fire-damp" and as "marsh gas." It will not support life, and produces suffocation when breathed into the lungs.

Carbon monoxide, CO. The weight of air being 1, it is $\frac{14}{14.42}$ or slightly lighter than air. This is a poisonous gas, highly destructive to animal life. It is colorless and tasteless.

Hydrogen sulphide, H_2S, the weight of air being 1, that of this gas is $\frac{17}{14.42}$. This is a poisonous gas and should not be breathed into the lungs. It makes its presence strongly felt, having an odor like that of rotten eggs. It is soluble in water to which it gives a filthy taste. It is given off by stagnant water in mines, and by such waters as drain into the mine and hold this gas in solution. It burns with a bluish flame like sulphur, producing sulphur dioxide and water; it has a very low point of ignition, taking fire at the temperature at which lead melts. From this cause it is one of the most dangerous gases met with in mines.

Hydride of Ethyl, C_2H_6. This gas is heavier than air in the proportion of 1 to 1·04, and is nearly double the weight of ordinary fire-damp. It is true this gas is not found abundantly in coal mines in the United States, but it is nevertheless found in marked quantities in the steam coal of South Wales and the cannel coals of Wigan and Scotland. It is very explosive, the most explosive mixture being 1 of this gas to 10·6 of ordinary atmospheric air. It burns with a luminous flame, and rapidly elongates with a white tail the flame of a lamp, and from this cause it is called "silver gas."

The elementary gases, hydrogen, oxygen, and nitrogen, have no color, taste, or smell. Oxygen will burn in an atmosphere of hydrogen, just as hydrogen burns in an atmosphere of oxygen; but nitrogen will neither burn itself or support combustion in the ordinary sense.

The compound gases, methyl hydride or fire-damp, CH_4; hydride of ethyl or silver gas, C_2H_6; carbon dioxide or carbonic acid, CO_2, carbon monoxide or carbonic oxide, CO; are all without color or smell when pure. Hydrogen sulphide or sulphureted hydrogen, H_2S, has no color, but smells like rotten eggs, and carbonic acid has an acid taste.

The relative weights or specific gravities of the gases, simple and compound, from the standpoint of the chemist, calculated from the weight of a unit volume of hydrogen, are as follows:

Hydrogen	1	Methyl Hydride	8
Nitrogen	14	Hydride of Ethyl	15
Oxygen	16	Carbon Dioxide	22
Carbon	12	Carbon Monoxide	14
Sulphur	32	Hydrogen Sulphide	17

The specific gravity unit of the chemist however, is not adopted by the miner, because this unit does not suggest with sufficient clearness the tendency of the gases to float or sink in air; consequently the unit weight of gases adopted by the miner is that of air; therefore, air being 1, the specific gravities of the compound gases are:

Methyl hydride, or marsh gas	·55
Hydride of ethyl, or silver gas	1·04
Carbon dioxide, or carbonic acid	1·52
Carbon monoxide, or carbonic oxide	·97
Hydrogen sulphide, or sulphureted hydrogen	1·17

MECHANICS IN MINING.

PUMPS.

Ordinary Lift Pumps.—The mechanical requirements of a lift pump are first, that the bucket at the top of its stroke shall never reach an elevation higher than 28 feet above the water in the well or sump. No pump will work satisfactorily at this elevation if the upward velocity of the bucket exceeds 20 feet per minute, and even then the clack and bucket valves must be very light. For good average work the elevation should not be greater than 20 feet.

Perhaps to elucidate the subject of lifting pumps it would be better to explain their mode of acting. (See Fig. 1.) Externally an ordinary hand pump consists of the tail-piece T, and the barrel B. Internally we have the clack-piece C, which is placed in a suitable seat at the bottom of the working barrel, as shown at C. The clack piece consists of a cylindrical shell, which is packed either with hemp or leather to make it watertight. On the top of the clack-piece is a valve which opens on the ascent of the bucket. Now by a little con-

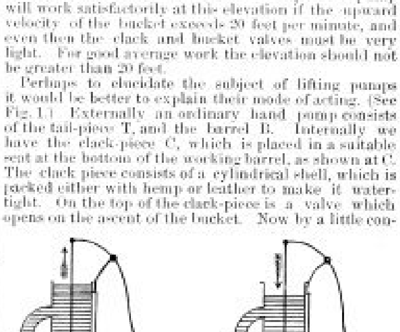


Fig. 1.

sideration it will be seen that as the bucket ascends it tends to produce a vacuum between itself and the clack. The atmosphere then immediately forces water up through the clack-valve into the barrel, so that when the bucket reaches the top of its stroke the barrel is full of water. On the downward stroke there being no force under the clack-valve it drops, but the bucket cannot descend without the bucket-valve opening to allow the water to pass through it. Fig. 1 shows the positions of the bucket and clack-valves for the upward and downward strokes which are indicated by arrows besides the pump spears.

Hand pumps of this variety are not now much used for mining purposes, plunger pumps having to a large extent taken their place. Lifting sets, however, are still extensively used in the sinking of shafts and for ordinary main pumps for ordinary mine drainage.

The lifting pump as used for shaft work, is a ponderous and expensive machine, and is only used in modern mining as a disagreeable necessity. It holds its own for the bottom set in a sinking pit for the following reasons: There is not and cannot be any standage; second, should anything happen to render the clack or the bucket inoperative, the spears may be drawn and the bucket changed; or should the clack fail in its action it can be fished up and a new one inserted in its place. To any person having a very elementary knowledge of pumps it will be clear that if the valves of a forcing set become inoperative, before repairs or corrections could be made, the water would rise in the shaft and flood the valve cases in such a way that they could not be reached.

What is true of a sinking pit is equally true of a mine where a danger exists of the valve cases of a forcing set being submerged under the conditions of a sudden outburst of water from old workings. It is, however, only necessary to make the bottom set a lifting one where the depth of the shaft exceeds 240 feet. In some old-fashioned arrangements two lifting sets are employed, one above the other, and the engine is balanced by a diagonal spear and bell-crank lever in such a way that when one set is plunging the other is lifting; but where a lifting and a forcing set are employed, both sets are worked by one main spear working from one end of the main beam of the engine, (see Fig. 2) L L is the lifting set F is the forcing set.

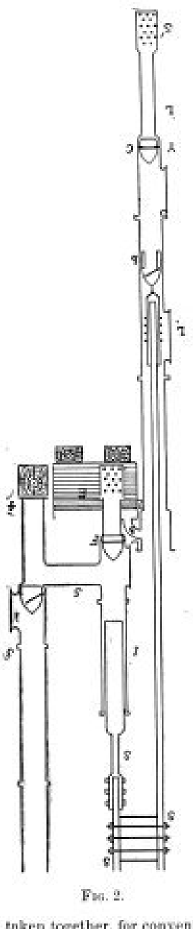


Fig. 2.

It will now be necessary to describe the principal details of a lifting and forcing set. At the bottom of the lifting set we have the strum marked S^3, and we have the clack and clack door seen at *c*, and the bucket and bucket door marked *b*, the spears S S S, and the cistern for the supply of the forcing set marked E. It will be here noticed that the lifting set delivers into a cistern from which the forcing set pumps the water to bank. The forcing set is provided with a strum, as seen in the cistern. Perhaps the portion of an ordinary forcing set of special interest to the student is what is called the H piece (the parts 1, 2, 3, 4, and 5 taken together, for convenience are here designated as the "H piece"). By close attention to the figure it will be seen the plunger works through a stuffing box on the top of leg, 1 of the H. Immediately below the cross-piece in the same leg of the H is seen the clack valve. Immediately above the cross-piece in the other leg of the H is seen the "keep" clack, which supports the water column by being shut when the clack valve is open. It will further be observed that the spear attached to the plunger is fastened on to the main spear by offset pieces in such a way that the main spear supports the ram, and the wet spears of the lifting set.

The thickness of pump sets is calculated by the following formula (English rule): The radius *r* of the set in inches multiplied by the pressure of the water per square inch *p*, and divided by the pounds in half a ton, 1120, or

$$\frac{r\ p}{1120} = T.$$

Here T is the thickness of the sets in inches.

The student must intelligently notice that it would be wasteful to make all the pipes in a long column of uniform thickness, but the thickness should never be allowed to fall below three quarters of an inch. The pressure of the water per square inch may be found by multiplying the vertical depth in feet by ·434. For example: A pit is 300 feet deep, and the set 16 inches in diameter; required the thickness of the set in inches. Here the pressure per square inch due to the water head will be 130 lbs, and the radius of the pump eight inches. Then

$$\frac{130 \times 8}{1120} = {\cdot}928 \text{ inch,}$$

or nearly one inch thick.

Generally the thickness of cast-iron water pipes is calculated by Mr. J. T. Fanning's formula as follows:

$$\text{Thickness in inches} = \frac{(\text{pressure in lbs. per sq. in.} + 100) \times \text{bore in ins.}}{4 \times \text{ultimate tensile strength.}} + {\cdot}333 \left(1 - \frac{\text{bore in inches}}{100}\right)$$

The ultimate tensile strength is usually taken at 18,000 lbs. per sq. in. According to the formula the thickness of set in above question would be thus:

$$\frac{(130 + 100)\ 16}{4 \times 18{,}000} + {\cdot}333\ (1 - \frac{16}{100}) \text{ or,}$$

$$\frac{230 \times 16}{7{,}200} + {\cdot}333 \times \frac{84}{100} = {\cdot}709 \text{ inches.}$$

The quantity of water in gallons that a pump of given dimensions will deliver to bank may be found in the following manner: First, to find the sectional area of the pump, we square the diameter in feet and multiply by ·7854, and this product multiplied by the length of the stroke will give the cubic feet of water lifted in one stroke of the pump; further multiply this last product by the number of the strokes the pump makes per minute and this will give the cubic feet of water the pump delivers per minute. But the work of pumps is generally given in gallons and not cubic feet, and there being 7·4805 U. S. gallons in a cubic foot; therefore multiply again by 7·4805, and you have the gallons of water delivered per minute by the pump. For example, a pump has a six feet stroke and a diameter of 16 inches; how many cubic feet of water will be delivered by one stroke?

Here $\frac{16}{12}$ is the size of the pump in feet, then

$$\frac{16 \times 16 \times {\cdot}7854 \times 6}{12 \times 12} = 8{\cdot}3776 \text{ cu. ft.}$$

To find the gallons of water as explained above, we multiply this by 7·4805, the gallons in one cubic foot, or

$$8{\cdot}3776 \times 7{\cdot}4805 = 62{\cdot}6686.$$

Suppose again, the pump makes six strokes per minute, then

$$62{\cdot}6686 \times 6 = 376{\cdot}0116 \text{ gallons per minute.}$$

The three questions already given would be stated as follows:

First,

$$\frac{16 \times 16 \times {\cdot}7854 \times 6}{12 \times 12} = 8{\cdot}3776 \text{ cubic feet.}$$

Second,

$$\frac{16 \times 16 \times {\cdot}7854 \times 6 \times 7{\cdot}4805}{12 \times 12} = 62{\cdot}6686 \text{ gallons.}$$

Third,

$$\frac{16 \times 16 \times {\cdot}7854 \times 6 \times 6 \times 7{\cdot}4805}{12 \times 12} = 376{\cdot}0116$$

gallons per minute.

It will be observed in these questions considerable calculation is required, but this may be avoided by the construction of a constant number which we will now proceed to explain. Take for example the second by way of illustration:

$$\frac{16 \times 16 \times \overline{{\cdot}7854} \times 6 \times \overline{7{\cdot}4805}}{\underline{12} \times \underline{12}}$$

Notice that the numbers above the line ·7854 and 7·4805, which are overlined, will always occur in questions of this kind, and the numbers 12 and 12 below the line that are underlined will also occur. Now, if the product of the first pair of figures be divided by the product of the second pair, we will get this constant, or

$$\frac{{\cdot}7854 \times 7{\cdot}4805}{12 \times 12} = {\cdot}0408.$$

It will be clearly seen that by the use of this constant the calculation is both shortened and facilitated, for instead of the previous long calculation we now have

$$16 \times 16 \times 6 \times 6 \times {\cdot}0408 = 376{\cdot}01 \text{ gallons.}$$

Or multiply the constant by the square of the diameter in inches and by the length of the stroke in feet, and the number of strokes per minute and we find the gallons the pump delivers per minute.

The ordinary pipes in a lifting set are made one inch larger in diameter than the bore of the working barrel, so that in the event of having to draw the bucket or clack they may pass freely through the set. The spears are made of the best pitch pine, and the section of the spears is calculated at the rate of five square inches per ton of load; or the following convenient formula may be employed: The square of the diameter in inches multiplied by the length of the column in feet, and by the constant number ·0008, will give the sectional area of the spears in square inches, and the square root of that will give the sides of the spears in inches.

The student will perceive that the section of a main spear will be equal to the sum of the sections of the lifting sets employed, if there be more than one.

NOTE.—In connection with the above it would be well to study the pump problems worked out on page 261, of the June issue, under the heading "Mechanics in Mining."

ARITHMETIC.

We are constantly meeting with people that are fairly expert in multiplying and dividing with whole numbers, but make the most outrageous mistakes when decimal points are involved. This statement should be a sufficient apology for the care we are taking in explaining the various modes of pointing off.

Suppose that from 27 it was necessary to subtract ·05. Now ·05 is a very small fraction of 1, indeed it is five hundredths of 1, and if you were presented with five one-hundredths of an apple you would immediately discover its miniature value, because if an apple was cut into a hundred parts, you would at once be conscious that they were no bigger than peas; and if you were presented with a fragment of an apple, the volume of which was no larger than five small peas, you certainly would not express your thanks very warmly for the gift.

Now the whole of the processes in arithmetic, and in advanced mathematics, are easily understood if people would endeavor to reconcile the queries involved by contrasting them with the common things of everyday experience. We are well aware that many of the words are new to beginners, and the object of these articles is to render the meaning of these terms clear to the uninitiated.

Let us return again to our problem, namely, the process of subtracting ·05 from 27, and let us suppose absolute ignorance of the use of the decimal point, and proceed as though the relative positions of the figures might be disregarded—by way of illustration let us notice that 2 at the left-hand side of 7 represents 27 or two tens and seven. Now invert the two figures, that is, set the 7 before the 2, and the altered positions of these figures will represent 72 or seven tens and two. It may almost appear to be playful, this mode of proceeding, nevertheless we must assume that the student's knowledge is either at zero or little above it, to develop the teaching of the lesson properly. Again

$$\begin{array}{r} 72 \\ {\cdot}05 \\ \hline 67 \end{array}$$

It will be seen that we have subtracted the 5 as though they consisted of five perfect units or five perfect things, and by thus proceeding we have made a fatal mistake. We have acted as though ·05 represented five entire apples, whereas it really consisted of an exceedingly small fragment of one apple. Again suppose we disregard the decimal point and even the units place, and so place the 72 over the ·05, as shown:

$$\begin{array}{r} 72 \\ {\cdot}05 \\ \hline 22 \end{array}$$

Now we have proceeded as though ·05 represented 50 apples, because we have taken it from the tens, and as 7 tens are 70 and 5 tens are 50, we must discover the serious error that has been made. Now, again, suppose the figures are wrongly placed for subtraction, as shown:

$$\begin{array}{r} 72 \\ {\cdot}05 \\ \hline 71{\cdot}5 \end{array}$$

We have committed another error by thus proceeding, we have used ·05 as though it was half an apple and the result is 71·5 apples are represented as being left. But let us make the subtraction correctly, then

$$\begin{array}{r} 72 \\ {\cdot}05 \\ \hline 71{\cdot}95 \end{array}$$

The result is 71·95 which is correct. Now then let us notice that either in adding or subtracting the decimal point is always set at the right hand side of the column of units or singles, or at the right hand of any figure representing units or singles. We are quite aware that the word unit is derived from the Latin language and never should have figured in the English language when the Saxon language had furnished us with a word the exact equivalent, namely, *one* and the word unit means precisely the same as *one*.

SCIENCE RELATING TO MINING.

Centrifugal Fans.

To those unacquainted with the principles of theoretical mechanics, the action of the Guibal, Waddle, and Schiele fans will be somewhat perplexing. It is a very easy statement to make, when it is said that they are centrifugal fans, and that the air is thrown off by centrifugal force. It is not our business in this article to give the mathematical value of the force, but to make the mode of its action plain and easy to understand. Newton first taught us that when matter was first moved by a single force, the particle of matter moved would continue its progress in the path of a straight line, until acted upon by another force, tending to move it in a different path. Now, centrifugal force is generated when an attempt is made to continually change the path in which a particle of matter is moving. If a straight lath be made to turn on one end as a center, while the opposite end is free to revolve in the path of a circle, and a marble to be placed about an inch or two from center, and the other end of the lath be made to revolve, the marble will at once begin a journey outward from the center of motion, and at once fly off from the other extremity of the lath. What moved the marble outward from the center of motion? Simply the marble by its inert force was moving in the direction of a more uniform, or a more nearly straight line path, one linear inch measured on the curvature of a small circle, is a greater divergence from a straight line than one linear inch measured on the curvature of a large circle. It is said that bodies have a tendency to fly off from the center of a circle, when they are confined to move in a curvilinear path. But the expression "to fly off" is so very vague, that we prefer the explanation previously given. Now, examples of the operation of this force are abundant in nature, the planets in the solar system would all fall into the sun, by his superior attraction, but for the counteraction this force exerts in the opposite direction to that of gravitation. The earth and the moon would run together with increasing velocity but for the preservative counteracting centrifugal force. The equilibrium of a planet in its path, may be imitated by fastening a piece of iron or lead to one end of a piece of string two feet long, if this weight be held by the piece of string at arm's length from your body, and you turn rapidly round on your heels, the ball will at once fly outwards, and remain at such an increased distance as will allow centrifugal force to exactly neutralize the force of the earth's attraction, tending to pull the weight of the string into the vertical direction of a plumb line. A very pretty illustration of centrifugal force is seen when a cup of tea is rapidly whirled round with a spoon, better still when a clear glass filled with water is placed on a dish. If the water is rapidly whirled round with a spoon, a depression will at once be formed on the surface of the water, after the manner of what is called a parabolic curve. By looking through the sides of the glass the depression can clearly be seen, and the water that overflowed from the full glass will be exactly equal in volume, to the depression produced by the centrifugal force. The governors of a steam engine are another illustration of the action of this force. A very beautiful illustration is met with, in the naturally serpentinous courses of rivers. At the outside of every curve it will be noticed that the centrifugal force of the particles of water in the moving current eats the land, or cuts it away, making the outside of the bend of the river precipitous, whereas a sloping shore will be seen on the inside of the curve where centrifugal force does not act. This is the exact analogue of the water pressing on the side of the glass, and the bottom of the depression in the glass corresponds to the pebbly sloping shore, on the in-side curve of a river. Now, how easily we can associate these illustrations, with the action of a centrifugal fan. The air is continuously taking in at an orifice round about the center of the fan, and the centrifugal force developed is made to be equal to the frictional resistance of the air current, that circulates through the mine.

The Air in Mines.

The average temperature of all mines is above that of the surface air; why it is so has never yet been clearly shown. One thing, however, is quite clear, that at the depth of about 50 feet, some say 100 feet, the rock or earth has a constant temperature corresponding to the mean annual temperature of the air, of any particular region. It is extremely probable that the temperature between 50 and 100 feet will be constantly nearly the same. In descending into the earth's crust, below 100 feet the temperature of the rocks increases at the rate of one degree for every 50 or 60 feet of descent. We say 50 or 60 because the temperature increases more rapidly in some cases than in others. In very deep mines the surface air is only at the hottest periods of the year, at the same temperature as the return air that has performed the circuit of an extensively-worked deep mine. In shallow pits the external air is always hotter than the air in the mine, because as the ventilating current traverses the galleries of the mine, it is cooled, the rocks being at a lower temperature than that of the external air. But this is not all, the cooling of the air produces a marked change in its composition. Hot air contains a large quantity of watery vapor, or more properly expressed, water as gas. The quantity of water-gas that air contains varies directly as the temperature of the air, this is why wet clothes held before a hot fire are rapidly dried. The air between the fire and the wet article is heated, and at once abstracts the water from the cloth, as water-gas; but the moment this hot air is cooled a cloud like that of condensed steam is seen, because the cool air can no longer retain its previous full charge of water-gas. Now, in summer time, especially on warm days, the roads in the mine are very wet, and unpleasantly dirty, the roof is covered with drops of water, and it is thought by some that the rocks shed more water in summer than in winter. This is quite a mistake: the water that makes the roads sludgy and covers the roof with drops is distilled from the air. Now the same mines in winter are characterized as being very dry. The reason of this is not far to seek; the cold air on entering the mine becomes heated, and on this taking place its power for absorbing water-gas is increased, the result is the water on the roof and on the roads is said to be dried up, that is to say, warm air has the power of converting the water into a gaseous form, and it is thus carried off. But what we have been speaking about in the mines takes place on a grand scale in nature, the air near the surface of the earth is always at a much higher temperature than the air of the upper regions of the atmosphere; it is for this reason that lofty mountains on the torrid zone are capped with everlasting snow. The warm air near the earth's surface absorbs water from the sea and the surface of the land, and when this air ascends to elevated regions it is chilled or cooled, and at once gives up its water in minute particles, so small that the mechanical movements of the air are quite sufficient to keep them floating, and countless millions of these little particles go to form clouds, which correspond with the cold drops of water on the roof of a seam in summer; so that what takes place in the seam is only a miniature copy of the operations of nature, in her more majestic transactions. It has often been observed that in the in-bye districts of a mine, where the air is warm and dry, warm because its temperature has been increased by the absorption of heat from the rocks, that the lamps do not burn so brightly, and that the men become dry and thirsty. The reason of this is deeply interesting. The greedy, parched air absorbs or dries the moisture out of the men's skins, and unless they have access to drinking-water, their blood becomes thick and hot, and they feel a feverish, painful lassitude which overtakes them. The same warm air, before reaching the lamps, has been greedily drinking up water in its journey, and is thus so heavily charged with water-gas, that its oxygen is diluted, and the result is dull, sickly, unexciting lights.

This subject is full of interest, for while the hot air dims the flames of the lamps, it renders the fire-damp with which it may be charged less dangerous and explosive. Nature is full of such marvelous counterchecks, and it must have been observed that explosions of fire-damp are more frequent where the air is fresh and cool than in surcharged hot air.

The Pressure of Gas in Coal.

Coal in the Bituminous seams, is always more or less subjected to bleeding. This is well known to the practical miner, he is constantly observing the sweating of the coal, accompanied with a hissing sound. The sweating undoubtedly is produced by the pressure of the gas stored up in miniature cavities and fissures of the seam.

The pressure of the gas is a subject of increasing interest, it has been found in some cases to be nearly equal to the pressure of the steam in the boilers of steamships. Pressures of 200 lbs. and upwards have been found to be common in deep seams newly opened out. What is interesting about the matter is the co-relationship of the pressure of the gas to the pressure due to a vertical column of water, measured from the seam to the drainage level of the rocks overlying the seam.

To make this clear, let us suppose a seam to be 250 fathoms from the surface; again, let us suppose that the drainage level is about 50 fathoms from the surface. Now by this data we may with considerable accuracy calculate the pressure of the gas stored up in the cavities of the seam.

Suppose the seam has not been wrought, but has been pierced by a bore-hole; if a long iron tube was inserted in this bore-hole and made gas-tight, that is to say, made to fit the hole so closely by some system of packing that no gas could escape—and a pressure gauge was screwed on the upper end of this pipe and allowed sufficient time for gas to accumulate in the bore-hole, the pressure ultimately observed might first be calculated as follows: vertical height of water being 200 fathoms, then

$$\frac{200 \times 6 \times 62{\cdot}5}{144} = 520 \text{ pounds press-}$$

ure on the square inch.

This calculation might, however, have been made by a simpler process, which we highly recommend; a square inch column of water having a vertical length or rise of 6 feet, weighs nearly 2·6 pounds, therefore $200 \times 2{\cdot}6 = 520$, or is equal to a pressure of 520 pounds on the square inch, as before.

Often, as faults and dislocations, water and gas are met with in unusual quantities; sometimes on cutting a fault, gas is given off generally at the bottom of the seam, and this gas often consists of sulphureted hydrogen. Water is often met with at faults, and it generally comes off at the fault at the top of the seam, and after the water has expended itself, it is followed by gas, which also consists of sulphureted hydrogen. Now, why gas should be found at the bottom of the seam and water at the top of the seam is a matter full of interest. Water is sometimes given off at the bottom of the seam, and when that is the case the reason why requires observation and investigation.

Now when water is given off at the bottom of the seam, some cavity in the neighborhood of the fault contains gas at a high pressure, but is situated above another cavity filled with water, so that while gas is pressing on the water, water flows from the bottom of the seam, through some vent or parting in the fault; but as water is heavier than gas, if the water and the gas are found in one cavity in the bottom stratum of rock communicating with the fault or fissure, then gas only is given off, and sometimes at a high pressure. But it will be noticed that after a while the gas is all spent off, and the air in the neighborhood of the fault resumes its normal condition. The gas is expelled by the operation of Boyle's law; it exists in this bottom cavity at a pressure considerably above that of the atmosphere, and if the pressure of the gas in the cavity was three times that of the atmosphere, on that pressure being removed it would expand into three times its original volume, or every cubic foot in the cavity would expand into three cubic feet, two of which would be expelled.

When the water is given off at a fault at the top of the seam, we may certainly expect this water to be followed by gas, because, being lighter than water, it is pent up at a high pressure above it, and the high pressure of the gas causes a rapid or violent outflow of water. Now as the gas cannot sink in the water, being lighter, if the bottom of the cavity communicates with the fault, then no gas will spend off until the water has all been expelled.

These facts correspond with everyday experience, and happy is the man that takes a pleasurable interest in these matters, because it is out of such observations that knowledge and experience are matured, and men are made useful and profitable to themselves and others.

Mine Water.

Mining is a vast and comprehensive subject, nevertheless the important details that should be learnt can be mastered by moderate industry if the student can but possess himself, and make study a pleasure instead of irksome toil.

Mine waters are interesting from many points of view, some of them are so relatively pure and good that they may be used for drinking purposes; but such a state of purity is seldom met with, indeed, at many large mines thousands of pounds are spent annually in providing pure water to feed the boilers, and all the while delivering into neighboring streamlets volumes of water equal to five hundred or a thousand gallons per minute from the pumps that are draining the mines.

Now mine waters hold in solution corrosive substances such as the sulphates of iron, lime, soda, and magnesia, and the chlorides such as chlorides of iron, lime, and so on. Now these bodies held in solution are not only destructive to pumps, to the shoe leather of the miners, and to their clothes, but if this water should be used to feed the boilers it rapidly destroys the plates, and soon ends in making the boilers worthless, or induces the greater peril of so weakening the plates as to produce explosions. This being the case, the matter is a serious one to the careful and competent mine engineer. So strongly are some mine waters charged with sulphates of iron, and even sulphuric acid, that the valves and their seats and the shells are rapidly destroyed, entailing serious expense, and often presenting difficulties that render working the mine a doubtful speculation. There is something marvelous about chemical action; actions and reactions are being constantly investigated, yet after all is done and said, there is a subtlety about chemical action that baffles the investigations of the most gifted minds; for example: sulphate of lime is known to the chemist as $CaSO_4$. Now this salt, when held in solution by water, and that water is in contact with iron, the SO_4 combines with the iron forming $FeSO_4$, the lime taking up the oxygen and carbonic acid from the water becoming again carbonate of lime. The quantity of sulphur in the shape of sulphide of iron contained in the rocks overlying and underlying the coal seams, and even in the coal seams themselves is a very large amount. Sulphur in coal is an undesirable constituent, reducing its commercial value, and doing damage in various processes of manufacture, such as in the smelting of iron, and reducing the commercial value of the iron or otherwise involving considerable expense in its removal, when it is necessary to produce the better qualities of iron or steel. The waters that percolate through the rocks become saturated with sulphur compounds, and in nature's marvelous laboratory the sulphur compounds indicate their changes, and we find the sulphur at last concealed in the interstices of a coal seam as sulphide of iron.

The Principle of the Jigger Screen.

The jolting or jigger screen, lately introduced into mining for screening, or more correctly, for sizing coals, is worth studying, and indicates the great advances that are being made by mankind in the pursuit of a knowledge of the operations of natural laws. The essential principles on which the screen acts, are three in number; first, the law of inertia common to matter; second, gravitation; third, friction.

The screen is made to move rapidly backwards and forwards, that is to and fro in the direction of its length, or, to use technical language, it has a reciprocating motion in the direction of its length, the throw being equal to 6″ or 9″, and this motion is produced by an eccentric and eccentric rod.

Now if the screen was set perfectly level, the coals would simply alternately move backwards and forwards, and would never advance to either end of the screen, consequently, the screen is made to have a small inclination, of about 1 in 18, this fall renders the force of gravitation about equal to the frictional resistance of the moving particles, so that on the backward motion of the screen, the pieces of coal are carried forward, by this simple and interesting arrangement, the jigger, or jolting screen, has made a complete success.

Its advantages are very great, not only can two screens be conveniently arranged under each other, and all the sizing done without having recourse to the old-fashioned methods of re-elevating the coals, and passing them through the second set of screens, but the coals are evenly distributed onto plate belts, where they may be screened and dressed for delivery into trucks.

Let the student take a small wooden board or thin sheet-iron tray, and place on this pieces of stone or coal and imitate the arrangement that has been described, and after having done so, he will then clearly understand all the principles involved.

Carbonic Oxide in the Fire.

When all the gas has been expelled and burned, which is given off by "green" or fresh coals, and the cinders are glowing with yellow heat on top of the fire, faint blue lambent flames are seen to be dancing; this flame is produced by carbonic oxide gas (CO), burning into carbonic acid gas (CO_2). The reason why carbonic oxide gas is produced in the lower portion of the fire is not far to seek; the immense surface of the rough cinders being at a high heat, are ready to consume more oxygen than the volume of air passing through the fire can supply, the result is the formation of (CO), instead of (CO_2), and it is only when the (CO) gas has reached the upper region of the burning mass, that additional air can be supplied to burn it into (CO_2).

Carbonic oxide is abundantly produced in blast furnaces, used for smelting iron, the hot blast can never be made sufficient to produce carbonic acid, and indeed, if carbonic acid gas was produced in the blast furnace, it would be at a lower temperature than that which produces carbonic oxide, and the result would be the wasting of the fuel. Here we are confronted with the beautiful operations of natural law, in the first place, the air injected into the furnace is at a high temperature, indeed, the temperature is such that the density of the hot blast is only about one-third that of the atmosphere, so that every cubic foot injected into the furnace is only equal in density to one-third of a cubic foot of normal air. The result is, if carbonic acid gas is for a moment produced, no doubt it will be when contacting with the first particles of burning coke; the upper particles of coke will take from that gas one particle of oxygen; producing two volumes of CO, thus while carbonic acid is produced at the lower portion of the furnace, the upper layer of incandescent cinders immediately converts the carbonic acid into carbonic oxide, and as carbonic oxide, it escapes from the upper portion of the blast furnace.

So conscious of this chemical fact are the smelters of iron ore, that in later days, a trap has been provided to collect this carbonic oxide, and burn it under boilers for generating steam.

Modern furnaces are provided with a kind of trap or bell top, so arranged that the carbonic oxide is carried away by pipes to the boiler fires to be burned, while the admission of coke, ore, and lime, only takes place intermittingly, and at the period of the admission of the charge, the characteristic carbonic oxide flame is seen on the top of the furnace.

Carbonic oxide gas is abundantly produced in cupola furnaces for melting cast-iron, and this characteristic flame may be witnessed when the cupola is in action at any foundry.

EXAMINATION QUESTIONS ANSWERED.

QUESTION 43.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

How would you examine the various safety-lamps in common use as to their safe condition for testing gas, also for working with, and what appearance has the flame of the lamp when brought in contact with various mixtures of an explosive nature?

ANSWER.—I would examine all parts of the gauze to see that it was clean and perfect. I would examine all joints to see that they were tight and perfect, and also examine the glass cylinder of those of the Clanny type to see that it was perfect.

With 2% of gas in the air, a small blue cap is discernible on the top of the flame. With 3% the cap will show from ·3 to ·4 of an inch above the flame. With 3½% the cap will be from ·6 to ·7 of an inch high. With 4% the cap will be nearly an inch high. With 5% the cap will almost fill the gauze, and with 6% an explosion of gas will frequently occur inside the gauze.

QUESTION 44.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

Will air diffuse with or dilute an accumulation of fire-damp quicker than an equal accumulation of black-damp? Give reasons in full.

ANSWER.—Air will diffuse with or dilute an accumulation of fire-damp much quicker than an equal accumulation of black-damp. Experiments have shown that a light gas will diffuse much quicker than a heavy gas, and that the ratio of diffusion is inversely as the square root of density.

Thus, the density of fire-damp is 8, the density of black-damp is 22, and the density of air may be approximately taken as 15. Then we have

$$\sqrt{15} = 3{\cdot}87 \text{ and } \sqrt{22} = 4{\cdot}69,$$

therefore their relative time of diffusion would be as 3·87 is to 4·69. In other words air will diffuse a given quantity of fire-damp in 3·87 minutes, while it will take black-damp 4·69 minutes to accomplish the same result.

QUESTION 45.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

Suppose you have charge of a mine generating fire-damp which requires active ventilation to keep the mine in a safe condition for working, upon arriving at the mine in the morning, unexpectedly, your fire boss reports that a certain door has been left open the evening before, causing a large accumulation of fire-damp in a certain part of the mine, how would you proceed to remove the same with the greatest safety to the men and the mine, the mine being ventilated by furnace power, and state what kind of lamps you would use while removing the same?

I would gradually remove the fire-damp in the following manner:

I would keep up as hot a fire as possible in the furnace, and increase the ventilating current. I would then, by opening and closing such doors as would suffice, divert a portion of the air current into the affected part, taking care to have a sufficiently large current flowing out of the main return to dilute the gas forced gradually out of the affected portion of the mine. I would keep this up until I had secured a normal state of affairs in the affected portion and would then restore the doors and main current to their proper conditions. While doing this I would allow no workmen in the affected portions but those necessary to restore ventilation and I would use no lamps but safety-lamps while prosecuting this work. Further, I would have no men engaged in the work but those who were accustomed to working in gas, and who fully understood the principles of the safety-lamp. After restoring the ventilation, I would endeavor to learn which of the employes had left the door open, and when found I would discharge him, for he would have shown by his action that he was too careless to have around the colliery in any capacity.

QUESTION 46.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

State fully how you would use the safety-lamp in testing gas, and under what circumstances is it unsafe?

ANSWER.—I would lower the flame as much as possible and slowly insert it in all places in which gas could accumulate, and would watch the flame carefully for a cap or for an ignition of gas in the gauze. If the latter occurred I would gradually withdraw the lamp, and if the gas still burned in the gauze I would smother the flame under my coat, always being careful to move the lamp slowly so as to prevent the flame being blown through the gauze.

In testing gas a lamp may be unsafe because the gauze is defective; because the gauze is greasy and dirty, and the grease and dirt ignite and fire the gas; because it is thrust into or withdrawn too rapidly from the explosive mixture and the flame be thus passed through the gauze; or because through inattention the lamp is left so long in the explosive mixture that the explosions inside and the heat thereof, have burst the gauze.

QUESTION 47.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

In a mixture of air and gas where safety-lamps are used, what should be done to prevent an explosion should the lamp become filled with flame?

ANSWER.—The lamp should be withdrawn slowly so that the flame be not passed through the gauze, and if the burning gas in the gauze does not die out owing to a better atmosphere, the lamp should be placed under the coat and the flame extinguished by depriving it of air, or in other words it should be smothered. It should never be extinguished by blowing.

QUESTION 48.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania on October 28, 29, 30, and 31, 1889.

How does fire-damp appear in a safety-lamp, and what proportion of fire-damp is mixed with the air when a cap begins to appear on the safety-lamp? At what proportion does it explode, and at what proportion will it extinguish lights?

ANSWER.—In the Galloway Royal Society's Journal of 1876, the following was given as to the appearance of fire-damp in a safety-lamp:

"The wick of the lamp, having been carefully trimmed, was drawn down until the flame presented the appearance of a small blue hemisphere about one-eighth of an inch high, one-quarter inch diameter at the base, and having a conical speck of yellow in the middle near the top.

"A mixture of one part of gas with sixteen parts of air gave a voluminous waving, spindle-shaped blue cap 3½ in. high.

"One part of gas with 18 parts of air gave a cap 2 in. high, which burned more steadily.

"One part of gas with 20 parts of air gave a cap 1½ in. high, with nearly parallel sides to about ⅔ of its height and then tapered to a point at the top.

"One part of gas with 25 parts of air gave a conical cap from ½ to ¾ in. high.

"One part of gas with 30 parts of air gave a conical cap ½ in. high.

"One part of gas with 40 parts of air gave a conical cap ¼ in. high.

"One part of gas with 50 parts of air gave a faint cap ⅛ in. high the top having the appearance of having been broken off.

"With one part of gas and 60 parts of air it was hardly possible to distinguish anything above the small oil flame."

Fire-damp explodes when it is mixed with air in the proportion of one part of fire-damp to thirteen parts of air. When there is only 9 or 10 times as much air as fire-damp, the explosive force is greatest. If the proportion of gas be greater than one part out of 9 or 10 of air, by volume, the force of the explosion gradually becomes less and less, until, when there is only five times as much air as gas, the mixture will not explode but will, on the contrary, extinguish a light.

QUESTION 49.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

If the temperature of 1,000 cubic feet of gas be raised from 60° to 90°, what will then be its volume?

ANSWER.—As air or gas expands $\frac{1}{460}$ of its volume for every degree of heat added, it will expand $\frac{30}{460}$ when the temperature is raised from 60° to 90°. Then as $\frac{30}{460}$ of 1,000 = 65·40, the volume at 90° will be 1,000 + 65·40 or 1,065 cu. ft.

QUESTION 50.—Asked at the Examination for Certificated Mine Bosses in the Bituminous Regions of Pennsylvania, on October 28, 29, 30, and 31, 1889.

If a room in a mine, 10 yards long, 4 yards wide and 3 yards high, be filled with fire-damp, how much pure air will be required to bring the mixture to an explosive point, and if the same was exploded, to what area would it extend?

ANSWER.—The room being 30 ft. long, 12 ft. wide, and 9 ft. high will have a cubical capacity of 3,240 cu. ft. To make 3,240 cu. ft. of gas explosive we must add to it 13 times as much air as there is gas. Then 13 × 3,240 or 42,120 cu. ft. of air must be added to make an explosive mixture.

The distance to which the explosion would extend cannot be accurately determined, but it has been found that the flame of a violently explosive mixture will expand to about 8 times the volume of the gas. As the explosive mixture in this case would consist of 3,240 cu. ft. of gas + 42,120 cu. ft. of air or 45,360 cu. ft., it would expand to 45,360 × 8 or 362,880 cu. ft. Then as the height of the workings is given as 3 yds., or 9 ft., the explosion would extend over an area of 362,880 ÷ 9, or 40,320 sq. ft.

QUESTION 4.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

In a seam or vein pitching 65° and 30 ft. thick, where large quantities of fire-damp are given off, what plan or system would you adopt with regard to mining and ventilation?

ANSWER.—I would work the coal on the breast and pillar system, making the gangway or haulage road the intake, and I would ventilate with an exhaust fan. I would divide my air so as to have no more than four breasts on each split, and I would make the inside manway of the inside breast the intake for the split, and the outside manway of the outside chamber or breast, the outlet. I would take the air up the intake just described to the face, across the face and down the other side to the first heading or cross-cut from the face, through it to the next breast or chamber, up it, across the face, thence by way of the upper heading to the next breast, and so on until I reached the outside manway of the outside breast of the split or group, and from there I would take it direct to the main return air course. The work should all be done with safety-lamps.

QUESTION 5.—Asked at the Examination for Certificated Mine Foremen of the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

In a seam or vein pitching 20° or less, and 8 ft. thick, where large quantities of fire-damp are given off, what plan or system of mining and ventilation would you adopt?

ANSWER.—I would work the coal on the pillar system, and ventilate the chambers or breasts in splits or sections of say 6 or 8 breasts each, and would have an air current of sufficient volume to dilute and carry off all gas. My system of ventilating would be similar to that given in the preceding answer.

QUESTION 6.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania on July 6 and 7, 1891.

What gases destructive to life are met with in coal mines—and what experience have you had with each, and in what mines did you encounter them?

ANSWER.—Light carbureted hydrogen, or fire-damp, carbonic acid gas, or black-damp, carbonic oxide, or white damp. I have worked in ——— colliery where large quantities of fire-damp are met with, and have been frequently driven out of my chamber by feeders that I cut. I have never been burned, because I could detect the gas in my safety-lamp and I was always on the lookout for it. I worked at one time in ——— colliery before the present owners had it and suffered from the effects of black-damp owing to insufficient ventilation. At one time the furnace, which produced the little supply of air we had, was carelessly allowed to go out, and I noticed that towards the close of the day I became sleepy, and very tired. My lamp did not burn with its usual brightness, and I knew that the cause was black-damp. I quit work and went to the surface. As soon as I reached pure air I was seized with a violent headache, and for several days felt the effects of the poisonous gas. I never worked at that mine again. I worked at ——— colliery at the time of the explosion in ——— and assisted in the rescue work. Owing to a portion of the mine being on fire a little carbonic oxide was met with in the air. A couple of the weaker men in the rescuing party were partially overcome by it, and I assisted in getting them to the surface in time to save their lives.

QUESTION 7.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

Give the plan or system of ventilation adopted in some mine at which you have worked, and state the difficulties that may be encountered, when final robbing takes place, to maintain the ventilation?

ANSWER.—I always worked in collieries ventilated by either an exhaust fan or furnace, and the air current was divided into splits, so that each section of the mine had its own air. There was comparatively little difficulty in maintaining the ventilation when the final robbing was done owing to this split system. We did, however, have a little trouble at one time. The robbing brought on a squeeze that burst out several stoppings and also partially closed an air course. As the vein gave off considerable fire-damp, we were required to quit robbing, and to set to work to restore the ventilation as soon as possible. This we did by putting up temporary stoppings with brattice-cloth, while another force cleared up the falls in the air course. All work was done with safety-lamps, and two fire-bosses were on duty while this work was being done.

QUESTION 8.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

A tunnel is driven from the surface, cutting three seams or veins, and having two gangways on each seam or vein, also two gangways are in operation on each of these veins below water level. How would you ventilate this mine, using only one fan?

ANSWER.—I would drive an airway and second outlet in the vein from the face of the tunnel if I had pitch enough. If not I would sink a shaft. I would place an exhaust fan on this airway. I would drive airways in the veins from each of the lower level gangways to those on the tunnel level. Then with a series of stoppings and crossings I would ventilate each gangway with a separate split.

QUESTION 9.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

In mines where fire is likely to occur, what precautionary measures would you adopt in your system or plan of ventilation, so as to guard against serious accident to life and property?

ANSWER.—I would have a line of water pipe along each gangway, attached to the column pipe in the slope or shaft, and I would have a number of places on the pipe lines where hose could be attached, or the water tapped. I would use the plan of separate splits in ventilating the mine, and would have doors so placed that by closing them I could reverse the air current in case the fire occurred in the intake air course. I would use no inflammable material in the construction of air stoppings.

Progress of Electro-Magnetic Science.

Arthur E. Kennelly, chief electrician of the Edison laboratory, at the close of a lecture delivered recently before the Brooklyn Ethical Association, on the evolution of electric and magnetic physics, thus summed up the important phases of the subject:

1. In electro-magnetic science the great achievement since Faraday's time has been the determination of the fact that all electricity flows, or tends to flow, in closed curves or circuits, so that we have the electrostatic circuit, the galvanic circuit, and the magnetic circuit, each resembling, as it were, an endless chain or a bundle of endless chains; and the laws which control these three different types of circuit show wonderful analogies.

2. The due appreciation of the influence of the ether and its importance in all electro-magnetic phenomena. While originally the electrical activity seemed to be confined to the battery or conducting wires of a galvanic circuit, it is now believed that the ether surrounding these conductors plays fully as active a part in the process of conduction; and the mind sees free space no longer void, but filled with an active and responsive substance—the ether. It looks almost as if matter were inert in comparison with the ether which surrounds it. Once more in the evolution of thought the tide of unbelief has turned, and we hold, under somewhat altered premises, the dictum that Torricelli refuted—namely, that "Nature abhors a vacuum." The properties of the ether almost threaten to surpass in interest and importance the properties of the matter it environs and pervades.

3. The evidence in favor of the proposition that light is a vibratory disturbance in the ether of an electro-magnetic nature is such as almost to amount to demonstration. When this shall be generally accepted, the whole domain of optics and radiant energy will be enrolled as one department and property of electro-magnetic physics.

Difficult as it is to clearly apprehend the course of evolution in the near past, where events press upon us in a narrow bounding throng, and the workers at the great loom of history yet stand by the mesh their hands have helped to weave, how still more difficult it is to guess the future! The prospect that opens is, however, a brilliant one. We may well believe that in science the same evolutionary process which has united electricity and magnetism, and welded both with radiation, will continue to magnify, simplify, and unify. Contrary to the course of evolution in the organic world, "from the homogeneous to the heterogeneous, the simple to the complex," the development of science is from the heterogeneous to the homogeneous, from the complex to the simple, and just as the evolutionary course of religious belief was from polytheism to monotheism, so with every fresh acquisition science becomes greater and grander and more succinct.

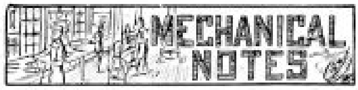
In the arts, electricity is destined, even apart from future discoveries, to take into its own hands the distribution of power. The telegraph has conquered time, and the electric motor is born to triumph over space; but whether we watch the vibrations of the telegraphic recorder that spells its messages across the sea, or watch the electric car, urged by invisible hands, pursuing its stealthy way, the rhythmic words of Ruskin rise into recollection's sight, "Not in a week, or a month, or a year, but by the lives of many souls, a beautiful thing must be done."—*The Northwest Magazine.*

The Study of Electrical Engineering.

We are constantly in receipt of inquiries from all over the country inquiring about the best ways, both practical and theoretical, of studying electrical engineering. An answer to these is by no means easy, on account of the great diversity in the needs and attainments of those who ask them. It should be borne in mind that electrical engineering is now rapidly becoming a crowded profession. The electrical schools are turning out every year hundreds of clever, well-educated young men who intend to devote themselves to the study of applied electricity. The result of this is two-fold—it makes competition rather severe, and the attainment of success by no means easy unless backed by a combination of ability and good fortune. In the second place it makes the task of the electrician who has graduated only from the workshop especially severe. Every profession goes through in its course of growth a series of sudden bursts of activity. Not many years ago civil engineering was the popular study among young men of scientific proclivities. The result was an enormous crowd of bright young engineers who glutted the market for brains for the time being, and by their very numbers made the chances of those who came after them much less than their own had been. It is all very well to quote the old saw that "There is plenty of room at the top," and say that for the young man of ability there is no such thing as a crowded profession. To a limited extent there is undoubtedly truth in these trite observations, but there is little comfort in them for the average man who enters the professions. Sheer ability alone seldom brings any man in professional life to the very front rank, and especially is this true of avocations in which the work is not individualized, as it is in the law and in medicine, but depends on great organizations. Both in civil and electrical engineering the first-class places that can be obtained are not very numerous, and the chances of individual work are lessened in the latter case by the existence of very large companies controlling the bulk of the business. The men who hold the good places, however they get them, are generally active and intelligent enough to keep them, and in electrical work the vast majority of the prominent men are under 40 years of age and consequently look forward to a quarter of a century of active professional life. They are sitting on the top of the ladder and smoking the pipe of peace, while the youngsters may have the privilege of cooling their heels on the bottom rounds. This is not in the least deliberately intended to discourage the study of electrical engineering, but its purpose is to hint to those who contemplate entering that profession that it is well not to raise their expectations of great and immediate success too high. To those who are willing to take up the study of practical electricity in a sensible, hard-headed way, looking on it as a lifework that will constantly interest them and as a means of livelihood at least as good as they are likely to find in business life under our present conditions, we would say, go in and work with every bit of energy you have. You may not get rich or famous, but you will have an honorable calling and a more respectable living than most of your fellow-mortals. The better education you start with the better off you are, but practical experience you have got to acquire somehow, whether you are a graduate of a scientific institute with a long name or not. You will most likely have to take off your coat and do a good deal of dirty, hard work, but it will not hurt you any more than it will any one of your 65,000,000 fellow-citizens. The only advice that we can give that will be of general assistance is to get as good a training as you can afford for the purpose of getting as good a start as may be, then get a foothold—a good one if you can, any sort of one if you cannot; and having obtained it hang on and do straightforward, faithful work.—*Electrical World.*

The London-Paris Telephone.

About fifty conversations per day are transmitted by the London and Paris telephone. These conversations are limited to three minutes each, unless one renews the payment, which is two dollars, and obtains another three minutes of this rather costly sociability. A bell rings automatically when the time is up, and the circuit is cut off; and no one is allowed the use of the instrument for more than six consecutive minutes. The receipts of the company at this rate are not less than $100 a day which would amount to $36,500 a year. The cable used has four conductors, giving two complete circuits. Each conductor consists of a strand of copper wire weighing 160 pounds to the mile, and covered with alternate layers of a composition and gutta percha. The four conductors are twisted spirally round each other and inclosed in a covering of twisted hemp, and this again in an outer covering of sixteen spirally wound galvanized iron wires.—*Mechanical News.*



Why Some Boilers Explode.

To many owners of plants a boiler is a boiler no matter how constructed, what shape or design it is, their only reliance is the thickness of plates and size of rivets. No attention is given to principle of circulation or difference in expansion between different parts of boilers and effects of same. The above class of proprietors do not believe in having inspections, they would save the cost of them and risk their own and the lives of those around. They know not that explosions have occurred with plenty of water in boiler or that many are due to unequal expansion and contraction through poor design; caused by dangerous defects and not discovered in time. They do not know that the safety of a boiler depends upon the circulation as much as upon the strength of the material. It is sometimes very hard to make them understand that thorough inspections by practical men are the only means of ascertaining the condition.

The ordinary two-flue boiler—and many are in commission to-day—have been very prolific in explosion; the greatest defect in design of this class of boilers is that of unequal expansion between flues and shell.

If large flues are put in they leave little space between flue and shell; leaving small body of water to amount of heating surface; dangerous cracks occur on heads at point between flue and shell on bends of flange and especially if bends of same are turned radical, or with small radius, either designedly or through attempts to fit head to shell.

If an iron head and grain of plate runs from top to bottom, as many are through lack of knowledge or want of thought in that direction they invariably crack, often on being first fired up.

Often sectional area above these boilers are poorly braced and heads thus receiving in addition to boiler pressure the pressure of expansion of flues.

Often braces in these boilers are found broken, and if these defects are neglected serious ruptures, if not explosion must follow.

Often it is impossible to see these checks when they first occur, especially if water used has lime or magnesia in it, that part (side of flues) is such that deposit collects around flange of heads, and heads of rivets of flue and shell; while being a bad place to clean it hides any of these defects from view, and should it be cracked through the leakage will help to draw deposit to that point, and should it be leaking bad it cannot be observed from inside. Many of these boilers are very long and no doors at the rear end of settings consequently the accumulation of ashes is so great that it is impossible to see the rear end only by taking down brick-work.

The above class of steam users will hesitate about doing any such work as it costs more than insurance usually to tear down and repair same; they do not consider it any advantage to them to be protected, they usually hire men to look after their boilers whose experience has been very limited, but are working cheap, but they are heard of often through the press of the country in something like the following notice: Small & Gains boiler exploded today with loss of life and property, cause not known; often remains not found yet.

Yet with such lessons almost daily, it is wondered why boilers explode.—*Stephen Christie, in the Safety-Valve.*

An Indicator of Acidity in Boiler Waters.

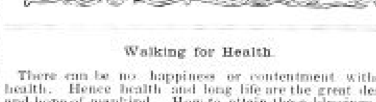
As is well known, water containing magnesium chloride is injurious to boilers, as the salt dissociates with the production of hydrochloric acid which attacks the plates. In large installations, where systematic purification of the feed water can be adopted, this evil is prevented, but in most cases the treatment in vogue consists in adding caustic soda to keep the contents of the boiler alkaline. An excess of the soda is wasteful and otherwise objectionable, and it becomes desirable to be able readily to ascertain when the water in the boiler ceases to contain alkali and needs a further supply. The handiest way to do this would be to have a certain quantity of some indicator always present in the boiler, but, unfortunately, all the usual indicators, such as litmus and turmeric, become decolorized under the influence of water at high temperature and pressure; the same objection applies to Congo red. Dr. Goldberg has, however, found that the sodium salt of paranitrophenol is entirely unaffected either by these conditions or by the salts usually present in feed waters. It is therefore possible, by introducing a sufficient quantity into the boiler, to judge of the alkalinity or acidity of its contents at any given moment by merely blowing the water out of the gauge glass and allowing it to refill. To give a distinct yellow color (the evidence of alkalinity) to the water, so that it may be seen in the small quantity of water in the gauge glass, about 20 to 30 grammes per cubic meter are requisite. The high price of the substance is the bar to its general use at present, the cost of the pure material being about 5s. a pound. As its successful application is not dependent upon its purity, a crude variety could doubtless be produced much more cheaply if a demand arose for it.—*Industries.*

Nickle-Plating Iron.

Iron is now plated with nickel by pressure between rolls at a welding heat, the nickel being recovered from the clippings and shearings of the plates by the action of dilute sulphuric acid at a temperature of 131°; the iron is dissolved and the nickel is obtained in the form of thin sheets as it was melted upon the iron. The operation is complete when the evolution of hydrogen ceases; even fresh acid at the same temperature has practically no effect. But though the separation of the two metals is apparently perfectly made, a curious fact is noted—namely, that when the residual nickel is chemically examined it is found to differ from its original composition, the amount of iron present being notably increased. For example, in a nickel containing originally only 19 per cent. of iron, two per cent. more was found when it was recovered from the plate cuttings, and even by a long-continued treatment with dilute acid, the iron could not be sensibly reduced. This peculiar behavior, it is believed, points to the possibility of positive chemical combination taking place between the metals, and that alloys of iron and nickel are produced in the process of welding. It being a fact very well known to chemists and metallurgists that iron, with but even a small proportion of nickel, resists the action of acids much more effectually than the pure metal.

Some Steam Statistics.

According to a recent estimate, four-fifths of the engines now working in the world have been constructed during the last twenty-five years. France owns 47,500 stationary engines, 7,000 locomotives, and 1,850 steamboat engines. Germany has 10,000 locomotives of all kinds, 59,000 stationary engines and boilers and 1,700 ship and steamboat engines. Austria has 12,000 stationary engines and 2,800 locomotives. The force equivalent to the working power steam engines represent is: In the United States 7,500,000 horse power; in England, 7,000,000 horse power; in France, 3,000,000 horse power; in Austria, 1,500,000 horse power, and in Germany, 4,500,000 horse power. In these figures the motive power of locomotive engines is not included, whose number in all the world at the beginning of 1890, was 105,000, representing a total of between 5,000,000 and 7,000,000 horse power, about 6,000,000 horse power, which, added to the other powers enumerated above, gives a total of 49,000,000 horse power for the world. A steam "horse-power" is equal to three actual horses' power, and a living horse's strength is equal to that of seven men. Therefore the steam engines of the world represent, approximately, the working power of 1,000,000,000 men, or more than double the working population of the world, the total population of which is usually estimated at 1,455,923,000 inhabitants. Steam has accordingly enabled man to treble his working power, making it possible for him to economize his physical strength while attending to his intellectual development.—*The Age of Steel.*



Walking for Health.

There can be no happiness or contentment without health. Hence health and long life are the great desire and hope of mankind. How to attain these blessings has been the aim and study of the sages of all ages. But notwithstanding all that has been done in the interest of health and longevity—to promote a more perfect development of the human system—the physical condition of man, as he exists to-day (in the cities at least), seems to be degenerating instead of advancing.

Not long ago there appeared in one of our leading monthly magazines some valuable statistics touching the subject of human longevity. The author of the publication sent out into all parts of New England some 5,000 circular letters asking for detailed information concerning the occupations, habits, &c., during life of persons over eighty years of age, male and female.

The inquiries were quite thorough and some interesting facts were furnished in the 3,500 answers that he received. The following among other facts were clearly established:

1. That longevity, without regularity of habits, is rare.
2. That physical activity is conducive to long life.
3. That bone and muscle are the basis and main support of health and long life.
4. That excessive flesh is rarely found in healthy old age.
5. That the percentage of those who attain a ripe old age is greatest among farmers, or those leading active lives in the country.

The statistics also showed a very low comparative health rate for the cities, in spite of the fact that cities and large towns enjoy the benefits of all that science can do in the way of improved hygienic appliances. In the cities, too, was found the greatest degree of physical degeneracy.

These unsatisfactory conditions are due largely to the inactive, lazy habits of city people, who take insufficient exercise. Street railways and cheap cab lines are responsible for a good deal of it. I once heard a well-known physician declare that every street car was a recruiting office for the hospital and the poor-house. Lazy people ride when there is no necessity for it, and when it would be a thousand times better for them to walk and save their money.

The important question, therefore, is, how can this tide of physical degeneracy which is destroying our manhood and womanhood be stayed? The answer is simple—outdoor recreation is the cure.

Nowhere is this evil more apparent than in the ranks of the rising generation. Boys and girls are growing up misshapen under their present careless and listless manner of carrying themselves. The physical culture of the youth of the land is a question of vast importance and it is one that is now occupying a good deal of attention. The establishment in the public schools of a department for training the pupils in the art of walking and other health-giving exercises is being vigorously advocated. This would seem to be a capital idea, for the true end of education should be development, the right adjustment of mind, body, and character. The need of some such system is unquestioned, especially in the interest of girls, who are more limited in opportunities for physical culture than boys.

Among the field sports, base-ball, croquet, and lawn tennis ought to be encouraged. These games furnish healthy diversion for both mind and body. Base-ball and croquet bring into play every joint and muscle of the body, and they are particularly efficient in promoting a healthy development of the organs of vision. Next to walking they are the best exercises for boys and girls.

The fact that tennis players, as a rule, use but one arm is an objection to the game, for it tends to promote uneven development. Lovers of this graceful fascinating sport should encourage the use of both arms.

That rational exercise is essential to a healthy condition of the human system will be admitted by all, but people are not so well agreed regarding the best method to be used. The relative merits of each of the various mechanical devices now employed are a fruitful source of discussion. Each method has its advocates as well as its critics. That each possesses advantages, as well as defects, cannot be denied. It must be said, however, that want of pure air and a natural tendency to over-exertion and straining are objectionable features of the gymnasium.

The bicycle, too—the upright, or large wheeled variety especially—must be objected to on account of its bad influence on natural physical development. It tends to curvature of the spine and other malformations of the system; and the boy or girl who takes to the wheel at an early age is apt to become stoop shouldered, weak-chested, and bow-legged, unless great preventive care is taken. The legs are abnormally developed at the expense of the arms and body, and grace and symmetry of figure are destroyed.

The superiority of walking, over any mechanical method, is so marked as to place it beyond the range of rivalry.

Walking is nature's own exercise. It is a health-promoting diversion which is free to all. The rich and the poor are alike welcome to its pleasures and benefactions. Little or no pecuniary expense is required in its enjoyments and it vouchsafes almost perfect immunity from the dangers which surround the gymnasium, the horse, the cycle, the boat, &c. And comparatively few can afford these luxuries. Sound feet and a reasonable amount of energy are the only capital required of the walker. Its very freedom from expense is, perhaps, the reason why walking is not more popular with city people. That which is cheap and easily acquired, is never eagerly sought after. But were the advantages and benefits to be derived from systematic walking better understood it is certain that its devotees would be numerous.

Very long walks are not to be recommended, especially in an enervating climate. Twelve to fifteen miles ought to be the limit. A walk to be beneficial must be enjoyed, hence fatigue should be avoided. Walking, when employed as a means of testing physical endurance—in other words, when it becomes a task—loses its charms and is positively injurious.

The best walking shoe is a snug-fitting calf gaiter (lace or button) with flexible oak-tanned leather soles. The soles should not be over heavy. Round toes are preferable to square ones.

To secure a good gait in walking the body should be erect, head up, feet low, a methodical, energetic step, the arms swinging lightly by the side.

A light cane might be carried with advantage.—*George Simmons in Washington Star.*

The Science of Old Age.

Old age has its special dangers and its special safety with regard to disease. For instance, whereas in a child the temperature goes up on the slightest provocation, in old age it can hardly be moved at all. The aged body is not, as a rule, prone to any acute disease. If a person passes eighty, it is rare for him to be seized with any special malady. In injuries, such as fractures, though from the lightness and brittleness of the bones they are easily met with, they are repaired solidly and quickly, even in centenarians. Slight shocks cause severe depression, but greater injuries are surmounted, and surprising recoveries made from severe maladies. Wounds and ulcers often heal quicker than in the young; the aged recover from attacks of congestion, paralysis, apoplexy, pneumonia, erysipelas and other affections in a surprising way. Diseases, as we have said, often pass them by. A man may live to one hundred in a house in which he had typhoid fever himself, and in which many of his children and grand-children have since died from it. It is probable these favorable results are due to the long time the organs have worked unitedly and helped each other, like old soldiers who pull well together and bear reverses under which younger troops would succumb. There is, on the other hand, a tendency in old age for slight diseases to become chronic. Now, as to the care of old age, the chief points are moderate and digestible food, sufficient warmth, and even, quiet life. The chief of the three is the food, or fuel for the lamp of life. While all fixed dieting is bad, where it can possibly be avoided, a few hints can be given that may prove of value. The older a person is after fifty, the less food he requires. Luigi Cornaro, who lived to one hundred, though of a feeble constitution, took 12 ounces of solid food and 14 ounces of fluid daily during the latter part of his life; and his most severe illness was caused by his increasing his allowance, through the continual entreaties of his friends. Very little proteid or animal food is required, and though in many respects false teeth are a great boon to the aged, they may lead to too great a consumption of animal food. It is not the amount of coal we put in a grate that warms the room, but the amount that can be burnt; and the great point is to avoid choking the digestive and excretory organs with excess of food. The food of the nursery is the best in old age. Bread and milk and honey is a capital diet. Milk agrees with nearly all. Hot milk with a little Mellin's food forms an admirable drink at night, and can be kept warm in a hot water jug covered with a cozy. Fruit is wholesome if ripe or well cooked. Fat is good, as cream or fresh butter. Warm food is very suitable. Soup enriched with cream or marrow is light and nourishing. All meals should be regular, and all excesses avoided. Of 800 persons over eighty, 60 per cent. were moderate eaters, 30 per cent. small, and only 10 per cent. large. If weight is being gained, the diet should be decreased. In addition to the after-dinner nap as years creep on, a doze after breakfast and before dinner is often helpful. As to clothing, it should be both warm and light. Fur is an admirable material. The underclothing should be of wool. A sealskin waistcoat is useful, and the feet and hands should be well and warmly clothed. An eider down quilt on the bed, which should be warmed in winter, is a good covering. No aged person should be suffered to get cold in bed. Two A. M., is the hour when most deaths take place, when the temperature of the body is lowest and its powers feeblest. All habits of old people should be respected, and not lightly altered. Whatever excites exhaustion should be forbidden. Early rising is therefore bad. Drinking hard water is not good, as it tends to hasten the calcareous changes in the body. Certain common errors in the care of the aged may be here pointed out; some we have already touched on.

1. That the aged require rich and nourishing diet.
2. That early rising is good for them.
3. That cold baths invigorate them; whereas they are fraught with imminent danger, and are often fatal.
4. That continual medicines and dinner pills are needed to digest the food; whereas, instead, less should be eaten.
5. That the rooms should be hot; whereas they should be cool, but not cold—65° to 70°.
6. That a fixed diet should be rigidly adhered to; whereas variety is often essential.

Old age is of two sorts: that which is natural, and that which is prematurely acquired in youth; and it need hardly be observed that it is only of the former variety we now speak. Self-denial often requires to be practiced by the aged in many ways, though not arbitrarily. All known weak spots in the constitution should be jealously watched. No care as a rule surrounds the aged as guards the young, because they are not in many ways the same objects of interest. But this is not as it should be, nor is it consistent with Christian profession. In animals, death when it comes is, as a rule, swift. There is, with the vast majority, no old age and debility suffered among them. No long wasting or disease or slow tumors embitter their lives; they are killed by their fellows when their powers fail, and are thus delivered from all these slow tortures by one sharp stroke. This apparent cruelty of nature is thus a merciful provision for those beings who know not the meaning of sympathy. In early ages and in savage life it was the same with man. The skulls found in the gravel beds are all full of teeth, as of those who died early. Now, in advanced civilization, love and care prolong life to a great age. This is not an unmixed good. Almost the very existence of slow decay and long disease has been brought about by the love and care that distinguish humanity. Hence it is peculiarly noble and Christan work to lessen the sufferings that in a sense our own care has made possible; and, as far as we are able, to make old age a period of serene sunshine and an unmixed blessing.—*Leisure Hour.*

USEFUL INFORMATION

Stick to the United States.

From time to time, numbers of people are seized with a craze to emigrate to some portion of South America, under the hallucination that certain prosperity awaits the settler in any part of that country. The fertility of its soil, the delightfulness of its climate, the fabulous richness of its mines of gold, silver and precious stones are set forth in glowing terms, and the fairy-tale is believed until the deluded emigrants arrive at their destination. Then they are speedily disillusioned, and after struggling a few years against the adverse circumstances of their environment, they either die, or return to the United States broken in fortune and in health.

A correspondent, who has been tempted to try his fortune in the southern half of the Western Hemisphere, but who seems to have thought it best to act with circumspection, wishes the *Ledger* to tell him why the fertile countries of South America advance so slowly in wealth and population. That is a very interesting question. In all that continent, which is considerably larger than North America, there are but twenty-six millions of inhabitants, while North America contains almost three times that number. Brazil, for example, which is about as large as the United States, and was settled sooner, contains only about ten millions of people, and nowhere exhibits anything like the prosperity which has marked every period of our own history.

The principal reasons of this difference are three in number. In the first place, nature herself in South America interposes mighty obstacles to the purposes of man. Vast plains exist, which, in the rainy season, are covered with luxuriant verdure, and in the dry season assume the appearance of a desert. The forests, owing to the fertility of the soil under a tropical sun, are so dense and tangled as almost to baffle the efforts of the pioneer to remove them. The principal rivers, which are the largest in the world, are more like flowing seas than navigable streams. The Plata, for example, is 130 miles wide at its mouth, and is full of strong, irregular currents. The Amazon, too, which is 4,000 miles in length, and navigable for one-half that distance, is, in many places, so wide that the navigator has to sail by the compass. The mountains, also, are precipitous and difficult of access, and contain thirty active volcanoes. All nature, in fact, is on a prodigious scale, and the very richness of the soil is frequently an injury rather than a help to man.

In the next place, the Spanish and Portuguese, who settled this continent, drawn thither by the lust of gold, were little fitted to wrestle with the obstacles which nature placed in their path. Lastly, the Spanish and Portuguese governments, narrow, bigoted, ignorant and tyrannical, for three centuries cramped the energies of the people and oppressed them by merciless exactions.

People who are thus oppressed for centuries lose heart and manliness of spirit; they sink into ignorance and superstition; they learn to be content with lives but little raised above the life of brutes, and so become incapacitated for prosperity. When, early in the century, owing to the heroism and and virtue of Simon Bolivar, the yoke of Spain was thrown off by the finest provinces in South America, the long-oppressed inhabitants were unable to profit by their liberation. They were totally unaccustomed to self-government; they had no conception of the binding obligations of public law or private agreements; they were not amenable to the influence of enlightened public opinion; they were incapable of restraining their provoked passions for the purpose of securing lasting future good, and so they have gone on from revolution to revolution, without stable governments, or steady industry, or thrifty commerce, and are now but little in advance of their condition half a century ago.

It is useless for citizens of the United States, who all their lives have been accustomed to obey and revere the laws which their fathers and themselves have made, to seek for a satisfactory home among people who have but crude ideas of the sacredness of public law and private obligations.—*New York Ledger.*

A Schedule of American Checks.

The banks of the United States receive for deposit in one day about $300,000,000. Often it far exceeds this amount, rarely goes below it. These receipts are accepted and placed to the credit of their customers, yet it is a remarkable fact that over 90 per cent. of these deposits are not currency in the common acceptation of the term. They are not gold, silver, greenbacks, nor bank notes. Ninety per cent. of them are checks. The business of the country is done chiefly by checks. A gives B a check for a thousand bushels of wheat; B gives C a check for a thousand bushels of potatoes; C gives D a check for fifty barrels of sugar; D gives E a check for a hundred sacks of coffee, each man paying his debt by check. Back of the check is supposed to be currency in bank subject to the checks of these parties, but the same $1,000 in currency answers for a dozen or fifty checks of a thousand dollars each. Not one of these men desires the currency. He would not accept the thousand dollars in silver for he could not carry it. He does not care to have on his person a thousand dollars in greenbacks or gold. The check suits him better, provided he is satisfied in his own mind that it will be honored when finally presented for payment, that is if the bank on which it is drawn certifies that it is good. Here then is a vast currency in the form of checks of which no account is made in the estimate of the circulating medium.

On a given day the forty-eight banks of New York City received and placed to the credit of their customers $165,193,347, of which 0·34 per cent. was gold coin, 0·01 per cent. was silver coin, 0·65 per cent. was paper currency, and 98·86 per cent. was checks.

Every check was good, and it was more convenient than the currency for the settlement of accounts between the parties doing business.—*New York Financier.*

Pigmies at the Fair.

There will be pigmies at the Fair. There will be a whole tribe of the little Central African dwarfs if the King of Belgians will permit the United States World's Fair Commissioner to carry them off, and the exposition authorities think that he will.

Lieut. Schufeldt, the agent of the Exposition in Africa telegraphs from Zanzibar that he could get all the pigmies desired if the King of Belgium would permit of their transportation. President Baker wants these pigmies and so does everybody else around headquarters, so when Schufeldt's telegram was received, Secretary of State Blaine was telegraphed and asked to use his influence with the Belgian monarch.

Walker Fearne, Chief of the Department of Foreign Affairs, anticipated no difficulty in that direction. He said the Belgian Government was friendly toward the United States.

Tippoo Tib, who has considerable influence in the Free State of Congo, must also be persuaded that the pigmies will be properly cared for.—*Chicago Journal of Commerce.*

What the Chinese Think of Us.

We are in the habit of expressing our views freely in regard to the peculiarities of the Chinese, their customs, clothes, politics, industries, and so forth; but it is comparatively a rare thing to meet with a statement of Chinese opinion touching American ways and institutions. The very oppositeness of their standpoint gives a piquant interest to the impressions they form of our national characteristics. Here is a recent utterance of the kind which is attributed to the *Pekin Gazette*. Speaking of the Americans, a writer in that journal is quoted as saying: "It is impossible to understand these barbarous people. One thing is certain: If they do a thing they do it with all their might. Thirty years ago they had a civil war. The whole country was turned into military camps and battlefields, and everybody, even to the women folk, were engaged in the war in one way or another, and one army numbered 2,000,000 men. And now there are young men, old enough to vote, who have never seen a company of soldiers in their life. In fact, these people seem to think that another war will never break out, especially in their part of the world. A person can travel clear across the American continent without seeing a soldier, and follow the main lines of travel, too. In fact, at the present time there is only about one soldier for every 2,000 persons, while Russia has one soldier to every 90."

Smoke From the Mint Carries Atoms of Gold Outside.

Three thousand dollars for an old tin roof would be a pretty steep price, but the man who gets the battered roof from the Tabernacle Church at Broad Street and South Penn square, which is now being torn away, for that sum will be in luck. Some years ago the paint was scraped off the old roof and yielded $5,000 in gold. It is almost certain to yield as much this time. The gold comes from the mint. When gold is being coined a considerable quantity of it volatilizes with the smoke through the chimney, and as soon as it strikes the air it falls. Much of it falls on the roof of the mint; so much of it that the officials save even the water that falls upon it during a shower. All the drains from the roof are connected with large vats in the cellar of the mint. Before the water finally gets to the sewer it is strained through many blankets and sieves which retain the gold. Notwithstanding all these precautions, the gold that is annually washed into the Delaware from the mint is worth thousands of dollars. Every particle of dirt swept up about the mint is carefully stowed away with the washings from the roof, and once every year it is sold to the highest bidder, as it cannot be used at the mint.—*Mining Industry.*

How Fish-Hooks are Made.

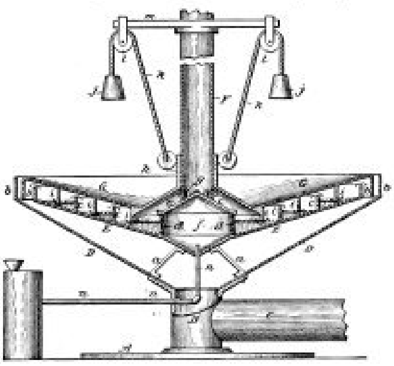
There is a little machine which turns out fish-hooks in six strokes. Stroke number one bites off a morsel of steel wire; number two makes the loop where you fasten your line; number three hacks the other end; number four flattens and bends back the barb; number five makes the point; number six bends the wire; and your fish-hook drops into a little bucket ready to be finished. Then it is either japanned—these are the common black fish-hooks—or it is tempered to the delicate blue that is sometimes seen in cutlery. For this finish it is heated red-hot and then cooled in oil.

Keeping a Grindstone in Order.

A grindstone has not, one would suppose, a very delicate constitution. It has never been chosen as a type of fragile sensitiveness, but it has nevertheless susceptibilities of its own, and the *Northwestern Mechanic* gives useful advice as to its care and treatment. The exposure of the stone to the sun, says that journal, has a tendency to harden it, and if one part be left in the water habitually it will grow soft, and wear away faster than the other. If the trough is put upon movable supports in a frame, it can be adjusted to the stone without much loss of time. Or allow the water to drip from a water-spout, and an old white lead keg will answer, fixed above the stone. Always clean off all greasy or rusty tools before sharpening, as grease chokes up the grit; and always keep the stone perfectly round by razeing it off when necessary.

AMALGAMATOR.

No. 452,177. John W. Culmer, New Brighton, Penna. *Patented May 12, 1891.* The mercury is carried in the conical pan E, which is divided into several compartments by circular partition rings c. The surface of the mercury in each compartment is covered by perforated metal plates, and the conical cover G is provided with circular partition rings i which touch the perforated plates. The water carrying the gold, enters through the pipe F and passes under the edge of the first and lowest ring i, exposing its gold to the mercury in the lowest compartment in so doing. It then flows over the first partition c, and under the edge of the second partition i, etc., until it finally escapes over



the edge b of the pan E into the pan D and flows away through the pipe C. As the diameter of the mercury compartments increases toward the outer edge of the pan, the flow of the water is slackened, having a larger area to flow over, and more time is thereby secured for amalgamation, in each successive ring. To warm the water and the mercury, superheated steam is let into the central chamber f by a pipe n. This chamber has a metallic cover e tightly cemented down on the ring d. This ring is made of hard burned potter's clay and is sufficiently porous to permit the passage of steam or hot gas for heating or agitating the materials. The cover G slides upon the inlet pipe F and is counter-weighted as shown.

GRINDING MILL.

No. 451,111. Henry A. Duc, Charleston, S. C. *Patented April 28, 1891.* Fig. 1 is a vertical cross-section of the mill on the line xx in Fig. 2. Fig. 2 is a vertical section along shaft J. The outer grinding ring B is supported by conical screens G and E which have trunnions mounted in the main casing A. The hub K on the shaft J has two pairs of lugs k, between which grinding arms L are pivoted. These arms are square in section, and are tubular. Rollers M are provided in the front end of each arm, which bear against the outer ring or die B, being pressed outward by their own centrifugal force, and also that of the arms, in addition to the force of the springs N. The arms act as brakes on the rolls compelling them to partly drag and partly roll over the material. The roll bears against the outer plate or rim of the arm, and is constantly scraped by it clean of all adhering material, the scrapings passing through the arm. The screen E at the receiving end, is composed of a series of independent ring plates, of successively

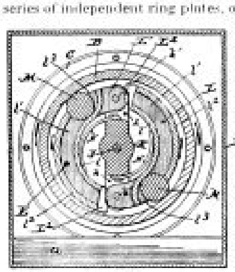
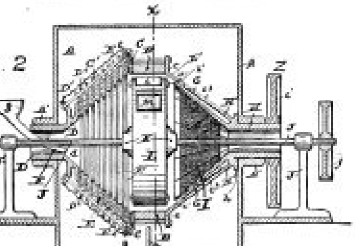


Fig. 1

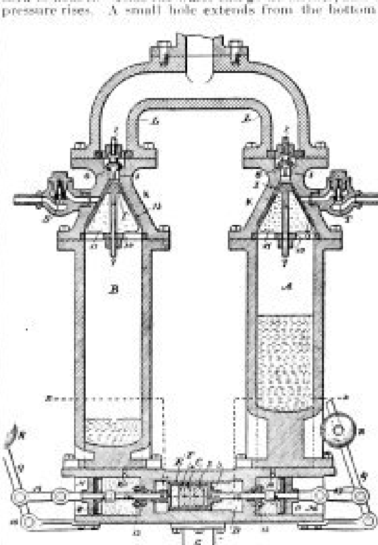
Fig. 2



greater diameters, and having lugs and eyes for suitable binding bolts as shown. These rings are separated by distance pieces of suitable thickness to make the desired mesh. A conical wire screen E' surrounds the ring screen E and serves to grade the material passing through it. Stuff which passes both screens falls out into the case A and passes out the hole a^1, and that which passes the rings only falls between the partitions shown, and out through the hole a^2. The delivery screens G and I are also conical, made of wire, in sections which are removable. Screen G is the finest, and receives only the ground material which passes the coarse screen I. All that fails to pass through it returns between the screens to the bottom of the die B and is again ground. The finished material which passes screen G passes out of the case by the hole a^3. The screens with the grinding ring B are rotated by a belt on the pulley Z, and the arms L are whirled in the opposite direction by a belt on the pulley j.

AIR COMPRESSOR.

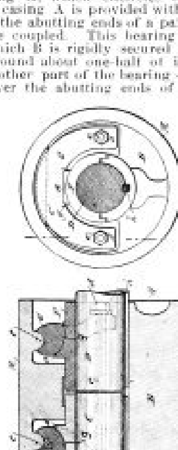
No. 451,460. Thomas C. Craven, Newark, N. J. *Patented May 5, 1891.* Water pressure is employed in this machine to compress the air or gas contained in the cylinders A and B. The water pressure pipe opens into the valve-chest D in which there is a common slide-valve E. This valve admits water to the cylinders alternately. As the water rises in the cylinder A it compresses the air to the density required to lift the check-valve G and then forces it out by the pipe L to the receiver. As the water reaches the neck of the cylinder it lifts the large conical valve I to its seat. This valve consists of a metallic shell filled with enough cork to float it. Thus the water can go no farther, and the pressure rises. A small hole extends from the bottom of



the cylinder to the chamber behind the piston O attached to the valve-stem. The piston is driven over until the play between the slide-valve and its yoke is taken up and the valve is moved so far as to shut off the pressure. By this time the weighted lever has swung its weight R beyond the fulcrum 16, and it falls by gravity still farther, far enough to move the valve and open the port to the other cylinder, in which these operations are repeated. When the valve opens cylinder B to pressure it opens A to the exhaust pipe G. The water in A runs out by gravity and air enters by the check-valve T. When the cylinder B is full, the pressure acts on the other valve-piston P and reverses the valve as before. The amount of extra pressure required to move the pistons and valve, is regulated by the weight and throw of the balls R.

SHAFT COUPLING.

No. 447,925. William B. Turner, Schenectady, N. Y. *Patented March 10th, 1891.* The coupling consists of a cylindrical casing A, which encircles the shafts to be coupled. The casing A is provided with a bearing upon its interior for the abutting ends of a pair of shafts C D which are to be coupled. This bearing is made in two parts, one of which B is rigidly secured to the casing A and extends around about one-half of its inner circumference. The other part of the bearing consists of a pair of caps E F over the abutting ends of the shafts C D,



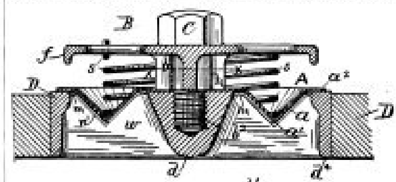
respectively. These two caps rest upon the halves of their respective shafts which are not inclosed by the lower bearing B, with their edges in contact with the upper edges of the latter bearing, as shown in the end view.

Each of the caps E F is provided upon its top surface with a seat a, preferably inclined, as shown, upon which rests the central cam-shaped under side g of a bifurcated lever G, the upper central portion of which is provided with a groove b, which receives a correspondingly-shaped rib r, formed upon the inner wall of the casing A.

The two levers G are connected upon each side of the shafts C D by rods z, which pass through the bifurcated ends of the lever, a nut d being provided at the end of each rod, by turning which the ends of the levers D are drawn inwardly toward each other. The seats a upon the caps E F are inclined upwardly toward the center of the casting, so that as the lower ends of the levers G are forced inwardly toward each other the cam-shaped portion of each lever rides up its inclined seat, thus forcing the caps E F down against the shafts C D and the bearing B, and thereby coupling the abutting ends of the shafts C D. For the purpose of giving the coupling a firmer hold upon the shafts the bearing B and the shafts C D are recessed, so as to receive a key h.

PUMP VALVE.

No. 453,347. George H. Remington and James T. Hexthorn, Providence, R. I. *Patented June 2, 1891.* This valve is spun or stamped of sheet metal, and is made with a deep **V** groove in which the spiral spring rests. The edges of the valve which form the seats are flat, as shown. The guard f limits the lift of the valve and guides it by means of wings or vertical ribs on its hub. The section of the hub is shown



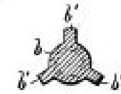


Fig. 2

in Fig 2. The ribs which connect the hub d of the valve seat, to the rim d^1, are notched to suit the under side of the valve. The **V**-shaped under side of the valve deflects the water both inward and outwardly, making its passage easier than with a flat valve. The valve cannot become cocked, because the notches in the seat ribs help to guide it to its proper seat at every stroke.

EXPANDING DRILL.

No. 451,789 Julius R. Watts, Springfield, Ill. *Patented May 5th, 1891.* This drill is designed to bore a hole to any desired depth, and then form a pocket at the end of the hole, big enough to receive a large amount of powder. The powder being enclosed in a pocket, there is much less liability of blowing out the tamping, and the blasting is done very effectively.

The feed screw 17, together with the divided feed nut and driving gear, are all mounted in a forked bracket, on a supporting bar stuck into the face, in the usual manner.

The bits A are hinged to the end of a rod 39, which passes through a tube 33, and couples to the end of the feed screw by a squared socket 22. When the rod 39 is forced forward relatively to the tube 33, the shanks of the cutters encounter a pin 41, which compels them to spread out to the dotted lines shown in Fig. 2, and thus enlarge the hole. The rear end of the casing tube is supported in a clamp box 28, which is arranged to slide along

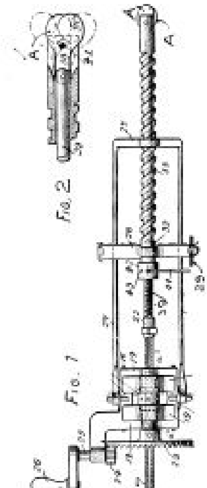


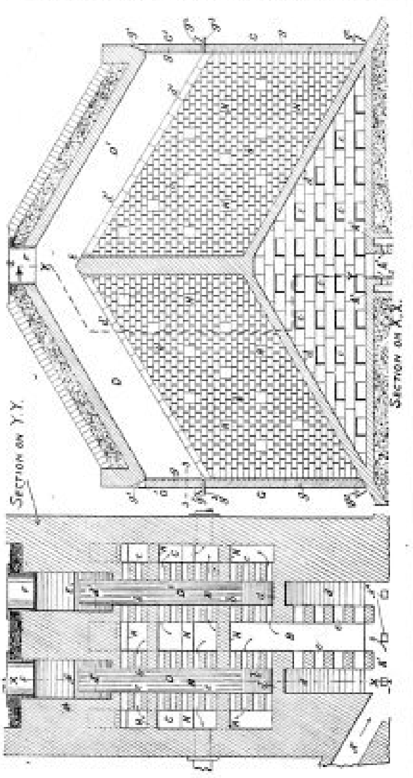
Fig. 2

Fig. 1

on the guide frame 27. This guide frame consists of two light rods secured by pins to the box of the main feed nut, and united at the front end by a cross bar which rests loosely on top of the casing tube 33. The rear end of the bit rod 39 is threaded and provided with a nut 42. When this nut is jammed tight against the end of the casing tube, both 39 and 33 revolve together, with the bits drawn back as shown in Fig. 1, and they remain thus until the hole has been drilled the desired depth. To form the pocket at the end of the hole, the nut 42 is backed off enough to free the tube 33, and is prevented from revolving by sticking a pin 44 into one of the holes shown. The clamp box 28 is made fast to the guide rods by the clamp screw 29, thus securing the tube against backing out of the hole. Now when the main feed screw is turned, the bit rod 39, and casing tube 33, turn with it. As the nut 42 cannot revolve, the bit rod is forced forward thus expanding the bits, and producing the desired enlargement of the hole. The coarse spiral groove on the outside of the casing tube 33, serves to carry out the chips and borings.

COKE MAKING APPARATUS.

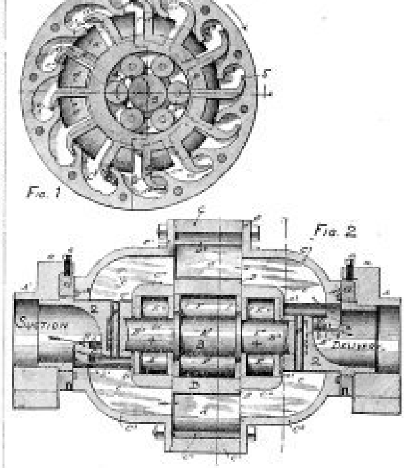
No. 451,488. Frederick J. Jones, St. Albans, England. *Patented May 5, 1891.* This apparatus is composed of five chambers, separated by perforated walls. The bottom of the chambers E E and B slant each way from the middle wall at a pitch of about 30°. Instead of holes through the walls, for the passage of gas, all the vertical joints in the brickwork from the bottom up to the shoulder d^3 are left open about half an inch. The width of the chamber E is from 12 to 18 inches according to the nature of the coal to be coked. Fuel gas from any ordinary "producer" is brought in by the flue A^1, and mixing with air admitted by the ducts A^2, it burns in the middle chamber B. Both chambers E are filled with coal through the funnels F and tightly covered. The burning gas in chamber B passes through the walls and permeates the coal in E rapidly coking it. The gas given off passes into the chambers C C. The side walls of each coking chamber are formed with a ledge or shoulder at d^3 at a slightly greater pitch than the inclined floor d, and upon these ledges the upper part of the charge, which fills the coking-chamber nearly up to the roof, rests and so seals the passage left by the contraction in bulk of the coal in the operation of coking and prevents gases of combustion passing round instead of through the charge. The discharge apertures of the coking chambers are closed during the coking operation by doors G G^1, hinged at one side, the lower door G closing the aperture up to the level of the ledges d^3, the upper door serving to give access for leveling the charge when the lower door



is closed, besides facilitating the sealing of the lower door. For sealing purposes, a rabbet is formed in the brick door-jambs, and a packing of dry sand, lime, or other suitable pulverulent material is easily run in after the door G is closed. This pulverulent packing absorbs tar from the gas and quickly makes a gas-tight joint, thereby avoiding the troublesome operation of luting in the ordinary way. The upper door G^1 is received in a similar rabbet and is made gas-tight in the same way, a space g^1 being left between the top flange of the door and the brick-work, into which sand, etc., is run, as well as into the side spaces. The joint between the doors is made gas-tight by the same means, (sand, etc., poured into a hopper g^2, carried by the upper door and resting on a plate g^3 on the top of the lower door, and so filling the joint). The lower door G is sealed in a similar manner. To insure the sufficient heating of the charge from below, the "producer" gas has access to the space beneath the floor d (which is of fire-brick) by orifices e in the lower part of the walls of the combustion chamber B, hot air being also admitted to the same space to effect perfect combustion. The mixed gases collected in chambers C, having absorbed fresh carbon by traversing the charge, may be burned therein with an admixture of more air and so assist the coking process, or they may be conveyed away and treated as in gas works, for the extraction of chemical products therefrom, and for use as heating gases. As the floor of the coking chamber, is inclined, and the doors GG^1 are as large as the end of the chambers, the charge, when finished, can be slid out as a coherent mass, with little or no breakage.

ROTARY PUMP.

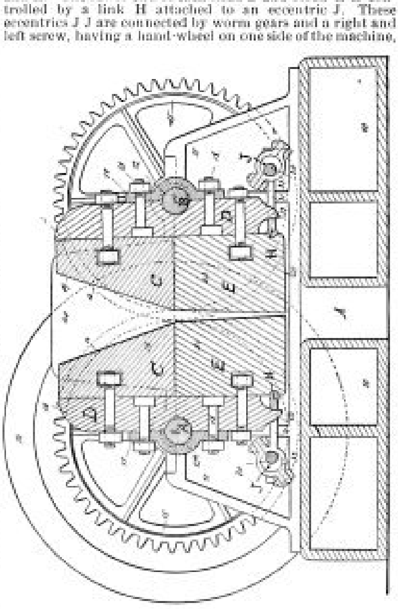
No. 448,335. Ellick H. Gollings, Lewiston, Idaho. *Patented March 17, 1891.* The body of this pump consists of a central ring C^2 containing the working chambers c^3 and two end sections C^1 which contain a series of ports or passages connecting the working chambers with the suction and delivery pipes. A belt is applied to the middle ring C^2 and the whole body or case revolves on the standing spindle 2. This spindle is hollow at the ends and has large ports B and B^2 which open on the under and top sides respectively. As the body revolves the passages c open one after another into these ports and so establish communication between the suction and those working chambers c^3 which are below the center line, and connect the working chambers above the center line with the delivery. A wrought iron shaft 4, 3, 4, is fastened to the end sections 2 by pins, as shown which hold it stationary. The body turns on rollers E which run on the parts 4 of the central shaft. The middle part 3 is eccentric, as shown in the cross-section in Fig. 1,



and furnishes a bearing for the winged wheel D which has wings d working within the chambers c^3 of the body C^2. Fig. 1 shows that the wings are in contact with the sides or edge of the working chambers only at 5, 6, and 7. These contacts continue only until the body or case and the wheel D have revolved far enough to bring the next wings into contact. The space enclosed between the case and the wings at 5 and 6 is much less than that enclosed between the points 6 and 7. It follows that the volume of the chambers gradually increase in rotating from the point 5 to 7, and as gradually decrease in passing from 7 to 5, consequently they will draw in water from the suction pipe on the lower half of their revolution, and will expel it through the delivery pipe during the upper half of the revolution. The case drives the wheel D by the contacts at 6. The action is continuous and no valves are required.

ROCK CRUSHER.

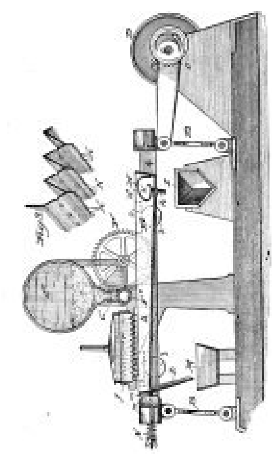
No. 450,489. William H. Howland, Bergenfield, N. J. *Patented April 14, 1891.* This machine has two driving shafts A and B, which are geared together as shown. Each shaft is formed with two eccentrics—each occupying half of the length between the journal boxes,—the throw of one eccentric being exactly opposite that of the other. Each eccentric carries a head D to which are bolted face blocks C and E. The lower end of each head D and block E is controlled by a link H attached to an eccentric J. These eccentrics J J are connected by worm gears and a right and left screw, having a hand-wheel on one side of the machine,



for adjustment. The driving shafts A and B are set so that their eccentrics are not exactly opposite, but those on one shaft are 90 degrees ahead of the other. The result of this arrangement is, that during a considerable part of the stroke, the jaws are moving vertically at different speeds or in different directions, thus exerting a powerful grinding action on the material between the jaws, in addition to the crushing force exerted while the jaws move toward each other. For grinding ores or rock, the blocks C and E are made of iron or steel, and for grinding softer material, the blocks E E are made of buhr stone, and for coffee, etc., end grain hard wood is employed.

CONCENTRATOR.

No. 451,926. Ryerson D. Gates, Chicago, Ill. *Patented May 12, 1891.* The pulverized ore is contained in the box G and is fed out through a slot in the bottom extending the whole width of the pan A. A double gate G^1 rests on the roller F^2 and regulates the feed. The roller F^2 is turned by gearing driven by a belt (not shown) from the main shaft S, and the stuff works out under the edge of the gate. For all ordinary cases the roller is made smooth. The pan A has lugs 2 on its sides, which rest on rollers 3 in the side frames 4 and is held against the end of the frame

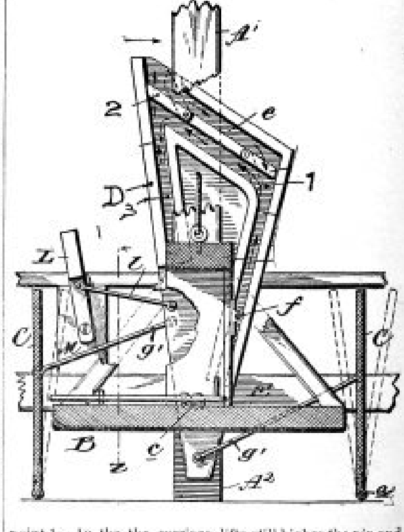


by the bolt and adjustable spring N. The frame is supported on rockers B and is moved back and forth by the eccentric C. The spring N serves to give the pan a sharp jerk or jar at each stroke. The bottom of the pan is inclined toward the discharge H. This plate is bent as shown, so that the water and gangue must work between it and the bottom of the pan and up over the edge b^1 to get into the discharge pipes b. The concentrates work up the inclined bottom and drop off at the plate L into the trough M. The water-box J has its bottom formed into V grooves, the sides of which are perforated as shown in Fig. 3. The lower edge of each V terminates in teeth K from which the water falls into the pan in drops, which are well distributed across the whole width of the pan.

MINE CARRIAGE.

No. 451,716. Isaac C. Welter, Luzerne, Pa. *Patented May 5, 1891.* The object of this device is to automatically operate the "fans" or platform stops, and unlatch the dogs which block the wheels of the car.

The fans C are connected by rods g^1 to a large triangular switch or cam board D, which rocks on a pin c attached to the shaft framing. The carriage is provided with a strong pin carrying a roller f on its outer end, which runs in the grooves formed in the cam board. When the carriage begins to come up, the cam board is tilted to the extreme left, and the fans stand leaning outward. As the carriage approaches the landing the roller on the end of the pin f, enters the groove in the cam and travels upward as shown by the arrows to the



point 1. As the the carriage lifts still higher the pin and roller pass to position 2, thus crowding the cam to the right and closing the fans sufficiently to receive the carriage as it descends, the roller passing a little ways down the groove 3, in so doing. When the carriage rises off the fans, preparatory to descending, the roller passes up through the latch 2, which is closed by a spring, and as the lowering begins the roller runs down the grove e, crowding the cam to the left and opening the fans. The roller passes on through the latch at 1 and down the groove by which it entered. The stop L is intended to trip the locking device employed to block the cars on the platform, and is moved into and out of position by the cam as it swings in obedience to the movements of the carriage.

The Colliery Engineer.

AN ILLUSTRATED JOURNAL OF

Coal and Metal Mining and Kindred Interests.

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THE ECONOMIC GEOLOGY OF SILVER.

The Mineralogy, Mode of Occurrence, and Production of Silver.

BY H. A. WHEELER, E. M., OF ST. LOUIS.

The true silver minerals can be divided into two classes that differ quite widely from each other in their relative toughness, or into (*a*), the *sectile series*, or those which are tough enough as to be cut into shavings by a knife, and (*b*), the *brittle series*, or those which crumble into powder when whittled or scratched with a knife. The more important members of the first, or sectile class, are:

Native Silver, or metallic silver, which occurs quite frequently in nature as scales, crystals, wires, and rarely as nuggets or "float" silver, the latter being irregular, rounded masses that have been rolled along by stream action. Native silver, if untarnished, is a pure white colored, soft, very malleable metal that has a specific gravity of 10 to 11 or about half again as heavy as iron. It is seldom perfectly pure, usually containing a little copper and occasionally some gold. Except when freshly mined, its beautiful bright white color is very apt to be tarnished by a dark film of sulphide of silver, as sulphur has such a strong affinity for the metal that the small amount contained in the atmosphere of our cities or in the smoke from blasting powder used in the mines will, in time, combine with it as a dingy, dull, dark coating. Nearly all silver veins are apt to contain small amounts of native silver, at or near the croppings, or where the vein comes to the surface, and occasionally, as at Silver Islet, on the north shore of Lake Superior, and at the Batopilas mines, in Western Mexico, this is the principal ore mined.

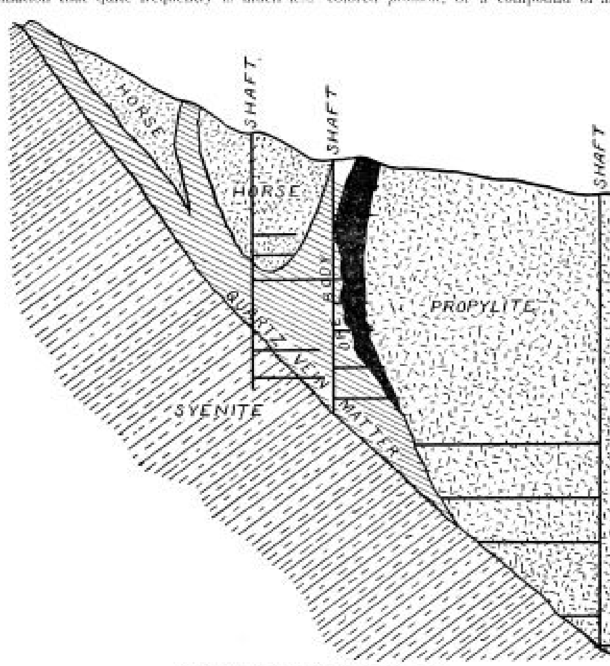
Argentite, or *silver glance*, is a sulphide of silver that contains about 87% of silver when pure. It is a soft, heavy, dull black mineral that can be cut as readily as the finger nails by a knife, while it will melt into a button of silver in the candle flame. It is quite a common mineral in some of the rich silver veins of Mexico, and frequently occurs in the high grade ores of the Western States and Territories.

Cerargyrite, or "*Horn-Silver*," or "*Chlorides*," is a chloride of silver that contains 75% of silver when pure. It is a soft, heavy, light to dark gray colored mineral with a dull waxy luster, and it can be cut or whittled as readily as horn, hence its common name of "horn-silver." It is not only one of the richest ores found, but as it is also easily milled, it is therefore justly prized by the prospector as this free-milling property enables very low grades ores to be worked, as at Silver Reef, Utah, where ores containing this mineral assaying only $5 to $10 a ton are worked at a profit. It is very frequently found at or near the outcrops of most of the silver veins of the West and occasionally it is found extending to depths of 300 to even 500 feet; but in the great majority of cases it soon runs into other silver minerals, as soon as any depth or the water-level is attained, that are more difficult to work and which are also often much poorer. It is an entirely too common experience in the West to find leaching works or pan-mills erected to work this ore which have perhaps no sooner got into regular running order when the chloride changes into a base silver mineral that necessitates roasting and even smelting to obtain the silver, requiring the rebuilding of the works or possibly their entire abandonment. Another very common error made in the West is to call all silver ores that are yellow-stained "chlorides," which quite often is correct, though in many instances such yellow-stained silver ores contain no horn-silver whatever, the silver being there in some other combination that quite frequently is much less tractable, while the yellow staining is usually due to oxide of iron.

Embolite, or bromide of silver, is a mineral that is identical in every respect with cerargyrite except that it is green-colored when freshly mined. This mineral is also very often misnamed by the Western miners and prospectors, who are apt to call all green-stained silver ores "bromides," when the green color is usually due to copper, and the silver is more frequently in some other less easily milling combination than as a bromide, which latter mills as readily as the chloride. Like the chloride, this mineral is usually found in the upper parts of many silver-bearing veins, and is apt to change into other combinations, especially with sulphur, as depth or permanent water-level is attained.

Of the *brittle* group of silver minerals, the more common ones are:

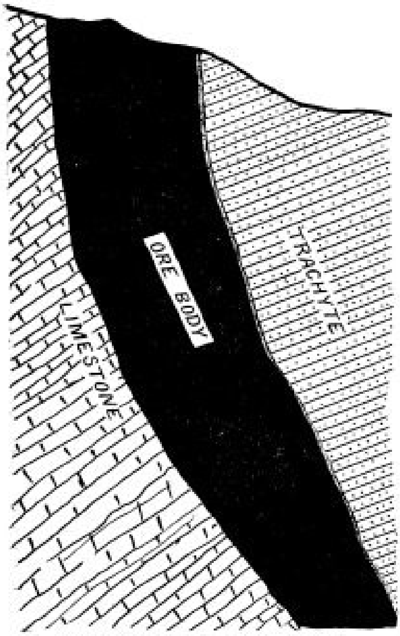
Ruby silver is a name applied to both the light-red colored *proustite*, or a compound of arsenic, sulphur, and silver, and to *pyrargyrite* or the dark-red to black colored compound of antimony, sulphur, and silver. They both give a red streak, are very brittle, and have a non-metallic luster, are heavy, and contain over 60% of silver. Ruby silver is the principal mineral of the famous Granite Mountain Mine, in Montana, and is very common in the Comstock Lode, of Nevada, while it is very apt to be present to a greater or less extent in most of the high grade silver veins of the West.



CROSS-SECTION OF THE COMSTOCK LODE.

Brittle silver, or stephanite, is a black compound of antimony, sulphur, and silver, that very much resembles the dark ruby silver in its properties, richness, and occurrence.

There are quite a number of other brittle silver minerals that are occasionally of local importance, like *polybasite*, at the Ontario Mine, Utah, *stromeyerite* at the Yankee Girl Mine, Colorado, but which are not of sufficient



CROSS-SECTION OF THE HORN-SILVER MINE.

general importance to deserve attention here, while all the gold ores, and especially the brittle telluride group, always carry at least some silver, but as its value is usually very much less than the gold, the silver is regarded as a by-product.

Silver ores which carry any of the above minerals are pretty certain to be profitable, and the only necessity of assaying them is to determine *how rich* they are; but there is another very valuable class of silver ores which give no reliable clue whether they are silver-bearing or not, and hence must be assayed to determine first *whether* they are argentiferous, and if so, then whether the silver is contained in profitable quantities. This class consists of the minerals of the base metals lead copper, iron, zinc, and antimony, which in certain districts are often found to be quite rich in silver, while in other districts they practically contain none; hence every new discovery of the base metal minerals should always be assayed, though usually they will not be found to contain silver or gold in profitable quantities in regions which are not already famous for their precious metals. The more important of these minerals that are liable to be silver-bearing are:

Galena, or the sulphide of lead, which is a very heavy, soft, bright metallic lead gray-colored mineral that almost invariably contains *at least some* silver, and in silver-bearing regions is nearly always a valuable silver ore. It seldom assays less than 1 or 2 ounces of silver per ton, and occasionally carries as high as 300 to 400 ounces. The very low grade galenas that do not contain enough silver to pay extraction (or less than 5 ounces per ton) are generally very coarse grained or split readily into cubes, while those galenas which carry silver in profitable amounts (or over 10 ounces per ton) are apt to be very fine grained or will not split into cubes. While the *grain* of the galena will thus give an idea in perhaps *most cases* as to its silver value, still there are *so many exceptions* to the rule that the only safe and proper way is to always assay every new galena and not put the implicit faith in the character of the grain that is so frequently done by Western prospectors.

"*Sand*" *and* "*rock*" *carbonates*, or the carbonate and sulphate of lead, are similar to galena in nearly always carrying paying amounts of silver in silver regions and very small and unprofitable quantities in districts like the Mississippi Valley, which is almost barren of silver veins.

"*Gray Copper*", or tetrahydrite, is a heavy, soft, gray-colored, metallic copper mineral that is often very rich in silver in silver regions, assaying as high as 2,000 ounces per ton, and is one of the most common and valuable silver ores of the West.

"*Yellow Copper*", or chalopyrite, is a heavy, somewhat hard, brass-yellow, metallic copper mineral that frequently carries paying amounts of silver, and is seldom entirely free from small quantities, but is more usually valuable for the gold that it is liable to carry than the silver. The other copper minerals (which are usually derived from this by alteration) are equally as liable to carry paying amounts of silver, and they probably are rarely free from small amounts or say ½ to 5 ounces per ton.

Blende, or "*Jack*", is a soft, yellow, brown to black colored, non metallic zinc mineral that usually carries some silver in silver regions, but frequently in amounts just too low to pay to extract on account of the difficulty in smelting such ores.

Pyrite, or "iron pyrites," is a heavy, very hard, light yellow, metallic iron mineral that frequently carries paying amounts of silver, though it is usually more valuable for the gold it is liable to contain in districts where the precious metals occur. The other iron minerals are also likely to contain some silver in silver regions, but are apt to be low grade.

Silver, as distinct silver minerals, or invisibly carried by argentiferous minerals of the base metals, occurs in nearly all classes of deposits. The class of silver deposits that are most highly prized and sought after by the Western prospector are the fissure vein, on account of the supposed permanence and reliability of this class of ore-bodies, and while this reputation is justly deserved in some cases, it has proved very unreliable in many other instances. One of the best known types of a silver bearing fissure vein is the *Ontario Mine*, in Parley's Park, Utah, which has been worked since 1872, and has paid in dividends the handsome sum of about $12,000,000 since the first was declared in 1877. The vein has a general east and west course or direction, and a dip of 70° to 80° to the north, though both the course and dip vary considerably; it has a width of 2 to 8 feet, with a vein filling of quartz carrying pay streaks of ½ to 4 feet in thickness. Both the foot and hanging walls are quartzite, though a dike occurs close to and nearly parallel with the vein in the hanging country. In the upper part of the lode (down to about 300 feet) the silver occurred largely in the form of horn-silver or chloride, but this has changed into polybasite and still deeper quite large amounts of smelting ore has made its appearance in association with blende, pyrite, and other sulphide minerals. The average value of the ore has fluctuated from $40 to $140 per ton, though some rich horn-silver ore from the outcrop ran as high as $1,000 per ton.

Another fissure vein that threatens to eclipse the brilliant record of the Ontario is the Granite Mountain, at Phillipsburg, Montana, which occurs in granite. The vein is almost vertical, runs nearly east and west, and has a width of 3 to 6 feet. Though the first dividend was declared in 1885, it has already paid over $11,000,000 to its stockholders and is continuing dividends at the handsome rate of $100,000 per month. The ore has run as high as $1,000 per ton in selected lots, and their milling ore has ranged from $60 to $150 per ton.

The most famous and heaviest producer of the precious metals thus far discovered in the United States is the Comstock Lode, at Virginia City, Nevada, on which the first claim was staked in 1858, and which has since produced over $350,000,000 in silver and gold, the latter metal making up 40 to 45% of this enormous amount. This lode runs nearly north and south, dips to the east at angles varying from 30° to 45°, has a foot-wall of syenite, and a hanging wall of volcanic rock, usually propylite. The vein varies greatly in width, from a few feet to as high as 300, and the vein filling is quartz and clay in which occur irregular bodies of the silver-gold bearing ores that vary from mere threads to over 200 feet in thickness. The large bodies of ore known as "bonanzas", occur very irregularly throughout the lode, being separated by stretches of barren quartz and clay, while they vary greatly in magnitude and value. As a result of this great irregularity in the occurrence of the ore-bodies, some of the numerous mines located on this lode have spent very large sums of money in prospecting or searching for them (from $500,000 to $6,000,000 each), which is here unusually expensive on account of the great width of the lode and the excessive heat encountered; whereas those few mines that have found them have been very profitable, while the bonanzas lasted, the famous consolidated Virginia having paid $40,000,000 in dividends, the Consolidated California over $31,000,000, and the Belcher over $15,000,000. The average value of the bonanza ore is not high, it ranging between $30 and $50 per ton, though picked lots of over $1,000 per ton have been obtained. The lode has been worked to a vertical depth of 3,200 feet, which is the deepest work thus far done in this country, while the mines adjoin one another for a length of over 5 miles. Great bodies of hot water are met with in this lode which makes the lower workings very trying to work in, as temperatures as high as 170° F. have had to be contended against by the free use of air currents, cold water led into the mines by pipes, a wholesale use of ice, and by paying wages of $4.00 for a 6 or 8 hour shift. The sketch shown of a section taken across the lode is at the Potosi Mine, after Hague.

A contact silver vein that has made an excellent record is the Horn Silver Mine, at Frisco, Utah, which since its discovery in 1877, has paid $4,300,000 in dividends. It has about a north and south course, dips about 70° to the east, and has a hanging wall of trochyte while the foot-wall is limestone and quartzite. The lode varies from 20 to 150 feet in width, and carries an almost solid body of ore that assays 30 to 90 ounces silver per ton, and 5 to 45% of lead. Some of the ore carried horn-silver, but most of it has been a sulphate of lead carrying 40 to 50 ounces of silver and 30 to 40% of lead. This mine was worked to the depth of about 1,000 feet before any water was struck, so that lead poisoning from the dust arising in stoping has been a very common complaint of the miners. After striking the water-level the ore has changed into galena, while the great width of the ore-body in the upper workings has been greatly reduced by the narrowing of the lode.

[TO BE CONTINUED].

THE JEFFREY STEAM STEVEDOER.

For Loading Coal, Grain, Lime, Ores etc., etc., on Board Vessels from Cars or Storage.

This machine consists of two hinged frames arranged to be supported upon the axles and wheels of a heavy truck, and to support the shafting, bearings, chains, guides, and buckets of an endless elevator.

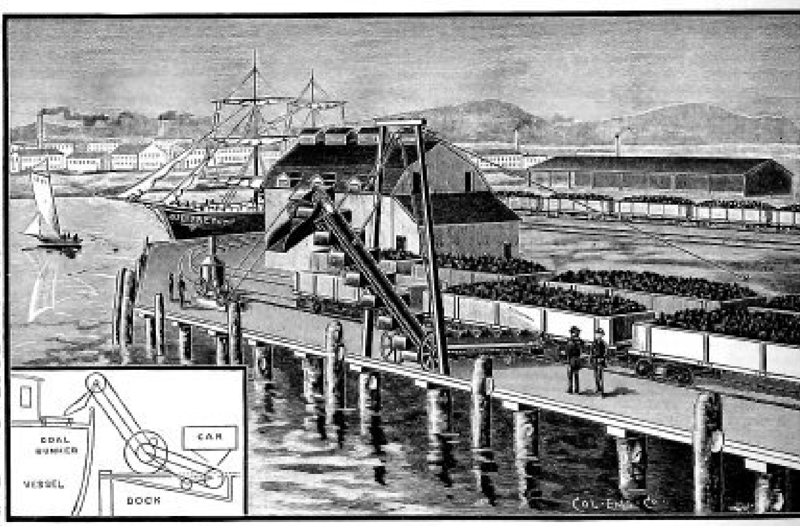
When not at work, the two portions of the frame are closed nearly together, the top portion resting upon a bolster trestle, the hinged end supported on axle and wheels, as shown in cut, the other end with bolster trestle on another axle and wheels, not shown. When folded and loaded as described, the whole apparatus with shears and guy wires, can be transported readily from place to place.

The illustration shows the machine ready for work to take coal from railroad transportation and deliver to vessel alongside of the dock.

The top of elevator is guyed in position and is driven by rope transmission from an ordinary dock engine connecting with worm and gear.

This machine can be placed, as shown, with the horizontal ladder running under and taking coal from the bottom of cars, or it can be placed at right angles to the position shown, with the horizontal ladder parallel to the railroad track, when a number of shovelers would load the passing buckets and a chute from the head would convey the coal or ore to the hatch of the vessel.

The wide field of usefulness of this machine is apparent at a glance, especially so to stevedoers at points where inland transportation on rivers, bays or canal, necessitates the use of barges, and where a capacity of



150 to 300 tons per hour at a moderate elevation of 25 to 30 feet is desirable. Its portability renders it as useful to the stevedoer or shipper as the hoisting engine.

This machine is manufactured by The Jeffrey Mfg. Co., who are well acquainted throughout the country as successful manufacturers of elevating and conveying machinery for handling material of all kinds. Their main office and works are at Columbus, Ohio, with a branch at 48 South Canal St., Chicago, Ill.

We have received from the Diamond Prospecting Company, of 15 and 17 North Clinton Street, Chicago, a copy of their new catalogue for 1891. It is a handsome and well-illustrated work, thoroughly describing their various types of diamond core drills, channeling machines, etc., etc., together with their two other important specialties, the Mitchell Coal Tipple and the Stanley Heading Machine. It will be sent free to mine owners, mining engineers and, mine superintendents on application, and it is a work that should be on file for reference in every mine office.

THE TRIPLEX ELECTRIC PUMP.

The triplex or three-cylinder pump, made by the Gould Manufacturing Company, possesses important advantages for combination with the Thomson-Houston Electric Motors. The pump offers absolutely even and unvarying resistance to the motor under all conditions, and consumes but a minimum power in friction of parts. Careful tests of the outfit complete have shown a high efficiency. The three-throw crank shaft, in the stroke of which there is no dead center, prevents jerking motion and vibrations. The pump and motor are mounted on one bed-plate, and are practically one machine, being thoroughly tested as such before going into active service.

In villages or cities where power can be had from electric light or power circuits, electric pumping offers relief from the discomforts of insufficient or hard and unfit water supply, and the hardly lesser trials of disagreeable, noisy, and dangerous pumping engines in vogue.

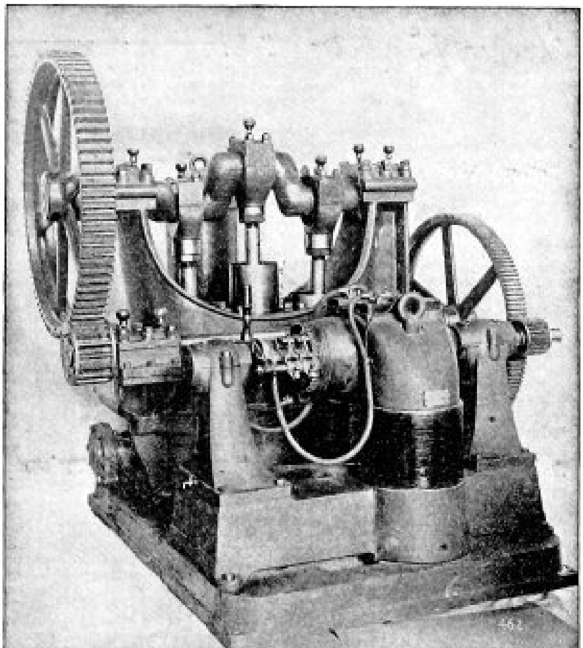
The triplex electric pump will take water from any source, as spring, cistern, or well, and force to upper supply tanks of residences, shops, warehouses, buildings, etc., or force city water to a higher point than its own pressure will carry it, as is often the case in the more elevated city districts or very tall buildings.

In such factories as large cotton mills, woolen mills, steel works, etc., and in fact, in any large establishment where work is distributed over a large territory, the employment of electrical transmission of energy for pumping can be used to great advantage.

The steam pump is in common use. Steam is generated in the boiler and transmitted through long lines of pipe to pumps where the work of pumping is performed. It has been found by actual experiment and demonstrated time and time again that these direct-acting steam pumps are most wasteful consumers of steam, using in the neighborhood of 25 pounds of coal per H. P. per hour. With electrical pumping outfits all this is changed.

One of the most troublesome questions in mining operations is the disposal of water. By the introduction of electricity for underground work the problem is greatly simplified. The necessity for long lines of steam pipe is removed, and in the place of hot steam pipes spreading dry rot in the vicinity, a small copper wire is suspended from wall or ceiling; or, the current may be taken from the trolley-wire if the mine is equipped with an electric haulage plant. In some cases, where transmission from the surface by steam or compressed air was utterly impracticable, and an underground steam plant seemed necessary, it has been found that the cost of excavating and drilling holes for the chimneys would exceed the total cost of the electric pumping plant.

The accompanying illustration shows a Goulds Pump and Thomson-Houston Motor, the combination which has met with such success in the applications mentioned above, and which is handled by the Thomson-Houston Motor Company for ordinary pumping work, and specially fitted for mining work by the Thomson-Van Depoele Electric Mining Company, for all mining, excavating, and metallurgical operations. Information on the subject of the applications of these pumping outfits, together with efficiencies and prices, will be furnished by the above companies upon request.



The Ingersoll-Sergeant Drill.

Mr. A. C. Douglas, who has recently completed two large tunnels in Pennsylvania, one at Ashland for the purpose of draining the Centralia coal basin, and the other at Park Place, for the purpose of draining another coal basin, has been given a contract by the Cataract Construction Company for canal and other rock excavation at Niagara Falls. Mr. Douglas has recently begun work, putting in new Ingersoll-Sergeant Piston Inlet Air Compressors and Ingersoll-Sergeant Drills.

Messrs. Rogers and Clements, the contractors for the main tunnel at Niagara Falls, have recently put in some Ingersoll-Sergeant drills, and are making rapid and satisfactory progress.

Indian Engineering states that the East Indian Railway collieries claim the deepest shaft in India, Jubilee Pit No. 2 having been already sunk to a depth of 450 ft., and a considerable distance having yet to be dug before coal is reached.

ON AN APPARATUS FOR THE LAYING OF COAL-DUST IN MINES.

BY MR. R. B. MAWSON.

[Transactions of the Manchester Geological Society.]

Mr. R. B. Mawson said: At the last meeting I was asked to read a paper on "Laying the Coal-Dust in Mines," but I have not been able to see my way to do it. There is nothing new about the system we use except the plugs at the end of the spray pipes, and though I am not prepared to read a paper upon the subject, I will endeavor to explain how we get over the difficulty of getting the spray fine enough at the Sovereign pit. The mine where we use the sprays is the Wigan 9 feet. The pit is 385 yards deep, and we get our water from the 7 feet lodges, at 200 yards from the surface. We have a pressure of about 240 lbs. The pipes from the lodges down the pit are 2 in. diameter. At the bottom of the pit we reduce them, and take 1½ in. pipes along the main level, east and west. We have about 500 yards of these 1½ in. pipes. At the bottom of each jig and the top of the down brows we have taps, and take the pipes about 30 yards into each district. At every 20 yards along these pipes we have ½ in. stand-pipes, to which the sprays are fitted. These stand-pipes have also taps, so that we can shut them or open them as we want, and have all or part of the sprays working. The system of pipes, &c., is the same as is carried out at a great many collieries now. The point I want to bring before the members being the lead plugs by which we get the sprays. When first we put the pipes in we tried No. 1 gas-burners, but these we found would not answer, as we could not get the sprays fine enough, and they always dropped and made the floor very wet for some feet around the bottom of the stand-pipes. This we could not do with, as the water caused the floor to lift, and had we continued with these burners we would soon have had the roads all upset. We next tried cane, which I had heard answered well at some places, but this would not do at all with our pressure, and the water simply came through in a jet. After this we tried everything we could think of and yet could not get the sprays fine enough, till Mr. Saint, one of Her Majesty's Inspectors of Mines, suggested lead plugs, which he said were used in South Wales. We, therefore, tried them, and after using them in various forms, at last hit upon our present form. We have now got the spray to the required fineness, and have had no trouble since. The lead plugs are simply screwed into the end of the pipe and then cut off, the length of the plug being about half an inch. We then drive a fine steel drift through the plug, which, besides making a hole through the lead, also swells out the lead in the pipe and makes it so fast that it will stand any pressure without blowing out. Upon turning on the water, if the spray is too coarse, we can get it as fine as we like by simply tapping the face of the lead plug with a hammer. We get the sprays just like a fog without any water dropping, and this fog traveling in the air renders all dust damp, so that if you take a handful and throw it, it drops straight down, and does not travel away in the air as dry dust does. The sprays are turned against the wind, and this breaks them up so that they act upon both floor, roof, and timber. You can trace this fog in the air from each jet for about fifteen yards, and we find by having them open about two hours per day we can render the dust damp enough and have no trouble with it. The plugs are very easily made, are inexpensive, and are not nearly so liable to get out of order as burners, which are very often stopped up by fine dirt getting in them.

DISCUSSION.

Mr. Hall. Do you find that these sprays have lowered the temperature at the face?

Mr. Mawson. In our case it has not done so, as our works are not extensive and are very cool. In some of the warm pits of South Wales, I am told, putting in the sprays has lowered the temperature from 8 to 10°.

Mr. Hall. Could you not get the same results by having shallow tanks full of water in the roadways?

Mr. Mawson. This might answer in warm workings where you could get evaporation, but except in warm workings, the tanks would have very little effect, unless the tubs were running through the water, in which case the wheels and links would carry the water to some distance and certainly prevent dust on the roads at those points.

Mr. McGreevey. Do you not find that these sprays cause the warrant to lift?

Mr. Mawson. We have no trouble in that direction now, as the sprays are simply like a very fine fog and have no effect on the floor of the mine. When we used gas-burners we could not get the spray fine enough, and always had more or less water dropping from the burners, which caused our floor to lift, and would have given us a good deal of trouble had we continued to use the burners.

Mr. Hall. How far does the fog travel in the air?

Mr. Mawson. That entirely depends upon the velocity of your air current. Our sprays are 20 yards apart, and you can distinctly see the fog for about 15 yards from the jet.

Mr. Robinson. Do you suggest it is practical to have them throughout the workings?

Mr. Mawson. Yes; I think so. It would be costly.

Mr. Dean. At Hindley Deep Pit we could trace the spray for 22 yards along the road.

Mr. Saint. There is another system of watering being tried in South Wales, the water being used in conjunction with compressed air. This means two sets of pipes, and also a compressed air engine, which greatly adds to the expense.

The President said the getting rid of dust in the main roads in mines was no doubt a very important matter, and one that had had a good deal of his attention. He had tried burners, but had experienced the difficulty of not being able to get the spray fine enough, and thus it upset his road. The lead plug seemed the right thing. It was very simple, which was a great point in its favor, and was not liable to get out of order. He certainly would try it. He thought a great deal might be done by improving the tubs used in the mine. Iron tubs were the thing, but when they came to consider the cost, it made them hold back. He was having his tubs improved by having the boards tongued and grooved and putting hoop iron in.

By this means he was making his tubs practically water-tight, and when he got all his tubs done, he expected to reduce the coal-dust in haulage roads to a very small item. They were about to try watering the top of the tubs before they started off from the bottom of the brow. Altogether, in one brow 900 yards long, by the means they had tried, they had reduced the quantity of dust made in twenty-four hours from eighteen tubs to three.

COST OF AMERICAN IRON.

The cost of production of iron and steel in this country is the subject of a report which the Hon. Carroll D. Wright, national commissioner of labor transmitted to Congress through the President on the 21st of February, 1891. This report is the result of several years of careful investigation, based upon an examination of the books of leading manufacturers and enquiries by expert special agents of the National Department of Labor. A comparison of the costs of materials used in the northern and southern states shows that the difference in favor of the south in the cost of ore and coal is very great. The ore used in the northern states costs per ton an average of 4·401 dols.; the cinder, scrap, &c., 2·031 dols.; and the coal, 2·035 dols. The ore used in the southern states costs per ton an average of 1·513 dols.; the cinder, scrap, etc., 1·031 dols.; and the coal, 1·565 dols. Figures of 118 establishments manufacturing pig iron are given.

The following table will show the comparative cost of making pig iron in different establishments in the United States and Europe. Each line represents the work of a separate establishment, and of the 118 given in the report those are quoted which fairly represent the highest, lowest, and average rates of cost of materials, labor cost, and total cost in each locality:

COST OF MANUFACTURING PIG IRON.

Locality.	Material.	Labor.	Total.
	Dols.	Dols.	Dols.
Northern	17·728	3·539	22·165
Northern	13·323	1·194	15·202
Southern	7·757	1·461	10·279
Northern	11·291	·955	12·584
Northern	11·663	1·344	13·133
Europe	9·559	·418	10·234
Europe	12·228	·912	13·434
Great Britain	9·230	·901	10·290
Great Britain	9·308	·743	10·729
Europe	14·219	·719	16·075
Northern	12·267	2·135	15·288
Northern	11·147	1·166	12·859
Southern	7·173	1·816	9·634
Southern	8·877	1·218	10·822
Southern	8·164	·595	9·622
Europe	9·885	1·414	12·070
Great Britain	9·529	·749	10·686
Europe	9·861	·731	11·107
Europe	7·327	·755	8·763
Great Britain	8·951	·608	10·163
Great Britain	9·236	·739	10·244
Great Britain	7·168	·710	8·175
Great Britain	6·844	·710	7·851
Europe	12·288	·912	13·436
Europe	10·256	·972	11·228
Europe	9·559	·835	10·394
Europe	8·333	·425	9·073
Europe	7·339	·461	8·639
Europe	7·182	·960	8·132

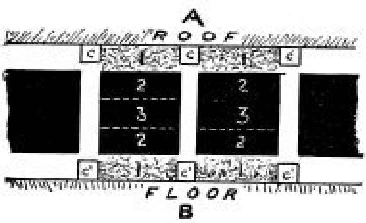
In each case the items of pay of officials and clerks, cost of supplies and repairs and taxes, constitute the excess of the "total cost" shown in the above table over the cost of material and labor. The establishments given under the head of "Europe" are situated in Germany and Belgium.

THE PRINCIPLES AND PRACTICE OF COAL MINING ON THE PILLAR SYSTEMS.*

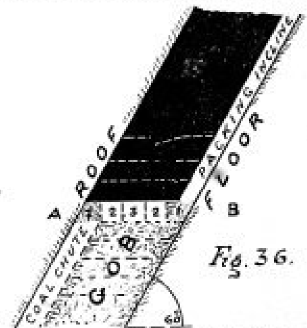
BY W. S. GRESLEY, M. E.

(Written for the Colliery Engineer).

Figs. 35 and 36. These do not appear to need much explanation, but it will be well to remark that they show a way of working a verk thick coal-bed on say a 60° pitch so that all the coal is removed. The close packing method is, of course, resorted to, because without it the whole of the seam could not be recovered by a very long way. As will be seen, the seam is first of all divided up into blocks or panels, and then worked away slice over slice, each one being mined on top of the gob or packing underfoot. The coal seam is thus worked away not parallel with its pitch or dip, but cut away systematically in horizontal slices or short lifts, each lift or slice being removed in the order of the numbers marked on plan Fig. 35 and each strip being packed tight and full as removed (see 1, 1; 1, 1, of each Fig). The coal is sent out to gangway down chutes c c c in the gob, next to the *roof of seam* or the *hanging wall* as it will be best to term it in such a system of mining. The material sent in for packing going in by way of other chutes, driven on the *foot-wall* (floor), c' c' c' Fig. 35. This method of working coal is a modified form of that illustrated in Fig. 34, applied to extraordinarily thick places in the seams.



PLAN Fig. 35.
Scale 40'

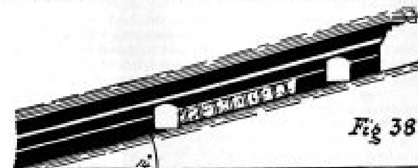


SECTION THROUGH AB Fig.
Scale 40'

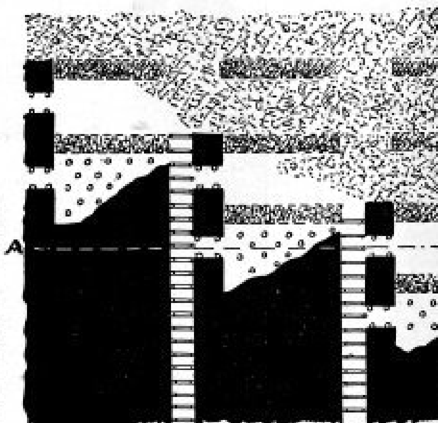
Fig. 37 is a plan, and Fig. 37a is a section on the pitch, of a system of working thick coal in France, also on the close-packing method. It almost amounts to "Longwall withdrawing." In the illustrations here given, the seam has a 14° pitch. It is opened up in lifts, in descending order. Gangways and other headings are driven in on the strike about 60 feet apart with cross-headings driven on the slant or about half pitch at suitable distances (see Fig. 37 plan). When the back of the area of coal desired to be worked is reached the rooms or working-places are opened up, beginning at the uppermost heading in the section or lift, and continuing forward in such a way as to have each "place" properly "stepped" or in advance of the next one below it as to allow of the packing material being properly stowed behind the diggers as they come along. Each room, as will be seen from Figs. 37 and 38, which is an enlarged view of part of Fig. 37, is opened narrow or with a "neck" for a few feet and then widened out, and on the high side of each stump a stone wall or brattice is built square up to the next level or roadway. These "buildings" or walls serve to carry the roof coal and keep the packing in place. The top coal is taken down between and over the buildings behind the first stage of work going on in the rooms. The props and timbering are shown in Figs. 38 and 38a which sufficiently explain the details of the system. The slant roads are for lowering the cars to gangways. Practically all the coal is recovered. The air goes in on the bottom gangway G, works up hill through the various rooms, and then back to return aircourse on upper or old gangway G'. The refuse for packing is taken in along the level communicating with the upper end of each room. It comes either from the surface or else from some other part of the mine, and is mixed with the slates and refuse of the coal seam, in such a way as to completely fill the gobs and prevent serious subsidence, or danger to overlying workable beds of coal. Probably the large amount of yardage work (heading) constitutes the chief draw-back of this system.

Figs. 39 and 39a are plan and cross-section of a mode of mining a very thick and highly inclined bed of coal formerly if not still mined in France. The seam is worked in horizontal slices, each about 7½ ft. thick, from top rock to bottom rock (hanging wall to foot-wall as the metal miner would say) and altogether without reference to the natural stratification or bedding planes of the coal. About five cuts or slices are taken in each lift or section, and each is removed separately, the excavations being filled with rubbish as the work proceeds. The lifts are mined in descending order. Fig. 39 shows the uppermost one exhausted, the middle one in course of working, and the lowest practically untouched. It will also be seen that slices or cuts Nos. 1 and 2 have been completely worked out, while No. 3 is now being worked on top of No. 2 gob. Fig. 39a being a plan of it on one side of the inclines or planes, by means of which the coal is sent out and the packing materials sent in, the latter coming from above, and the coal going down through the timbered chute in the gob to the lowest hauling road or gangway level communicating with the shaft or hoisting slope. In this way, coal beds, no matter how thick, can be all worked out. Caves are avoided, squeezes can hardly occur, and everything is done with method and exactness.

[TO BE CONCLUDED.]



CROSS SECTION ON A-B



Scale 40' PLAN Fig 38.

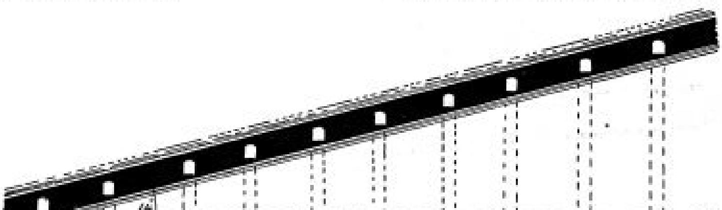
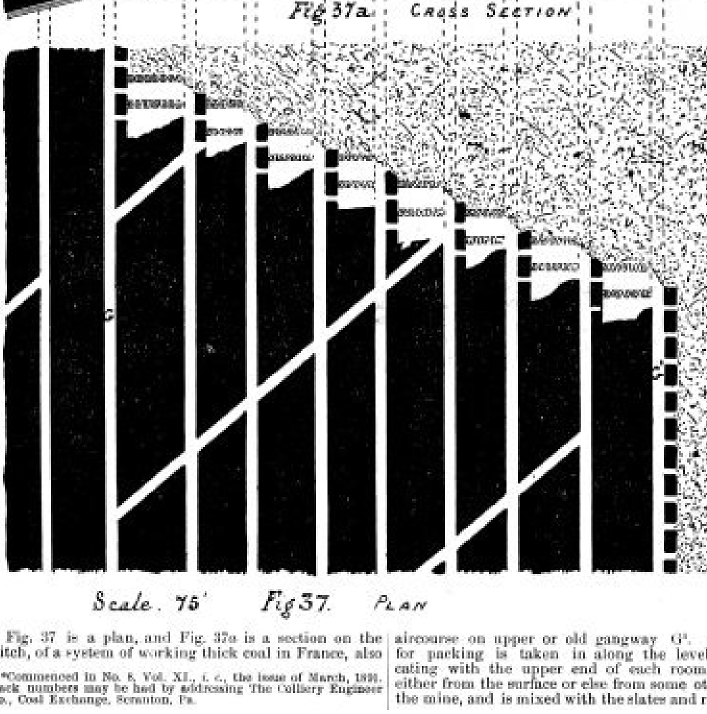


Fig 37a. CROSS SECTION



Scale. 75' Fig 37. PLAN

*Commenced in No. 8, Vol. XI., i. e., the issue of March, 1891. Back numbers may be had by addressing The Colliery Engineer Co., Coal Exchange, Scranton, Pa.

Forced Draught.

The Mining Journal, of London, in the issue of August 15th, reviews a paper read before the summer meeting of the Institution of Mechanical Engineers, at Liverpool, by Mr. Alfred Blechynden entitled "A Review of Marine Engineering During the past Decade." The views of Mr. Blechynden and of the members who participated in the discussion of the paper which followed its reading as to the relation between fuel consumption and forced draught are of special interest to fuel users who are interested in the burning of culm with forced draught. The *Journal* says:

"We do not think Mr. Blechynden is much above the mark when he estimates that the principle of forced draught means a saving of as much as 15 per cent. of coal relatively to power. Cheaper classes of fuel may also doubtless be used and a possible decrease of weight of boilers is also another advantage to the steam user. The author holds that it seems to be fairly well established that if the boilers are well constructed, and are provided with ample room to ensure circulation, their steaming power may without injury be increased to about 30 or 40 per cent. over that obtained on natural draught for continuous working, and may be about doubled for short runs. He proceeds to lay it down that such augmentation is accompanied in normal cases by an increased consumption per indicated horse-power; but he points out that, the same or even greater power being indicated, it may with moderate assistance of forced draught be developed with a smaller expenditure of fuel; providing that the grates and other portions of the apparatus are correctly proportioned. Doubtless, under certain conditions of weather, when with normal boiler proportions it would not be practicable to maintain steam for the ordinary speed with natural draught, the normal power may with forced draught be ensured. Strong confirmation of certain of Mr. Blechynden's views was forthcoming during the discussion, especially when Mr. F. C. Marshall pointed out that some steamship companies were using nothing but slack at 5s. 6d. a ton with forced draught stokeholes. The success of the application of forced draught was further remarked upon by Mr. W. Laird, who instanced some of the steamers running between Dublin and Holyhead. Nor was Mr. White far wrong when he observed that whatever discredit had fallen upon the forced draught system was in many cases due to the boilers to which it had been applied. From the remarks of Mr. Jeremiah Head, Mr. C. Cochrane, Mr. Macfarlane Gray, Mr. Ford Smith, Mr. Longridge, and Sir James Douglass, it appears that all the members of the institute who took part in the discussion are in favor of the principle inasmuch as full value can always be got out of the fuel no matter what are the atmospheric conditions. When gases from the funnel are used to heat the air proportionately, enhanced benefits are doubtless obtained."

COAL MINING IN THE BELLEVILLE SEAM, NO. 6, AT ST. CLAIR CO., ILL.

BY LEO GLUCK, E. M., MO. GEOL. SURVEY, JEFF. CITY.

The Belleville Seam, No. 6, of the Illinois series, was the first coal seam worked in the State, which is doubtless due to the fact that it outcrops along the Mississippi River bluffs in close proximity to St. Louis.

In St. Clair county, which is for the greater part underlaid by this bed, it is the principal seam worked.

Formerly this seam was mined extensively by drifts along the river bluffs; but the larger developments have been made from shafts in the interior of the county. It has quite a uniform thickness of 6 feet, varying generally between 5 feet and 7 feet, but reaching as much as 10 feet occasionally. At the Reinecke Mine, No. 1 (Consolidated Coal Co.), Birkner Station, St. Clair County, Illinois, which is a representative mine as regards thickness of the seam, method of working, output, management, etc., the writer had an opportunity to study the seam in detail, where the coal varies little, if any, from 6 feet in thickness.

The following general section, which includes a detailed section of the coal bed, shows the "partings and bands" in the coal, and the local names of the divisions:

20′ to 150′ loess.
150′ thin beds of limestone, shales and clay alternating and varying in thickness.
10′ shale.
5′ limestone.
5′ clay.
20′ to 25′ nodular, fossiliferous limestone (head rock).
1″ to 3′ slate.
12″ "top seam" or "blacksmith seam."
½″ "bone parting."
9″ "nine inch seam."
½″ "bone parting."
12″ to 14″ "drift seam."
½″ "clay or bone parting."
12″ "block coal."
½″ to 1″ pyritiferous or "sulphur" parting.
4″ "four inch seam."
½″ to 1½″ "bottom coal."
4′ to 16′ fire-clay.
Limestone (bottom rock.)

This coal is of the soft Bituminous variety, rather high in sulphur and ash, but its comparative great thickness, freedom from faults, its slight dip, and easy mining, make it compete favorably with other better Illinois and Ohio coals for steam and domestic use.

The impurities in this seam are pyrites and gypsum, which are found at irregular intervals throughout the seam, except in the Blacksmith which is remarkably free from them. The pyrites occurs, both as concretions, especially in the "Four-inch seam," and as flakes. The gypsum occurs as plates in the jointage planes.

The Blacksmith seam on account of its freedom from pyrites was formerly sorted out for blacksmith's use; commanding 2 cents more per bushel than the rest of the seam.

The plan of work adopted in opening up this seam is, as a general rule, the "Single Entry Room and Pillar" plan; which is continued until the workings become quite extensive, and then the "double or triple" entry plan is adopted and continued until the limits of the property are reached. Some of the larger mines are opened on the "double or triple" entry plan.

The pillars are left standing, and the coal is mined from the rooms to the extreme limits of the property before any trimming or robbing of the pillars is undertaken. If this precaution is not taken, the cracking of the roof would let in surface water, and by softening the "under clay" would cause "squeezes," even with pillars as thick as are used at present; increasing thereby the mining, pumping, and tramming expenses, besides making the mining operations more hazardous.

After the property limits are reached the coal in the pillars is regained by the "robbing system," retreating towards the shaft.

The following are the dimensions of the workings by the two different plans:

	Single Entry Plan.	Double Entry Plan.
	Feet.	Feet.
Rib between rooms	30	30
Rib between main entry and first room	60	60
Rooms started at	18 to 20	18 to 20
Rooms widen to	35 to 40	40 to 45
Width of entries	18	18
Distance between entries	300	
Distance between parallel entries		50
Cross cuts driven every		50 to 75
Distance between sets of parallel entries		600

There are two general methods of mining the coal practiced in this district; one by undercutting and shooting the coal down, the other by shooting out the coal in the solid. The former method is in general use, however.

At the Reinecke Mine the undercutting in the fire-clay was formerly done by hand; but coal cutters rapidly took the place of hand cutting, even though the former may have been temporarily cheaper.

The reason for this is that the frequent occurrence of strikes in this district, as can be seen from the coal statistics of Illinois, made the introduction of coal cutting machines almost a necessity; as with them a definite output of coal can be gotten without especially skilled labor. Any able-bodied man can become an expert machine man in a very short time. Thus giving the mine owner the advantage of placing large coal contracts with safety.

The Harrison machine, run by compressed air at 80 pounds pressure, making 220 revolutions per minute, is the mining machine used. It is operated by being placed on a board 10 feet long and 3 feet wide, inclined 9 inches in 10 feet towards the coal face.

The machine cuts along the width of the board; then it is shifted to another board, placed by the side of the first board, and it is then ready for another 3-foot cut. This is continued until the whole face of a room is undercut 3½ feet under, about 12″ high at the face, and 3″ to 4″ at the back. The undercutting is done in the fire-clay; but if the clay becomes too hard, or pyrites balls are encountered, or rolls in the floor, cut out the fire-clay, then the cutting is done in the coal.

Generally the cutting is done in part in the coal, and in part in fire-clay, cutting a wedge from each. About ⅙ of this coal is recovered as lump coal, the other ⅚ goes into the gob.

Each Harrison machine has a complement of six steel picks, two picks being generally in the blacksmith's shop for repairs. From six to eight picks are dulled by each machine daily. Each machine has five faces to work consecutively, thus giving the coal loaders opportunity to load the coal shot down.

The Harrison coal cutter in room work experiences in a day, of ten hours, the following delays:

10 bits or picks are changed @ 1½ minutes each, 15 minutes.
22 board shiftings are changed @ 3 minutes each, 66 minutes.

2 machine shiftings,	2 loadings @ 5½ minutes each,	11 min.
	2 " @ 6 minutes each,	12 min.
	2 trammings @ 4½ minutes each,	9 min.

Time lost by necessary delays, 113 minutes, or say two hours, 120 minutes.

Thus, in working a shift of 10 hours, 2 hours are lost by necessary delays, making the efficiency of the Harrison coal cutter under the best conditions 80% of the time of the working shift.

The labor required per machine is as follows:
1 machine runner.
1 machine helper.
1 blaster.
4 coal loaders.

The Harrison machine can cut on an average along 1 foot of face in 6½ minutes; as determined by the writer, from a long series of observations over a period of four weeks. Therefore, in a day of 10 hours, on this basis, assuming that no time was lost except as enumerated before, the Harrison machine can cut along 74 linear feet of face with an undercut of 3½′, which in a 6 foot seam amounts to 1,554 cubic feet, or 1,554 bushels of coal.

When a room is partially undercut by the coal cutters, then the blaster follows the machine and puts in holes for blasting down the coal with a geared auger drill, operated by hand, and attached to the coal face by expanding jaws inserted into a shallow hole made by a pick or jumper drill 3″ below the hole to be bored or drilled.

A kit of tools for the boring machine consists of two 2-foot, two 4-foot, two 6-foot augers, and two 18″ extensions. One set of tools are dulled every day, and require refacing by the blacksmith; although they are refiled by the blaster after each use.

In blasting down the coal, three and four holes respectively are used, of which one and two respectively are used in entry and room driving; all of which are usually started in the drift seam.

The following table gives the dimensions and speed of drilling the different kinds of holes:

	Entry Work.	Room Work.
Diameter of holes	2¼″ to 2¾″	2¼″ to 2¾″
Number of "breaking in" holes	1	2 (also incline to-
Inclination to the horizontal of "breaking in" holes	30°	30° wards each
Incl. to vert. of "breaking in" holes	15°	15° other.)
Length of " " "	5½′	5½′
No. of rib holes	2	2
Incl. to horizontal rib holes	20°	20°
Length of rib holes	3½′	3½′
Time taken to attach auger ready for drilling	4 m.	4 m.
Time taken to drill breaking in hole, (average)	15 m.	15 m. (average)
Time taken to drill rib hole	12 m.	12 m. "
Time taken to detach auger	1 m.	1 m. "

The loading of the holes is done by either of two methods the "Needle" or "Barrel" method, described in detail in the *Engineering and Mining Journal*, Feb. 22, 1890, by the writer, giving the several advantages.

It takes on an average 10 minutes to load a hole by the "Needle" method and one can load twice as fast by the "Barrel" method.

The "Breaking in" holes are fired first, and then the face is squared by the "rib" holes.

From a plot of the mine, the writer determined that 38% of the coal is left as pillars, leaving 62% of the coal to be mined.

The 4″ and 5″ of partings are lost, which is 9″ of 6′, or 12½% of the seam; again the amount of slack made by the mining of the coal depends greatly on the miner, but 5% will, without doubt, fully cover this loss, so that not more than 17½% of the 62% of the seam is the coal that is lost, or 62% − 17½% of 62% to = 51·15% is the coal that is hoisted.

By observation at the shaft landing it was determined that 81% of the coal hoisted went to the slack dump to be sold for practically nothing and part to be used as fuel at the mines. Therefore the marketable coal of the seam is only 40·89% of the total seam; but to this must be added about 25% of the 38% left as pillars, which is to be regained by robbing the pillars. Thus the total amount of the Belleville seam which is available as lump coal by the present methods of mining is 56·39% of the total seam.

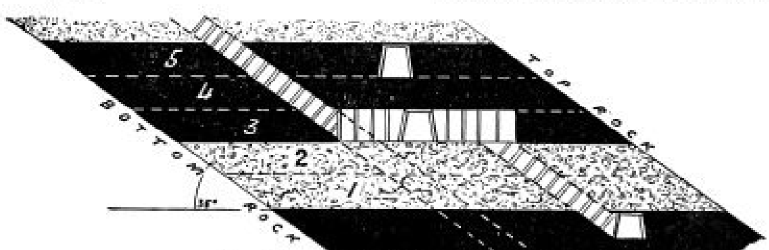
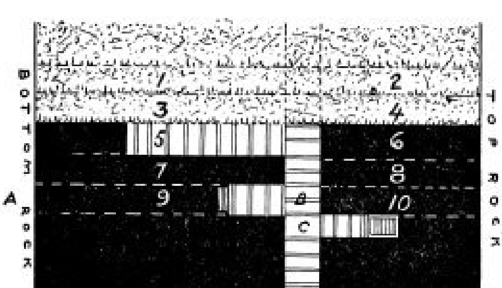


Fig. 39.

CROSS SECTION THROUGH A.B.C.D. on PLAN Fig. 39a



PLAN OF SLICE 3 in SECTION Fig. 39

Fig. 39a

THE PRINCIPLES AND PRACTICE OF COAL MINING ON THE PILLAR SYSTEMS.

The Probable Depth at Which Coal is now Being Worked in the British Isles.

A paper on this subject by Professor Hull is printed in the Transactions of the Manchester Geological Society, Volume XX. The author says:

"In connection with the duration of our coal supply, it is of interest to enquire into the average depth at which coal is being worked, and the rate of increase of that average. If at the introduction of steam winding engines about 1820 it be supposed that 100 yards was the average depth at which coal was mined; and that now, as a near approximation, the average depth be taken at 350 to 400 yards, then the rate of increase in depth is about 4 yards per annum if uniform, which it has not been. For the counties of York, Derby, and Notts the average depth at present is probably near 250 yards, while in Lancashire and Cheshire it is much greater—say, nearer 400 yards."

A DESCRIPTION OF THE ENDLESS ROPE HAULAGE AT CASTLE EDEN COLLIERY.

BY WALTER BELL.

[From the Proceedings of The British Society of Mining Students.]

As the engine planes for endless rope haulage must, of course, be wider than those for systems where single rails are used, the state of the roof has an important bearing on the choice of a system of haulage.

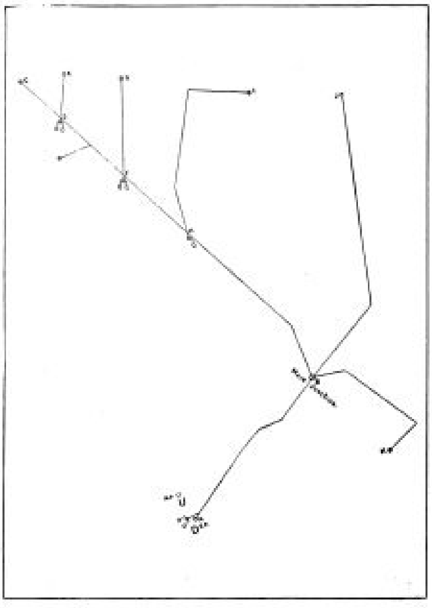


FIG. 1.

REFERENCE.

From A to B	814 yds.,	29·55	feet	rise.
From B to C	1991 yds.,	89·17	feet	fall.
From D to E	187 yds.,	6·94	feet	fall.
From F to G	418 yds.,	28·54	feet	rise.
From H to I	913 yds.,	40·85	feet	rise.
From B to J	1362 yds.,	166·94	feet	rise.
From B to K	682 yds.,	62·29	feet	rise.

The wagonways at Castle Eden are about 12 ft. in width, the gauge being 2 ft. in width, and 3 or 4 ft. being provided on one side of the road as a traveling way.

The height of the seam varies from about 3 ft. 6 in. to 4 ft. 6 in., and the top stone is "ripped" on one side to make height for the traveling way.

The hauling engine is underground, and was first fitted up for tail-rope haulage, but by adding gearing (7 to 1) it has been altered for slow motion. It is a condensing engine with two cylinders 16 in. diameter, 24 in. stroke. The drum is 9 in. wide. The engine is worked by steam or compressed air.

The driving-wheel for the rope is 8 ft. diameter and is of slightly conical form, the rope being passed around 3½ times, going on at the large diameter and coming off at the lesser, thus preventing friction of the coils against one another. The trod is lined with crucible cast steel so that it can be replaced when worn. This wheel is a duplicate of that shown in Figs. 4 and 5, without the friction-clutch.

Fig. 1 is a plan showing the number and direction of the wagonways where the rope is employed.

The rope runs underneath the tubs, and each tub is attached separately to the rope by means of a clip (see Figs. 2 and 3), rollers being placed about 10 yards apart for the purpose of preventing the rope from trailing on the ground, but low enough to allow free passage for the clips.

The system is worked by means of a main driving-rope 2⅞ in. circumference, which drives a wheel at the point B on Fig. 1, this wheel giving motion, by means of friction-clutches, to other wheels which drive the ropes leading into other districts, and each wheel can be separately put into or out of gear. By means of the friction-clutches the driving-wheels can be started gradually, thus relieving the ropes of any unnecessary strain.

The friction-clutch is the main feature of interest in the haulage. The driving-wheel A and friction-wheel B (see Figs. 4 and 5) are made to run loose on the shaft C when the clutch is out of gear. The strap as shown in plan is in three segments, each segment having projections *d* at the ends with screwed recesses in which work right and left-handed screws E. In the center of each segment there are holes F which receive pins passed also through the driving-wheel, as at H. On these right and left-handed screws are fixed levers K, connected with the arms L of the sliding box M, which is actuated by a screw and lever from above. When the sliding box is made to slide up, the screws bring the segments of the strap closer to one another and so gripe the friction-wheel, and the wheel revolves. This is tightened sufficiently to move the given load, and should the load become greater at any time the friction wheel slips and becomes stationary. If only the weight of coal is the cause of the heavier load, the sliding box can be pushed up still further, and the strap tightened.

In the wheel-pit, therefore, there is first the main driving-wheel, always running, then 3 sets of wheels and clutches below for the 3 different ways.

The wheels have false trods T of crucible cast steel, but show very little signs of wearing, although they have been on about 7 years.

The district B C is slightly dipping inbye, and tubs are taken off and hung on at 5 junctions. Three separate engines work the branch roads, H I, F G, and D E, which have compressed air as their motive power.

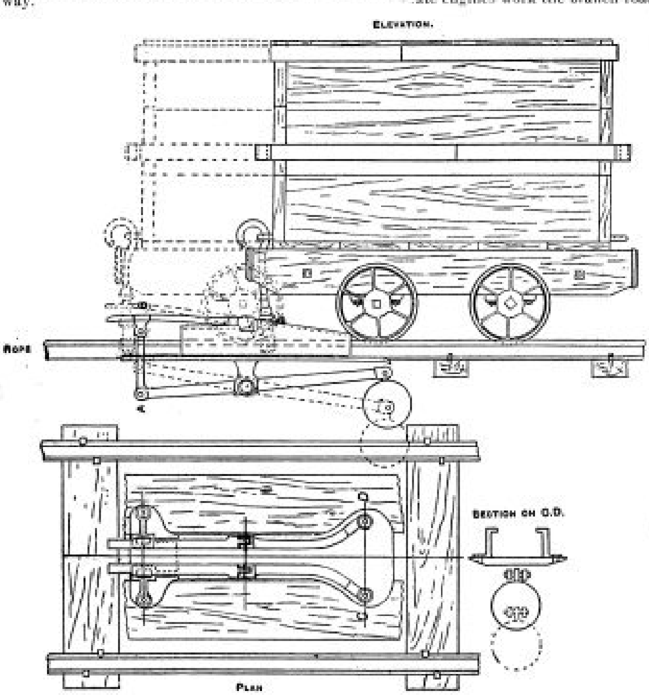


FIG. 2.

REMARKS.

The dotted lines drawn illustrating the "knock-off" in the elevation, show it in its natural position; where the tub is shown in dotted lines the clip is detached, the arms having been lifted up again by the ball and lever after being depressed.

The straight-on district B J rises inbye all the way, which does not put much work on the engine as the full tubs help to bring the empties up.

In the reference to Figure 1 the lengths and total rise or dip of the wagonways are given.

About 900 tons of coal pass over the main rope in tubs of 8½—9 cwt. capacity, and the rope runs 11 hours per day.

At the main junction B, the empty tubs are drawn up a "kip" to get an impetus to run into the other districts, in which there are "swalleys," where they are attached to the rope. In the same way on the full sides of the branch roads, the full tubs are brought on to a "kip," and when knocked off they run down to the main rope.

Speed. The rope travels about 3 miles per hour.

Curves. In passing round curves there is a series of bell-sheaves (those found to suit best are drawn to scale in Figs. 6 and 7), placed at equal distances around the curves and between the rails, which are so placed that a clip, when passing round with the rope, shall be in the center of the two rails, so when the rope is running alone it is a little out of the center. The clips having a firm grip of the rope, are easily drawn round the sheaves, and the tubs pass without jerks. The boxes of the clips must not be too low down, (which sometimes happens when the clips are worn) or, else they are liable to be lifted up and the clip become detached.

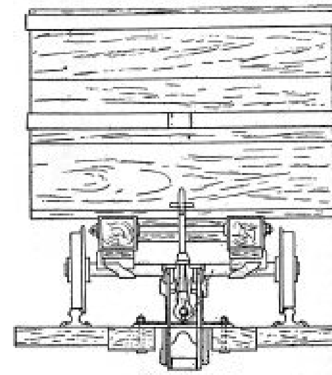


FIG. 3.

Swalleys. There being a greater tension on the full, than on the empty way, when passing "swalleys" the rope has a tendency to lift the tubs off the rails, but these "swalleys" are partially filled in on the full side. The tension not being so great on the empty way, the rope lies between the rails.

"Backs" or hills are in the same way cut through.

Gradients. The heaviest gradients on the outbye end or driving-rope is 1 in 9 on the full way, and 1 in 6 on the empty way.

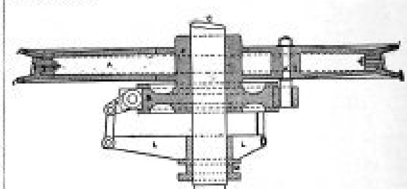


FIG. 4.

Tension Gear. Owing to the varying condition of the way, there are at different times and places, strains on the ropes which unless balanced to some extent, would throw the tubs off the rails.

To balance these the following method is applied: The rope is passed round a wheel supported on a sliding carriage on wheels, the carriage being attached to a chain at the end of which are placed weights, the chains passing over pulleys as in Figs. 8 and 9. The weights can be altered according to length of rope or

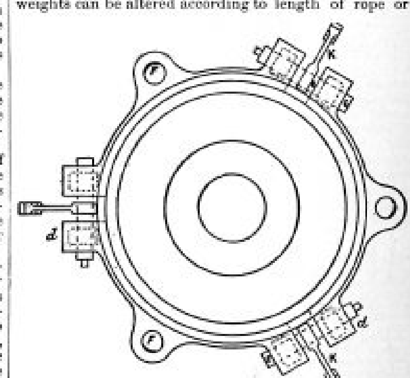


FIG. 5.

weight of mineral on road. These are placed on the trailing rope or empty tub side as near the driving-wheels as possible, so as to take up any slack after coming round these wheels.

Hanging on and knocking of the clips. The "hanging on" of the clips at first sight seems difficult, but the lads soon get trained to the work and can hang them on very quickly.

On the other hand, the "knocking off," when the tubs follow one another closely, and the clips being stiff at times, is attended with considerable difficulty, and should a tub miss, being detached near the return wheel, damage to the rope becomes serious.

To prevent such accidents an automatic "knock off," arrangement is placed at the terminus of the rope. Figs. 2 and 3 explain the working of it, which acts admirably.

Different sized clips are used for the different ropes. New ropes sometimes give trouble until they get stretched.

Size of ropes: Main road 2¼ in. circumference. Branch roads, 2¼ in. and 1¾ in. circumference.

Greasing. Automatic greasers are placed at various points throughout the mine which grease more effectively than in other systems where the tubs run at a greater speed.

Signals. Electric signaling is used throughout the pit, and the rope can be stopped within a few yards after the signal has been sent either to the engineman for the outbye end, or to the main junction for the other ropes (where a man is kept arranging the tubs into and out of the different districts) and any rope is immediately put out of gear.

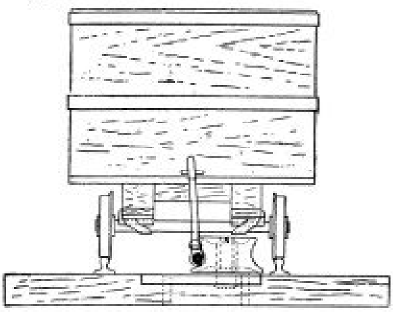


Fig. 6.

Bells are placed in circuit at all the junctions, so that those lads employed there can tell whether the ring comes from inbye or outbye.

Pumps can be coupled up to the return wheels the same as in other systems.

Compressed air is carried into the face of the district B C, and the branches on this road are worked by separate engines, as shown in Fig. 1.

The engine at H has one cylinder, 14 in. diameter by 18 in. stroke, geared 2½—1. The engine at F has two cylinders, 6 in. by 12 in. stroke, geared 6—1. The engine at D has two cylinders, 8 in. by 14 in. stroke, geared 8—1. The engine at H has lately had another cylinder added, namely, 20 in. by 20 in. stroke, and the gearing is to be altered to 6—1.

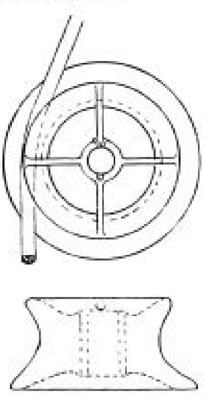


Fig. 7.

Naked lights are a great benefit at the junctions as they aid the lads much in hanging on the tubs properly, and where safe, open lights are used. At these stations, or about 20 yards both inbye and outbye, are fixed between the ways levers, which, when a tub passes over them, the axle pulls a bell at the junctions and warns the lads there of the approach of either full or empty tubs, according to the direction the ring comes from.

Advantages. Extensions of the rope can be made in very small distances, and consequently the putters or trammers put direct on to the rope, and so driving horses are done away with, which saves the cost of making the roads higher.

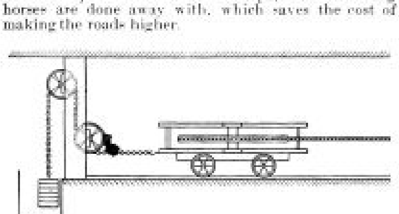


Fig. 8.

The strain and tear on machinery, trams, and ropes are a great deal less than in the tail-rope system, and if an accident does happen it is not generally of a very serious nature, as when a tub gets off the way the bow of the clip straightens out and leaves hold of the tub.

By attaching the tubs at equal distances apart, the weight of the rope is carried along with less friction on the ground and rollers.

A very regular supply of coal is brought to the shaft.

Over Endless Chain—less weight in the rope than in the chain, curves worked without any hand labor.

Over Quick-running Endless Rope—the clips being stronger and running in sets, the rope is liable to injury. No set-riders. Less liability to accident.

A rope lasts 4 years on the average.

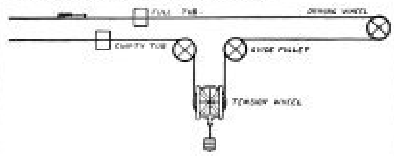


Fig. 9.

Costs. Maintaining way and all wagonway cost is about ·85 d. per ton, and cost of ropes about ·76 d. per ton.

The cost per ton for rope lads, *i. e.*, all lads taking off tubs and hanging on, is 1½ d. per ton.

The cost per ton per mile is about 3 d. Steam power and repair of tubs is not included in this. This is somewhat high on account of the rope being taken right into the "flats."

DEFINITIONS OF TECHNICAL TERMS.

KIP.—A level or gentle sloping roadway going outbye at the extremity of an engine plane, upon which the full tubs stand ready for being sent up the shaft.

SWALLEY.—A hollow in the road.

MINE INSPECTION IN THE TERRITORIES.

The Act for the Protection of the Lives of Miners in the Territories Passed by the Last Congress.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in each organized and unorganized Territory of the United States wherein are located coal mines, the aggregate annual output of which shall be in excess of one thousand tons per annum, the President shall appoint a mine inspector, who shall hold office until his successor is appointed and qualified. Such inspector shall, before entering upon the discharge of his duties, give bond to the United States in the sum of two thousand dollars, conditioned for the faithful discharge of his duties.

SEC. 2. That no person shall be eligible for appointment as mine inspector under section one of this act who is not either a practical miner or mining engineer and who has not been a resident for at least six months in the Territory for which he shall be appointed; and no person who shall act as land agent, manager, or agent of any mine, or as mining engineer, or be interested in operating any mine in such Territory shall be at the same time an inspector under the provisions of this act.

SEC. 3. That it shall be the duty of the mine inspector provided for in this act to make careful and thorough inspection of each coal mine operated in such Territory, and to report at least annually upon the condition of each coal mine in said Territory with reference to the appliances for the safety of the miners, the number of air or ventilating shafts, the number of shafts or slopes for ingress or egress, the character and condition of the machinery for ventilating such mines, and the quantity of air supplied to the same. Such reports shall be made to the governor of the Territory in which such mines are located and a duplicate thereof forwarded to the Secretary of the Interior, and in the case of an unorganized Territory directly to the Secretary of the Interior.

SEC. 4. That in case the said mine inspector shall report that any coal mine is not properly constructed or not furnished with reasonable and proper machinery and appliances for the safety of the miners and other employes it shall be the duty of the governor of such organized Territory, or it shall be the duty of the Secretary of the Interior to give notice to the owners or managers of said coal mine that the said mine is unsafe and notifying them in what particular the same is unsafe, and requiring them to furnish or provide such additional machinery, slopes, entries, means of escape, ventilation, or other appliances necessary to the safety of the miners and other employes within a period to be in said notice named, and if the same be not furnished as required in such notice it shall be unlawful after the time fixed in such notice for the said owners or managers to operate said mine.

SEC. 5. That in all coal mines in the Territories of the United States the owners or managers shall provide at least two shafts, slopes, or other outlets, separated by natural strata of not less than one hundred and fifty feet in breadth, by which shafts, slopes, or outlets distinct means of ingress and egress, shall always be available to the persons employed in said mine. And in case of the failure of any coal mine to be so provided it shall be the duty of the mine inspector to make report of such fact, and thereupon notice shall issue, as provided in section four of this act, and with the same force and effect.

SEC. 6. That the owners or managers of every coal mine at a depth of one hundred feet or more shall provide an adequate amount of ventilation of not less than fifty-five cubic feet of pure air per second or thirty-three hundred cubic feet per minute, for every fifty men at work in said mine, and in like proportions for a greater number, which air shall by proper appliances or machinery be forced through such mine to the face of each and every working place, so as to dilute and render harmless and expel therefrom the noxious or poisonous gases; and all workings shall be kept clear of standing gas.

SEC. 7. That any mine owner or manager who shall continue to operate a mine after failure to comply with the requirements of this act and after the expiration of the period named in the notice provided for in section four of this act, shall be deemed guilty of a misdemeanor, and shall be fined not to exceed five hundred dollars.

SEC. 8. That in no case shall a furnace shaft be used or for the purposes of this act be deemed an escape shaft.

SEC. 9. That escape shafts shall be constructed in compliance with the requirements of this act within six months from the date of the passage hereof, unless the time shall be extended by the mine inspector, and in no case shall said time be extended to exceed one year from the passage of this act.

SEC. 10. That a metal speaking-tube from the top to the bottom of the shaft or slope shall be provided in all cases, so that conversation may be carried on through the same.

SEC. 11. That an approved safety-catch shall be provided and sufficient cover overhead on every carriage used in lowering or hoisting persons. And the mine inspectors shall examine and pass upon the adequacy and safety of all such hoisting apparatus.

SEC. 12. That no child under twelve years of age shall be employed in the underground workings of any mine. And no father or other person shall misrepresent the age of anybody so employed. Any person guilty of violating the provisions of this section shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined not to exceed one hundred dollars.

SEC. 13. That only experienced and competent and sober men shall be placed in charge of hoisting apparatus or engines. And the maximum number of persons who may ascend or descend upon any cage or hoisting apparatus shall be determined by the mine inspector.

SEC. 14. That it shall be lawful for any inspector to enter and inspect any coal mine in his district and the work and machinery belonging thereto at all reasonable times, but so as not to impede or obstruct the working of the mine; and to make inquiry into the state of the mine, works, and machinery, and the ventilation and mode of lighting the same, and into all matters and things connected with or relating to the safety of the persons employed in or about the same, and especially to make inquiry whether the provisions of this act are complied with; and the owner or agent is hereby required to furnish means necessary for such entry, inspection, examination, and inquiry of which the said inspector shall make an entry in the record in his office, noting the time and material circumstances of the inspection.

SEC. 15. That in all cases of fatal accident a full report thereof shall be made by the mine owner or manager to the mine inspector, said report to be in writing and made within ten days after such death shall have occurred.

SEC. 16. That as a cumulative remedy, in case of the failure of any owner or manager of any mine to comply with the requirements contained in the notice of the Governor of such Territory or the Secretary of the Interior, given in pursuance of this act, any court of competent jurisdiction, or the Judge of such court in vacation, may, on the application of the mine inspector in the name of the United States and supported by the recommendation of the Governor of said Territory or of the Secretary of the Interior, issue an injunction restraining the further operation of such mine until such requirements are complied with, and in order to obtain such injunction no bond shall be required.

SEC. 17. That wherever the term "owner or manager" is used in this act the same shall include lessees or other persons controlling the operation of any mine. And in case of the violation of the provisions of this act by any corporation the managing officers and superintendents, and other managing agents of such corporation, shall be personally liable and shall be punished as provided in act for owners and managers.

SEC. 18. That the mine inspectors provided for in this act shall each receive a salary of two thousand per annum, and their actual traveling expenses when engaged in their duties.

SEC. 19. That whenever any organized Territory shall make or has made provision by law for the safe operation of mines within such Territory, and the Governor of such Territory shall certify said fact with a copy of the said law to the Secretary of the Interior, then and thereafter the provisions of this act shall no longer be enforced in such organized Territory, but in lieu thereof the statute of such Territory shall be operative in lieu of this act.

Approved March 3, 1891.

Testing Mineral Land.

So many mistakes have been made in the purchase or leasing of mineral lands, that it is now regarded as absolutely necessary that lands should first be tested by a diamond drill before the sale or lease is completed. Then, if the cores are carefully preserved and recorded, an almost perfect idea of the value of the minerals may be arrived at. Mr. H. P. Simpson, of Scranton, Pa., who for several years had charge of the prospecting business of Simpson and Watkins, has succeeded the latter firm, and the class of prospecting that he is doing is so satisfactory to the large coal companies of the Lackawanna and Wyoming region, that he has several drills constantly at work. Among his clients are the Hillside Coal and Iron Company, the Pennsylvania Coal Company, the Lackawanna Coal Company, Limited, the Parrish Coal Company, and others.

Mr. Simpson's facilities are such that he is prepared to contract for any number of test holes, and will guarantee good work and quick time. All records are kept strictly confidential. Those of our readers wishing to learn accurately the quality, position, and extent of strata in mineral lands, will do well to write Mr. Simpson for terms, etc.

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ *Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.*

Siphon.

Editor Colliery Engineer :

SIR :—I submit the following in reply to "Miner," of Elizabeth, Pa., whose question appeared in the August issue:

Can a siphon have too much fall for its lift, and why?

I believe it can, as I have found by experience that there is a certain medium when the siphon will work best. If a siphon has a 30′ fall and is giving good results, by adding another length or more of pipe instead of making the flow of water better, it will hinder it. The quantity of water may not be much less, but the siphon will not run as long a time without charging as it did before the length was increased. Also in the 30′ fall the pipes will not be full of water, and in consequence there will be more or less of air in them, which in time will work its way to the summit and cut off the flow of water. If the fall is lengthened the room for air will be increased, and the flow of water will be cut off sooner, requiring it to be charged oftener. Also, the more the length of the pipe is increased the more friction there will be to overcome.

Yours, etc.,
JOSEPH CAIN.

Whitwell, Marion Co., Tenn., September 1st.

Certificated Mine Superintendents.

Editor Colliery Engineer :

SIR :—I have watched with much interest the articles which have been appearing in your journal for the past several months on "Certificated Mine Superintendents," and wish to add my views to the list.

Your journal has followed me to a large number of different States and places on this Continent, and at each of these mining places, of course, there were superintendents, and with the exception of one case I have not met with incompetent superintendents, so that my experience does not coincide with some of your correspondents. The one incompetent superintendent I refer to was met in the State of Alabama, and he only held the position for a short term.

Although the superintendents with whom I have come in contact are competent men well suited to the responsible positions which they hold before the people—not before the law so much—I think that even their standard of excellence could be raised by the law requiring that every official should have a certificate of competency, and this would bar out those who might by any chance desire to fill a position they are not fitted by education or practice to fill. We are aware that many incompetent men desire such positions, and we may thank the good judgment of general managers or executive committees for the selection in most cases of good men.

I am not of the opinion that superintendents should be required to have a special certificate but by all means let him pass the mine foremen's examination before he is considered eligible for the position of superintendent. This would, as I have just said, place a barrier strong enough to keep incompetent men out of the field and I think this is all that fair-minded mining men desire. Thus fitted out the superintendent will be a suitable man to adjust difficulties or give suitable advice or instructions at the proper time if called upon to do so. Being thus qualified himself he will also be the better able to select the best men to fill the positions of trust under him, and in the failure of mine bosses to do their full duty (some do not do their full duty) he can reprove in fitting language, knowing whereof he speaks.

Such a certificate would bring with it one other advantage, it would hush the voice of contumely and silence the crank, be he mine boss or a citizen in another walk of life.

Mr. Roy, by his simple remarks, started discussion on an important subject and I hope that the various candidly expressed opinions of the correspondents on this subject will aid Mr. Roy in the good work which so many years of his life he has been identified with.

Yours, etc.,
H. L. D. W.

Lethbridge, N. W. T., Canada, August 31st.

An Agricultural Phenomenon on Coal Land.

Editor Colliery Engineer :

SIR :—In Jefferson County, Ohio, there is a singular phenomenon which I would like to bring before your readers for explanation.

There are a great many apple orchards in that country, and on the hill-sides where the coal stratum comes to the surface, it has been noticed that above the stratum there is a large yield of apples, but below it there is not a single apple. This phenomenon exists in all of that section. In the spring, while the trees were in blossom, there was a heavy frost and the blossoms on the trees that did not bear were all destroyed. Now it is evident that the coal in some way protected the fruit trees from the frost by some inherent property, or chemical affinity that the coal possesses. I hope that some one will give a scientific explanation of the cause of this. It is also asserted that the frost destroyed all the delicate and tender plants and vegetable blossoms below the coal stratum.

Yours, etc.,

Pittsburgh, Pa., September 9th. W. W. CABLE.

Ventilation and Mining.

Editor Colliery Engineer :

SIR :—Please insert the following in answer to "A. L. G.," of Audenried, Pa.:

(1). In Wilson's book on mine ventilation the following formula is given to find the perimeter of an elliptical shaft:

$$\frac{\sqrt{\frac{A^2+a^2}{2}}+\frac{A\times a}{2}}{2}\times 3{\cdot}1416.$$

Please explain it by working it out fully.

For convenience we will take an elliptical shaft whose long axis is 10 ft. and short axis 5 ft., then $A = 10$, $a = 5$, then substituting their values in the formula and solving we have

$$\sqrt{\frac{10^2+5^2}{2}} = 7{\cdot}9,\quad \frac{10+5}{2} = 7{\cdot}5, \text{ and}$$

$$\frac{7{\cdot}9+7{\cdot}5}{2}\times 3{\cdot}1416 = 24{\cdot}19, \text{ perimeter.}$$

(2). In opening out a gangway to the width of a double track or turnout, how would you increase the length and diameter of your collars?

Assuming the gangway to be 8 ft. wide, using 8 in. collars, and it to be opened out to 12 ft., the collars being 3 ft. apart, each collar would have to be made 1 ft. longer.

The first collar on the turnout would equal

$$\sqrt[3]{\frac{9^2}{8^2}}\times 8^3 = 8{\cdot}653 \text{ in. diameter.}$$

The second collar on the turnout would equal

$$\sqrt[3]{\frac{10^2}{8^2}}\times 8^3 = 9{\cdot}28 \text{ in. diameter.}$$

The third collar on the turnout would equal

$$\sqrt[3]{\frac{11^2}{8}}\times 8^3 = 9{\cdot}9 \text{ in. diameter.}$$

The fourth collar on the turnout would equal

$$\sqrt[3]{\frac{12^2}{8^2}}\times 8^3 = 10{\cdot}482 \text{ in. diameter.}$$

(3). If there are two airways of the same length one being 12 ft. by 6 ft., and the other 9 ft. by 9 ft. what pressure applied to the former would give the same quantity of air that a pressure of 10 lbs. per sq. ft. gives to the latter?

Their perimeters and lengths being the same the pressure will be according to

$9 \times 9 \div 6 \times 12 = 1{\cdot}125$ = difference in size of airways and in velocity of air, being as 1 is to 1·125, then

$$\frac{1^2}{1{\cdot}125^2} : \frac{1{\cdot}125^2}{1} :: 10 : 14{\cdot}254.$$

Yours, etc.,

Hanna City, Ill., Aug. 22d. A. B.

[Solutions to the above questions were also received from "S. U. P.," of Red Bank, Pa., on account of their similarity they are not inserted.—ED.]

Answers to Miscellaneous Questions.

Editor Colliery Engineer :

SIR :—I wish to thank "R. M. S.," of Avoca, Pa., for his answers to my questions in the August issue of your journal. He asked for a calculation on the second question so that he might show where I was wrong. I would say that I solved the question myself after sending it to the THE COLLIERY ENGINEER.

As I am but a student in the theory of mining and having worked out the various fan questions given in your journal, and noticing that our District Inspector could always find more air at foot of upcast than the fan could exhaust, it rather puzzled me, I measured the airway, however, which I found to be 8′ 6″ × 9′ 4″ or an area of 79·4 sq. ft., and the anemometer showed a speed of 900 revolutions per minute, and 900 × 79·4 = 71,400 cu. ft. per minute. The dimensions of the fan are, diameter, 20′; width of blades, 7′; orifice 8′, and a velocity of 40 revolutions. Now by formula

$$(D + D) \times (D - D) \times {\cdot}7854 = \text{area, or}$$
$$20 + 8 = 28$$
$$20 - 8 = 12$$
$$28 \times 12 \times {\cdot}7854 = 263{\cdot}8944, \text{ area.}$$

And

$$263{\cdot}8944 \times 40 \times 7 = 73{,}890{\cdot}432 \text{ cu. ft. of air,}$$

then

$73{,}890{\cdot}432 - 71{,}400 = 2{,}490$ cu. ft. of air which the fan is displacing. I think this is nearly correct for the velocity will be much greater at blades of fan than at foot of upcast.

Yours, etc.,

Westville, N. S., Aug. 25th. JOS. QUIGLEY.

Ventilation.

Editor Colliery Engineer :

SIR :—I notice there is quite a difference in the answers to the questions asked by "Jim Trinket," in your April issue, arising out of a misconception of the principle involved. It is true air expands $\frac{1}{459}$ part of its volume for each degree of heat added *from zero up*, but the expansion must be computed from zero, or in other words take $\frac{1}{459}$ part of what the volume would be at zero for the expansion due to one degree of heat added, and this multiplied by the temperature will give the expansion. I think it can best be illustrated by taking an example for which we will use the same data given in "Jim Trinket's" question.

If 18,000 cubic feet of air at 55° be reduced to 0°, what then would be its volume? Again, if the volume found be raised to 180° temperature, what would the volume be? As air expands $\frac{1}{459}$ part of itself for each degree of heat added from zero, 459 must have expanded 55, and 459 + 55 = 514. The expansion, therefore, at 55° has been $\frac{55}{514}$ of the volume which equals

$$\frac{18{,}000 \times 55}{514} = 1{,}962{\cdot}07, \text{ then}$$

$18{,}000 - 1962{\cdot}07 = 16{,}073{\cdot}93$ which would be the volume at zero. Then

$$\frac{16073{\cdot}93}{459}\times 180^\circ = 6303, \text{ the expansion}$$

from zero, and

$16{,}073{\cdot}93 + 6303 = 22{,}376{\cdot}93$ equals the volume at 180° which is the same as

$$(459 + 55 = 514, \text{ and } 459 + 180 = 639)$$
$$514 : 639 :: 18{,}000 : 22{,}377.$$

Yours, etc.,
T. S. C.

Gardner, Ill., August 31st.

Effect of Gas on the Flame of a Safety-Lamp.

Editor Colliery Engineer :

SIR :—Please insert the following question in your journal:

What difference is observed in the flame of a safety-lamp when light carbureted hydrogen (CH_4) and air are mixed in the following proportions: 1 of gas to 13 of air; and 1 of gas to 5 of air?

Yours, etc.,
R. P.

Greensburg, Pa., September 1st.

Examination Question.

Editor Colliery Engineer :

SIR :—Not being satisfied with the solutions given in the August issue to my question in the July number, I herewith submit the following, being very desirous to be corrected if in the wrong. The difference at pressure between the downcast and upcast shafts is 5·2 lbs., now $\frac{5{\cdot}2}{5{\cdot}2} = 1$ inch water-gauge, and assuming water to be 833 times heavier than air, we find that

$$\frac{833 \times 1}{12} = 69{\cdot}4 \text{ ft. the length of the motive}$$

column producing ventilation. Let us now take the formula acknowledged by all authorities to be correct, viz.,

$$\frac{T - t}{459 + T} \times D = M, \text{ but as "T" is the un-}$$

known quality, we have only

$$\frac{(\ ) - t}{459 + (\ )} \times 400 = 69\tfrac{5}{12}, \text{ now let } X = T, \text{ the}$$

required temperature, then we have

$$\frac{X - t}{459 + X} \times 400 = 69\tfrac{5}{12}, \text{ or substituting the}$$

value of t it becomes.

$$\frac{(X + 40)\,400}{459 + X} = 69\tfrac{5}{12} \text{ clearing of fractions.}$$

$$400\,X - 16{,}000 = (459 + X)\ 69\tfrac{5}{12}, \text{ trans-}$$

posing and collecting we have

$$400\,X - 69\tfrac{5}{12}X = 31862\tfrac{1}{4} + 16{,}000$$
$$330\tfrac{7}{12}\,X = 47{,}862\tfrac{1}{4}$$
$$X = 144^\circ\ 47', \text{ or, say, } 145^\circ \text{ as the required}$$

temperature.

Proof,

$$\frac{145^\circ - 40^\circ}{459 + 145} \times 400 = 69{\cdot}53 \text{ nearly, same as}$$

above.

Yours, etc.,

Westville, Picton Co., N. S., Aug. 24th. J. W. S.

Ventilation.

Editor Colliery Engineer :

SIR :—I send the following in answer to "S. U. P.," of Red Bank, Pa.:

(1). In an elliptical shaft, whose diameters are 8′ and 14′ respectively, and whose depth is 600′, with a volume of 43,982·4 cubic feet of air passing per minute, what is the velocity?

The area is found as follows:

$14 \times 8 = 112 \times {\cdot}7854 = 87{\cdot}9648$, and the volume $43{,}982{\cdot}4 \div 87{\cdot}9648 = 500'$ per minute.

(2). Using Atkinson's coefficient of friction, what would be the pressure and water-gauge resulting?

Using Wilson's formula to find O,

$$\frac{\sqrt{\frac{14^2+8^2}{2}}+\frac{14+8}{2}}{2}\times 3{\cdot}1416 = 35{\cdot}18859 \times$$

$600' = 21113{\cdot}154$, or S, then

$$\frac{K\ S\ V^2}{a} = P, \text{ or}$$

$$\frac{21113{\cdot}154 \times 500^2 \times {\cdot}0000000217}{87{\cdot}9648} = 1{\cdot}302 \text{ lbs., pressure,}$$

and $1{\cdot}302 \div 5{\cdot}2 = {\cdot}25$ w. g.

Yours, etc.,

Connellsville, Pa., August 19th. SUBSCRIBER.

[Answers to these questions similar to the above were also received from "Miner," of Braidwood, Ill., "Taffee," of Fall Brook, Pa., Joseph Quigley, of Westville, N. S., "R. P.," of Greensburg, Pa., "T. S. C.," of Gardner, Ill., and "P.," of Whitney, Pa. As the solutions cover the same principles they are not inserted.—ED.]

Mensuration.

Editor Colliery Engineer:

SIR:—Will you kindly insert the following question in your Correspondence Department, that some of your readers may answer:

A tree 80′ long, 6′ diameter at butt end, tapers to 1′ diameter, how long a rope will it take to coil around it, the coils to be close together, also how long will the rope have to be, allowing 12″ between coils?

Yours, etc.,
TRACKMAN.

Reynoldsville, Pa., September 19th.

Pumping.

Editor Colliery Engineer:

SIR:—In answer to "Beginner," of Mount Pleasant, Pa., I would say that the pump placed in the pit 20′ instead of 5′ from bottom would require less power, because it would only have to force the water 80′ instead of 95′. The difference is caused by the fact that the suction would work just as well at 20′ as 5′, if the pipe, etc., were all tight. The difference in steam power would be

$$15 \times \cdot 434 = 6 \cdot 51 \text{ lbs.},$$

for every sq. in. of plunger area. Say, the area was 80″ the theoretical amount would be 520 lbs. less weight each stroke, which divided by area of steam cylinder would give the amount of steam pressure less per sq. in. needed.

Yours, etc.,
J. V.

Punxsutawney, Pa., September 21st.

Blasting.

Editor Colliery Engineer:

SIR:—In answer to Mr. Kane's question in the September issue, I am of the opinion that it cannot explode the powder for the following reasons:

It requires all of the air in close proximity of the needle-hole to feed the flame, and as the flame cannot exist without air, it is obvious that as the air is consumed as rapidly as it approaches the hole, it cannot enter the hole. It is impossible for the flame to enter where there is no air to feed it.

Yours, etc.,
JAY.

Gamble Mines, Ala., September 16th.

Ventilation.

Editor Colliery Engineer:

SIR:—In answer to "S. U. P.," of Red Bank, Pa., I submit the following replies:

Let $m\,c$ = motive column = 23·07′.

Let w = weight of 1 cu. ft. of downcast = ·079518 lbs.

Let P = pressure — 1·8351 lbs.

Then,

(1). $q = \sqrt{\frac{P\,a}{K\,s}} \times a = 15{,}700.$

(2). $m\,c = \frac{P}{w} = 23 \cdot 07$ ft.

(3). $P\,q = u = 28{,}811 = \cdot 89$ H. P.

(4). $\sqrt{9} : \sqrt{4} :: q^3 : q^3 = 10{,}466 \cdot 66.$

(5). The units of work in this case = 19,207·2; in first case 28·811. The cause of difference is due to the fact that the power is not all used in this latter case. The fact is that with furnace ventilation you cannot change length of airways of the same perimeter and area, unless you change the pressure. Had the power been all used up the pressure would have been greater and the quantity greater.

Yours, etc.,
J. V.

Punxsutawney, Pa., September 21st.

Ventilation.

Editor Colliery Engineer:

SIR:—I wish to thank "T. S. C.," of Gardner, Ill., for his correction of my reply to "R. R. S." On pages 52 and 53, of Mauchline's book, a similar problem is worked out on the same principle, which must be wrong according to method used by "T. S. C.," hence my error. It is simply a difference in authors. I have serious doubts whether either method would be correct, if properly tested in practice.

Yours, etc.,
S. U. P.

Red Bank, Pa., September 12th.

Pumping and Surveying.

Editor Colliery Engineer:

SIR:—Will some of your readers kindly answer the following questions:

(1.) How many imperial gallons of feed water per minute will be required to supply six boilers representing 288 nominal horse-powers?

(2.) In a heading which is S. 71° E., what must be the course of a cross heading at right angles to its north side?

Yours, etc.,
T. S. A.

Anita, Jeff., Co., Pa., September 14th.

Mining.

Editor Colliery Engineer:

SIR:—Please insert the following questions in your next issue:

(1.) What is the kinetic energy, and potential energy of a cage and load weighing two tons at the top of a shaft 600′ deep, also at the bottom?

(2.) Find the kinetic energy of a train of cars weighing 30 tons, moving at the rate of 10 and 20 miles per hour respectively.

(3.) The haulage rope letting a train of cars weighing 20 tons down an incline is suddenly broken, the train passes on to a level road with a velocity of 20 miles per hour. What distance will the cars travel before they come to a stop, the friction being $\frac{1}{75}$ of the load?

(4.) Suppose the train in the previous question instead of traveling onto a level road, the road should rise 1 in 20, what distance up the incline will it go?

Yours, etc.,
R. R. S.

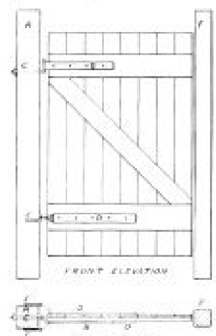
Winburne, Clearfield Co., Pa., Sept., 15th.

Mining.

Editor Colliery Engineer:

SIR:—I submit the following in reply to "Subscriber," of Lehigh, Ind. Ty.:

Will any of your readers kindly give plan and directions how to erect a door in a 4½′ vein to be opened by mules traveling both ways?



FRONT ELEVATION

GROUND PLAN

In the sketch A represents the post on which the door is hung, B a hinge made of leather, C a hook, which is fastened on the outside of the post with a nut, D D are strap hinges at the bottom of the door, and F a post which the door passes in opening either way by ½ inch. The bottom hinges should be not less than 3″ apart and hooks placed in the same post should be on a level and adjusted as required. The upper hinge should be strong, as all of the weight of the door rests on it. This door is not practicable where strong currents of air are passing, but are convenient for deflecting a weak current in another direction, or on steep grades where mules can go through both ways.

Yours, etc.,
SAMUEL KINSEY.

Glenshaw, Allegheny Co., Pa., September 12th.

Ventilation.

Editor Colliery Engineer:

SIR:—In answer to question of "S. U. P.," given in your August number, you published in your September number several solutions none of which agree. I enclose solution still different; which is right?

(1). Let

a = transverse diameter.
b = conjugate diameter.
x = 3·1416

Then

$a \times b \times x$ = area

substituting

$$\frac{14 \times 8}{2} \times 3 \cdot 1416 = 87 \cdot 9648 \text{ area},$$

And

$$43982 \cdot 4 \div 87 \cdot 9648 = 500' \text{ velocity}.$$

(2). We find that the circumference or perimeter by the following formula:

$$\sqrt{\frac{14^2 + 8^2}{2}} \times 3 \cdot 1416 = 35 \cdot 817 + \text{perimeter}$$

and 35·817 × 600 = 21,490·2 rubbing surface, and by formula

$$\frac{K\,s\,v^2}{a} = \text{pressure}.$$

Substituting

$$\frac{\cdot 0000000217 \times 21490 \cdot 2 \times 250{,}000}{87 \cdot 9648} = 1 \cdot 325 +, \text{ pressure}.$$

And

$$1 \cdot 325 \div 5 \cdot 2 = \cdot 254 + \text{w. g.}$$

Haswell is my authority for formula for finding area and perimeter of an ellipse,

Yours, etc.,
W. N. S

Falls Creek, Pa., September 12th.

Blasting.

Editor Colliery Engineer:

SIR:—I submit the following in reply to "J. T. G.," of Braidwood, Ill.:

There is a blast-hole charged with powder and tamped ready for firing. The needle is withdrawn and from the hole or orifice molded by the needle there issues fire-damp. When this fire-damp or gas is ignited at the mouth of the needle will it explode the powder at the end of the hole? State reasons, whether the answer is in affirmative or negative.

It will be impossible to explode the powder by firing gas issuing from the needle hole when the needle is withdrawn, for the reason that gas will not burn in its pure state, or not until it is mixed with oxygen. Gas issuing from a needle-hole or pipe is unmixed until it reaches the aperture, hence it will not burn but will extinguish fire. In this case the gas would burn at mouth of neeble hole the same as a jet, but would not burn in the needle-hole on account of lack of oxygen to support combustion. Also, the needle-hole acts the same as gauze on safety-lamps, *i. e.*, will cool the flame and extinguish it before it could reach the powder.

Any person that has seen gas burning either as a blower in a mine, gas jet, or from pipes, must have noticed that there is no flame at orifice, but the flame begins at a distance from the orifice, the intervening space being occupied by the gas in its purity and the flame begins at the point where enough oxygen has has been mixed with the gas to render it combustible. This space varies according to the pressure or amount of gas to be mixed in a given time.

Yours, etc.,
S. U. P.

Red Bank, Pa., September 12th.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following in reply to "A. S.," of Wilkinsburgh, who asked the following question in your July issue:

Suppoeing we have two shafts of equal depth, 500′ each, and 5′ × 5′ area. The average temperature in the downcast shaft is 41°, and in the upcast or furnace shaft, 234·9°. What amount of air will this furnace power produce in an air course 1,000′ in length, and 5′ × 5′ area? And what amount of air will this same power produce in an air course of the same size, and 4,000′ in length? We will first find the weight of a cubic foot of air in both the downcast and upcast shafts and from that data compute the pressure, thus: for the downcast

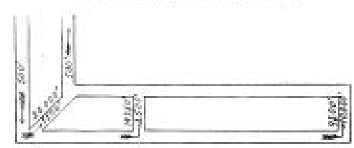
$$\frac{1 \cdot 3253 \times 30}{459 + 41} = \cdot 0795.$$

And, for the upcast

$$\frac{1 \cdot 3253 \times 30}{459 + 234 \cdot 9} = \cdot 0572, \text{ then}$$

$$\cdot 0795 - \cdot 0572 = \cdot 0223 \times 500 = 11 \cdot 15 \text{ lbs.}$$

pressure at the bottom of the downcast shaft.



We will assume the two shafts to be 500′ apart and an entry driven from one shaft to the other making the 1500′ pass 20,000 cu. ft. of air with 11·15 lbs. pressure per minute, then

$$11 \cdot 15 \times 20{,}000 = 223{,}000 \text{ units of work, and}$$

$$\frac{223{,}000}{\cdot 0217 \times 50{,}000} = 590 \times 25 = 14{,}750 \text{ ft. per minute},$$

$$\frac{223{,}000}{\cdot 0217 \times 200{,}000} = 372 \times 25 = 9{,}300 \text{ ft. per minute}.$$

Then the horse power for the 1,500′; 2,500′; and 10,000′ airways respectively are found thus to be 6·7 horse-power.

$$\frac{11 \cdot 15 \times 20{,}000}{33{,}000} = 6 \cdot 7 \text{ H. P.}$$

$$\frac{15 \cdot 11 \times 14{,}750}{33{,}000} = 6 \cdot 7 \text{ H. P.}$$

$$\frac{24 \cdot 2 \times 9{,}300}{33{,}000} = 6 \cdot 7 \text{ H. P.}$$

Yours, etc.,
HENRY NICHOLSON.

Cannonsburg, Pa., Aug. 10th.

Algebra.

Editor Colliery Engineer:

SIR:—I would say in reply to "A. B. C.," of Pittston, Pa., that in the question given, the value of x must be 2, and of y 3. Proof

$x^2 + y = 7$, substituting the values
$2^2 + 3 = 7$, or $4 + 3 = 7$, again
$x + y^2 = 11$, or
$2 + 3^2 = 11$, or $2 + 9 = 11$.

Yours, etc.,
T. S. A.

Anita, Jeff. Co., Pa., Sept. 14th.

[This question was also answered the same as the above by "Jay," of Gamble, Ala.—ED.]

Pumping.

Editor Colliery Engineer:

SIR:—Please insert the following in reply to "Beginner," of Mount Pleasant, Pa., in your August issue;

In a shaft 100′ deep a pump is placed with 5′ suction and 95′ discharge. Will it require more, or less power, if the pump is placed up the shaft with 20′ suction and 80′ discharge?

The power required with 5′ suction and 95′ discharge is found thus:

95′ × ·434, the constant give per sq. in. = 41·230 lbs. the power required.

For the 80′ discharge, using the same constant, we have

80′ × ·434 = 34·720 lbs., and 41·230 — 34·720 = 6·510 lbs., or it takes 6·510 lbs. less pressure for an 80′ discharge and 20′ suction.

Yours, etc.,
T. S. A.

Anita, Jeff. Co., Pa., September 14th.

Ventilation.

Editor Colliery Engineer :

SIR:—I submit the following in reply to questions by "S. U. P.," in your September issue:

(1). We can find the ventilating pressure per. sq. ft. by computing the difference of the weight of a column of air 1 sq. ft. in area and 100′ (which is the depth of the upcast shaft) long and at a temperature of 191° F. and a column of air of the same dimensions and at temperature of 41° F. (the temperature of outside air). Assuming a barometer of 30″, we have

$$\frac{1{\cdot}3253 \times 30}{459 + 191} \times 100 = 6{\cdot}117 \text{ lbs.} = \text{weight of}$$

column in upcast, and

$$\frac{1{\cdot}3253 \times 30}{459 + 41} \times 100 = 7{\cdot}952 = \text{weight of}$$

column of outside air.

Then

$7{\cdot}952 - 6{\cdot}117 = 1{\cdot}835 =$ ventilating pressure per sq. ft. We will assume that the shaft is the same sectional area as the airway, which being added will make the length 4100′, the perimeter being 32′.

Now

$$q = a\sqrt{\frac{P\,a}{K\,s}}, \text{ substituting the values given,}$$

we have

$$63 \times \sqrt{\frac{1{\cdot}835 \times 63}{{\cdot}0217 \times 4100 \times 32}} = 12{,}694 \text{ cu. ft per}$$

minute.

(2). The pressure is the weight of the motive column; and the pressure divided by the weight of a cubic foot of air of the outside temperature will equal the motive column.

Thus

$$\frac{1{\cdot}835}{{\cdot}07952} = 23{\cdot}076' = \text{motive column, or it can}$$

be found by the formula

$$D\,\frac{T - t}{459 + T} = \text{m. c., or}$$

$$100 \times \frac{191 - 41}{459 + 191} = 23{\cdot}076'$$

(3). The horse-power expended by the furnace equals

$$\frac{p \times q}{33{,}000} = \frac{1{\cdot}835 \times 12{,}694}{33{,}000} = {\cdot}706 \text{ H. P.}$$

(4). When the length is increased we have

$$a \times \sqrt{\frac{P\,a}{K\,s}} = q, \text{ by working out the formula}$$

we have

$$\sqrt{\frac{1{\cdot}835 \times 63}{{\cdot}0217 \times 9100 \times 32}} \times 63 = 8520 = q.$$

(5.) The h. p. expended $= \dfrac{8{,}520 \times 1{\cdot}835}{33{,}000} = {\cdot}473.$

The difference in horse-power is due to the fact that the quantity has decreased, owing to the increased length, while the pressure has remained constant, and as $p\,q = u$, the power must be less, because the quantity is lessened the pressure is the same.

Yours, etc.,
T. S. C.

Gardner, Ill., Sept. 12th.

Colliery Management.

Editor Colliery Engineer :

SIR:—I wish some of your correspondents would answer the following question to satisfy some of your readers:

Where and how can the best results be obtained from a furnace at a coal mine, whether at the top of outcast or at the bottom of outcast and state reason why?

Yours, etc.,
S.

Wilkes-Barre, Pa., September 10th.

Ventilation.

Editor Colliery Engineer :

SIR:—Please insert the following in reply to "S. U. P.," of Red Bank, Pa., who asked the following questions in your September issue:

A mine (drift opening) is ventilated by furnace. The outside temperature is 41° F., and the upcast shaft, which is 100′ in depth, has a temperature of 191° F., the dimensions of the underground airway are 7′ × 9′ × 4,000′.

(1). Using Atkinson's co-efficient of friction what will be the volume of air obtained under the above conditions?

(2). What will be the length of the motive column; (show method and formula by which length is ascertained)?

(3). What horse power will be expended by the furnace in producing this volume of air?

(4). Suppose the length of the airway is increased to 9,000′, what would be the quantity obtained, the area and pressure remaining the same?

(5). What will be the horse power expended, when the length is increased? Explain cause of difference in horse power, if any?

As the size of shaft is not given, we will assume it to be the same size as the underground airway. First, we will find the volume, as the depth, temperature, and length are given we obtain the area thus:

$2 \times 7 = 14$; $2 \times 9 = 18$, and $14 + 18 = 32 =$ O, and $32 \times 4{,}100$ (length) $= 131{,}200 =$ S, and to find the pressure

$$\frac{1{\cdot}3253 \times 30}{459 + 41} = {\cdot}079518.$$

And

$$\frac{1{\cdot}3253 \times 30}{459 + 191} = {\cdot}061167, \text{ then}$$

${\cdot}079518 - {\cdot}061167 = {\cdot}018351 =$ difference of pressure, which multiplied by the depth of the shaft, 100′, gives the total pressure, thus

$${\cdot}018351 \times 100 = 1{\cdot}8351 = p.$$

Now to obtain the velocity we use the formula

$$v = \sqrt{\frac{P\,a}{K\,s}},$$

substituting the given values we have

$$\frac{1{\cdot}835 \times 63}{{\cdot}00284704} = 40602{\cdot}25, \text{ and}$$

$\sqrt{40602{\cdot}25} = 201{\cdot}5$ the velocity, and this multiplied by $63 = 12{,}694{\cdot}5 = q$.

Second, we can find the motive column by the formula

$$D \times \frac{T - t}{459 + T} = \text{motive column,}$$

substituting their values,

$$100 \times \frac{191 - 41}{459 + 191} = 23{\cdot}077 \text{ ft.}$$

Third, the horse power of a furnace is found thus:

$P\,a \times q = u$, which divided by $33{,}000 =$ h. p.

$115{\cdot}6113 \times 12694{\cdot}5 = 147{,}627{\cdot}64 \div 33{,}000 = 4{\cdot}473$ h. p.

Fourth, by increasing the length 5,000′ the quantity is found thus

$$115{\cdot}6113 \div {\cdot}00631904 = 18{,}295, \text{ and}$$

$$\sqrt{18{,}295} = 135{\cdot}2 = v \times 63 = 8{,}517{\cdot}6 \text{ quantity.}$$

Fifth, to find the horse power

$115{\cdot}6113 \times 8517{\cdot}6 = 984{,}696{\cdot}4659 \div 33{,}000 = 29{\cdot}8275$ h. p. The difference in horse power is caused by not having as large a volume of air through increased surface without increased pressure and decreased velocity.

Yours, etc.,
J. K.

Connellsville, Pa., September 14th.

Examination Question.

Editor Colliery Engineer :

SIR:—Please publish the following in reply to "J. W. S.," of Westville, Picton Co., N. S.:

The weight of a cubic foot of air at 40° F. is found thus

$$\frac{1{\cdot}3253 \times 30}{459 + 40} = {\cdot}0797 \text{ lbs. nearly, and}$$

$$\frac{5{\cdot}2}{{\cdot}0797} = 65{\cdot}2' \text{ motive column. Now}$$

$$T = D\,\frac{459 + 40}{D - M} - 459 = 400 \times \frac{459 + 40}{400 - 65{\cdot}2} - 459$$

$= 137°$ temperature of upcast.

I notice "H. L. D. W." in answering this question proves one mistake by making another. The formula to prove it instead of being

$$M = D\,\frac{T - t}{459 + t}, \text{ should be}$$

$$M = D\,\frac{T - t}{459 + T}, \text{ and by using the latter we}$$

have

$$400\,\frac{137 - 40}{459 + 137} = 65{\cdot}1 = M.$$

Yours, etc.,
T. S. C.

Gardner, Ill., Sept. 12th.

Ventilation and Mining.

Editor Colliery Engineer :

SIR:—Will you please insert the following questions in your next issue for answer:

(1) Suppose a volume of 64,000 cu. ft. of air per minute is passing through a rectangular shaft, 8′ × 16′ and 500′ deep, what is the pressure?

If the shaft is partitioned off, *i. e.*, a brattice run from top to bottom making two 8′ × 8′ shafts, or air passages, what volume may be expected, pressure to be the same in both cases?

(2.) In case a serious breakdown should occur in the fan machinery or in the fan itself when the mine is very gassy and the fan should be stopped, would more or less danger attend the stoppage of an exhaust fan, or a blower, and why? In case a large fall should occur near the outlet where a blower is used, and another near inlet when exhaust fan is used, in which case would most danger arise? If the obstruction should be suddenly removed in both cases what would be the different effects on escape of gas from strata?

Yours, etc.,
S. U. P.

Red Bank, Pa., Sept. 15th.

German Coal Mining.

Our foreign correspondence has afforded some interesting information with reference to the richness of the great coal basin of the Sarre. This basin was formerly sought to be comprised in the French Empire, and it will be remembered that the Prince Imperial received his *baptême de feu* at Sarrebruck, at the commencement of the Franco-German War in 1870. It is now estimated that the Sarre basin contains the enormous quantity of 14,000,000,000 tons of coal. It is a generally recognized axiom that the country which possesses the most coal is destined to the greatest industrial future, and if Germany can maintain possession of the two provinces which she wrested from France in 1871 she ought to become one of the richest manufacturing nations in the world. Our foreign correspondence reveals the further important fact that the coal wealth of the Sarre basin is being at present worked upon an almost ridiculously small scale, the output being now only about 6,000,000 tons per annum. At this rate it is calculated that 2,333 years will elapse before the coal is the Sarre basin is exhausted. All kinds of fresh human combinations may be developed in the course of 2,333 years, but the probability is that the extraction of Sarre coal will proceed at an accelerated rate during the remaining years of the present century, and if it should be doubled by 1900, of course the calculation as to the 2,333 years over which the working of the basin may be expected to extend would at once fall to pieces. All calculations of this kind have a curious statistical interest rather than any real practical value; but, at any rate, the substantial fact remains that the war of 1870-71 left Germany in possession of a coal field of enormous value, from which the German Government may expect to derive an important revenue for a long series of years.

The extended working of coal in Germany is one of the most remarkable features in modern German life. If we go back to the commencement of the present century we find Germany the scene of fierce struggles for power between the French and the Germans, in which victory inclined at first to the side of the French, although they had to retreat within their original frontiers on the re-organization of Europe in 1815. But whether the Germans or the French were victorious during the first ten or fifteen years of the century, neither party appears to have paid any heed to the utilization of the coal wealth which lay buried beneath the soil over which the contending forces moved. An explanation of this is to be found not only in the preoccupation of the European mind with other matters during the Napoleonic wars, but also in the fact that the demand for coal was much less active then than it is now. Steam power had to be introduced upon a great scale before the dormant coal wealth of what is now the German Empire could acquire any substantial value But now that Germany has followed in the wake of Great Britain, Belgium, and France, and has developed numerous stationary steam engines, railways, and steamers, and now, also, that Germany has obtained what she sadly lacked in the early years of the century, viz., strength and security—she is beginning to work her coal wealth in earnest. The probability is that the output of Sarre coal will not only be doubled during the next fifty years, but that it will also be multiplied three-fold, or even five-fold.—*The Colliery Guardian.*

WESTERN PENNSYLVANIA MINING INSTITUTE.

First Bituminous District.

The following are the minutes of the meeting held in Knights of Labor Hall, Monongahela City, Pa., Saturday, September 5, 1891. Mr. Thomas S. Hutchinson presided.

Mine Inspector H. Louttit asked whether any one present was acquainted with fissures, fractures, or open spaces in the earth. Mr. Andrew Fraser said he knew of a fracture that had been made drawing pillars in the "Coal Valley Mine", the depth of the seam was 175 feet. Mr. Elijah Dainty, briefly described the fracture made in this district usually known as clay veins. Mr. Roger Rigby, of Elizabeth, gave an account of an experience he had had with faults in England. Mr. R. C Campbell, California, said that he had met with an open fracture in a mine in Tioga County, Pa., 250 feet from the surface, and that he had also seen one in Scotland, 75 feet beneath the surface. Neither of these spaces had any visible connection with the surface. The President mentioned a fracture he had met with in the Pittsburgh District which ranged in width from one to seven inches but was traceable for several miles. Mr. Statham, of Somerset County, related some experience with faults in England 30 years ago and said that at different times in his mining experience since he had noticed fractures or fissures with no connection with the surface above.

Mr. Jas. Louttit, Supt. of Brown's Mines, called attention to the fact that the dangers and difficulties attending mining were increasing, and that it was their duty as mine managers and mine officers to increase their efforts to save life and protect property. Referring to the numerous bore holes being put down for oil and gas which pass through the coal beds in the Pittsburgh District, Mr. Louttit said that he considered it the duty of every mine official whether a member of the Institute or not, to assist the operators and Mine Inspectors in preventing the sinking of bore holes or the plugging of them in the vicinity of mines. Mr. Adam Kyle, of McKeesport, endorsed Mr. Louttit's views and ernestly objected to plugging disused holes. After remarks on the subject by other members, the following resolutions were adopted:

"*Resolved*, that we, the members present, feel it our duty to state that if a Mine Inspector on visiting a mine finds such mine unsafe, or in a condition that if not at once removed may lead to serious disasters and jeopardize both life and property, that such Inspector should have, by virtue of his office, power to stop such mine working until the dangers are removed.

"*Resolved*, that we, the members of the Western Pennsylvania Mining Institute of the First Bituminous District, pledge ourselves to assist both operators and Mine Inspectors in every reasonable way, in the prevention of the loss of life and limb and in the preservation of property."

The meeting adjourned to meet in November.

A lump of coal was gotten out of No. 2 mine at Monongahela, near Fairmont, W. Va., recently, which measured 3x5x8 feet. It is large for a single lump of coal and weighs eight tons. It will be sent to the Pittsburgh Exposition, and it is the intention to forward it from there to the World's Fair.

THE PREVENTION OF ACCIDENTS IN MINES.

An Essay on Practical Means to Insure Safety in Coal Mines.

(The following paper of Mr. John L. Williams, of Shenandoah, Pa., Division Superintendent of the Philadelphia and Reading Coal and Iron Company, was one of the four essays recommended for publication by the committee of judges in the *Pittsburgh Times'* prize competition for $100 for the best essay on the "Prevention of Accidents in Mines." The prize was awarded to Mr. Austin King, formerly Inspector of Mines, but now in the employ of The H. C. Frick Coke Company. We shall publish the other two papers recommended for publication in due time.)

In order to treat intelligently upon the subject under consideration, it will be necessary to divide it into different heads or classes, which have a particular bearing upon the methods to be adopted. These, I am confident, would avert many of the great mine disasters.

In the first place employers should spare no expense in the erection of a safe and reliable plant; everything should be of the best possible kind, and especially adapted to the surrounding circumstances. All engines should be fitted more than equal in power to meet any and every contingency. The fans should be capable of producing a much greater quantity of air than is actually necessary in the present distribution. Then, in case any large and unexpected outburst of gas takes place, the fan or fans would be capable of diluting it and rendering it harmless.

MINE MANAGEMENT.

In the selection of a person to take charge of a mine great care should be exercised; his experience should be of the most practical and extensive kind, and undoubtedly he should possess tact and firmness in the management of his men. The more harmony that exists between master and men the more satisfactory results can be expected. The person in charge of a mine should be invested with power to choose his own subordinates and no restrictions should be placed upon him in the matter of procuring a sufficient number of officers to meet all emergencies. There should be a sufficient number of officers so that they could reach every working face before the men reach their work; and one or more visits should be paid each and every working face while the men are at work. This fact cannot be too deeply impressed. Whenever an order is issued, the person in authority issuing such order should see that it is fully and punctually carried out; a failure to do so results in loose discipline, which is often the cause of disasters. Whenever danger is found in any man's working face, there should be a sufficient number of officers to allow one of them to spend the greater part of his time in endeavoring to remove said danger, also to give the men the benefit of his superior ability and experience. Whenever an order that has been issued fails to be complied with by reason of negligence, then the person receiving such order should be immediately dismissed.

MINING.

Serious and mature consideration should be given to the matter of opening a new mine. The pitch of the vein, the nature of the top, hard or soft, brittle or pliable; also the indications of gas in great or less quantities would serve in aiding the person in charge in arriving at a conclusion as to the best method to be adopted in the system of mining the coal. Depending upon the depth of the shaft, etc., as to the width of the pillar that would remain intact, a wrong move in the outset has in certain cases resulted disastrously. A general squeeze covering the whole area of a colliery has been occasioned by leaving insufficient pillars. There should be a good and substantial pillar left between each breast, and every 100 yards there should be a reservation pillar of 50 yards in width. These should be left in every vein worked, and each pillar to overlie each other, so that the second outlet that I will again refer to, can be driven in every third reservation pillar, or in the second, if found necessary. This would enable us to rob the workings in different sections between the reservation pillars without affecting the safety of the gangway or general conditions of the colliery. Equally well you could first rob the breasts in the upper vein, between the reservation pillars, within a safe distance of the gangway; then proceed with the underlying veins in the same way. Thus the gangway could be kept intact until it reached the pillar line. By robbing the pillars in the manner described, no general squeeze of a large area could occur which has so often caused disasters and loss of life. In case the overlying top is of too hard a nature, and does not give way after the process of robbing has been completed between the reservations, I would suggest that this space be filled up with culm from the banks. This would avoid any concussions from heavy falls, that might cause disaster. This method of filling has been practically proved to be a success, as shown at Kohinoor Colliery, Shenandoah, Pa.

THE SECOND OUTLET.

I will now call attention to the second outlet as a means of safety for the men. In the Anthracite regions where the coal crops out to the surface, these second outlets could be driven in each and every vein to the surface, and if driven at the maximum distance of 300 yards between each and every one, if an accident should ever occur and close the men inside, the greatest distance they could be situated from the outlets as means of escape would be 150 yards. Such outlets as mentioned would ensure an easy way for rescue or escape. In the Bituminous region, where holes to the surface would not be always practicable, small shafts could be sunk at the distance mentioned, to serve precisely the same purpose. I would suggest that these outlets be maintained in good condition until the coal be all worked in the basin, gangways completed to boundary line and pillars robbed back to inside outlet; then all the pillars that have been retained to support the inside outlet can be robbed, and then the coal intervening between this and the next outlet can be dealt with in the same manner.

ENGINEERING DEPARTMENT.

The inside boss in charge should be provided with a correct map of his workings which should be kept posted once in three months at least. I would suggest that all air courses, main stoppings, and splits be marked on the map, in order that the directions of the currents be always present to his mind. This should be done before the map can be considered complete. All workings lying in close proximity to the colliery that is being opened out should be correctly surveyed and resurveyed, leaving no doubt in the minds of the employes and employers as regards the exact distances they can proceed with their workings without endangering a life. All abandoned workings should be marked on the maps, giving the relative positions of any two points that are desired to be known. If the abandoned workings contain any noxious gases or large quantities of water, or are supposed to contain them, a very wide margin should be left to insure safety, and even before reaching the margin laid out on plan, they should have bore-holes in advance of them, so that any and every precaution made will give you the satisfaction that lives are at stake and have been saved through the exercise of extra care.

LAMPS.

In a gaseous mine the miner carries his life in his hand. He is defenceless and open to be carried into eternity without the slightest warning if not provided with a good and reliable safety-lamp, a lamp that has been subject to the severest tests and has stood them. There are lamps in use that can be relied upon, as far as construction and principle are concerned. The lamp should be protected from too high a velocity of air, as danger is imminent when the flame pierces the gauze. It is not altogether from a defective lamp that mine disasters have originated, but from the careless and indifferent use made of them. In the first place, the lock of the safety-lamp should be so constructed as to defy a person to tamper with it that would not lead to detection. But a greater evil exists when illiterate and inexperienced persons are engaged who really do not know the danger that envelops them. Here is the point that should be pressed home. The miners, as a rule, are an educated class, but it cannot be disputed that there are a number of miners who need educating in the little duties and responsibilities that daily attend the full, practical, and safe execution of their work. Where blowers of gas are expected suddenly or have occurred, a safety-lamp should be provided that would surely be extinguished by the presence of gas inside the gauze. Any one found to have tampered with his lamp should be instantly dismissed, and prosecuted according to law.

VENTILATION.

This is no doubt the most important feature of a successful mine. By the word successful, I mean the mine which is practically free from all disasters that can be ascribed to the insufficient circulation of air. It is almost as impracticable to float a boat without water, as to imagine that a gaseous mine can be successfully operated free of disasters without the aid of a sound system of ventilation. Very often the quantity of air to circulate through a new mine is arrived at and based upon mathematical inferences or theoretically, which is not always reliable. It is desirable sometimes to take into consideration the condition of adjacent mines, worked under similar circumstances. Whenever such a basis is taken to work upon, care should be taken to allow sufficient margin. The ventilating power should be augmented. Then there are no risks. The fan engines should be regulated to meet different conditions as it is not always policy to have too strong a current of air. The miner's comfort commands our every consideration. I know of instances where the ventilating current is so strong that it impregnates the eyes and nostrils with dust, making it very uncomfortable. Experiments are numerous when, even after watering the roadway, the current has been so strong, together with the natural heat of the mine, as to make it impossible to keep the dust down.

THE DUST THEORY.

The theory advanced in support of the argument that coal-dust has been known to originate an explosion, I give no credence. All my experience proves to me that the explosion is only aggravated, intensified, and elongated, which is sufficient to impress upon us the importance of paying particular attention to the matter of keeping the dust down. By sections of pipes laid down the whole length of the main roadways, with jets at regular distances the water is thrown out at regular intervals, and thus the roadways are always kept damp. The distribution of air into splits cannot be too highly approved of, as each section of men receive an adequate quantity of pure air, and it is not charged with the air that men have inhaled in other sections of the mine. Each split of air is carried direct to the return and then to the upcast. Cases very often occur where explosive gases exist in small quantities, that the miner is provided with a safety-lamp to detect the presence of gas in his own working face, where it sometimes generates while he might be called away for a few minutes at a time. The fire boss examines during his prescribed time. This practice of giving a miner a safety-lamp together with his naked light "is absurd." That is where explosive gas is found.

Every year fresh evidences are chronicled in the mine inspectors' reports where men discard the safety-lamp, or accompanied their safety-lamp with a naked light, thus endangering the lives of hundreds of men. Anything that is done in a slipshod manner or by halves should be done away with. If good results are to accrue, then radical changes and improvements must be expected. All old and abandoned workings, that cannot be hermetically sealed, should be kept thoroughly ventilated and inspected at least once a week by the inside foreman or his assistants, and a correct report of the condition of the same be kept in the record book at the colliery office for the inspection of the mine inspector, and a copy sent to the district superintendent. There should be a duplicate fan kept at each and every colliery. In case anything happens to one fan, the other could be put in motion in a few minutes. I would also suggest that all fans should be so constructed that they could be changed in a short space of time from an exhaust to a propelling fan and *vice versa*. If so constructed the air currents could be changed in a short time in case of fires or explosions. Thus great disaster could be averted. I would also suggest that the air courses be of large dimensions, so that large quantities of air could be propelled through at a slow velocity. This would increase the ventilating current, by diminishing the friction. Every attention should be paid to maintain these air courses at any cost, in a first-class manner.

It is preposterous to presume that anything short of strict surveillance, careful and systematic management, and a sound system of ventilation, can prevent our hearths and homes being besieged and penetrated by tales of woe, of horrible explosions, and consequent desolation.

PROMINENT EXHIBITS AT THE PITTSBURGH EXPOSITION.

The Thomson-Houston Co.'s exhibit is a specially notable one. The sign displayed is an arrangement of incandescent lights forming the words "Thomson-Houston System." The display consists of one 30 H. P. generator which furnishes the power for all the motors in the building. There is also a 650 light alternating machine, one 100 light direct current insulated machine, and one 12 light arc machine. They also exhibit a beautiful new arc light, 23 inches high. It has no carbon rod, and no chimney. The carbon is in the form of a ribbon on a spool. As it burns, it is uncoiled, and will last for nine hours. They also show their automatic indicating instruments, which show at a glance, not only the energy supplied by the motor, but the amount consumed in the circuit. These machines took the first prize of 10,000 francs at the late Paris Exposition. Mr. H. F. Albright, Jr., a competent and affable electrical engineer is in charge of the exhibit, and he informed our representative that, owing to unavoidable delays, he had not been able to get their display of mining machinery to Pittsburgh in time for the opening of the Exposition, but he expects to have it on exhibition in a few days. Owing to the fact that the Thomson-VanDepoele Co. is very busy filling orders for mining machinery required at once, the display will necessarily be less complete than the Company would wish, but there will be enough shown to give mine owners, superintendents, and mining engineers an idea of its excellence.

Messrs. Arthur Kirk and Son, the agents for the Ingersoll-Sergeant Rock Drill Co., of New York, have on exhibition one of the Standard Sergeant Percussion Rock Drills, which attracts a great deal of attention from mining men.

The Shook-Anderson Mfg. Co., have on exhibition a couple of the celebrated New Pulsometers, manufactured by the Pulsometer Steam Pump Co., of New York. These pulsometers are in operation and practically demonstrate their superior qualities as a mine pump, where the lift does not exceed one hundred feet. Large numbers of these pumps are annually sold by the Shook-Anderson Mfg. Co. for use in mines, on coal and sand boats, and at paper mills.

The display of The Edison General Electric Co. is a specially fine one. The beautiful arrangement of incandescent lamps forming the words, "Edison General Electric Co.," attracts the visitors' eye at once. The display of electrical machinery is very fine, and the arrangement of lights in the enclosed space is artistic and beautiful. Two 20 H. P. generators furnish power for the lights, and the operation of motors. Prominent in the exhibit are two of the new Edison Single Reduction Street-Car Motors, one of 25 H. P. and one of 20 H. P. Standing side by side in happy contrast are a large 200 H. P. Motor, and one of the tiny motors used to run a sewing machine, a dentist's drill, or other light running machines. The display of electric fans, the switchboard, and new Edison arc lamps, are very fine. Mr. J. Calisch, of the New York office, is in charge of the exhibit, and he expects in the course of a few days to add one of the Edison percussion drills, and an electrical coal mining machine to the exhibit. Mr. Calisch is a pleasant and obliging gentleman, and visitors to the exposition will find him always ready to answer questions and give detailed information concerning the Edison exhibit.

Branch House.

The Lidgerwood Manufacturing Company, with headquarters at 96 Liberty street, New York City, have established a branch house in St. Louis for the sale of their standard hoisting engines, at 610 North 4th street, and 609 North 3d street, under the management of Mr. Chas. W. Melcher, a gentleman of well-known ability and enterprise.

The Lidgerwood Manufacturing Company is one of the busiest and most prosperous concerns in the United States, and have sold over 8,000 of their famous engines.

The Colliery Engineer.

AN ILLUSTRATED JOURNAL OF

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THE COLLIERY ENGINEER COMPANY, PUBLISHERS.

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STATE GEOLOGICAL SURVEYS.

ONE of the most potent factors in enhancing the prosperity of any state or country is a comprehensive public knowledge of the mineral resources of the territory. Years ago, the fact that a certain section of country was remarkably fertile, was enough to attract settlers and a moderate amount of wealth, but this is not attraction enough now.

Capital has always regarded mineral lands and mining operations as the most desirable investments, and it is naturally attracted to such sections as can show expert evidence that they possess mineral wealth. The development of the mineral resources of a state, brings in its wake, and closely following, railroads and manufacturing establishments, collectively affording employment for large populations. These large populations must in turn depend on the agricultural community for food, and as the demand for agricultural products increases, the farmer naturally secures better prices for his crops, and the value of his land, for agricultural purposes alone, is enhanced. If the same land should, after careful geological examination, be found to contain mineral wealth, it becomes still more valuable.

Notwithstanding the fact, that a geological survey benefits the farmer more directly and in a greater degree than any other citizen, the greatest opposition to state geological surveys comes from this class of citizens.

A well organized state geological survey can gather and publish more information and data concerning the natural wealth of a state in one year than any other department of a state's government can in ten years.

In every state in the Union, there are hundreds of patriotic intelligent citizens who will cheerfully, and without expense to the state, assist in making such a survey a success. They will give information and data to a competent geologist or engineer, which they will not give to any other state official for publication, because they know that no one but a professional geologist can compile the information in such shape as to make it intelligible instead of ridiculous.

The primary work of a geological survey is necessarily very general in its character. Owing to local jealousies all portions of the state must be treated on in a general way at first, and to satisfy public clamor the report must be issued as soon as possible and in a hurried manner. Such a general report must necessarily be very incomplete, and will possibly contain errors that must be corrected in subsequent reports issued after more careful investigation.

However, such a report serves as a foundation on which to build a far more complete and elaborate set of reports that will publish to the world the mineral wealth of the state, corroborated by the most indisputable evidence.

After a first general report has been issued, the state can be divided into districts and one or more district at a time can be examined. Careful surveys, and researches among the notes and memoranda of local geologists and engineers, enables the geologist in charge to arrive at valuable conclusions, and to publish a comprehensive report on the geological structure of the district. Naturally it takes time and money to do this and do it with a certain degree of thoroughness, all over a state, but it pays to do it, and to do it well.

After a state has been entirely gone over in this manner, and the reports printed, the work should not cease. A small force under the charge of a competent practical geologist should be a permanent part of the state's government, so that more recent discoveries and the corrections of details made necessary by the use of the pick and drill, may be compiled and published as additional information regarding the state's mineral wealth.

No geologist that ever lived, can go over the whole territory of a state and from his own surveys and examinations produce an absolutely correct report. He may make a very close generalization of the matter, but he will necessarily be faulty in many of the minor details. Local geologists and others going over the same ground a few years later, when the strata is more exposed by railroad cuts, tunnels, or mining operations, will find the original report faulty, and if there is a permanent state geologist he will be informed of these facts, and thus be able to make necessary corrections or change conclusions that were arrived at by incomplete evidence.

A number of the states now have geological surveys in operation, following the example of Pennsylvania; but it is to be sincerely hoped that they will not follow Pennsylvania's example in calling the surveys finished when not much more than preliminary reports have been issued of the major portion of the state.

It seems, at this writing, as if the old fogy element had control of such matters in Pennsylvania. The survey will be called finished, and after a few reports and maps now in hand are published, all work will cease. In twenty or thirty years, a new generation will demand a geological survey based on broader and more comprehensive grounds. The detailed information made evident each year will prove, in course of time, that the last survey, while in the main correct, is very incomplete. Such a re-survey will be an expensive one, and if it is summarily ended as the previous one was, will also in course of time, be found incomplete.

Therefore, it will be wisdom for each state, and particularly Pennsylvania, to establish a permanent department of the state government, under the charge of a competent geologist, which shall annually issue a report containing the latest reliable data and conclusions regarding the geology of the state. These reports will be valuable supplements to those already issued, and they will add to the value of former issues by corroborating them in some parts and correcting unavoidable errors in others.

Most of the data necessary for this work will be collected by volunteers. All that is required of the state is the permanent employment of a small corps, and the publication of the reports.

In a recent letter, a prominent geologist makes the following pertinent remarks: "States should be brought to look upon a geological survey as a necessary permanent part of the government, and until they do this they will never derive full advantages from the work. The plan of having such surveys conducted intermittently is extremely wasteful and, in fact, in many cases a survey is not continued long enough for the facts which have been acquired to be made public, and they are seldom continued long enough for all the conclusions which have been deduced from these facts to be made available. It will be a great misfortune if the Pennsylvania survey is allowed to die out completely; but from all I hear, I fear this will be the case; unless some energetic movement is made to resuscitate it."

As we noted in our last issue, a national organization of government geologists was formed in Washington, D. C., on August 29th, and the influence of this organization will be great in establishing surveys in states which never have had any, and in securing their perpetuation in other states.

This National Association of Government Geologists is now in existence, and at the meeting at Washington, the Secretary, Mr. Arthur Winslow, State Geologist of Missouri, was instructed to draft a constitution and by-laws to be submitted to the committee at a meeting to be called in connection with the annual meeting of the Geological Society in December next, and he was also requested to notify all State Geologists of this movement towards organization and to invite them to be present at the next meeting.

Pennsylvania with her boasted intelligence and great mineral development should, without delay, establish a permanent department devoted to geological research.

THE COLLIERY ENGINEER MINING SCHOOL.

WE are presenting in our advertising columns a new plan for obtaining a mining education which deserves mention here.

There is no industry which is advancing more rapidly than coal mining. During the past twenty-five years the output has increased seven-fold, and the difficulties and dangers in procuring the mineral have increased at nearly as great a rate. This necessitates more careful working, a thorough knowledge of the practice and theory of mining, and a sound acquaintance with the allied sciences. This is proved by the legislation in different mining countries, having for its object, an increase in the standard of education among mine officials.

In mining, more than in any other occupation, the safety of all the workmen depends upon the individual knowledge of each and every separate person employed, and while this is true, there is no industry in which the facilities for technical education are so limited. This is chiefly owing to the fact that the number of those who see the necessity of such an education is so small as to prevent the employment of an efficient teacher for each mining locality.

That such is the situation is due principally to want of thought on the part of the miner himself, but it is often fostered by the scoffs of the older school of mine officials, who while possessing certificates of *service* themselves, profess to deride the so-called theory of mining.

We know instances where officials, secure in the possession of these service certificates, have been heard to say that THE COLLIERY ENGINEER in giving answers to questions, does so in symbols which are unintelligible to common workmen, and which require a college student to understand.

Now, the fact is, that a little time carefully and systematically spent, by anyone whose heart is in his work, will enable him to thoroughly understand all these seemingly formidable problems. We are glad to think, however, that such people are the exception, and that the service certificated men are on the whole only too glad to embrace any opportunity of increasing their knowledge.

The necessity of some method of education which will be thorough and cheap, and which will at the same time enable every student to enjoy its full benefits, no matter however isolated he may be from all other sources of knowledge, has been evident to us for a long time, but it is only lately that we have been able to see our way to a practical issue. Our readers will have observed an advertisement in the September number, of a Correspondence Class, by Mr. Alexander Dick, an efficient and experienced Mining Engineer and Colliery Manager. After the appearance of the advertisement we concluded that the Colliery

Engineer Company, as publishers of the leading Journal of Coal Mining in this country was the best agency for the successful conduct of such a school. We have therefore entered into an arrangement with Mr. Dick, whereby he agrees to carry on his system of education as Director of The Colliery Engineer School of Mines. Mr. Dick will devote his entire time to make the school a success. We will also give the work our personal attention so that he may have all assistance in pushing the students forward.

Our plan of Correspondence Lessons in Mining is no experiment, but is an elaboration of a system which has worked with great success in Europe for the past ten years. In the United States similar plans are now being conducted with complete success in almost every study with the exception of mining. We mention this as an answer to inquiries which have been made as to whether mining practice can be successfully taught by mail. If in England, with its compact population, such a method is necessary, and beneficial, how much more useful will it be here, where scattered and isolated districts preclude the possibility of separate teachers obtaining a sufficiently large class to warrant them devoting their time to teaching.

Having once gone into this matter we intend to make it a success. It may be that through want of a proper understanding of the system some will be deterred at first from entering, but the fact that there is a system should go far to reassure them. At present, a miner is debarred from the benefits of an efficient teacher, and if he wishes to study, goes plunging through the various subjects without aid or method. The secret of success in every study is system. Our school will guide the student to give the necessary prominence to each subject. It will help him to form habits of method. It will give him the advantage of a thorough periodical self-examination in each branch of his studies, and practice him in the art of expressing his ideas clearly upon paper, so that when he goes before the examining board for his certificate he may not be in the position of "knowing what the answer is, but not being able to put it in black and white."

The text-books will be chosen for their conciseness and cheapness, and will be adhered to strictly throughout the course.

In the classes of regular schools there are differences in the ability of the students, and the result is that, either the dull pupil keeps back the others, or the others drag the dull member forward at a pace greater than his capabilities will justify, so that his last state is generally worse than his first. This can not occur in the correspondence system, as each student begins the course when he likes, and, taking one subject, and one set of papers at a time, goes through them, and only when they are mastered does he obtain the next, and so on through the course. Each student is taught independently, and of two entering at the same time, one may finish months before the other, without either being interfered with. And then again, if any student feels, after he has gone through any particular subject, that he is not sufficiently informed, or if we consider further teaching in that branch necessary, he will receive a second instalment of work before he starts on the next part of the course.

No one need fear entering on the course from want of sufficient education, as we take every subject from the rudiments, and all we require is that each student shall have a few hours every week to devote to the work, with a purpose in view, and a firm determination to succeed.

To intending candidates for Mine Foremen's certificates, the School will henceforth be a necessity, and to those who may have already obtained that magic piece of paper, we recommend the course as a well organized means of keeping the theory of their profession fresh upon them, and maintaining their knowledge on a level with the times.

The Department for the actual practice of surveying and drawing, with instruments supplied by us for the use of the students, is an idea of our own which is not introduced in any similar method of instruction. We wish it borne in mind that this department is open to any student *without any additional fee*, if he will come and reside in Scranton for a week or two. It is not necessary that every student should do this to enable him to obtain a Mine Foreman's certificate (he can be taught all he requires to know by correspondence), but, as an auxiliary at the disposal of those who wish to go more fully into the course, we consider it will be welcomed by many of the pupils.

Our aim will be to conduct The Colliery Engineer School of Mines, so that those who may obtain its diploma will gain something more than a mere empty title cheaply gotten. On the contrary, the diploma, as it will only be secured after a hard examination, will be looked upon by employers as a guarantee of ability in those who possess it.

DISCIPLINE IN MINES.

IN many instances, the official investigation of the causes of accidents in mines leads directly to a lack of discipline. More accidents occur from either direct disobedience of orders, or carelessness, than from any other causes.

Mine laws alone will not bring about immunity from accidents. If the workmen will not use every precaution to ensure their own safety, the mere fact of certain laws being on the statute book will not help them.

Colliery officials owe it to themselves, their employers, and humanity, to enforce discipline in all cases. All violations of the mine laws, however slight, should be followed by a reprimand or suspension from work, and a repetition of the offence, should mean instant discharge.

The peculiar circumstances and changes, accompanied in many cases by sudden danger, which occur constantly in mines indispensably require thorough discipline as essential to safety. Whenever the source of danger is understood and can be avoided; neglect or lack of discipline resulting in loss of life or property is inexcusable, whether it be displayed by management or the workmen.

Discipline is just as essential in the working force of a mine, as in the army. Where the carelessness of one man may result in the death or injury of a dozen or hundreds, it is of no avail that all are careful and well disciplined men, but one. All must be subject to a rigid disciplinary system. A careful perusal of the reports of both the American and British Mine Inspectors, shows that the major portion of the mine accidents with their attending destruction of life and property are due to carelessness or disobedience of orders or in other words, to lack of discipline. The cause being known, it is the duty of those in authority to apply the remedy.

It may be impossible to wholly remedy this evil, but a strong and continuous effort should be made. Spasmodic treatment will not cure the evil. To use a familiar expression, "Eternal vigilance is the price of safety."

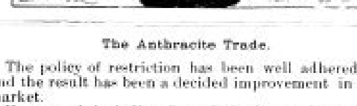
EDITORIAL NOTES.

PROF. M. C. IHLSENG, Professor of Mining in the State School of Mines, at Golden, Colo., writes us under date of Sept. 13th, as follows:

"It was purely accidental that I learned of your journal. Since I have subscribed and had opportunity to examine four numbers, I have been more and more pleased with it. And voluntarily, without any ulterior purpose, wish to say that to the mining man, it is the best, ablest and clearest journal published. I propose to recommend it to my students this school year, and hope you will gradually win the favor you deserve in this Western region.

With many wishes for continuance of the excellence, I am yours truly.

M. C. IHLSENG,
Professor of Mining.



The Anthracite Trade.

The policy of restriction has been well adhered to, and the result has been a decided improvement in the market.

Up to and including Sept. 20th the production of Anthracite coal for the year has been 27,058,225 tons, an increase of 2,815,153 tons over the production to same date last year. Notwithstanding this increase in production of nearly 3,000,000 tons, the stocks on hand at tide-water shipping points are lower than they were at the same time last year by nearly 120,000 tons.

The sales-agents held a meeting on the 16th ult. and ordered an advance of from 10 to 25 cts. per ton on all free burning coals, to take effect on October 1st. All the companies have pledged themselves to strictly adhere to these advanced prices. There was no advance made on Lehigh coal, but a proportional one will surely follow.

According to a previous agreement, all the companies on the 15th ult. cancelled all unfilled orders received previous to Sept. 1st. This action has materially strengthened the trade, and the action of the individual operators in continuing to supply coal at prices prevailing earlier in the season will not materially affect the trade. The demand is gradually getting stronger and all coal shipped is going into consumption. The outlook for the balance of the year is very promising, and the demand will certainly be heavy and prices naturally better than have been received at any time during the year.

The new railroad being built by Messrs. Coxe Bros. & Co. is being rapidly pushed toward completion as is also the Reading's line connecting it with the latter's system. As soon as the connection is made the transfer of tonnage from the N. J. C. and L. V. to the Reading Road will be made. Mr. Eckley B. Coxe, who is personally overseeing the construction of this road, is building one of the most substantial lines in the country. With all branches, it will aggregate about 60 miles in length, and will be finished in the course of a couple of months. When this transfer of tonnage is made, it is expected that there will be considerable trouble over the adjustment of the Reading's percentage for next year, but all parties are earnestly hoping for an amicable settlement of the question.

The Bituminous Trade.

The Bituminous trade is stiffening under the present condition of affairs. The demand for fuel is increasing, and while the production under ordinary circumstances could be kept to an enormously high point, but cars are scarce owing to the enormous grain production and the consequent heavy shipments. Prices are firm and will no doubt rule higher as the demand for coal, coupled with the grain shipments, is bound to be so great as to tax the capacity of most transportation companies, in the car line, beyond anything ever known before.

This naturally means an enforced restriction of production and it will have a beneficial effect on the trade.

The Coke Trade.

The coke trade is active and the demand is strong enough to warrant full time, though prices have not advanced beyond those of a month ago, or in fact for several months. Connellsville coke is still selling for $1.90 for furnace coke, $2.30 for foundry coke, and $2.65 for crushed coke, all for tons of 2,000 lbs. f. o. b. cars at ovens.

It is hard to foretell the prospects of the trade for the balance of the year. All will of course depend on the iron market, and the *American Manufacturer* declares that there is an overproduction of pig-iron, and as the semi-organ of the iron producers it is in position to pass a better opinion on the subject than any other journal. It is possible that its fears are groundless, for the country seems to be entering on a season of great business activity, and iron will naturally share in the benefits of such a condition of affairs.

At present the furnaces are making large outputs, and naturally are using large quantities of coke.

A Valuable Work.

We have received from the Mason Regulator Company, of Boston, Mass., the most complete work on steam engineering, designed for the use of practical men with limited educations, that we have ever seen. There have been many works published on steam, and the steam engine, which, although treating the subject in a comprehensive and scientific manner, have, nevertheless, failed to accomplish that which was intended (the education of the engineer), simply because the terms used by the writers, and the scientific character of the books, were beyond the comprehension of the great majority of the men who are expected to profit by their contents.

In this little treatise all terms and tables not easily understood have been avoided, and in the simplest language possible, the writer has briefly answered such questions as are likely to arise in the mind of an intelligent and practical engineer, using figures when necessary, in their simplest form, and only such illustrations as will be readily understood by any one with a common school education. Chapters I. to X. treat on air, water, fuel, steam, boilers, engines, engineers, belts, and shafting, speed of pulleys, tables, etc., respectively. These are all treated in a catechetical manner, so that this part of the work is really a thorough steam engineer's catechism. Part second treats on the combustion of coal, chemically and practically considered. It is handsomely bound in leatherette, and contains no advertisements. It is sold at the low price of thirty cents, and every colliery manager, engineer, and fireman in the country should have one. They can be procured by sending thirty cents, either postal note or stamps, to the Mason Regulator Company, Boston, Mass.

ANTHRACITE COAL STATISTICS.

Statement of Anthracite coal shipments, for month of August, 1891, compared with same period last year. Compiled from returns furnished by the Mine Operators, by John H. Jones, Chief of Bureau of Anthracite Coal Statistics.

	August 1891.	August 1890.	Difference.		For Year 1891.	For Year 1890.	Difference.	
From Wyoming Region,	1,669,625·04	1,749,217·06	Dec.	79,592·02	13,278,819·13	11,363,073·13	Inc.	1,915,746·00
From Lehigh Region,	509,640·17	578,370·17	Dec.	68,730·00	3,982,850·03	4,041,850·06	Dec.	58,999·03
From Schuylkill Region,	967,108·11	964,004·12	Inc.	3,104·19	7,641,198·18	6,562,780·13	Inc.	1,078,418·05
Total	3,146,426·12	3,291,652·15	Dec.	145,217·03	24,902,868·13	21,967,684·11	Inc.	2,935,184·02

The stock of coal on hand at tide-water shipping points, August 31st, 1891, was 648,900 tons; on July 31st, 1891, 703,634 tons; decrease, 54,734 tons.

THE NEW MINE INSPECTORS.

A Protest Against Their Appointment Filed With the Governor by Senator W. H. Hines, of Luzerne County.

We are indebted to the *Wilkes-Barre Record* for the following copy of the protest filed with the Governor against the appointment of Messrs. Blewitt and Roderick as Inspectors of the First and Second Mine Inspection Districts of the Anthracite coal regions.

WILKES-BARRE, PA., Sept. 18, 1891.

TO HIS EXCELLENCY, ROBERT E. PATTISON, GOVERNOR OF PENNSYLVANIA: I hereby, as attorney, file the following protest against the issuing of commissions to Messrs. Blewitt and Roderick as inspectors for the first and second districts of Lackawanna County under the provisions of the Act of Assembly approved the second day of June, 1891, assigning the following reasons therefor:

First, That previous to the passage of the aforesaid Act the First and Second Anthracite Coal Districts were included in one district of which Mr. Blewitt was mine inspector. That under the Anthracite law approved the 30th of June, 1885, the Judges of the Court of Common Pleas were authorized to appoint an Examining Board of the aforesaid districts.

That under and by virtue of said act of 1885 the Judges of the courts of Luzerne County appointed an Examining Board for said district and said Board appointed by the Luzerne Judges held the examinations and passed upon applicants for mine inspectors, and recommended the names of Messrs. Blewitt and Roderick for the aforesaid Anthracite mining districts. That the act approved the second day of June, 1891, repealed the act approved the thirtieth day of June, 1885; and therefore it was improper for this old Board appointed by the Luzerne Judges to examine applicants for mine inspectors in the First and Second Districts.

That so far as the undersigned knows, the Judges of Lackawanna County have not appointed a Board of Examiners for said first and second districts, nor have they any authority to do so under the act of 1891 until the first term of court held in 1892, therefore the aforesaid Board acted illegally and without authority in their recommendations of mine inspectors.

Second, That the Board above referred to were not sworn for several days after their appointment, and, in fact, were not sworn until the day they were to examine candidates for mine inspectors.

Third, that said Board of Examiners acted improperly in making up the percentages that should be allowed to candidates for questions answered. The said Board granting certain percentages to candidates for the positions they occupied, the kind of work they were engaged in, giving some high and others low percentage, thereby reducing the percentage of some entitled to more of a general percentage for questions answered relative to operating of Anthracite coal mines.

Fourth, That the act approved the 2d day of June, 1891, is not in full the act as it passed the Senate of Pennsylvania. The records of the Senate of Pennsylvania show that in section five, of said, act, all the words after the word "governor" down to the word "weekly," were stricken out, but the transcribing clerks without any authority inserted these words in the transcribed bill which was afterwards approved by the governor.

That said Board of Examiners in violation of the law that passed the Legislature have not forwarded to the governor the names of all the applicants for mine inspector qualified for the office. That several applicants who stood the examination and are qualified their names were not sent in to the governor.

That Mr. Roderick, whose name has been sent in to the governor as mine inspector, is not of legal age, and is therefore disqualified to hold the office.

That under and by virtue of the said act, approved June 2, 1891, the inspector for the new mine district created by said act cannot be recommended by any Board of Examiners until the first term of court, 1892, and by a Board then appointed by the courts of Lackawanna County. That if any vacancy exist until that time the only person who can have the power to appoint is the Governor of the Commonwealth.

I therefore ask, in consideration of what is above set forth, that no commissions be issued to Messrs. Blewitt and Roderick until such time as the matters hereinbefore set forth are properly adjudicated by the proper legal tribunal.

Truly yours,
W. H. HINES,
Attorney.

The objection against the appointment of Messrs. Blewitt and Roderick because they were passed and recommended by an Examining Board under the old law will hardly hold water. The Attorney-General has already decided that the Boards of Examiners for mine foremen, etc., appointed under the old law can legally perform their duties. It seems to us that the same line of reasoning through which the Attorney-General arrived at this opinion will apply with equal force to the Boards of Examiners for Mine Inspectors. The Attorney-General's opinion on this subject as published in our July issue is, "Under the terms of this Act, and especially Sec. 3, Article VIII., the appointment of the Board which consists of the District Inspector of Mines, two practical miners, and one owner, operator, or superintendent of a mine, or in fact any officers mentioned in this section is to be made at the first term of Court in each year." As this time is already passed in 1891, there could not be an appointment made under this Act until the first term of Court in 1892.

"It will be observed that this act repeals all parts of the act of 1885, inconsistent or in conflict with the provisions of this act. As the act of 1885 relates to the same subject matter, it is repealed by the act of 1891. Under the act of 1885 the appointments of the Board of Examiners for Mine Foremen, Assistant Mine Foremen, etc., as mentioned in your letter, were made for one year. It is my opinion these officers will continue and perform the duties under this act (which are essentially similar to those required by act of 1885) during the time for which they were appointed."

"The act of 1891 does not seem to have provided for the appointment of its officers for the year 1891, and therefore is not inconsistent with the continuance of the officers appointed or now holding office under the act of 1885. Under the act of 1891 no appointments can be made before the first term of Court in the year 1892. It would be advisable for the officers holding certificates under the act of 1885 to qualify under the act of 1891."

It is Section V., of Article 2d, of the new law that Senator Hines states is different in the copy of the law approved by the Governor from that passed in the Senate. In the copy signed by the Governor the Section reads "Whenever candidates for the office of Inspector are to be examined, the said examiner shall give public notice of the fact in not more than five papers published in the inspection district, and at least two weeks before the meeting, specifying the time and place where such meeting shall be held. The said examiners shall be sworn to a faithful discharge of their duties, and four of them shall agree in their recommendation of all candidates to the Governor who have answered 90 per centum of the questions. The names of the applicants, the questions asked, and answers thereto, shall be sent to the Secretary of the Commonwealth, and published in at least two local papers, daily or weekly, and shall recommend only such applicants as they find qualified for the office.

"Should the Board of Examiners not be able to agree in their selection and recommendation of a candidate, the Judges of the Court of Common Pleas shall dissolve the said board, and appoint a new board of like qualifications and powers."

"Upon the recommendation of the Board of Examiners as aforesaid, the Governor shall appoint such person or persons to fill the office of inspector of mines under this act, and shall issue to him a commission for the terms of five years, subject, however, to removal for neglect of duty or malfeasance in office, as hereinafter provided for."

Mr. Hines says that the words in the first paragraph after "Governor" down to and including the word "weekly" were stricken out of the law in the Senate, and should not have been incorporated in the copy sent to the Governor for his signature. At the time of the passage of the law we understood this was the case, and when we received a copy of the act signed by the Governor we delayed printing the same, and did not print it until we were informed, by what we considered good authority, that the law was likely to stand as signed by the Governor. We think the law (as Senator Hines says it passed the Senate) is as good if not better than it is as signed by the Governor, because it is less difficult to carry out, and will secure the appointment of as good officers. There is nothing to be gained by requiring the examining boards to favorably recommend all applicants who may answer 90% of the questions asked, nor can we see any benefit to be derived from publishing, at a very great expense, the questions and answers in two local newspapers every time an examination is held. It is enough to require the Boards of Examiners to report all the applicants whom they think qualified for appointment. The objection made to this arrangement is that the majority of a Board if they favor a particular candidate are likely to report the name of only a single person as qualified. Admitting that this objection is well founded, we think that it will be better for the majority of a Board to make an appointment than to leave the matter in the hands of the Governor, who will select, not the best man recommended, but the one among those recommended who has the strongest political pull. It is not safe to leave anything in regard to mining with the class of Governors we are having in Pennsylvania. The gentleman who now governs this State, with its mammoth mining interests, knows so little about the industry, and has such a poor opinion of its importance, that when the late World's Fair Commission was appointed, there were not enough mining men upon it to make a sub-committee of three. It was necessary to fill vacancies in the commission with miners to make up such a committee. This comes from selecting men who have spent their lives as clerks, and who have no idea at all of the industries from which the wealth of the Commonwealth is gained, as candidates for Governor. However, this has nothing to do with the new mine law. However much Mr. Hines may object to it, it is likely to stand as the Governor signed it.

Objection is also made to the examination the candidates were required to pass. The law says nothing in regard to the kind or standard of examinations that candidates shall pass. The whole subject is left to the judgment of the Examining Boards. Even if Mr. Hines' objections are pertinent they will have no weight, since the Boards of Examiners are the sole judges of the standard of examinations which candidates shall be required to pass. Objection is also made that Mr. Roderick is ineligible to the office, because he is not old enough. If Mr. Roderick is not eligible he cannot be appointed, but if this is a fact it is surprising that he was an applicant.

The dissatisfaction, which is voiced by this protest forcibly illustrates the folly of legislating upon mining subjects in a hurry. Senator Hines and his friends are responsible for the appointment of a thirty-five day commission to revise the mine laws. The time was utterly inadequate to study the important matters involved and report real improvements in the law, and as a consequence the new law is not as good as the old one.

The Litchfield Car & Machine Co., of Litchfield, Ill., has won an enviable reputation for good and prompt work, and mining machinery built by this company is now in use in almost every American coal field. A recent letter received from the general office of the company, informs us that they have sold and delivered a pair of hoisting engines to Messrs. Yoch and Brandenburger, of Belleville, Ill., and have just closed a contract for a pair of the Litchfield engines for the Kansas and Texas Coal Co. They are also building an engine and stock and box car loader for the Sandcoulee Coal Co., Sandcoulee, Montana, and among other inquiries which they attribute to their advertisement in THE COLLIERY ENGINEER, is one from New South Wales.

Mould's Hydraulic Coal-Getter.

For a considerable time past, Mr. E. Mould has been endeavoring to design a suitable mechanical contrivance that would take the place of explosives in dusty and fiery mines. He has produced screws and hydraulics of various forms, as well as a cylinder in the far end of the hole and water forced through a tube. But the bursting of the tubes was a nuisance. He then tried the cylinder outside, but this design was too heavy and cumbersome and others were inefficient. However, he now claims to have designed an instrument of a little over 60 lbs. in weight, to break loose almost any coal in the ordinary way of working.

This apparatus, which may be used as an ordinary hydraulic jack for any lifting purposes up to 10 tons, is thus described by the inventor: There are (1) the head, (2) the cylinder, (3) the mandrel, (4) the piston-rod, the side pieces and the pump handle. The side pieces and the pump handle are the only loose parts.

The head contains the pump, and in part answers the purpose of a reservoir.

The cylinder is simply a round parallel barrel, screw-threaded at each end, and is so connected to the head at the top end and to the mandrel at the bottom end. This cylinder is covered by a shell cylinder, leaving a cavity between the two—the inner and outer cylinder. The inner cylinder is perforated on the side at the bottom end, to allow the water to pass from the under side of the piston while it is being forced into the cylinder on the top side of the piston by means of the pump, thus supplying the pump during the operation of breaking loose the material in which it has been placed. As already stated, the inner cylinder is screw-threaded at each end. Now, while it is being screwed together, the outer shell is drawn into faced joints, both top and bottom end, and is so made water-tight, and becomes a portion of the reservoir for water. Thus there is ample provision in the head, the cylinder, and the cavity. This is to avoid the necessity of constantly refilling with water, which may be more or less unclean.

The mandrel is screwed into the bottom end of the cylinder, and so becomes a permanent joint. The mandrel is also provided with recesses, constituting inclined planes. In these inclined planes are placed side pieces or wedges, thus making the mandrel cylindrical in form, and is so placed in the hole prepared for it.

In addition to the cylinder and a piston, there is a piston rod. The rod passes from the piston in the cylinder through the mandrel, and on the bottom end there is placed a collaring, so as to enlarge the bearing, because this becomes the basis of pressure. It is very important that the machine should go to the far end of the hole, and to ensure this the drill should always be ¼ in. larger in diameter than the machine.

Now, supposing the machine is in the hole, quite at the far end, the moment pumping is commenced, the piston rod being against the far end of the hole cannot go forward, therefore, the machine moves outward, and the friction on the sides of the hole being greater than that of the incline planes, the said pieces become fixed and the machine moving outward, produces lateral pressure by means of the incline planes, thus forcing asunder the material in much larger blocks than when exposed to the shattering influence of an explosive; securing better results, and at the same time avoiding all the evils contingent on the use of explosives.

The merits claimed for this machine are: (1). Efficiency. (2). Portability, being a little over 60 lbs. when charged with water; the same is used over and over again, it may be for months, so that you see the pump is intact; and this is accomplished by the simple means of a thumbscrew. When the operation is completed, by turning a thumbscrew, the water returns to the underside of the piston. (3). Economy, being less in first cost, and less liable to get out of repair, its loose parts being so few in number—viz., side pieces and pump handle. (4). Simplicity—place the side pieces in the recesses of the mandrel, force it to the far end of the hole; if the coals are to be lifted up or forced down the side pieces must be top and bottom. But if the coal is to be forced sideways the side pieces must be right and left. Then commence pumping, and in about five minutes the coals will be down or on the sprags, ready for dropping, as required.—*The Colliery Guardian.*

Keep Up with the Procession.

In this day of close competition and small profits, it is necessary for every mine owner, superintendent, mining engineer, and mine foreman, to avail himself of all improved mechanical appliances that tend to reduce cost and enhance the value of his products. To do this he must watch carefully the new devices constantly being set before the mining public. Therefore we advise our readers to

Send for the circulars, catalogues, etc., of The Harrington & King Perforating Co., Nos. 222 to 226 North Union St., Chicago.

Send for the circulars, catalogues, etc., of The Reliance Gauge Co., 736 Ontario St., Cleveland, Ohio.

Send for the literature on self-oiling mine car wheels, mine cars, etc., published by Messrs. Hockensmith and Wagoner, Irwin, Pa.

Send for the handsome catalogue of The Goulds Steam Pump Co., Seneca Falls, N. Y.

Send for "Steam," a very handsome cloth and gilt bound volume treating on steam production, care of boilers, pipe covering, etc. It is really a text-book on the subject. Babcock & Wilcox Co., 30 Cortlandt Street, New York.

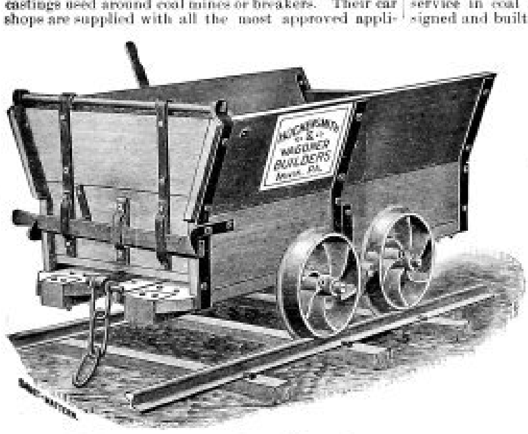
Send for "Key to Steam engineering," a simple and convenient catechism on steam engineering, completly covering the subject, and including also a treatise on combustion of fuels. Price 30 cents post-paid. Address The Mason Regulator Co., Boston, Mass.

All the above but the last will be sent free. The latter is fully worth the nominal price charged for it. When writing mention THE COLLIERY ENGINEER.

A GOOD MINE CAR WHEEL.

The strongest proof of the excellence of any specialty, whether mechanical or otherwise, is secured when the sales to parties eminently qualified to judge of its merits rapidly increases in a regular ratio, and when each purchaser repeats his order. This has been the case with the "Common Sense Mine Car Wheel," manufactured by Messrs. Hockensmith & Wagoner, of Irwin, Pa. This firm is composed of two young and energetic men whose whole business life and natural inclination eminently fit them for the business in which they are engaged. The "Common Sense Wheel" is the invention of Mr. Frank C. Hockensmith, who for over twenty years has been actively engaged in mechanical pursuits, having started at the early age of seventeen years. After much thought and study, and numerous experiments, he invented and patented the wheel of which we give a sectional view herewith. The points of advantage in this wheel are: (1) It has no loose parts to get out of repair. (2) The device for oiling the back part of the journal effectively, where the hub and axle collar come in contact, which it is important to keep well oiled, is perfect. (3) It effects a saving of from 50 to 75 per cent. of oil. (4) The bracket in the oil chamber prevents the oil from being thrown out when running on curves. (5) The oiling arrangement only adds 4 lbs. to the weight of the old style wheels. (6) Its simplicity and cheapness of first cost and durability and efficiency. Since the formation of the firm of Hockensmith & Wagoner and the purchase of the Irwin shops, in 1886, the firm has, beside its other business, sold over eighty thousand of these wheels. They are in use in every American coal field, and sample sets are sent on approval to responsible parties. If not satisfactory they can be returned at the manufacturers' expense.

In addition to the car wheel foundry, Messrs. Hockensmith & Wagner are prepared to make all kinds of castings used around coal mines or breakers. Their car shops are supplied with all the most approved appliances and their mine cars substantially and conveniently constructed. They make all sizes and styles of mine cars and equip them with either "Common Sense" or plain wheels. The present capacity of their works is six hundred car wheels and fifty mine cars per week. In 1886 when they started under the firm name of Hockensmith & Wagoner, they employed five men. The superiority of their products soon won for them a reputation, and the number of hands employed was gradually increased till now they employ fifty, and they will continue increasing as rapidly as their business demands it. They realize that two things are necessary to secure and hold trade, and that they are ready to furnish both. These are superior goods, and prompt filling of orders. It will pay colliery owners and colliery officials to write to Messrs. Hockensmith & Wagoner for circulars.



Remington Brothers' Newspaper Manual, 1891.

We have just received the fifth annual edition of the Newspaper Manual of Remington Bros., of Pittsburgh, Pa., which appears in a greatly enlarged form, and is now one of the most concise, convenient and reliable works of its kind. The general arrangement of this useful book remains unaltered, but important and valuable additions have been made, thus increasing its value to the general advertiser as a reference work and in the compilation of his list.

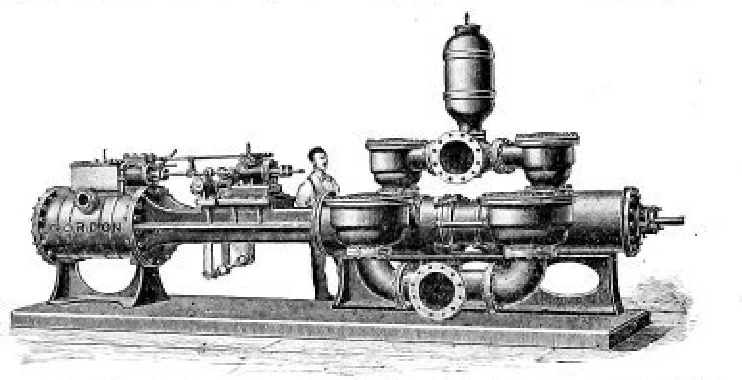
The contents include complete lists of all newspapers in the United States and Canada, with their days of issue, politics, and circulations, and properly classified list of the principal Dailies and Weeklies, and the best Agricultural, Religious, Scientific, and Trade publications and leading Magazines. All the lists are catalogued by towns in alphabetical order, and in the general list the population is given of each town and of the county in which it is located

The photo-engraving, on page 3, of Remington Bros.' extensive and handsome main office at Pittsburgh will give some idea of the extent of their business transactions.

We have tested the accuracy of the Manual and find it singularly free from errors. To advertisers especially it must prove invaluable, containing as it does every particular necessary for the general description of each newspaper, and so arranged as to admit of the readiest reference.

A SUPERIOR MINE-PUMPING ENGINE.

In this issue we present to our readers an illustration of a large mine pumping engine, which is one of a number of its kind constructed by the Gordon Steam Pump Co of Hamilton, Ohio. This particular machine has a steam cylinder 24″ in diameter, water plunger 15½″ in diameter, and a stroke of 36″. The water cylinder with all valve chambers, valves, plunger, and plunger-rods, suction and discharge connections are cast of a high grade of composition, and the amount of this metal in the pump end is a little over seven tons, the total weight of the engine being in the neighborhood of twelve tons.



This pump engine is particularly adapted for the hard service in coal and other mining practice, being designed and built especially for this class of work.

One of the leading and peculiar features of this engine is the cataract and self-governing device. The combination of these secure results which entitle it to the well-known characteristic of Isochronal or equal spaces in equal times; that is the strokes of the piston are all equal in length and are made at equal times, being unaffected by variations in the steam pressure, or in the resistance against which the engine is working. The isochronal valve-gear not only neutralizes the bad effect of the sudden change in the steam pressure or the load of the engine, but also secures other advantages of the greatest value. By means of the cataract the movements of the main steam-valve are automatically graduated and controlled, so the speed of the piston is reduced as it nears the end of the stroke, allowing the valves to seat themselves gently and quietly and the moving column of water to come to a gradual and easy rest. In fact, the cataract is an ever watchful and never-tiring engineer, always promptly adapting the movements of the engine to the external conditions of the work.

Large columns of water may be raised to great elevations or forced against heavy pressure from without shock or jar of any kind and with entire safety to the machinery and connections.

The Isochronal pumping engine is especially adapted and conveniently fitted for draining out mines, furnishing rolling mills, iron furnaces, or any establishment requiring a large supply of water. This engine is built in all sizes and for all duties, and is also built either compound, compound-condensing or high pressure, both duplex or single, as the case may demand.

Parties contemplating the purchase of pumping machinery would do well to open a correspondence with the Gordon Steam Pump Company and investigate their engines.

PERSONALS

MR. WILLIAM J. WATKINS, formerly connected with the Oregon Improvement Co., has assumed charge of a new mine at Blue Canon City, Whatcom Co., Washington.

MR. WILLIAM J. MCDOWELL, of Snowshoe, Center Co., Pa., has accepted the position of Superintendent of the O'Shanter Mines at Clearfield, Pa.

MR. JOHN H. JONES, the well-known compiler of coal trade statistics, has been appointed General Manager of The J. B. Sanborn Company for the territory east of the Ohio river. We predict that under Mr. Jones the Agency will be brought up to a high state of efficiency.

NEW MINING COMPANIES.

Names and Post-Office Addresses of the New Mining Companies Incorporated in the United States Since our Last Issue.

Russell Coal and Mining Company,	Russellville, Ark.
Ophir Mining Company,	Butte, Mont.
Marengo Gas, Mineral, and Mineral Water Co.,	Liberty, Indiana.
Columbian Lead and Zinc Co.,	Chicago, Ill.
The International Railway Supply and Improvement Co.,	Chicago, Ill.
Chancy Creek Mining Co.,	St. Paul, Minn.
The Wylie Mining and Milling Co.,	Denver, Colorado.
The Calender Mining and Milling Co.,	Denver, Colorado.
Almeda County Improvement Co.,	Oakland, California.
The Peck Montana Co.,	Chicago, Illinois.
Eastern Oregon Development Co.,	Portland, Oregon.
Cleveland Gold and Silver Mining Co.,	Sierra City, Cal.
St. James Mining and Mineral Paint Company,	East St. Louis, Ill.
The Fanny Rawlings Mining Co.,	Colorado Springs, Colo.
New York and New Jersey Mining Company,	New York, N. Y.
The Castle Mining Co.,	Denver, Colorado.
The Willow Mining and Milling Co.,	Denver, Colorado.
The Ruby Mining and Milling Co.,	San Francisco, Cal.
Marion Iron Ore Company,	New York, N. Y.
Silver Horn Mining Co.,	Neihart, Mont.
The Clear Creek Mining Co.,	Springfield, Ill.
The Austin Mining Co.,	Jersey City, N. J.
Dry Fork Mining Co.,	Barker, Montana.
Bear Valley Mining Co.,	San Bernardino, Cal.
The Garabaldi Mining and Smelting Company,	Chicago, Ill.
The Dodson Lead and Zinc Co.,	Bethlehem, Pa.
The Chicago and Florida Phosphate Company,	Chicago, Ill.
The May Queen Lode Mining Co.,	Pueblo, Colorado.
Yellowstone Mining Co.,	White Sulphur Springs, Mont.
Blackbird Coal Co.,	Unionville, Mo.
The Dufont Mining Co.,	Camden, N. J.
Westmoreland Fire Brick Co.,	Pittsburgh, Pa.
The Gaylord Coal Co.,	Martins Ferry, Ohio.
Bone Valley Phosphate Co.,	Portland, Me.
The Anglo-American Cotton Milling and Coal Mining Co. (Amended),	Kansas City, Kansas.
Montezuma Improvement Co.,	St. Louis, Mo.
Acme Coal and Coke Co.,	Opekiska, W. Va.
Principio Furnace and Rolling Mill Company,	New York, N. Y.
American Land Co.,	Louisville, Ky.
Kentucky Land and Improvement Company,	Louisville, Ky.
Montgomery Marble and Mining Co.,	Montgomery City, Mo.
The Milan Land and Coal Mining Co.,	Milan, Mo.
Ozark Mineral Land and Mining Co.,	Carthage, Mo.
American Mining Company of Kansas City,	Kansas City, Mo.
The American Tin Plate Co.,	Elwood, Ind.
The Kaufman Gas Co.,	Arcadia, Ind.
The Crown Mining and Milling Co.,	Denver, Colorado.
Chicago Carbonate Mining Co.,	Anaconda, Mont.
The Bandora Mining and Milling Co.,	Colorado Springs, Colo.
Kenova Coal and Timber Co.,	Kenova, W. Va.
The Saratoga Mancos Gold Mining Company,	Mancos, Colorado.
The Boulder Comstock Mining Co.,	Helena, Mont.
Little Nellie Zinc Mining Co.,	St. Louis, Mo.
Montague Coal Mining Co.,	Fort Worth, Texas.
The Anchor Mining Co.,	Kansas City, Mo.
The Springfield and New River Development Co.,	Springfield, W. Va.
The Hammett Mining Co.,	Jersey City, N. J.
The Indiana Mining Co.,	Butte, Mont.
The Mexico and Central and South American Mining and Colonization Company,	Denver, Colorado.
The Francenia Mining Co.,	Leadville, Colorado.
The Vesuvius Mining and Milling Company,	Leadville, Colorado.
Silver Queen Mining Co.,	Ardmore, Ind. Ter.
San Domingo and Hay Tunnel Mining Company,	Oshkosh, Wis.
San Mateo Mining Company,	Oshkosh, Wis.
Eureka Gold Company of West Virginia,	Philadelphia, Pa.
Lone Mountain Mining Co.,	Silver City, N. M.
Ophir Mining and Milling Co.,	Great Falls, Idaho.
The Sapphire Mining Co.,	Victor, Mont.
The Buckwheat Coal Co.,	Lewiston, Ill.
Gold Mountain Mining Co.,	San Francisco, Cal.
Sacramento Mexican Mining Co.,	Sacramento, Cal.
Mount Morian Quartz Mining Co.,	Downieville, Cal.
Bonner Oil Company,	Los Angeles, Cal.
The Bituminous Consolidated Mining Company,	San Francisco, Cal.

DEATH OF HON. WM. L. SCOTT.

Hon. Wm. L. Scott, of Erie, Pa., one of the largest individual owners of coal land in the world, and heavily interested in other business enterprises, died at Newport, R. I., shortly after midnight on the 20th ult.

Mr. Scott was a typical self-made American, and his rise from poverty to great wealth and prominence in both the business and political world was marvelous, and was due entirely to his great mind and his aptitude to foresee chances that are evident to most men when such chances become things of the past. In our November issue we will publish a portrait of Mr. Scott, and a synopsis of his life more in keeping with his character as a man, a patriot, and a philanthropist than is possible in the limited space at our disposal in this issue.

THE PROGRESS IN MINING.

Reviews of the Important Papers Relating to Mining Published in the Proceedings of the Mining Institutes and in the Mining Publications of Europe, United States, and Canada.

Coal Cutters. — A paper recently read before the Mining Institute of Scotland, by Mr. Robert Martin, descriptive of the working of Mechanical Coal Cutters by compressed air, has been fruitful in eliciting a few experiences from the members present. The case in question was where one of Rigg & Micklejohn's patent machines holed a face of work 126 yards long. The seam was 4 ft. thick, with an even holing, and the depth holed was 30 inches. The air was compressed on the surface and conducted underground 700 yards in pipes. The cutters were of "titanic" steel, and worked like a horizontal circular saw. The machine which worked at night was manipulated by three men, two of whom looked after the cutters, whilst the third cleaned the dirt from the holing and set the sprags and props to sustain the coal until morning when a staff of nine fillers with three drawers and four brushers came to load it out. The machine, barring accidents, traveled the whole length of face (126 yards) in a night, and the cost in fuel at the boilers for this work was five tons. The fuel was dust, passed through a ½" screen.

It requires training to make the men competent to work the machine, and difficulty is sometimes met in obtaining them. The general expression of opinion by the members seemed to be, that the only material saving was in the smaller percentage of small coal made by the machine as compared with hand labor, and so far as Scotch mining is concerned, it has only been where men are scarce that the machine has been adopted. The initial outlay is always great, and the amount of machinery involved demands an increased staff of skilled mechanics. To secure favorable results there must be a plain, unvarying holing, free from occasional ironstone nodules, the presence of which generally results in stripping the cutters and placing the machine *hors de combat* for several days.

Longwall.—Balgonie Colliery, in Scotland, was troubled with gob fires. The seam worked is seven feet thick with a parting of stone a few inches thick in the middle. For the purpose of preventing spontaneous combustion, Mr. Alexander Jamieson, the manager, introduced a new method of Longwall, and as it has been successful in abolishing these fires during five years, it has been described in a paper read before the Mining Institute of Scotland, by Mr. Robert McLaren. The working is divided into sections by parallel heading roads driven to the rise, and from these headings branch roads are turned level course 12 yards apart. As they advance the bottom leaf of coal, three feet thick, and the stone parting above it, is all excavated, and the stone utilized for building roadside packs. To make height, the roadways are brushed up to the top of the vein (7 feet). Care is taken to build the roadsides tight, and when the brushing &c., is not sufficient to do so, old slabs and coal-dross are utilized. This working progresses until the next panel or section of the pit is reached, when the miners start back, excavating the upper leaf, and using the old roads for drawing the coal which were used in the first working. Mr. Jamieson claims that by this method he has a cheaper and safer working, better ventilation, and perfect immunity from gob fires. Formerly both halves of the seam were worked in the same direction, one behind the other.

In discussion before the Institute the question was raised as to what percentage of the entire seam was necessary for efficient brushing. In the section in question the percentage of rubbish was 30% of the entire area excavated, and a member who had investigated numerous instances throughout Scotland, stated that experience proved that the best results were obtained where there was 40% of rubbish.

Propping.—A paper on this subject recently read before the Scotch Institute, by Mr. Robert Martin, whilst containing nothing striking in the way of novelty, drew from the president the very trite remark, that, in the West of Scotland, where he is Government Mine Inspector, while 40 per cent. of the entire accidents were due to falls, the majority of these were in places where the roof had obtained a good reputation. At collieries where the roof was *notoriously* bad, timber could be seen put up as close to the working force as possible, and consequently accidents were very rare; but if a roof was generally good the miner seemed to turn careless, and while one might see the traveling roads beautifully timbered, at the same time, the working places, where the men spent all their time, would be devoid of wood for 10 or 12 feet from the face. Familiarity breeds contempt!

Oil Shale Mining.—During the past few months the Mining Institute, of Scotland, has had under discussion a series of papers descriptive of the methods of mining as practiced in the oil shale industry in the East of Scotland, and whilst a few extracts may be interesting, it might also be well to recount in a few words the circumstances which led to the founding of an industry which, in all its ramifications, gives employment to thousands of the workers in the Scottish mining and chemical industries.

Somewhere about thirty years ago a discovery was made of oil exuding from the rock in a Derbyshire mine. A sample was sent to James Young, a Manchester chemist, who found that it contained chemical properties which made it valuable as a burning oil. The circumstances under which it was discovered led him to the conclusion, that, before such an oil could exist, there must have been some mineral from which by natural distillation the oil was procured, and he made it his life study to find that mineral. Ultimately his quest was successful in the discovery, in the Lothians in the East side of Scotland, of a series of seams of Bituminous mineral, somewhat akin to Cannel coal, and amongst which was the famous Boghead or Torbanehill gas coal, the cause of one of the greatest law-suits that ever excited the mining world; and from the discovery of those seams arose the paraffine oil shale industry which now gives employment to many thousands of Scotland's industrial army, and transformed the quondam Manchester chemist into a millionaire.

In the geological section the oil shales lie below the Hurlet limestone which is the base of the legitimate coal field of the great Lanarkshire basin. The workable seams of shale were originally six in number, as follows: Dam Shale, Mungle Shale, Grey Shale, Fell's Shale, Broxburn Shale, and Dunnet's Shale, and the base of these was the Burdiehouse or Campe Line.

In recently published sections, however, there is another seam shown as existing below the Burdiehouse Line, and which is named the "Pumpherston," from the only locality in which it has been found. Peculiarly enough, however, where the Pumpherston shale is found there is some geological disturbance to prevent the geologist from inspecting the Dunnet, and *vice versa*. Of course this may not be so strange in a district where the field is so overrun with faults, that the student is sometimes at a loss to say whether he is in a stratification of seams interspersed with faults, or in a conglomerate of faults, besprinkled with oil shales. Be this as it may, however, there seems reasonable cause for doubting the positive existence of two separate seams, more especially as each has many features in common, and some, well versed in the section, are inclined to say that the Dunnet and Pumpherston are identical.

A few months ago we were in conversation with a mining engineer who has earnestly studied this district for many years, and he said: "Let me illustrate "the problem by a story: A man who had come into "an estate, arrived to take possession, and noticed that "the butler and gardener were extremely like each "other. He arranged upon several occasions to have "them both together, but when the time arrived something was sure to turn up to prevent him from seeing "them side by side. Ultimately he succeeded, by "thorough investigation, in finding out that they were "one and the same person, taking advantage of his "inexperience to draw a double salary. So is it with "these two seams, where Dunnet is Pumpherston is "absent, and where Pumpherston is, Dunnet is not."

The general method of mining the oil shales is explained in a paper read by Mr. Alexander Faulds, on "Shale Mining at Oakbank."

In this seam, the Dunnet, the section is as follows:

Roof.	Fakes.
Second Working	Shale 3 ft.
Brushing.	Blaes 3 ft. 5 inches.
First Working	Shale 3 ft.
Pavement.	

The system is Longwall. The length of each working face is 15 yards, and as the roof is tender it is found advisable to have each face a "fall" in advance of the one next on the "inbye" side. Oil shale labors under this disadvantage, that it is sometimes extremely difficult in the pit to distinguish between good shale and the blaes, or dirt, which in every case, lies either over the seam or intermingled with it in layers of varying thickness, and it will be observed that in this case a band of 3 feet 5 inches intervenes between the two portions of the seam. The lower leaf is first holed under and blasted down for a distance of 9 feet in from the face, and after this is loaded the timbers supporting are drawn, and the overlying strata, to the top of the upper leaf, is then dropped. The shale being uppermost is now put into the cars, and then the "blaes" is used for building the roadsides. The roadways, which run directly to the rise, rarely exceed 300 ft. in length, being cut off periodically by slope roads or levels driven from the main incline. Each of these working faces of 15 yards long is worked by two miners, and a drawer, the duty of the latter being to run the cars, which hold half a ton each, down the roads to the gangway. These three men use 3 pounds of gunpowder per day, and put out 5·37 tons, or an average of 1·79 tons per man.

The Fall Meeting of The American Institute of Mining Engineers.

The sixtieth meeting of the American Institute of Mining Engineers will be held at Glen Summit, a beautiful mountain resort near Wilkes-Barre, Pa., beginning Tuesday evening October 6th.

The following provisional programme is announced by the Secretary:

Tuesday evening, Opening Session.

Wednesday morning and afternoon, sessions for the reading of papers and discussions.

Wednesday evening, "Camp Fire," on the grounds of Gen. Paul A. Oliver, at Oliver's Mills.

Thursday, Excursion in the Wyoming region; luncheon at Harvey's Lake.

Thursday evening, Final Session.

Friday, excursion in the Lehigh region, including visit to the iron breakers of Coxe Brothers & Co., and to collieries where large Anthracite seams are worked by stripping off the overlying strata.

That the sessions will be interesting is evidenced by the announcement of the following papers to be read:

Electricity in Mining, as applied by the Aspen Mining and Smelting Company, by M. E. Holt, Aspen, Colorado.

Electric Locomotives in German Mines, by Karl Eilers, Berlin, Germany.

The Manufacture of Liquid Sulphurous Acid in Upper Silesia, by Karl Eilers, Berlin, Germany.

A Chinese System of Gold-Milling, by Henry Louis, Singapore, Straits Settlements.

The Utilization of Puddle-Slag for Paint-Stock, by Axel Sahlin, New York City.

The Florence Oil Fields, Colorado, by George H. Eldridge, U. S. Geol. Survey, Washington, D. C.

A Survey of the Planches de Plata Mines, Sonora, by Henry M. Stanley and Henry O. Flipper, Nogales, Arizona.

Co-ordinate Surveying, by Henry O. Flipper, Nogales, Arizona.

Cord-wood in the Matting Blast-Furnace, by Herbert Lang, Mineral, Idaho.

The Bendigo Gold-Field, by T. A. Rickard, Allemont, Isere, France.

Apparatus for the Manipulation of Iron and Steel Plates during the Process of Finishing, by Gram Curtis, Pittsburgh, Pa.

The Handling of Ingots and Moulds in Bessemer Steel Works, by Gram Curtis, Pittsburgh, Pa.

Centrifugal Ventilators, by R. Van A. Norris, Wilkes-Barre, Pa.

Tandem Tanks for Hoisting Water from Flooded Slopes, by J. H. Bowden, Wilkes-Barre, Pa.

The Utilization of Anthracite Waste by Gasification in Producers, by W. H. Blauvelt, Philadelphia, Pa.

The Use of Magnetic Concentrates in the Port Henry Blast-Furnaces, by N. M. Langdon, Port Henry, N. Y.

Special discussions are also expected on the following topics:

The Preparation and Utilization of Small Sizes of Anthracite Coal, and The Practical Uses of Concentrated Iron Ores.

Mr. Norris' paper on Centrifugal Ventilators will naturally be one of great interest, and there will no doubt be considerable discussion of this important subject.

McARTHUR-FORREST PROCESS OF GOLD EXTRACTION.

BY J. S. McARTHUR.

(In the Journal of the Society of Chemical Industry, Vol. IX., Abstracted by A. L., of the Mining Institute of Scotland).

The author describes briefly a number of the different mechanical and chemical processes hitherto in use, by which the metal has been separated from the ore. After experimenting on ores from all parts of the world, the inventors adopted the following process, which may be stated in the author's words: "The ore is ground to about the fineness of sand. If, instead of ore, we are working tailings from the amalgamation process, these are generally not re-ground, but treated as delivered. The finely-divided material is mixed with a solution of cyanide, say cyanide of potassium, containing on an average 0·4 per cent. of cyanogen as the cyanide of potassium or other alkali or alkaline earth. The ore and solution are stirred together for six hours, more or less; and when the gold is known to be dissolved, the pulp is discharged into an ordinary filtering tank, where the filtration may, if necessary, be assisted by suction, and where the ore is washed by water or by the waste cyanide solution from a previous operation. The ore, after treatment with cyanide solution, is unchanged to the eye, as almost nothing but the imperceptible proportion of gold present has been removed. The gold now being in solution, the next object is to get it precipitated, and here we encounter a serious difficulty. Gold and cyanogen have such a strong mutual affinity that it is difficult to get any substance that will separate them. The gold cannot be precipitated by any ordinary method, such as the use of ferrous sulphate or oxalic acid; even sulphureted hydrogen and sulphide of sodium will not precipitate gold from its cyanide solution, though they precipitate silver. We had noticed, however, by experiment, that zinc precipitated gold very feebly, and tried this in the same way that copper is precipitated from its ordinary solutions by scrap iron, but scrap zinc had no effect; then granulated zinc was tried, with a most imperfect and disappointing result; then heating in presence of scrap and granulated zinc, but this had only the effect of forming urea, and assisting the precipitation very little indeed. Further, we tried zinc dust, but still there was no success. Finally, we prepared some zinc in a form like sawdust, porous, and with a large surface of bright metal. On allowing the cyanide of gold solution to trickle through a mass of the zinc, we found that it trickled out gold-free, and, better still, we found that the action became more vigorous and pronounced after a portion of the gold had been precipitated on it, doubtless as gold and zinc formed together a more powerful electro-chemical precipitant than zinc by itself. An arrangement of a porous mass of zinc like a sponge formed a chemical filter, which at once precipitated and collected the precious metal; indeed, so like an ordinary water-purifying device was this zinc filter that many non-technical visitors formed and held tenaciously to the idea that the gold was in suspension in the cyanide solution, and the zinc was used merely because of its durability. Improvements in detail were made in the direction of increasing the surface, and decreasing the weight of the zinc, till now we have it in threads, 1 lb. of which occupies about two gallons measure. The zinc in this form is possessed of enormous chemical activity, of which the strongest and most direct evidence is the fact that it burns in the air like thin shavings of wood. When the gold has been deposited, it is necessary to separate it from the excess of zinc present. The filiform structure of the zinc, and the exceedingly fine powder, as which the gold is deposited, render this an easy matter. The filiform mass of zinc, with gold powder adhering, is vigorously shaken in water, and the gold falls off, and the fibrous particles of the zinc may be collected in a sieve. The gold settles easily, is collected, and fused directly into bullion."

PRIMARY EDUCATIONAL DEPARTMENT

FOR CANDIDATES FOR

MINE FOREMEN'S CERTIFICATES

AND FOR

STUDENTS OF MINING.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the sciences related to mining and to learn how to answer the questions in ventilation, surveying, and mechanics which are asked at the examinations for mine foremen's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine foremen and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and many calculations are worked out at length for the benefit of those who are not familiar with figures.

CORRECTION.

Some of the readers of this department in the last month's issue of THE COLLIERY ENGINEER, were doubtless confused by Fig. 2, page 42, which was through a mistake of the pressman printed upside down.

PENMANSHIP.

The capital letter E is generated by the same elements as the other letters. It will be seen that it consists essentially of two ellipses, the upper and the lower, the major axes not only being parallel, but when correctly drawn, lie in the same straight line; the loops and scrolls are generated in just the same way. Figs. 18

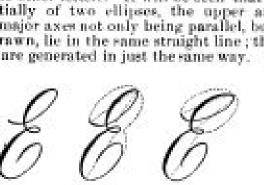


FIG. 18.

and 19 furnish illustrations of the correct principles on which this letter is produced, and also show how any divergencies from the correct elliptical arrangement produce deformities. Beginning at the left hand side of Fig. 18 the first letter is correctly drawn; Letter 2 illustrates the development of the letter by the laws of penmanship, it shows the axes of the two large ellipses to be parallel, and the upper loop is shown as a development of an ellipse whose major axis is inclined at an angle of about 20° from the major axis of the large ellipse. The little or intermediate loop is shown to be developed by the interlocking of the two large ellipses, and the scroll consists of two ellipses having their axes parallel.

In Letter 3 the major axis of the upper ellipse is not parallel to the major axis of the lower ellipse, hence the letter appears as a manifest deformity.

Letter 1, Fig. 19, shows that the proportions between

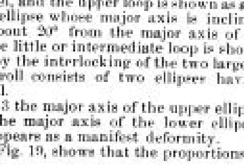


FIG. 19.

the upper and the lower ellipses are not correct, the major axis of the upper ellipse being too short. Letter 2 manifests the same disproportions in an opposite way, namely, the major axis of the upper ellipse is excessively long contrasted with the major axis of the lower ellipse. Letter 3 shows that the major axis of the ellipses that generates the loop is inclined too little from the major axis of the upper ellipse.

Figs. 20 and 21 illustrate the development of the capital letter F. Letter 1, Fig. 20, beginning at the left

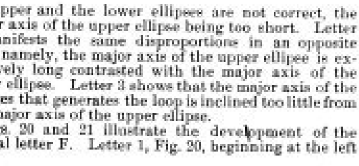


FIG. 20.

is drawn on correct principles, and is in conformity with the general laws of penmanship. The second letter illustrates the development of the Fig. by the first four laws of penmanship. Letter 3 shows two causes of deformity; first, the involved lines of the scroll are not parallel, and the letter is crossed below the middle of the stem, producing a deformity painful to the feelings.

Letter 1, Fig. 21, shows that the stem of the letter is crossed at too great an elevation, hence arises a deformity as manifest as that of the former. In Letter 2 the initial curl of the letter violates the first laws of pen-

FIG. 21.

manship, namely, all strokes shall be parallel, hence the offensive feature in this letter, which renders it repellant to the feelings.

ARITHMETIC.

FRACTIONS.

There is nothing difficult in arithmetic, the difficulty lies in ourselves, we study rules and incorrect principles, all the while forgetting that rules are only ordinary arrangements arising out of principles. Numbers may be said to express things in whole or things in part, one or more wholes may be expressed by ordinary figures, and a part of a whole must be expressed as less than one, therefore, this part is called a fraction, a piece or particle taken from a whole, or remaining after a portion of a whole has been taken away. To understand this is to have clear views of concrete, or complete things, and fractions, or portions of a thing. Again, we might speak of one foot as a unit of length, and as far as that unit of length is concerned one inch is only a twelfth of one foot, because there are twelve inches in a foot; let us for a simple illustration imagine a strip of paper twelve inches long, if eleven inches be cut off that strip only one inch will remain, and this one inch will represent the $\frac{1}{12}$ of the original foot, or the eleven inches cast away may be represented as $\frac{11}{12}$ of a foot, so that we say we have cast away $\frac{11}{12}$ and retained $\frac{1}{12}$ or, in other words the whole of anything is equal to its parts, then the whole foot must be equal to $\frac{1}{12}$ of the foot and to $\frac{11}{12}$ of a foot, and these two portions conjoined produce the original whole. An inch may be considered itself to be a whole inch. Having a strip of paper one inch long, if one-fourth of its length be removed three-fourths remain, that is to say we cast away $\frac{1}{4}$ of an inch of the paper and retain $\frac{3}{4}$; again, the whole is equal to all its parts for if $\frac{1}{4}$ be added to $\frac{3}{4}$ we recover or restore the original whole, viz., a one inch strip of paper.

From what has been here said it will be seen that even the term fraction has a relative rather than a positive meaning in many cases, for instance, one foot may be itself equal to a whole, but one foot as related to a yard is only one-third of the yard, because there are three feet in a yard, in the same way one inch may be considered a whole, but related to a foot it is only a twelfth, or related to a yard it is only a thirty-sixth, because there are 36 inches in a yard, if however, we speak of an apple, a half of the apple can never be a whole, because one apple is the largest expression that can be made in relation to the mere thing without breaking it, anything less than an apple then is a fraction of an apple. This reasoning may appear to be very elementary, and to some it may even appear unnecessary, but we often come across men that are fairly expert in the use of figures, but totally fail in the solution of some problems, simply because they have neglected to furnish their minds with right ideas of the relative values of expressions such as we have been adverting to.

CHEMISTRY RELATING TO MINE VENTILATION.

HOW THE GASES ARE PRODUCED BY NATURAL AND ARTIFICIAL PROCESSES.

Hydrogen. Small quantities of this gas are given off by active volcanoes, but it is seldom found in nature in a free or uncombined state. It is always a constituent of fats, oils, and resins, consequently wherever the resinous remains of vegetable matter are found, there we find methyl hydride, or marsh gas. In the autumn of the year, decayed leaves and vegetable tissues, fermenting in pools and stagnant ditches, give off this gas abundantly, but this is not pure hydrogen, but $C\,H_4$.

Hydrogen can be produced by artificial means, and we advise the student to make himself practically acquainted with the processes. Mere reading will never enable him to cultivate the observing faculty by which alone he can hope to succeed in his studies.

Hydrogen can be prepared in two ways:

First. When steam is passed through a red hot iron pipe containing small scraps of iron we have H_2O + Fe; but to obtain a complete multiple number, we proceed with four molecules of water and three atoms of iron, or four volumes of water and three volumes of iron, and thus obtain magnetic oxide of iron and free hydrogen, thus

$$4\,H_2O + 3\,Fe = Fe_3O_4 + 8\,H.$$

If the remaning steam and hydrogen be passed through cold water, the steam is condensed, and the pure hydrogen may be collected by an inverted jar filled with water.

Second. If a bottle be charged with a few pieces of thin sheet-zinc cuttings, and half filled with water containing one-sixth of its volume of strong sulphuric acid, the acid and the zinc will form new combinations, as follows: One molecule of sulphuric acid, and one atom of zinc, $H_2SO_4 + Zn = ZnSO_4 + H_2$ so that two volumes of hydrogen are set free. By putting the shank of a tobacco pipe through a cork in the bottle neck, the hydrogen may be collected in a bladder for future experiments.

Oxygen occurs free in the atmosphere mixed with nitrogen.

The best way to prepare oxygen artificially is the following: Get powdered potassium chlorate, 2 oz., mix with clean sand, 1 oz., and put the mixture into an iron pipe with one end closed, connect the other end by some means with a bladder, and insert the closed end in the fire; very soon pure oxygen gas will be given off. The gas will cause the most intense ignition if any lighted body be placed in it. To show the experiment, a bottle should be filled with it, and if very fine iron wire with a lighted thread on the end, be plunged into the gas, the iron will burn with the most beautiful scintillations.

Fill a bladder with one-third oxygen and two-thirds hydrogen; taking great care to have a suitable small brass pipe with a tap inserted in the neck of the bladder, and to keep yourself away from all lights while you hold the bladder. Now blow a little of the mixed gases into a dish containing soap water "milk warm," and after carefully removing your bladder, throw a lighted piece of paper into the foam produced by the injected gases, when a violent explosion accompanied by a loud report will ensue.

In this way, and by no other, can you have proper ideas of explosive mixtures. You will here see that by taking one-third by volume of oxygen, and two-thirds by volume of hydrogen, you have formed water which is made up of three atoms, H_2O.

It has been noticed that nearly one-fifth of the air we breathe is oxygen in a free state. Five volumes of air would give up one volume of oxygen and that added to two volumes of hydrogen would be an explosive mixture. It will be here seen that the four volumes of nitrogen do not assist in the explosion, and remain unaffected by the chemical action set up.

Nitrogen occurs in a free state in the atmosphere mixed with oxygen, and is easily prepared as follows: Take a large glass jar full of air, and having inverted the jar suspend in it a piece of burning phosphorus, taking care to then place the mouth of the jar (which is now downwards) in water; white fumes at first seem to fill the jar, but these are soon absorbed by the water, leaving almost pure nitrogen in the vessel.

This gas is the principal constituent of after-damp in mine explosions. It is not poisonous, as has been shown, and its function with regard to the animal economy and ordinary combustion is to dilute the oxygen, otherwise pure oxygen would burn up the tissues of the living organism, and the iron bars or other fittings of the fire-places and furnaces would burn and melt like wax in the flame of a candle.

Methyl hydride, a compound gas produced in nature by the decomposition of decaying vegetation, and given off by coal seams in quantities varying with the conditions of the strata and coal where it is found. It can be produced artificially by the following process:

Heat the following mixture in a retort, and collect the gas after passing it through water: Acetate of soda, 2 parts; caustic potash, 2 parts; and quicklime, 3 parts.

Hydride of ethyl. This gas is one of the paraffin series, and is produced in the neighborhood of petroleum springs and oil shales overlying coal seams.

Carbon dioxide, or carbonic acid, is very abundant in nature. The atmosphere contains by weight no less than 300,000,000 tons of this gas, and yet the proportion in the air is only 4 in 10,000 parts. It pours in enormous volumes out of the craters of volcanoes; it is produced wherever animal and vegetable matter is decomposed; it is exhaled by animals, and produced wherever carbon is burnt in air; water holds it in solution, and it is chemically combined with lime, magnesia, etc., forming carbonates.

For experiments it can be produced with great ease, all that is required for the purpose being a bottle with a pipe inserted through the cork and about a yard of india rubber tubing. Having connected the tubing with the pipe, put into the bottle some pieces of chalk, or lime, or marble, but best of all some common washing soda. Now pour on to the carbonate of lime or carbonate of soda dilute sulphuric acid, when the gas will come off and soon fill another jar into which you convey it with the tube. Here you can extinguish lights, and show its great density or weight by pouring it on the flame of a candle, and make many other such experiments as the future articles will suggest.

Carbon monoxide is produced when carbon is burnt in a limited supply of air. It can also be produced for experimental purposes by passing carbon dioxide through an iron tube kept at a red heat and containing red hot coke. The lambent flames on a coke fire are produced by carbon monoxide burning in air, here $C\,O$ takes an O from the air and becomes $C\,O_2$ or carbon dioxide. Carbon monoxide is a poison, and will not of itself support combustion. It will, however, burn in air when lighted like gas at the open end of a pipe.

Hydrogen sulphide is produced in nature chiefly by the decomposition of sulphates in the presence of organic matter.

Watery vapor is absorbed by the atmosphere when the temperature of the air is raised, and on the air being lowered in temperature it delivers up its surcharge as dew, rain, hail, and snow.

To understand this natural operation a few examples may be noted.

Steam under pressure in a boiler is an example of water taking the gaseous form, when like most other gases it is invisible, and obeys the laws of expansion and contraction, in short it fulfills Boyle's law, namely, "the pressure is inversely as the volume," and its capacity for heat at constant volume and at constant pressure is the same as in a gas under like conditions.

Let it be carefully noted that the boiling point of water varies directly as the pressure.

For example: When the barometer shows a pressure equal to 30 inches of mercury at the sea level, at such level water boils at 212° F., while at an elevation of 600 feet boiling point is at 211° F., and at an elevation of 1,200 nearly, the boiling point is 210°. Now as 600 feet is equal to 100 fathoms, it follows, that the boiling point will rise directly as the depth, increasing 1° F. for every 100 fathoms of descent. An excellent example of this law may be found in a simple experiment. Take a Florence flask and boil in it by the aid of a spirit lamp, a little water, let the water boil until all the air is expelled; suddenly insert a cork and remove the flask from the lamp, when it will cease to boil. Now pour a little cold water on the sides of the flask, when it will begin to boil again, and as the result of the contained steam being condensed, and the pressure being thereby reduced.

Explosive mixtures of fire-damp and air ought to be properly understood by the mining student. It has already been noticed that two volumes of hydrogen and one of oxygen, when ignited, combine with explosive violence. It is also true that one volume of marsh gas or fire-damp, when mixed with two volumes of oxygen and ignited, generates an explosive force nearly twice as great as the afore-mentioned mixture. Now, as has been shown, two volumes of oxygen mixed with one volume of marsh gas makes the maximum explosive mixture; therefore one volume of marsh gas mixed with 9·52 volumes of air, makes what is known to the miner as the maximum explosive mixture of fire-damp and air.

CH_4 is the chemical formula of marsh gas, which is a chemical compound of two elementary bodies, whose united atomic volume is equal to the volume of two atoms of hydrogen. Now the carbon atom will require for complete combustion two atoms of oxygen, and the four atoms of hydrogen will require for complete combustion two atoms of oxygen also, making altogether four atoms of oxygen; but as we have already noticed, the five atoms on chemically combining would be condensed into the volume of two. Now divide the four atoms by two, and there remains two volumes of oxygen to completely burn up one volume of marsh gas. But the oxygen in the air is only ·21 of its volume; therefore, $\frac{2}{21} \times 100 = 9·52$, the volumes of air required to completely burn up one volume of marsh gas.

After an explosion of one volume of fire-damp mixed with 9·52 volumes of air, the resultant gases would be carbonic acid CO_2, watery vapor H_2O, and nitrogen N, the whole constituting that deadly atmosphere called after-damp, making, the moment after the explosion, the following mixture:

Nitrogen or N	=	71·48 per cent.
Watery Vapor or H_2O	=	19·01 per cent.
Carbonic Acid or CO_2	=	9·51 per cent.
		100·00

But the watery vapor will immediately condense, leaving the after-damp as a mixture of nitrogen and carbonic acid of the following proportions per volume, per cent.:

Nitrogen or N	=	88·26
Carbonic Acid or CO_2	=	11·74
		100·00

Perhaps these proportions would be better retained by the memory, by saying after-damp is a mixture of 88 per cent. nitrogen and 12 per cent. carbonic acid.

At the moment of explosion 70 per cent. nitrogen, 20 per cent. steam, and 10 per cent. carbonic acid. It would perhaps be safe to say that in no case in an actual mine, an explosion has occurred with a true chemical mixture of 9·52 of pure air and one of marsh gas.

There are a great number of explosive mixtures ranging from 4·76 of air to one of gas to 14·28 of air to one of gas. The explosive range, might, however, be stated to lie between 5 of air and 15 of air to one of gas; the meaning of this statement will require further explanation. The student must for a moment consider that one of gas and one of air could not in any sense, constitute an explosive mixture; and here it would be wise to notice what we mean by the term explosive mixture. We mean then, such a mixture of gas and air as would, if ignited, produce *instantly* a volume of flame filling the space occupied by the mixture. Now, with a mixture of one of gas and one of air even ignition cannot take place, because there is not sufficient oxygen in the air to burn up the hydrogen constituent of the fire-damp, the heat of combustion being instantly absorbed; or if the flame was to be set up in any one point it could not extend beyond that point, because the heat absorbed by the unburnt gas and the nitrogen of the air would keep the heat permanently below the temperature of flame. With a mixture, however, of five of air and one of gas, ignition of the whole mixture would just be possible, or to put it more clearly, the heat developed by the hydrogen burnt with the oxygen present would just be able to raise the temperature of the hydrogen and the unburnt carbon to the lowest possible temperature of flame. Combustion under these circumstances would develop unburnt carbon as soot, steam, and free nitrogen. With a mixture of 7·14 of air and 1 of gas, we would just have sufficient oxygen to convert the hydrogen of the fire-damp into steam, and the carbon of the fire-damp into carbon monoxide. With 14·21 of air and 1 of fire-damp we reach the extreme limit of an explosive mixture when air is in excess. Practical illustrations of such mixtures would have to be sought for under peculiar conditions. For instance: A mixture of 5 of air and 1 of gas would have to be sought for in a gob fire, or where a seam was on fire. The maximum explosive mixture, viz.: 9·52 of air and one of gas in an ordinary goaf, but it is extremely probable that nearly all explosions of fire-damp in mines originate where the mixture is between 9·52 and 14·28 of air to one of gas.

To summarize these conclusions, the after-damp under three marked conditions of mixture would be constituted as follows: In round numbers, where the explosive mixture was 5 of air and 1 of gas:

Nitrogen	66 per cent.
Steam	34 per cent.
	100

or, when the steam was condensed the after-damp would consist of pure nitrogen, the soot of the unburnt carbon having been deposited as a solid. Here it will be well to notice that wherever fire-damp is burnt in a very deficient supply of air carbon as soot is deposited.

Second form of after-damp. When the mixture consists of 7·41 of air and 1 of fire-damp, the resultant gases are:

Nitrogen	79 per cent.
Steam	14 per cent.
Carbon Monoxide	7 per cent.
	100

or after the steam is condensed:

Nitrogen	92 per cent.
Carbon Monoxide	8 per cent.
	100

and the maximum explosive mixture as given before.

MECHANICS AND MINING.

PUMPS (CONTINUED).

The use of the balance bob. Where a single set is worked by a double acting engine it is necessary to balance the engine with a counterpoise, because on the upstroke the engine is lifting both water and spears; consequently on the down stroke the counterpoise should be equal to the weight of the spears plus half the weight of the water.

Where a forcing and lifting set are employed the engine can be balanced by a proper adjustment of the lengths of the two columns, and this is often done by giving a lift of 240 feet to the lifting set, and a force of 360 feet to the forcing set, or the balance may be stated in the form of an equation. Let E = the power of the engine, W = weight of column, S = weight of spears, then W + S = E in the case of the lifting set and for the forcing set W = S + E.

Special pumps are used whenever the conditions are favorable. They have many advantages over the spear pumps, being cheaper in the first erection and less expensive in repairs; besides they have another great advantage, viz., the ascending column moves at a nearly uniform velocity, and thereby economizes the force that is wasted on inertia, when the movements of the column are intermittent, as in ordinary lifting and forcing sets. The special pump is fixed near the bottom of the shaft, and works a pair of rams or plungers so arranged that either one or the other is constantly in the act of forcing. The velocity of the column is kept uniform by a spring air cushion in the form of what is called the air vessel. The most serious difficulty in the use of this class of pumps arises out of ignorance in the management of the glands of the plungers; the glands ought never to be perfectly water-tight, a little play with the gland, not too tight, and the pump will give comparative satisfaction. When special pumps are used to force water to higher elevations than 600 feet practical difficulties of a serious nature always arise, such as broken joints, fluting of the skin of the plungers, and the constant failing of the packing and glands.

Pumping water out of dip workings has been accomplished by many different applications of energy. The oldest methods employed would undoubtedly be by buckets and kibbles and the ordinary lift pump. Even yet in many cases, the common lift pump is employed, but this is quickly being superseded by plunger force pumps sometimes worked by manual labor. At other times a gin is set up to work plunger pumps by horse power. These pumps are also frequently worked by passing tail ropes round a grooved wheel, the rope being kept round the wheel by binding sheaves. This mode of working pumps is expensive in consequence of the damage done to the ropes, and sometimes a large engine is kept running to work these pumps when the ordinary work of the mine does not require the use of the engine. One of the best motive powers recently used for pumping water out of dip workings is the hydraulic pump, this arrangement being very effective when the pumps are not situated very far from the shaft, arising from the circumstance that the hydraulic motor is worked by a column either taken from the tubbing in the shaft or from the main pumping set. It will thus be seen that a long range of pipes for the motive column would often be required. But for the expense of these long ranges of pipes, often of considerable diameter, perhaps no better motor for pumping water from dip workings could be found. It is a class of pumps that requires very little attention, and has worked for months when entirely submerged. To understand its mode of action the motor consists of an ordinary cylinder with piston and piston rod, the diameter of the piston being regulated by the height of the motive column. The percentage of useful effect being only about 30, which is relatively small, the area of the motor piston is often about one-third of the pump plungers. The water of the motive column is alternately admitted to each end of the cylinder, and the exhaust water is discharged into the delivery pipe of the pump. It will thus be seen that a motive column, about ten times greater than the elevation to the shaft sump, will often be required; or let the modulus be ·3, and the elevation from the pump to the sump at the shaft bottom be 40 feet, then if the area of the piston of the motor be one-third of the sectional area of the plungers, $\frac{40}{·3} \times 3 =$ the motive column in feet, or 400 feet of motive column. A later innovation is compressed air for working pumps in dip workings. This form of energy is applied through the medium of an engine, precisely similar to a steam engine.

MECHANICAL PROBLEMS.

Q. 1.—What are the most severe and damaging strains to which haulage ropes are subject?

A.—The most severe and damaging strains to which haulage ropes are subject, arise out of the carelessness of the brakeman or engine man. The heavy drums, or rope rolls, and the moving parts of the engine are possessed of considerable inertia, when started at a comparatively high speed with a slack rope. Now the inertia due to the heavy cars is so great, that the rope is subjected to a severe strain by the quick starting of the engine, so much so, that often some of the wires, or one of the strands, or the rope itself, is broken, or a socket is drawn, or some of the coupling chains of the coupling bars of the cars are broken by this cause. The engine ought to be started with a creeping motion, until the rope and all the coupling chains of the cars are tight, then the speed may be quickened with comparative safety.

Q. 2.—An incline rising to the shaft at the rate of two inches to the yard is 3000 yards long, the engine is required to haul sixty cars of ten cwt. up this incline; required the strain on the rope.

A.—The cars would be half the weight of the coal, and the coal will weigh thirty tons, and the cars fifteen tons. Jointly the cars and coal will weigh forty-five tons. Let us first proceed to find the strain on the rope due to one ton of the load, which will arise from two causes, first, gravitatio ; second, friction due to traction. As the co-efficient of traction can only be determined in each special case by experiment, we will assume it to be thirty pounds to the ton, which is the average for pit cars; next proceed to find the strain due to gravitation per ton. This is found as follows: Multiply the pounds in one ton by the inches of the rise per yard, and divide by thirty-six the inches in a yard, as follows:

$$\frac{2240 \times 2}{36} = 124·4,$$ Now to 124·4 add 30, which is equal to 154·4 pounds the strain on the rope per ton moved. Now if 154·4 pounds be multiplied by 45, it will equal the strain on the rope in pounds, and is found as follows: 154·4 × 45 = 6948. Now if 6948 be divided by 2240, we have the strain on the rope in tons, namely, 3·1.

Q. 3.—What horse power of an engine will be required to haul 500 tons of coal per day of ten hours along an engine plane of 3,000 yards long, the average rise to the shaft being 2½ inches to the yard?

A.—The cars are always half the weight of the coal they carry, consequently the load on the engine will be 750 tons. The resistance due to gravitation per ton is found as follows: First, multiply the pounds in a ton by 2½, the inches rise per yard, and divide that product by 36, the inches in a yard, and the result will be the resistance in pounds due to gravitation, as

$$\frac{2240 \times 2·5}{36} = 155·5 \text{ lbs.}$$

Now the average co-efficient of traction per ton in cars is 30 pounds, consequently 155·5 + 30 = 185·5 lbs. per ton power required to haul each ton along the road. Again, 750 × 185·5 × 3,000 × 3 = the units of work to be done, but that is the units of work to be done per shift of ten hours. The engine, however, by the main and tail-rope system will only be engaged in hauling coal one-third of the time, that is, 200 minutes; consequently, the units of work will be found as follows:

$$\frac{750 \times 185·5 \times 3,000 \times 3}{200} = \text{the foot lbs. due to haulage.}$$

If these foot pounds be divided by 33,000, the foot pounds in one horse-power, the result will be the theoretical horse-power of the engine required, but we require the indicated horse-power, therefore if the modulus of the engine be taken at ·7 to make due allowance for the friction due to drums, ropes, and rollers, the size of engine required will be found as follows:

$$\frac{750 \times 185·5 \times 3,000 \times 3}{200 \times 33,000 \times ·7} = 271 \text{ H.P.}$$

Q. 4.—What should be the speed of the rope to haul to the shaft the tons of coal mentioned in question 3?

A.—The speed of the rope should not exceed ten miles per hour.

Q. 5.—At ten miles per hour, what would be the strain on the rope for the work done in question 3?

A.—If the units of work in the indicated h.p. of the engine be divided by the speed of the rope in feet per minute, the result will be the strain on the rope in pounds. The speed on the rope in feet per minute will be found as follows:

$$\frac{5,280 \times 10}{60} = 880 \text{ feet per minute.}$$

Therefore the foot pounds in 271 h.p. will be found as follows: 271 × 33,000, but the foot pounds in 271 h.p. divided by the speed of the rope in feet per minute, will be the strain required

$$\frac{271 \times 33,000}{880} = 10162·5 \text{ pounds strain on the rope.}$$

Q. 6.—How many ten cwt. cars could this engine haul out at once, that is, the engine to do the work of question 3?

A.—First find the strain required for one car. According to the solution in question 3, 185·5 lbs. strain were required to haul one ton up the incline; now a 10 cwt. car and its coal will weigh 15 cwt., or three-quarters of a ton; therefore—

$$\frac{185·5 \times 3}{4} = 139·1 \text{ lbs.}$$

Therefore, if the total strain on the rope be divided by the strain due to one car, the result must be the number of cars in one set, as—

$$\frac{101625}{1391} = 73 \text{ cars.}$$

SCIENCE RELATING TO MINING.

THE BAROMETER.

In all ages mankind have been addicted to the same practice of trying to satisfy their craving for knowledge by giving names to things they do not understand.

FIG. 1.

Matters pertaining to the barometer have been treated in precisely the same way, and are even treated so now. It is a misfortune, however, to invent names and excuses for ignorance. He is the best of all men that dare say "I don't know," and make an honorable retreat.

Up to the year 1643, the action of a common pump was not understood, and the reason assigned for water rising up through the tail-piece of a pump was sagely given by saying "Nature abhors a vacuum," or in other words: "Nature hates a vacuum." Now if nature hated a vacuum, nature could think and feel like a man, and if nature hated a vacuum, the very statement gives to nature and vacuum two distinct personalities, which is absurd.

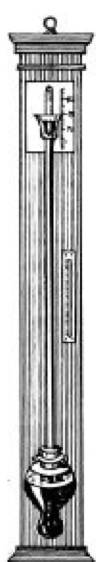


FIG. 2.

The pupil of the great Galileo, whose name was Torricelli, began to think that the oft-repeated statement of nature abhorring a vacuum was foolish and untenable, for it had dawned on his mind that the atmosphere exerted considerable pressure, and that a vacuum was a space void of air, and, therefore void of the pressure peculiar to air, and to prove these conclusions he made the first barometer. Happy will it be for every reader of this article who has not hitherto made a barometer, if he proceeds at once to construct one precisely the same way as Torricelli did. In the left hand portion of Fig. 1 a glass tube is shown closed or hermetically sealed at the lower end, and filled to the top or open end with mercury. Torricelli tightly fixed his thumb over the open end, and by this means both ends of the tube were closed. Now, in this manner he turned the tube upside down, dipping the open end with his thumb pressing tight on it into a cup of mercury, as shown in the right hand side of the figure, when the mercury fell to a height as shown in the right hand tube, corresponding to the pressure of the atmosphere. Now the weight of what we call a cubic inch of mercury would correspond to some other volume and weight of mercury peculiar to Italian weights and measures, and by this means Torricelli was enabled to determine the pressure and weight of the atmosphere.

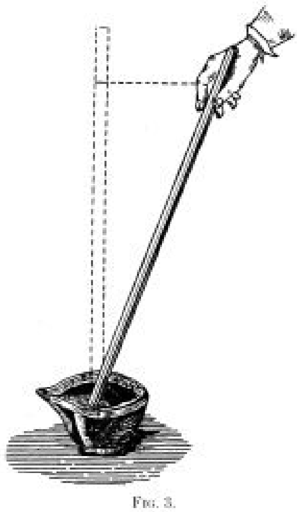


FIG. 3.

A cubic inch of mercury weighs ·4908 of a pound; now, if this be multiplied by the height of the mercury column above the level of the mercury in the cup the pressure of the atmosphere can be determined according to English units. Suppose this height to be 29·7 inches, then 29·7 × ·4908 would be the pressure of the atmosphere under these conditions, or 14·59676 pounds on the square inch.

Fig. 2 illustrates a barometer as supplied by makers; Fig. 3 is intended to illustrate that the length of the column of mercury in the glass tube is shortest when in a truly vertical position, and if the tube be canted to one side from a vertical line the relationships will be that of the radius to the cosine of the angle. It will be seen when the tube is canted the column is longer than when in a vertical position, as shown by the dotted line, or in other words, the vertical height of the length of the mercury in the tube from the level of the mercury in the cup is unalterable while the atmospheric pressure remains the same.

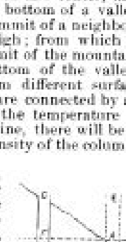
EXAMINATION QUESTIONS ANSWERED.

QUESTION 10.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

What causes natural ventilation? Explain fully. Also explain the various means by which mine ventilation may be produced.

(This question was answered several month ago, but for the benefit of new subscribers we republish the answer.)

ANSWER—In order to understand the theory of natural ventilation, it must be remembered that the height of the atmosphere does not follow the undulations of the earth's surface, but that its outer edge is everywhere equi-distant from the earth's center, and that if it is 50 miles high from the bottom of a valley it will only be 47 miles from the summit of a neighboring mountain which is 3 miles high; from which it follows that the pressure at the summit of the mountain is always less than it is at the bottom of the valley. Hence if two shafts are sunk from different surface levels to the same level seam and are connected by an airway, and there is a difference in the temperature of the air inside and outside of the mine, there will be a current of air created, because the density of the columns of air in the two shafts will differ.



To illustrate this, let A B be a shaft 100 ft. deep, and C D another shaft 200 ft. deep, connected at the bottom by the heading D B. Suppose the air inside to be the warmer, as in winter, and for example let the air inside weigh one-half ounce per foot of shaft per square yard of section, and the outside air weigh three-fourths of an ounce for the same bulk; then the relation between the two shafts would stand thus:

Shallow shaft, 100 ft. at ½ oz. per ft.	50 oz.
Outside column from A to E at ¾ oz. per foot, and 100 ft., equal	75 oz.
Total	125 oz.
Deep Shaft, 200 ft. at ½ oz. per foot	100 oz.
Difference	25 oz.

The balance in favor of the shallow shaft, 25 ounces, will make the shallow shaft the downcast by a pressure equal to 25 ounces per square yard of section. If the temperature outside were the highest, as in summer, this result would be reversed. The difference of weight between the air in the deeper shaft from F to C, and the imaginary column A E is the pressure producing ventilation.

In the case of a drift driven into the side of a hill with an air-shaft opened to its summit under similar conditions the same results are produced. The difference in the weight of the air in the shaft and of an imaginary column in the opening air, from the mouth of the drift, to the level of the shaft, is the pressure producing ventilation. In winter, when the temperature inside the drift is warmer than the air outside, the current will be up the shaft, but in the summer, when the outer air is the warmer, the current will be reversed, and the direction will be out the drift. When the temperatures inside and outside are equal there will be no current. Natural ventilation, on account of its feebleness and liability to derangement by change in the temperature of the atmosphere, at the surface, is inadequate for operations of considerable extent, and recourse must be had to artificial ventilation.

The different modes of producing mechanical ventilation are by furnace, water-fall, steam jet and mechanical ventilators.

In furnace ventilation, a furnace is placed at the bottom of the upcast, which heats and rarifies the air, thus increasing the difference of weight in the two columns in the upcast and downcast shafts. This, of course, acts in assistance of the natural warmth of the earth; this kind of ventilation is much less liable to disturbance from atmospheric changes, although far from exempt from their influence.

The waterfall is not generally used, but is a useful auxiliary for driving air into a mine after an explosion. It causes a current by cooling and increasing the density of the air in the downcast, and also has a tendency to displace considerable air in falling.

The steam-jet acts in a manner totally different. It is a mechanical force applied to propel the air through the shaft. When the jet of high pressure steam is blown into an atmosphere at a state of rest, it produces a violent disturbance in that fluid. The particles of steam are in rapid motion; and since the first law of motion is, that a body in motion continues to move for ever or until stopped by something else, when stopped it communicates its force to the body stopping it. The force of the jet of steam is expended on the air on which it strikes and through which it passes; and this force is applied to the air as fully as if it were applied to a piston in a steam engine. Thus by this method we have the steam power applied directly to the object we require to move, avoiding all the friction of an engine. The force thus obtained is used in forcing the air up or down the pit, or both, according to requirements, and is under more perfect control, and is a more powerful agent when properly employed than the furnace; the furnace not producing above three inches of disturbance of the water-gauge level, the jet has been shown to produce fifteen inches of mercury, which is equal to 15 feet of the water-gauge. It requires no machinery, but a simple pipe in connection with the steam.

Mechanical ventilators are either large air pumps, or exhaust or blower fans. Fans are now justly regarded by all mining engineers as the best means of producing ventilation, and the majority of the leading mining authorities prefer the exhaust fan. There are, however some high authorities that advocate the use of blower fans. Fans produce an air current either by drawing the vitiated air out of the upcast, or by blowing fresh air down the intake.

QUESTION 11.—Asked at the Examination for Certificated Mine Foremen of the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

In mines where large quantities of fire-damp are given off, what are the requirements of the mine law?

ANSWER.—In addition to the general requirements intended for all mines, the law requires that the following rules shall be observed in all mines generating explosive gas:

All accessible parts of an abandoned portion of a mine in which explosive gases have been found shall be carefully examined by the mine foreman or his assistants at least once a week, and all danger found existing therein shall be immediately removed. A report of said examination shall be recorded in a book kept at the colliery for that purpose and signed by the person making the same.

In mines generating explosive gases, the mine foreman or his assistant shall make a careful examination every morning of all working places and traveling roads, and all other places which might endanger the safety of the workmen, before the workmen shall enter the mine, and such examination shall be made with a safety-lamp within three (3) hours at most, before the time for commencing work, and a workman shall not enter the mine or his working place, until the said mine or part thereof, and working place are reported to be safe. Every report shall be recorded without delay in a book which shall be kept at the colliery for the purpose and shall be signed by the person making the examination. The person who makes said examination shall establish proof of the same by marking plainly the date thereof at the face of each working place and all other places examined.

A station or stations shall be established at the entrance to each mine or different parts of each mine, as the case may require, and the workmen shall not pass beyond any such station until the mine or part of the mine beyond the same has been inspected and reported to be safe. It shall be the duty of the fire boss to remain at the danger station until relieved by some person authorized by himself or the mine foreman, who shall stand guard until said mine or part of mine shall be reported safe, and he shall not let any person pass without permission from the fire boss.

If at any time it is found by the person for the time being in charge of the mine or any part thereof that by reason of noxious gases prevailing in such mine or such part thereof, or of any cause whatever, the mine or the said part is dangerous, every precaution shall be used to ensure the safety of the workmen. And every workman, except such persons as may be required to remove the danger, shall be withdrawn from the mine or such part thereof as is so found dangerous until the said mine or said part thereof is examined by a competent person and reported by him to be safe.

In every working approaching any place where there is likely to be an accumulation of explosive gases, or in any working in which danger is imminent from explosive gases no light or fire other than a locked safety-lamp shall be allowed or used. Whenever safety-lamps are required in any mine, they shall be the property of the owner of the said mine, and a competent person, who shall be appointed for the purpose, shall examine every safety-lamp immediately before it is taken into the workings for use, and ascertain it to be clean, safe, and securely locked, and safety-lamps shall not be used until they have been so examined, and found safe, clean, and securely locked, unless permission be first given by the mine foreman to have the lamps used unlocked.

No one except a duly authorized person shall have in his possession a key or any other contrivance for the purpose of unlocking any safety-lamp in any mine where locked lamps are used. No lucifer matches or any other apparatus for striking light shall be taken into said mine or parts thereof.

No blast shall be fired in any mine where locked safety-lamps are used except by permission of the mine foreman or his assistant, and before a blast is fired the person in charge must examine the place, and adjoining places and satisfy himself that it is safe to fire such blast, before such permission is given.

QUESTION 12.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

In opening up a new mine where the veins or seams have an average dip of 15°, it is proposed to work three seams or veins. State how you would open the slope, and fan way, and other openings, and how you would conduct your air current?

ANSWER.—I would sink a double track slope in the middle vein, as near the center of the track as possible. I would drive tunnels to the other veins near the inside end of the slope turnouts, one tunnel on each side of the slope. I would drive my fan way also in the middle vein, and use the slope for the downcast until I could get airways driven to the surface from each of the other veins. As soon as I could get this done, I would arrange my ventilation so as to draw fresh air into each vein through its own airway, and would split it so that each of the six main sections of the mine should have proportionally the same amount of air. I would also, if feasible, make the second outlet from the slope vein the downcast instead of the slope so as to prevent freezing the slope in winter.

QUESTION 13.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

In which case in your opinion does the greater necessity exist for timbering, in a shaft sunk through measures pitching 70 degrees, or in a shaft sunk through the same measures pitching 5 degrees?

ANSWER.—In the shaft sunk through measures pitching 70°, because there is more likelihood of slips or slides in the various strata of rock, or mineral passed through.

QUESTION 14.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

When a mine is passing 20,000 cubic feet of air, with a pressure of four pounds per square foot, what will be the pressure when the mine passes 40,000 cubic feet of air per minute?

ANSWER.—The pressure varies as the square of the quantity, therefore

$$20{,}000^2 : 40{,}000^2 :: 4 : (\ ) \text{ or}$$
$$2^2 : 4^2 :: 4 : (\ ) \text{ or 16 pounds per sq. ft.}$$

QUESTION 15.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

Describe the plan or system of mining at some colliery at which you have worked, and state how the same was ventilated?

This question must be answered according to individual experience and is intended to draw out the candidate's power of observation, experience, etc.

QUESTION 16.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

Suppose you were approaching an abandoned mine, filled with water to a vertical height of 300 feet, vein or seam 30 feet thick and coal free. How much pillar would you leave to prevent the water from bursting in?

ANSWER.—At least 50 yds. In certain portions of the Anthracite region it is customary to leave line pillars of 20 yds. on each side of a land line (40 yds. in all) to protect the workings from floods or fires in adjoining collieries, but as the seam in this case is very thick, and the coal free it would be better to leave 50 yds.

QUESTION 17.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

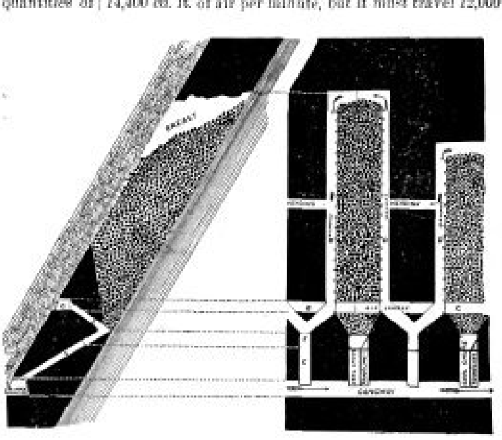
What are the duties of a mine foreman, and what should be the exten. of his knowledge to best fit him for the position?

ANSWER.—The duties of the mine foreman are to see that the process of mining is conducted in an economical and safe manner. To see that the ventilation of the mine is fully up to the requirements of the law, to enforce discipline in the mine, and to generally supervise the underground workings and secure the largest possible output of coal at the least cost consistent with safety to the employes. He should have a good practical knowledge of ventilation, the different systems of mining, should be able to keep his time book, etc., in a correct and legible shape, and he should possess sufficient executive ability to have all his orders obeyed without causing trouble among those of his subordinates who are too ignorant to understand why he wants certain things done contrary to the way they think they should be done.

QUESTION 18.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

In a mine where the vein or seam is 30 feet thick, and pitching 50 degrees, and where large quantities of fire-damp are given off, state how you open gangways, chutes, headings, and breasts, and how you would conduct your air-current?

ANSWER.—In a vein of this character I would drive the gangway, along the top of slate, to give greater security to the gangway and also to allow the chute to be at such a grade as will permit the coal to be under the control of the loader in its passage from the breast to the wagon. I would drive the air course C, against the top above the gangway and connect it with the manways E E, between each breast, by the passages F F. When the breasts are in operation the air course or "monkey gangway" C, is not used, the arrows indicating the course of the air, the gangway, of course, being the main intake. The great advantage of this system is that it secures a permanent return for the air after the breasts are exhausted.



The coal made along the manways D, may be drawn from the manways E. The main chute, marked "coal chute," should be driven 9 ft. wide with a traveling, way on one side to allow a man to attend to the drawing of the coal. I would have a separate current for each section of four or less breasts, and would endeavor to prevent the coal "rushing," and thus liberate gas in larger quantities than the air current could safely cope with.

QUESTION 19.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

What system or plan of mining would you adopt where the vein or seam is inverted, and how would you sink the slope and make other openings?

ANSWER.—I would proceed the same as if the seam was lying in a natural position with a similar inclination, but as inverted seams are often faulty, I would be reasonably sure that it would be a paying operation before spending much money on dead work.

QUESTION 20.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

What in your judgment should be the difference in the thickness of pillars left to support the overlying strata of a mine between that of a 10-foot vein or seam and that of a 30-foot vein, and which should be the largest pillar on a pitching or horizontal vein?

ANSWER.—Approximately, the strength of pillars vary inversely as the square of the thickness of the seam, all things being equal. Then, as the square of the thickness of the thin seam is to the square of the thickness of the thick seam, so is the fourth power of the side of the pillar in the thin seam to the fourth power of the pillar in the thick seam, and the fourth root will, of course, be the length of the side.

Thus

$$10^2 : 30^2 :: 1^4 : (\ )^4 \text{ or}$$
$$100 : 900 :: 1 : (\ )^4 \text{ or } 9.$$

Then the fourth root of 9 is 1·732. Therefore the sides of the pillar in the 30-ft. seam should be 1·732 times the length of the sides of the pillar in the 10-ft. seam.

SPECIAL QUESTIONS AND ANSWERS.

By request we answer Questions 14, 18, 20, and 21, given at the Iowa Examination for Mine Inspectors, on April 9th, 1890.

QUESTION 14.—If a water-gauge shows a difference of reading of twelve inches between the intake and return of a certain portion of a mine, and the anemometer indicates a velocity of ten ft. per second, size of entries, 6 ft. × 8 ft. what effective horse power has been expended in that portion of the mine?

The difference of twelve inches in the reading of the water-gauge shows that to overcome friction a pressure of 12 × 5·2 lbs. or 62·4 lbs. per square foot has been required; and as the velocity is 10 ft. per second in an entry of 48 square feet sectional area there is a current of 10 × 60 × 48 or 28,800 cu. ft. passing. Then the rule to obtain the effective horse power is to multiply the pressure per square foot by the volume of air passing per minute and divide by 33,000.

Thus

$$\frac{62{\cdot}4 \times 26{,}800}{33{,}000} = 50{\cdot}7 \text{ — H. P.}$$

QUESTION 18.—In what part of a mine should observations with the anemometer be taken and why?

ANSWER.—Observations with the anemometer should be taken at the inlet and outlet airways, at or near the face of each main heading, and at the nearest heading to the face of the inside and outside chamber, where men are employed. That is, the reading should be taken at such localities as will give the velocity of the current in each split or section of the mine.

QUESTION 20.—In the section of the mine mentioned in Question 14, which we will designate as "Section A," the air travels 6,000 ft. of entry including return. In "Section B" of the same mine there is required 14,400 cu. ft. of air per minute, but it must travel 12,000 ft. of entry including the return, how would you arrange the regulator, or in what proportion would you split the air for these two sections to equalize the ventilation currents in them, size of entries in both sections the same?

ANSWER.—As both sections have the same sectional area and differ only in length, and the total volume of air passing is 26,800 cu. ft. (see Answer to Question 14) plus 14,400 cu. ft. = 41,200 cu. ft. The question resolves itself into the following:

Given two airways of equal sectional area, one of which is twice as long as the other, how would you split the air to ensure an equal current in each? The answer naturally is, by placing a regulator in the shorter airway. Now as to the size of this regulator. Most persons in calculating the size of regulators, use the rule to find the areas of airways of different lengths to pass the same amount of air. It must be evident to every practical man that this cannot be right, because a regulator is an obstruction and obstructs the free passage of the current suddenly. Its rubbing surface is entirely different from the rubbing surface of an airway. It is in fact simply a gate valve which regulates the flow of a fluid called air under a certain pressure, through an underground tube. The only way in which the correct size of the regulator can be determined is by experiment. If it is possible to equalize the current by making one air course longer, and the other shorter it is a much better plan than using the regulator, because the power necessary to overcome the resistance offered by a regulator to a current of air is a waste of energy, and every regulator placed in a mine means an expenditure of work that would otherwise be available for increasing the total quantity of air in the mine. Of course it is often impracticable to avoid the use of regulators, but when they can be dispensed with they should be.

In the case under consideration the regulator must offer a resistance equal to the resistance offered by the entire rubbing surface of "Section A," and it should be placed at or near the point where the current joins the main return current. If an approximate rule is necessary to find the size, the following will be as close as any:

$$\sqrt[3]{12{,}000} : \sqrt[3]{6{,}000} :: 48 : (\ ) \text{ or}$$
$$\sqrt[3]{2} : \sqrt[3]{1} :: 48 : 38 + \text{sq. ft.}$$

QUESTION 21.—How would the friction of the air current in "Section A" compare with the friction of the air current in "Section B."

ANSWER.—As both airways have the same sectional airway, and differ only in length, the frictional resistance before putting in the regulator would only be ½ as much in "Section A" as in "Section B." The use of the regulator is resorted to, to increase the resistance in "Section A" to an amount equal that in "Section B" which has twice as much rubbing surface.

Scientific Advancement

Vital Force—What Is It?

At a recent meeting of physicians and surgeons at Chicago, a paper was read by Dr. H. J. Treat, entitled: "Vital Force the Surgeon's Best Friend," upon which quite a lengthy discussion was held, from which we extract as follows:

Dr. Hasty thought the paper a most excellent one. Had no criticisms to offer, and but one query to make, and that was with reference to an "intelligent force" that has to do with the respective process in surgery or medicine. The vital force had been talked of as an intelligent independence or an independent intelligence, an independent entity, an intelligent entity, etc. He thought that the matter should be well considered, in order not to make ourselves ridiculous in the eyes of intelligent, thinking men and women. He did not for one moment question the existence of a vital force, but that it existed as an independent intelligence he did seriously question. Vital force in his opinion was a property of matter. He thought that Dr. A. Curtis was not far from the truth when he said that "whatever always exists in connection with matter, but has no existence without it, is called a property of matter." Inasmuch, therefore, as "vital force" always exists in connection with living matter, and has never been found to exist outside thereof, or independent thereof, it must be a property of living matter, and we can know nothing about vital force aside from living matter.

Dr. O. P. Fletcher queried: "What is vital force?" He had never yet heard it defined, and would like to know what it was. Had thought at times that it was intelligent. If you can find any force, not intelligent, that could bring together bones, muscles, nerves, blood vessels and all the various parts of this human machine, and put it in working order and maintain it in that condition 50, 60, or 100 years, he would like to know its name and to know more about it. In college he was taught to believe that chemical force was not to be thought of as producing any of the results witnessed in the animal economy. It seemed to him now that life could not exist without chemical action.

Dr. Pechuman remarked that our bodies are mysterious. Life and soul are used as synonymous terms by some. If the soul is the life, it is different from matter. The body is the house, the soul is the occupant. When life goes out, the house is left to decay. The bioplasm of plants and animals are, so far as can be ascertained by chemistry and microscopy, the same. Some of these bioplasts go to make bone, some form muscle, others form serous membranes, some skin, and so on through the whole body. When the man dies, his body is liken to Mr. Jones' house—empty—something has gone out of it. The house still contains all the elements that were found in it during life, but there is something gone. This something is not a property of matter, but, as he viewed it, an intelligence—a something separate from the living matter.

Dr. Treat concluded that we can tell what vital force is as well as we can what life is, as well as we can tell what electricity is, as well as we can tell what gravity is. They are all known by their effects upon matter. It is only a play of words to say it is a property of matter. We know it is independent by its effects.

Dr. W. A. Harris remarked that the question put him in deep water. If a bone be broken, the vital force goes to work to repair the injury and reunite the parts. It looks and acts like it was intelligent. As to its being independent, I have nothing to say. It seems to have power to resist chemical force.

In reply it was said: A tree gets bruised by the woodman's ax. The living matter, by virtue of the inherent force in it, heals the injury. Is there an intelligence there?

Dr. Treat says there is a force or forces that overcome vital force—if it were not so, we would not die. Vital force is limited in its capacity to resist chemical force.

Dr. Scroggy said if the process of digestion be chemical and there was no vital force to resist it, the stomach itself would be digested.

Dr. Pechuman said that many in the profession hold that all changes that take place in our bodies are due to chemical force, yet some of these thinkers are changing their minds in this respect. When the vital force leaves the body, the chemical forces go to work to decompose it. The natural heat of the body is produced by chemical action of changing fluids into semi-fluids—all chemical action is attended with changes of temperature.

Unsolved Problems of Chemistry.

So simple-looking a substance as the white of an egg is yet a most stupendous mystery to our science. It and all the albuminoids are awaiting this very light. The fever and pain, discomfort and delirium of disease are now known to be due, in many cases, to ptomaines manufactured by bacteria. They are believed to break down albuminous substances by aid of the ferments they secrete. We want to know the nature of these ferments. Until such knowledge is acquired we can not really say that we know how nitric or acetic acids, and all the nitrates and acetates, are made as common and cheap as they are. Micro organisms produce them. The bread problem of the future is believed to carry its solution in this same question.

From cellulose to starch is a very short step, but we can not take it in the proper way. By a crude process long known, sawdust can be converted into an exceedingly coarse article of bread, the catalytic body being sulphuric acid. We await the discovery of the proper organic contact action body to do perfectly what can now be roughly done. The world may yet see deal boards transmuted into the whitest kind of starch. We can and do now change starch into that kind of sugar called glucose. Let us next find how to make it into levulose, and then discover how to unite these two, and we will have cane sugar. Hundreds of chemists have worked at this problem. The man lucky enough to solve it has an enormous fortune awaiting him. We have lately found how to give cane sugar the flavor of maple sugar, so that, should the maple forests give out, the supply of that sweet morsel can still be maintained.

Among the many problems that still await solution, but that lie along the line we have been considering, is the synthetic production of such valuable substances as India rubber, cotton, silk, and wool. The possibilities of organic chemistry are numberless, and many of them may never be realized; but we have already the sweet consciousness of having mastered more than enough to pay for the disappointment of our alchemical predecessors who hoped to be able to convert iron into gold. But their dream, wild as it really was at that time, may yet become an established fact. No chemist would to-day risk his professional reputation by asserting it an impossible feat. Let some reliable man of good repute in this department of science assert that he had made such a discovery, and it would doubtlessly raise considerable skepticism, but that would be all. No one knowing the present status of the science would use the word "impossible." Reasoning *a priori* on the subject, we would expect that the cost of production would always exceed the value of the product. This is poor encouragement for this line of investigation. In the fields hitherto invaded and conquered the reverse has been true. Substances worth less than nothing—actually having a negative value because of being incumbrances that it cost cash to remove—have been and are being made into goods worth many millions of dollars. The actual facts, when stated in simple language, are more wonderful than the tales of the Arabian Nights. "Yes!" some one answers, "and the names found in the story are perhaps quite as remarkable as any in that volume." This is very true. To read of a substance that has been christened methyl-ethyl-hydroxyl-tetra-hydro-pyridine-tropate sounds anything but musical to the ears of non-chemists, especially when they learn that it is the dangerous medical poison atropine. Every syllable of this name has a meaning, and the whole tells just how the molecule is constructed. To say that rheumatic pains can be relieved by oil of wintergreen is a plain statement to ordinary mortals. Tell him such relief can be had by the use of methyl-ortho-mono-hydroxyl-benzoate, and you puzzle him sorely, though the things are the same.—*Dr. Robert G. Eccles.*

Useful Information

The "Holy Coat" of Treves.

On August 18th, of the year 1844, there was exhibited in the cathedral of the ancient city of Treves in Prussia, the most famous of all sacred relics—the "Holy Coat," a garment said to have been worn by Christ throughout His Passion, His trial before Pontius Pilate, and his agonizing journey to the spot where his crucifixion was carried out. Between the date mentioned and the sixth day of October, when the relic was again withdrawn from public gaze, over a million people, bishops, priests, and laity, visited the cathedral of St. Pierre and feasted their eyes on the sacred robe, for the most part with wonderment and veneration. On the 20th of August after an interval of exactly forty-seven years, the "Holy Coat" will again be exposed to the view of all comers, no matter what their creed, and by virtue of an edict issued by the Church through Bishop Felix, of the local diocese, remain so for a like space of time. The event, it is needless to say, has been for weeks and months awaited with the greatest interest by all true Catholics, not only of Germany, but of the whole Old World. During this period the influx of pilgrims and vistors into the old cathedral city has been daily increasing, until, from the latest accounts, their carriage and lodgement has become a serious question to the railroad authorities and the worthy burghers of Treves. No small proportion of these travelers consists of the sick and maimed, in whose minds is firmly riveted the idea that to touch or even look upon the sacred garment will insure a complete and instantaneous cure.

The history of this venerated relic—to the minds at least of those whose religion bids them venerate it—is plain and sufficiently well authenticated. It was obtained by the Empress Helena, mother of Constantine the Great, during her sojourn in the Holy Land, and presented by her on her return to Treves, then the capital of Belgic Gaul and residence of the Roman Emperors, to the cathedral of the city. This was during the episcopate of Agritius, and some time between the years 314 and 334. That the Empress did make some such gift is proved by an ancient ivory, for centuries in the possession of the cathedral, which represents her seated at the church door awaiting the arrival of a procession closed by a chariot in which two ecclesiastics are standing on guard before a chest containing some precious gift. The ivory was carefully examined and its legend substantiated by the Archæological Society of Frankfort in the year 1846.

At the close of the twelfth century the Holy Coat was translated from the choir—its first resting-place—to the high altar of the cathedral, and, after an interval of three hundred years, was exhibited "for the veneration of the faithful" in 1512. During the wars and stormy times of the seventeenth and eighteenth centuries it was deposited for security first at the castle of Ehrenbreitstein, and later at Augsburg. From this latter hiding place it was removed in the year 1810 by special permission of the first Napoleon, and restored with great ceremony, to the cathedral of Treves then, and until the treaty of 1815, a French possession. In spite of the chaotic troubles through which all Europe was then passing, over 227,000 pilgrims journeyed to the city to celebrate the restoration of the relic.

The exhibition of the Holy Coat in 1844 left a mark, and almost an indelible one, upon the history of the Roman Catholic Church. The excitement caused by the pilgrimage of a million souls to one small Prussian town was as nothing compared with subsequent events which arose solely from the action of the Church in allowing the relic to be displayed and worshipped. Certain members of the Church, stigmatized then and now as rationalists, took offense at the proceedings, and argued in writing not only against the authenticity of the Holy Coat, but against the advisability of thus working upon the feelings and credulity of such vast numbers of their fellow-religionists.—*A. C. Townsend, in Harper's Weekly.*

How Much a Knot is.

How much is a knot? This question is asked, we believe, in every sea passage by some passenger or other, and never meets with a clear reply. Sailors themselves do not describe it distinctly, and books of reference differ as to its dimensions.

A knot is one-sixtieth of a mean degree of the earth's meridian. This definition requires explanation and also numerical computation. The earth's meridian is commonly described as any circle whose center is the center of the earth and whose circumference passes through the poles. This is not exact, because the meridan is not a true circle.

Evidently, it would be a true circle if the earth were a true sphere, but the earth is not a true sphere—it is a spheroid, its diameter measured on the axis being less than its diameter at the equator. Hence the circumference of a section of the earth by a plane passing through its center and the poles, which circumference is a meridian, is not a true circle, but an oval. Bearing this in mind, it will be easy to understand the meaning of a mean degree of the earth's meridian.

If 360 separate degrees be set off from the center of a perfect circle it is evident that the circular measure of each degree measured on the circumference of the circle will be the same. But if they be set off from the center of the oval the measurements on the circumference of an oval will not all be the same. That this is the case any one may demonstrate for himself by drawing an oval and its minor axis, and then, from the center of the oval, with radius equal to its semi-minor axis, inscribing a circle in the oval. If, now, degrees, or rather, for convenience, equi-multiples of a degree, be set off from the common center the geometry of the figure will show at once the variation in the circular measurements on the circumference of the oval.

Now, a mean degree of the earth's meridian is the average length of these 360 unequal measurements, and it is obtained by dividing the length of the meridian by 360. Astronomers have measured the earth's meridian and found it to be 131,259,287 English feet.

Dividing this by 360 we get 364,609·13 feet as the length of a mean degree of the meridian. One-sixtieth of this, then, is a knot, and thus by division a knot is found to be 6,076·818 feet, or 2,025·6 yards, or 1 mile 265·6 yards.

It will now be convenient to notice that a knot being 6,076·818 feet, and a mile being 5,280 feet, the proportion of a knot to a mile is very nearly as 6,076 is to 5,280, or dividing by 4 as 1,519 is to 1,320, which is very nearly as 15 to 13. So that for ordinary purposes knots may be converted into miles by taking thirteen knots as equal to fifteen miles, and *vice versa.*—*Chamber's Journal.*

Money Getting.

Some people think that it is necessary to be mean and miserly in order to become wealthy. There never was a greater mistake. Any man of common intelligence may be prosperous if he chooses to labor diligently and faithfully in a calling which he thoroughly understands. Of course, prudence is indispensable to success—*prudence* mind, not *niggard meanness.*

The man who, commencing with little or nothing, has resolved to rise, must also resolve to sacrifice nothing to appearance. He cannot gain one true friend, nor obtain any popularity that will be really useful to him in his efforts to achieve independence, by endeavoring to *seem to have* that which he has not. The world is shrewder than pretension supposes it to be. It is a curious world—looks sharply into people's private affairs, and if an individual makes a show beyond his means, soon discovers and distrusts him.

No one who has a fortune to make, or who desires to receive even a moderate competence, can afford to incur the world's distrust. Therefore if you are at the foot of the ladder and want to mount, go up in your work-day guise and don't affect purple and fine linen.

Climate and Morals.

The world is tolerably well mapped out as to diseases. The colored charts show us where we may most probably dwell with malaria, with consumption, or with general debility. We study also the adaptability of plants to different climatic conditions. But our knowledge of the relation of man to climate is still far from scientific—that is to say, of the influence of climate upon character and conduct. To come to a detail, what, for instance, do we know of the effect of climate upon veracity? There are portions of the earth's surface where the inhabitants regard truth as a luxury seldom to be indulged in; in others the mind seems rather inclined to truthfulness. Whether the difference is owing to race or climate our observations do not yet enable us to determine. There is a popular notion that the habit of prevarication goes along with warmth, or with a debilitating atmosphere, and that cold is a tonic, a sort of stimulant for truthfulness. We indeed have in the phrase: "the cold truth," a recognition of this. "We say that the northern latitudes nurse the rugged virtue of veracity. It never occurs to us to expect veracity in Egypt, nor in any part of Africa. We should never think of saying that an inhabitant of Malta was untruthful; we should simply say that he was a Maltese. The name Levantine carries with it the same idea. The Levantine, the African, the Oriental habit of indirection is sometimes explained by the amiability of the people, their desire to say that which will be agreeable. Whereas the Englishman prides himself on his blunt honesty, and on speaking the truth, especially if it is disagreeable. But plant the Englishman, or any man whose moral fiber is hardened by a frigid climate, in Egypt, and how long will he continue to speak the truth? How is it about the northern travelers in Africa, who never argue with each other about anything, and habitually accuse each other of misrepresentation? Is this due to climate, or to the contagion of a bad moral example in an atmosphere of duplicity?—*Charles Dudley Warner, in the Editor's Drawer, in Harper's Magazine for July.*

The Arrangement of the Cellar.

When the housekeeper has bought, built, or hired her house, after due consideration of the family needs and tastes, and after careful examination of the locality and construction of the chosen home, her earliest attention should be directed to the cellar, as that part of the home which is most often neglected, and where order and convenience combined add no small amout to the comfort and healthfulness of all parts of the house.

The arrangement of the cellar takes time and attention rather than any great outlay of money. The windows should first be seen to. A stuffy, unventilated cellar, full of dead air, is an abomination. The windows should be so hung that they can be removed from the inside, and during all but the extreme winter months should be taken out, and even in mild days they should be opened in the middle of the day. The outside of the windows should be protected by galvanized wire window-netting, costing two and a half cents the square foot. A heavier, coarser-meshed quality can be used instead, if great strength is desired. This quality costs six cents the square foot. The hatchways of the city houses are troublesome in cold weather. Both the rear and front hatchways admit a great deal of wind during the winter, in spite of the wooden covers that are fitted to them, and make the kitchen and dining-room floors draughty and cold. This can be remedied by covering the iron grating over each hatchway with several folds of old carpeting or furniture sacking, and then fitting the cover down tightly. The hatchway on the sunny side of the house must be frequently opened for air. The cellar ceiling and walls should be thoroughly whitewashed, two heavy coats being enough.

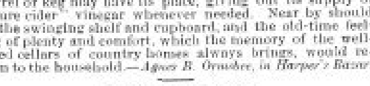
All city cellars, and many in the country towns and villages are cemented, which under most conditions is the safest and cleanest flooring. But in the country, where the ground is not poisoned from leakages of sewers or the foul gases of cesspools, and where yet farther, the ground is dry and sandy, a cellar bottom of well-beaten earth is not unwholesome, and has a mysterious capacity for keeping fruits and vegetables beyond that of cemented cellars. Such a cellar should have boards for walks to bins, barrels, and cupboard, to keep the house-mother from fretting over the dirt "tracked up." If these boards are occasionally turned over when swept, there will be no trouble from dampness or "saw bugs." Raising them up slightly from the ground by inch cleats nailed to the under side of the boards is another and better method.

In a cellar where there is a furnace it is a great help to household management to have a portion of the cellar divided from the furnace portion by a tight board partition, with a padlock door opening into it. The boards used may be rough and cheap, costing two cents a foot; but the partition must be tight, so as not to admit the warm air from the furnace. Under ordinary circumstances the expense need not be over ten dollars, and in many cases even less.

In this cold cellar the vegetables and apples, butter and preserves, may be kept, and even in the city, the uncomfortable habit of living from hand to mouth might be changed to a great degree. Here the time-honored vinegar barrel or keg may have its place, giving out its supply of "pure cider" vinegar whenever needed. Near by should be the swinging shelf and cupboard, and the old-time feeling of plenty and comfort, which the memory of the well-filled cellars of country homes always brings, would return to the household.—*Agnes B. Ormsbee, in Harper's Bazar.*

Scientific Paradoxes.

The water which drowns us—a fluent stream—can be walked upon as ice. The bullet which, when fired from a musket, carries death will be harmless, if ground to dust before being fired. The crystallized part of the oil of roses, so grateful in its fragrance, a solid at ordinary temperature, though really a volatile, is a compound substance containing exactly the same elements, and in exactly the same proportions, as the gas with which we light our streets. The tea which we daily drink with benefit and pleasure, produces palpitations, nervous troubles and even paralysis, if taken in excess; yet the peculiar organic agent theine, to which tea owes its qualities, may be taken by itself—as theine, not tea—without any appreciable affect.—*The Age of Steel.*



Electricity in Mining Operations in England.

Several years have passed away since electricity was first used in connection with coal mining in the United Kingdom, that occasion being, if we remember rightly, the erection of an underground electric pump in the Forest of Dean. Since then, this particular application has been slightly extended, and electric lighting, electric haulage, and electric coal-cutting machines have been introduced. The extent to which electricity has been adopted for these various purposes has, however, been very restricted and has not answered the expectations of either those who wish prosperity to the industry generally, or of those firms which undertake the supply of electric mining plants. At the present time, the number of installations or applications of electricity to different mining purposes in the United Kingdom is probably not more than fifty. Out of these, no less than twenty-eight are electric light installations in mines located in the South Wales district. In these twenty-eight instances, 1,171 fixed incandescent lamps are in use, and the greatest distance lighted is 365 yards from the bottom of the shaft.

What a contrast the great mining districts in the United States present! There electricity has come into very extensive use for: (1) drilling in rock and ironstone; (2) in under-cutting coal, the system of using a series of rotating drills being looked upon with most approval; (3) locomotives hauling underground; (4) pumping water from dip working to the shaft; (5) raising coal in cages of ordinary capacity, or by smaller machines in kibbles; (6) lighting the mines, etc. Remarkable, indeed, is the enormous development which has taken place in the use of electricity for these purposes, and the substitution of electrical for steam, compressed air plant, which process is going on continually, shows conclusively that the American mine owners have learned that electricity is not only more economical, but that it can be adapted to perform work in those parts of a mine where any other agency would be inadmissible. Why has not a similar development taken place in the United Kingdom, and are there any theories which can be advanced to explain the cause of the slow rate of progress made in this country? The answer is in the affirmative.

The first reason is the natural aversion of mine owners to adopt anything new; and the second is that they do not generally feel disposed to incur expense in making experiments with small plants; and the third—which is the most important—is that they object or rather many of them do, to the use of electricity as being unreliable. We will take it for granted that the first two reasons will be generally admitted, but the third may be considered as a bare statement, without any foundation in fact. Let us see whether such is the case.

If reference be made to the proceedings of the various societies of which the mine owners, managers, and engineers are members, it will be found, when the subject of electricity is brought forward, that the majority of the speakers express the opinion that that agency is unreliable and no matter whatever an electrical engineer may say, in order to endeavor to prove that such is not the case, the impression that electricity cannot be depended upon still remains in their minds. Take, for instance, the recent meeting of the Federated Institution of Mining Engineers, and the discussion which followed the reading of the paper descriptive of an electrical safety apparatus for cages. One of the speakers, in order to try to show the unreliability of electricity, stated that he had a telegraphic apparatus which got out of order every week, whilst another said that batteries were always "going wrong," and so forth. After these damaging statements had been made, the efforts of the author of the paper to remove them seemed to be of no avail. Now, the Federated Institution, although a young society, consists of many gentlemen who have been engaged in coal mining for over thirty years, and it is becoming, if it is not so already, the most important mining institute in the kingdom. Consequently, the opinion of the members may be taken as fairly representative of the feeling throughout mining circles in the country.

It is this wrong impression—this impression as to the unreliability of electricity in mining operations—that electrical engineers interested in mining plant must endeavor to remove, and until such an effort is energetically made, the adoption of electricity in the future will proceed but slowly, as in the past. What would doubtless have a good effect on mine owners, would be the collection of data regarding each application that has been made in this country, data giving the cost of installation and of working, comparisons with previous methods employed, and general results of working. Figures dealing with these points, and coming from those mines where electricity has already been adopted, would be more convincing than all the arguments in the world; they would not only remove the "unreliability" objection, but would doubtless greatly increase the trade in this branch of the electrical industry.—*London Electrical Review.*

Electricity in the Orient.

The dreamy and slow-going populations of the Orient, in sympathy with their Western brethren, are beginning to utilize the wizard-like power of electricity in the world of industry and the sphere of private and public illumination. Its practical utility for power purposes is being demonstrated by frequent experiments of societies formed for that purpose, and the reports of their investigations are being received with much favor by many who hitherto have been arrayed against the introduction of the new improvements and practices developed by our more progressive civilization.

The city of Tokio, Japan, now has a telephone exchange, in charge of the government, which has 329 subscribers, and is in a very prosperous condition, and Yokohama also has a similar institution liberally patronized and daily increasing in the popular favor of the people.

The empire of Japan has made rapid strides in the march of progress in the past few years and the traveler from America finds himself quite at home among the rising generation, which seems to have caught the modern fever for rapid transit in no slight degree.

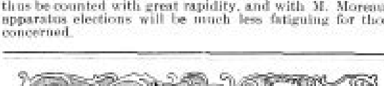
There is a tower in Tokio in which the tourist is carried skyward on an electric elevator, the current being furnished by the Tokio Electric Light Company, and the motor used is of the Sprague type, 10-horse power capacity.

At two or three different places in the Empire experimental works are in operation for refining copper by electricity, and the results thus far are said to be highly satisfactory.

On the whole it is plain that our Oriental kinsmen are no longer in the rear of the parade and their supplies of electrical appliances will no doubt be drawn in a very large measure from the United States.—*Industrial World.*

A New Electric Voting Apparatus.

We have inspected, says the *Independance Belge*, at the Brasserie Flamande, the voting machine invented by M. Moreau, of La Louviere. This machine presents precisely the appearance of a small piano or harmonium. As keyboard there is a series of buttons on which the elector must press to record his vote. The names of the candidates are classified by list. To each name a button corresponds. M. Moreau proposes to place the candidates' photographs opposite their names, so that the illiterate would know for whom they were voting. Under the keyboard is a cupboard, the case of the machine, in which is enclosed a tell-tale. Each button has its tell-tale, which registers the votes in units, tens, hundreds, and thousands. The electric batteries are placed under the case in place of the pedals. To approach the instrument the elector must get on a small rostrum, which suffices to establish the electric current, and he can then vote. The essential of this invention consists in the distribution of electricity. M. Moreau has succeeded in regulating the machine according to the number of votes to be recorded by the elector. If the complete list of candidates is five, the instrument is regulated in such a manner that each voter cannot record more than five votes. It is equally impossible for him to press twice on the button. To do that he must descend and get up again after the lapse of a few seconds. The rostrum, however, is to be made very large, and the presiding officer will see the elector the moment he gets up and also when he descends. No fraud is possible in this direction. We have omitted to say that the machine is naturally protected by a partition. The apparatus permits of the lists being supplied in different colors. There is a button on which the elector must press to obtain a white paper. This button produces the same ringing as the others. Secret voting is thus absolutely ensured; moreover, a number of electricians and skeptics have already been to see the machine, and all, or nearly all, have recognized its practical use. For our part, concludes our contemporary, we have questioned the inventor on a number of points, and all doubts vanished before the precise answers and conclusive experiments. The tell-tale cupboard will be naturally closed at the commencement of operations. When the election is finished it will be opened and the presiding officer will have nothing to do but to take down the figures given by the tell-tales. An election will thus be counted with great rapidity, and with M. Moreau's apparatus elections will be much less fatiguing for those concerned.



The Habit of Washing.

No practice, however long established, has ever been allowed a permanent right to respect. Sooner or later its turn will come to be weighed in the critic's balance, and its quality will have to be proved. Let us quote as a recent illustration, the habit of daily bathing, the utility of which has of late, though not for the first time, been seriously questioned.

The reasonableness of doubt in such a matter, and under ordinary circumstances, does not, we confess, commend itself to our judgment. Whether the opponents of ablution fear the shock of cold immersion, or whether they dread the cleansing stimulation thus applied to the excreting skin surface, their objection must appear to most persons possessed of ordinary health and vigor to threaten impairment of both by fostering uncleanliness. If, on the other hand, it is the too free application of heat by Turkish and other warm baths which appear objectionable, we do not deny that there is here a possible ground for complaint. Let it not be supposed that we ignore the curative influence or the cleansing property of this method when used with judgment. It is true, however, that experience has often proved the mischievous effect of its misuse—in cases, for example, of cardiac weakness or general exhaustion. Cold bathing in like manner is not without its occasional risks. It is not suitable for persons enfeebled from any organic cause, though mere nervous languor is often braced and benefited by it. It has no proper places among the habits of those who are subject to chronic visceral congestions. As regards one advantage derived from bathing—*i. e.*, its cleansing property—there is no reasonable ground for difference of opinion. Less practiced by one people than another though it may be, there still is commonly recognizable a constant habit of ablution, and this fact in itself attests at least an almost universal belief in the necessity of insuring cleanliness by means of washing. Nor can we find reason to doubt the general soundness of this belief. In bathing temperature is of course a chief consideration. For the robust, cold immersion followed by rapid friction is a valuable tonic of nerve, skin, and heart function. For less vigorous constitutions—those, for example, which have been tried by disease, and those of young children—the addition of heat up to temperate point is only judicious. With some persons a warm bath is a daily luxury. Notwithstanding its efficacy as a means of cleanliness, however, this custom is or ought to be discredited by its inevitable action as a nervous depressant, which places it in an unfavorable position compared with the more bracing practice of cold affusion. The benefit derived from bathing, therefore, is likely to assert itself in spite of all adverse criticism, and its mismanagement, which is only too common, should not be suffered to condemn it in the eyes of any judicious and cleanly person.—*Lancet.*

To Make Good Coffee.

"It is quite astonishing that so few persons really know how to make a good cup of coffee," said the master of the house, making a wry face over the thick, muddy fluid which the new cook had served for breakfast. "And it is so simple," he continued, "any one could make it. When I was a bachelor and lived in rooms, I always made my own coffee, and I never failed. Here is my formula, if you like to have it for your new cook, who, I must say needs a hint or two. It is better, of course, to grind your own coffee, as then you are sure of having it good, but I never cared to take the trouble or the time myself. Put the ground coffee in the coffee pot, the quantity being regulated according to the number of persons; a family of six would require about a teacupful. Add half a pint of cold water and one raw egg, but do not put in the shells, as many ignorant cooks do, considering that the broken bits have a peculiarly clarifying power. Stir all well together, add one quart boiling water and let the whole boil for fifteen minutes. While still boiling pour in half a cup of cold water, and put the coffee pot on one side of the stove where it will not boil, and let it stand for several minutes. Coffee made in this manner will be found clear, strong, and free from 'grounds'."—*New York Tribune.*

Apples as Medicine.

Chemically the apple is composed of vegetable fiber, albumen, sugar, gum, chlorophyll, malic acid, gallic acid, lime, and much water. Furthermore, the German analysts says that the apple contains a larger percentage of phosphorous than any other fruit or vegetable. This phosphorous is admirably adapted for renewing the essential nervous matter, lethicin, of the brain and spinal cord. It is, perhaps, for the same reason, rudely understood, that old Scandinavian traditions represent the apple as the food of the gods, who, when they felt themselves to be growing feeble and infirm, resorted to this fruit for renewing their powers of mind and body.

Also, the acids of the apple are of signal use for men of sedentary habits whose livers are sluggish in action; these acids serving to eliminate from the body noxious matters, which, if retained, would make the brain heavy and dull, or bring about jaundice, or skin eruptions and other allied troubles. Some such an experience must have led to our custom of eating apple-sauce with roast pork, rich goose, and like dishes. The malic acid of ripe apples, either raw or cooked, will neutralize any excess of chalky matter engenerated by eating too much meat. It is also the fact that such fresh fruits as the apple, the pear, and the plum, when taken ripe and without sugar, diminish the acidity in the stomach rather than provoke it. Their vegetable salts and juices are converted into alkaline carbonates, which tend to counteract acidity. A good ripe raw apple is one of the easiest of vegetable substances for the stomach to deal with, the whole process of its digestion being completed in 85 minutes.

Gerard found that the "pulpe of roasted apples mixed in a wine quart of faire water, and labored together until it comes to be as apples and ale—which we call lambswool—never faileth in certain diseases of the raines, which myself hath often proved, and gained thereby both crownes and credit. The paring of an apple, cut somewhat thick, the inside whereof is laid to hot, burning, or running eyes at night, when the party goes to bed; and is tied, or bound to the same, doth help the trouble very speedily; and contrary to expectation—an excellent secret."

A poultice made of rotten apples is of very common use in Lincolnshire for the cure of weak or rheumatic eyes. Likewise, in the Hotel des Invalides, at Paris, an apple poultice is used commonly for inflamed eyes, the apple being roasted and its pulp applied over the eyes without an intervening substance. A modern maxim teaches that—To eat an apple going to bed, the doctor then will beg his bread.—*London Hospital.*

What is Education?

In order to be successful in active life a man must have a working knowledge of three things:

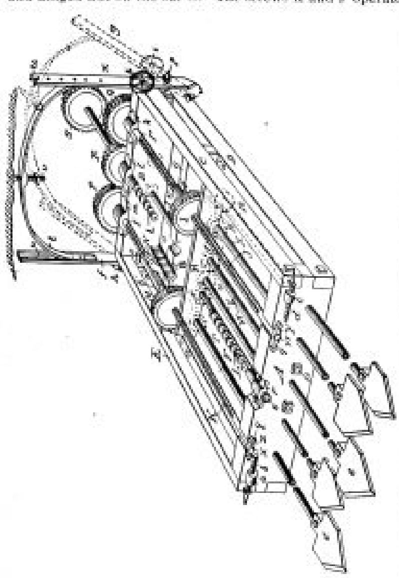
1. Human nature.
2. The practices in vogue among his neighbors.
3. Logic.

Whatever study or mental exercise or discipline teaches him the most regarding these matters is the best practical education. This practical education must be supplemented by special training in the prerequisites of that particular vocation in life which he is to follow.

Other things being equal, a large school or college affords a better education than a small one, for the reason that it gives to each student a larger opportunity to observe human nature and the customs of his neighbors. The mere information obtained by studying text-books is in itself ordinarily of very little value compared with the whetting which it gives to the mind, and when the mind is once sharpened it should be so turned as to learn from the world of to-day, if the student wishes to be in the world and of the world. Should he show a fondness for studying politics and a wish to enter public life, a comprehension of American democracy is of more value to him than a knowledge of Athenian democracy. Should he decide to enter business, knowledge of human nature and business practices is of equal consequence with logical nicety of calculation—an important result of studying the classics—however valuable this last may be. This fact explains why it is that those valedictorians who do not join in the general life of their college class and who devote themselves entirely to the text-books, are frequently outstripped in public life, law, and business by classmates who stood a grade or two lower in scholarship. These latter give a portion of time to observing their environment, while valedictorians of the kind mentioned take all their views from books, and are consequently less self-reliant.

MINING MACHINE.

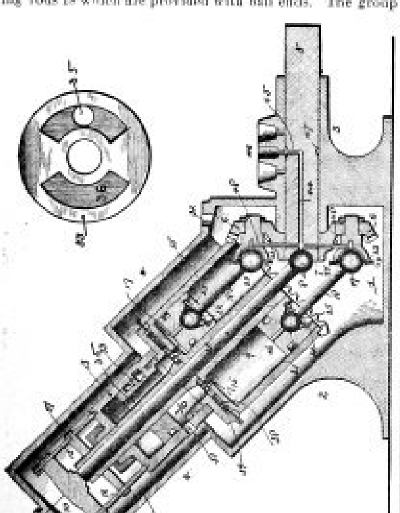
No. 451,988. Isaac Wantling and James T. Johnson, Peoria, Ill. *Patented May 12, 1891.* A gang of rotary cutters *e e* are set so close that the cut of one overlaps that of the next. These cutters are fastened to suitable shafts which are turned by spur pinions (shown by dotted circles) carried in the sliding-head H G. The pinions are driven by gears M I, which are carried on long screws K and J. Both screws have a keyway cut from end to end, and the gears K and J are turned by feathers running in these grooves. The screws work through nuts which are divided and hinged on the bar G. A course pitched screw L (shown broken away in the middle) also passes through a divided and hinged nut on the bar G. The screws K and J operate



as feed-screws to drive forward the head G H with the boring bits *e e*, and at the same time convey the power to rotate the cutters. The screw L operates only as as a return feed. When the machine is boring and the head G H is feeding forward the nut on L is thrown open, as shown. When running back the nut on L is closed, and those on K and J are opened. The sliding head is guided in slots in the side frames. Spur points *a e o p* are provided at the corners of the frame, and an adjustable brace *f t z* serves to firmly anchor the machine when at work. Small truck wheels are attached to the brace to help in moving the machine from place to place. By turning the frame up on edge, vertical cuts are readily made.

ENGINE.

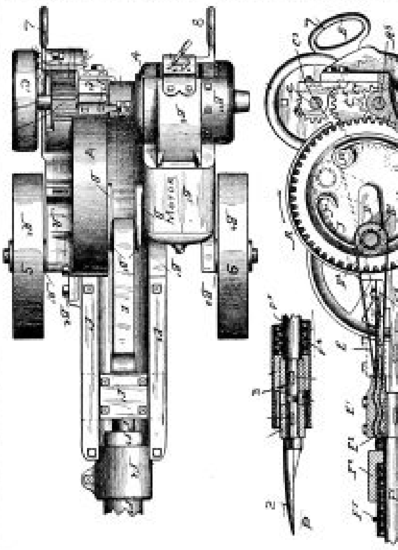
No. 453,862. Robert C. Berry, Lafayette, Indiana. *Patented June 9, 1891.* A number of single-acting steam cylinders are grouped around a central shaft 9, and the several pistons are connected to the crank disc 6, by connecting rods 18 which are provided with ball ends. The group



of cylinders revolve with the shaft 9, in unison with the crank disc, the two being connected by bevel gearing, as shown. The pistons are driven outward by the steam or compressed air during the downward half of the revolution, and during the upward half the crank drives them back to the inner end of their cylinders. A stationary circular valve 33 located within the stationary steam chest 13, bears against the cylinder head, and controls the admission of steam through the port 35, and the exhaust through the ports 36 and 31. Between the end of each separate cylinder and the head 30 is a small "grid-iron" slide-valve. These valves are forced toward the center shaft by coiled springs 38, whose tension can be adjusted by the set screws shown. As the cylinders revolve, these valves are thrown outward by centrifugal force, and throttle the opening into the cylinders, thus operating as governors. All the working parts are enclosed in the casing shown, and the internal friction of the engine appears to be unusually small. There are no dead centers, and it runs equally well in either direction. The movement can be reversed by turning the valve 33.

MINING MACHINE.

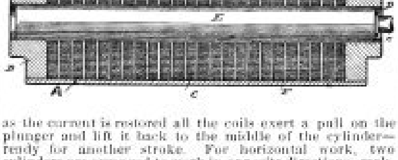
No. 454,500. Elmer A. Sperry, Chicago, Ill. *Patented June 23, 1891.* This machine employs a reciprocating pick 2, which is keyed into a collar 3, which is keyed to the sliding bar F^3 and slides inside the guide tube F^6. The bar and pick are thrown forward against the coal by a heavy coiled spring F^4 coiled within the guide tube and bearing against the collar 3. The pick is drawn back and the spring compressed by means of a strap pitman E which is attached to the cross-head E^1 and E^2. The pitman is provided with a bushing D^1 filled with balls or rollers where it bears on the crank pin of the crank D. This crank is double, and



the crank shaft consists merely of short trunnions which bear loosely in sockets in the center of the spur-wheel C^8 and in the field magnet B^2 of the electric motor which drives the machine. The armature 4 of the motor is attached to the shaft C^5, and the speed is reduced, and the power is conveyed to the driving-wheel C^8 by the spur-gearing shown. The driving wheel carries a strong curved spring J which is hooked at J^1 in such a way that it catches the crank pin (which extends through one side of the crank) as the wheel revolves, and carries the crank around with it, in the direction shown by the arrow. Soon after the crank passes the back center, or approaches the position shown in dotted lines, the spring F^4 throws forward the bar F^3 and pick 2 and causes the crank to jump to the position shown, where it stands until again picked up by the hook J^1 on the revolving driving-wheel C^8. The machine is mounted on two loose wheels 5 and 6, and is pushed into the cut and held up to its work by means of the handles 7 and 8, which are grasped by the operator. The fly-wheel C^1 and spur gear C^9 are attached to their shafts by spring couplings, which are intended to ease off the shocks caused by the violent motions of the pick and bar. A rubber collar F^7 is also placed between the crosshead E^2 and the front end F^2 of the machine frame for the same purpose.

ELECTRO-MAGNETIC RECIPROCATING ENGINE.

No. 450,543. Charles J. Van Depoele, Lynn, Mass. *Patented April 14, 1891.* This is a new arrangement of the coils composing the "cylinder" of reciprocating apparatus suitable for rock-drills, etc. The outer casing is a heavy tube of A iron closed at the ends by iron heads B. The coils C of insulated copper wire (shown in cross-section) are separated by iron discs F which act as inward extensions of the magnetic casing A, when an exciting current is run through the coils. By this means the magnetic pull of the coils tending to draw the iron plunger E to the center of the cylinder (the position shown) is greatly increased. When the current is interrupted, the plunger E which carries the drill rod, will fall by gravity, and as soon



as the current is restored all the coils exert a pull on the plunger and lift it back to the middle of the cylinder—ready for another stroke. For horizontal work, two cylinders are arranged to work in opposite directions, making the plunger double-acting. The plunger E is of such length that it can close the magnetic circuit between the heads of the machine, and in this position the plunger is capable of sustaining a great weight with a very small amount of current passing through the motor-coils. The main feature of the present invention consists, as before stated, in employing the magnetic extensions between the iron envelope of the machine and the moving piston, and this may be availed of in a very great many ways.

LIQUIDS FOR SEPARATING METALS FROM GANGUE.

No. 454,116. Joseph S. Lurie, Kansas City, Mo. *Patented June 16, 1891.* After the quartz has been passed through the stamping mill or crusher it is passed into a vessel containing water and a liquid which is insoluble in water, which is of greater specific gravity than water, and which is also of greater specific gravity than the quartz, but of less specific gravity than the metals mixed with the quartz. It will be seen that the quartz will float with the water on the surface of the liquid, which is of greater specific gravity than the quartz and water, and that the metal that has been held by the quartz until the same has been crushed will be precipitated through said liquid. Any desired number of troughs and screens may be used to grade the materials. Four liquids are made, called No. 1, No. 2, No. 3, and No. 4. The inventor thus describes his processes: "Liquid No. 1 is obtained in the following way: By the action of bromine on alcohol I get a fluid which by distilling at a temperature of 280° Fahrenheit is decomposed into two parts, one of which remains in the retort and the second is distilled over into the receiver. The fluid which remains in the retort is taken out and decomposed by a caustic alkali, forming a bromide of the alkali and a heavy fluid at the bottom. The last named fluid, being carefully washed and of a specific gravity of nearly 4, constitutes my liquid No. 1. For the liquid No. 2 I use the tetrabromethane ($C_2H_2Br_4$) mentioned in any extensive chemistry; but I take care that if the liquid is prepared with acetylene the acetylene should be obtained in a perfectly pure state. Liquid No. 3 is made as follows: In preparing liquid No. 1 I receive a part which is distilled over into the receiver. This liquid is separated from the water which is on top of it, and combined with pure acetylene is changed into a liquid of a specific gravity of about 2, thus forming my liquid No. 3. Any methyl-propyl-benzene or cymene being dissolved in alcohol gives my liquid No. 4. These four liquids can be combined by two, three, or all together in the proper proportions to give a mixture of a specific gravity greater than any quartz or gangue but of less specific gravity than the metals therein contained.

"It is obvious that in treating the quartz the proportions of the various liquids must be regulated according to the specific gravity of the quartz being treated. Consequently I do not confine myself to any specific proportions of the same. The following proportions which I have used in the treatment of the following ores will enable any one skilled in the art to perform the same.

"In treating carbonate ore of 1·8 specific gravity I use one-half part of liquid No. 1, two parts of liquid No. 2, one part of liquid No. 3, and one-half part of liquid No. 4. In treating white quartz ore of 2 specific gravity I use one part of liquid No. 1, two parts of liquid No. 2 and one part of liquid No. 4."

It will be seen that the liquid employed is a non-metallic and a non-mixing one—that is to say, it will not unite with the metals to be operated upon.

ROCK DRILL.

No. 454,228. Edward A. Rix, San Francisco, Cal. *Patented June 16, 1891.* The front cylinder-head I is made in halves and is clamped together by bolts J. The back head R is held in place by a stout spiral spring S which is confined by a yoke P. This yoke is connected by long bolts M to the front cylinder-head I, so that the spring acts to keep both heads in their places. If the main piston E strikes either head they are free to yield and thus avoid breakage. The spirally grooved rod H and the ratchet *s* are very similar to those commonly used for turning rock

Fig. 2

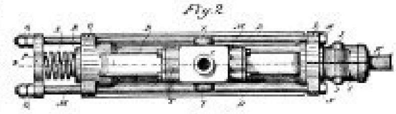
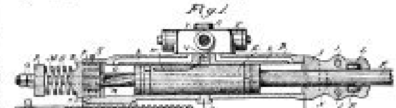


Fig. 1



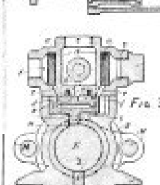
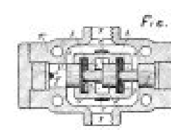


Fig. 3

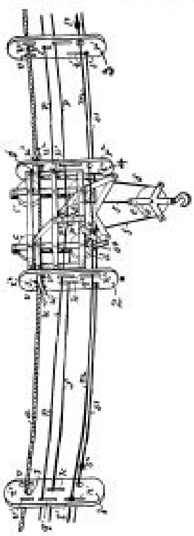
Fig. 4



drills. The point of the set-screw *g* works in a groove in the loose cylinder-head R and keeps it from turning. The main valve U is a piston valve which is clearly shown in Fig. 4, which is a section through the steam ports Y. Small ports *y* extend to a small supplementary valve V, shown in Fig. 3, which moves crossways of the main cylinder and controls the movement of the main valve. The small valve V is moved by a lug which projects into the main cylinder and enters the long cam groove W in the main piston. The body of the piston is kept from turning by a feather 3. The cylinder B slides on the frame A in the usual manner.

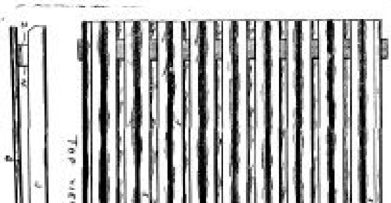
LIFTING AND CARRYING APPARATUS.

No. 447,892. THOMAS S. MILLER, NEW YORK, N. Y. *Patented March 10, 1891.* The trolley runs on the stationary cable *a* which is stretched between two towers or masts. The rope *f*, is the fall rope, one end is secured to the block *e*, and it passes over sheave d^1, then to the block sheave c^1, then over sheave *d*, to the left-hand tower where it is operated by any approved windlass. The trolley is held in its place along the cable *a*, by the rope *p*, which is fastened to the trolley at p^1 and runs to the right-hand tower, where it passes around a proper sheave, and returns to the left-hand tower where it is operated by a second windlass located in the same frame as that which controls the fall rope *f*. Hoisting is performed by locking the drum holding rope *p*, and then hauling on rope *f*. The load is carried to the left by hauling on rope *f* and simultaneously paying out rope *p* an equal amount, and movement to the right is effected by paying out *f* and hauling on rope *p*. The operating ropes *f* and *p*, are prevented from undue sagging by wooden hangers 1, 2, 3, 4, etc., which are strung on the main cable *a*. These hangers are spaced by ropes s^1 and *m*, which are provided with stop balls of varying sizes. The holes in the hangers for the passage of ropes s^1 and *m*, are also of varying sizes, and each stop ball will engage only that hanger which it cannot pass. The hangers are prevented from sliding upon and chafing the main cable, by means of horns *n*, n^1, and n^2, n^3 on the trolley, which pick up the hangers, lifting them clear of the cable, and carry them until they are pulled off by the stops on the stop ropes s^1 and *m*.



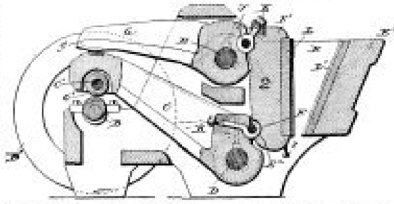
SLATE PICKER.

No. 454,393. EDMUND A. BARTL AND JACOB C. BOWMAN, SCRANTON, PA. *Patented June 16, 1891.* This picker is composed of a series of angle-iron bars 3, placed with the angle upward as shown in the end view. Each bar is attached by a post or pin 4 to cross bars 1 and 2 at each end. A set of round bars 6 are placed below the spaces between the angle bars; these round bars drop away from the angle bars toward the lower end of the picker which is set on an incline, so that flat pieces of slate passing through the spaces between the angle bars will not stick and clog the apparatus. The beveled sides of the angle bars give the flat pieces of slate a strong tendency to separate from the coal, and drop through the slots shown, while the coal passes onward over the bars to other screening or sizing apparatus.



STONE CRUSHER.

No. 452,615. JOHN O'NEIL, JR., KEESEVILLE, N. Y. *Patented May 19, 1891.* The moving head 2 is operated by two levers C and G, which rock on shafts D and H. The lever C has a roller C^1 at its rear end, which bears on the eccentric on the driving shaft B and is moved up and down by it as the shaft turns. The lever G bears on top of the lever C as shown and receives motion from it. Both levers are connected to the moving head 2 by hinge pins J and F. These pins lay in half round grooves made across the back of the moving head, and across the face of the levers, and transmit the motion of the levers to the head. They are held in place and the joints are completed by the hook bolts K. By the arrangement of the levers shown the head

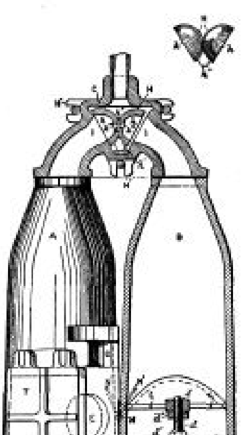


is moved forward and slightly downward, both ends alike. The fly-wheel B^1 is held on the shaft by the friction clamps, which are adjusted to just such a degree, that in case anything gets into the hopper that will not crush, the fly-wheel will slip on the shaft instead of twisting it off, or breaking the levers.

PULSOMETER.

No. 452,400. WILLIAM P. THEERMAN, SALFORD, ENGLAND. *Patented May 19, 1891.* One working chamber is shown in section, also the steam chest and valve. The two working chambers A and B are of any ordinary form, preferably circular in cross-section and tapering toward the top, and are connected together at the top in the usual way by means of a valve chamber or chest C, and are fitted at the base with water-valves D and E for suction and delivery, one opening into an inlet-chamber F and the other into the discharge-chamber G. The steam-valve H, which is placed in the valve-chamber C and controls the admission of steam to working chambers A and B, is formed of two hemispheres or half-balls *h*, joined together at their back or convex surfaces. Each of the semi-spherical parts *h* of the valve may be concave, as shown, or may be solid with a flat face. The concave or flat face of the valve H finds a seating over the ports I in the upper end of each of the working chambers A and B. On the under side of the steam-valve H midway between the two parts *h* projects a rib or lugs *h'*, upon which it rests and oscillates between the valve-seats over the ports I, opening and closing them alternately.

This form of valve offers less obstruction or resistance to the steam and allows the valve to change from one side to the other, quicker than a ball. The impact of the incoming current of steam acts to assist the change of the valve from one seating to the other. When intended to be used with exhaust-steam, or steam at a very low pressure, the valve is formed with a vertical passage *h''*, extending from the top of the valve between the two semi-spherical parts *h* down to

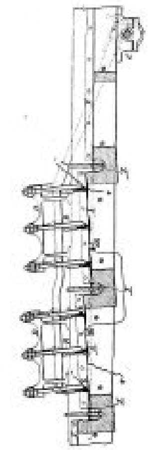


meet a horizontal cross-passage *h'''*, leading from the interior cavity of the one part into that of the other part. The cross-passage *h'''* is of double V-shape, or of V-shape at each opening, to allow for rapid expansion of steam as it is passed through. Through these passages a small quantity of the exhaust or low-pressure steam is admitted into the working chamber after the valve H has closed the admission of steam to that chamber. By this means a sufficient vacuum is produced to insure the complete filling of the chamber with water. The inlet and discharge-valves D and E have each a conical seat K, which fits loosely in a conical bearing, cast in the body of the pump and chilled. The valve is of rubber, and covers the joint between the seat K and its bearing. The seat is held down by a stud *d* which passes through a boss on the edge of an inclined shelf L, which extends part way across the chamber. The space under this shelf forms a kind of pocket, the use of which is explained further on. At this level there is also formed a passage or port N, leading from the discharge-chamber into and joining a passage or port N' from one working chamber to the other. When the water has been forced down in one of the working chambers below the shelf L, a certain amount of water that has been held up by the pressure of the steam under the shelf L falls and meets the steam, thus forming a partial vacuum, relieving the pressure, and thus causing the valve H to close. A jet of water is then projected either from one chamber into the other through the passage N^1, or from the discharge-chamber by the passage N, or from both, and by these means the condensation of the steam in the working chamber is almost instantaneously effected.

ELECTRICAL AMALGAMATING APPARATUS.

No. 455,164. GEORGE BUTTON AND WILLIAM E. WYETH, GRIQUALAND WEST, SOUTH AFRICA. *Patented June 30 1891.* The table is constructed with transverse shallow channels or corrugations A, in each of which is contained a body of mercury, and the finely-crushed ore to be treated is made to flow, together with water, along the table, passing across these channels A. Above each channel is mounted on a framing D a brush B, composed of any desired bristles ordinarily employed in making brushes, said brush extending the whole width of the table and its bristles of such lengths as to dip into the water and nearly touch the surface of the mercury. Against one side of each brush is fixed a conducting-bar *b* adjustable in height. The brushes all receive from a crank or eccentric C a reciprocating motion so as to sweep to and fro over the surface of the mercury.

The table, which is by preference formed of corrugated copper plates, is connected to the negative electrode of a dynamo-machine or other source of electricity, while the conducting-bars *b*, bearing against the brushes, are connected to the positive electrode. Thus as the ore and



water flow continuously along the table, passing from channel to channel, an electric current is transmitted by the bars to the brushes and through the ore-bearing liquid and the mercury to the table, and the electrolytic action combined with the stirring action of the brushes causes the gold or silver to be effectually taken up by the mercury and amalgamated with it.

The corrugated plates are preferably coated with gold burned into the copper, so as to prevent any action upon the latter.

The ore and water are made to flow over flat plates E, both before and after passing over the corrugated table, and these plates are also preferably coated with gold burned in. It is also of advantage to have dams F containing mercury.

ORE CRUSHER.

No. 450,890. WILLIAM L. MORRIS, CLEVELAND, OHIO. *Patented April 21, 1891.* Fig. 1 is a cross-section of the machine on the line *xx* in Fig. 2. Fig. 2 is a vertical section lengthways of the hopper. As shown, the hopper B is inverted and is nearly semi circular in cross-section. It is provided with three removable die blocks C, 1, and 2. The middle one serves as a key to retain the other two, and it is

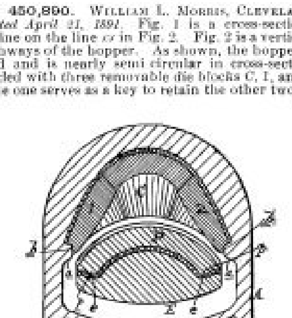
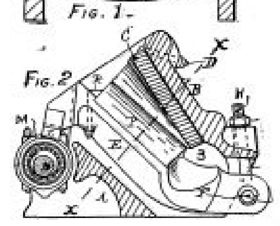


FIG. 1.

FIG. 2



fastened in place by a hook bolt D. The movable jaw E is also faced with a removable die P, which is secured by a hook bolt R. The moving jaw is hung by trunnions F and a jaw bolt H, by which it is adjusted. The hopper has a large side opening 3, on each side, by which the crushed material escapes. The jaw is worked by an eccentric N and strap M. The jaw is provided with a wearing block L, where it bears on the eccentric strap. As the edges of the movable die P are clear of the hopper on both sides and end, it follows that the crushed material can escape far more readily than in other forms of crushers, where escape is possible only at the throat of the hopper; consequently the power is used wholly for crushing, and none is wasted in merely pressing material already ground fine enough, but unable to escape.

The Colliery Engineer.

AN ILLUSTRATED JOURNAL OF

Coal and Metal Mining and Kindred Interests.

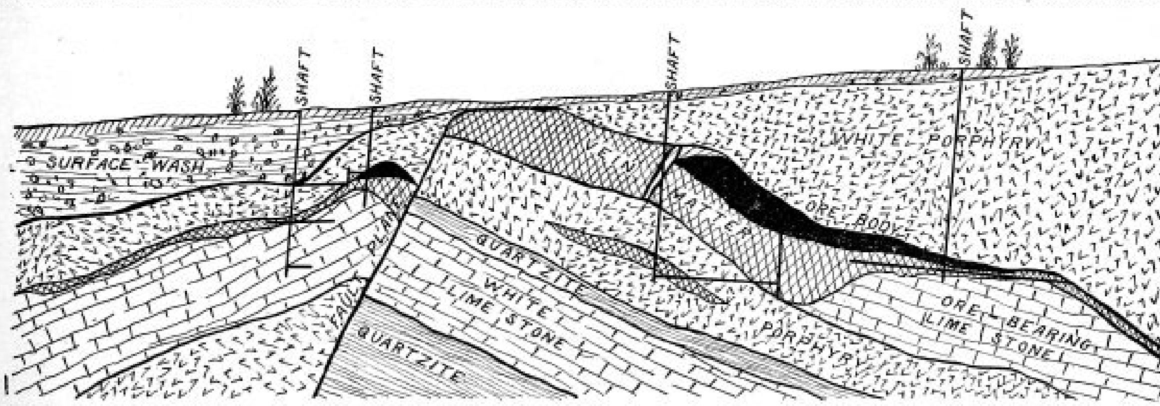
VOL. XII.—NO. 4. SCRANTON, PA., NOVEMBER, 1891. WITH WHICH IS COMBINED THE MINING HERALD.

THE ECONOMIC GEOLOGY OF SILVER.

The Mineralogy, Mode of Occurrence, and Production of Silver.

BY H. A. WHEELER, E. M., OF ST. LOUIS.

A district which created great excitement in 1878 is Leadville, Colo., where numerous profitable miners usually extract their ore along the contacts of an overlying trachyte and an underlying limestone, or else in the limestone only. Some very rich horn-silver ore has been found in some of the Leadville mines that sold for $1,000 to $10,000 per ton, but the great bulk of the ore is either lead carbonates in the upper parts of the mines, assaying 20 to 200 ounces per ton, or galena from the lower workings that assays 10 to 100 ounces per ton. The veins usually lie quite flat, or with dips of 5 to 25°, and are quite badly faulted. While the ore bodies are not continuous and much money is often spent in searching for them, the Leadville mines, on the whole, have been exceptionally profitable, and few camps can show such a magnificent record as this does for its moderate length of life and large number of dividend-paying mines. The sketch shown is through Carbonate Hill, back of Leadville, after Emmons. The Aspen district, which is but a short distance west of Leadville, is a young mining camp that has thus far done very well and threatens to finally eclipse Leadville's handsome record, from a group of mines that very much resemble those of the latter place.



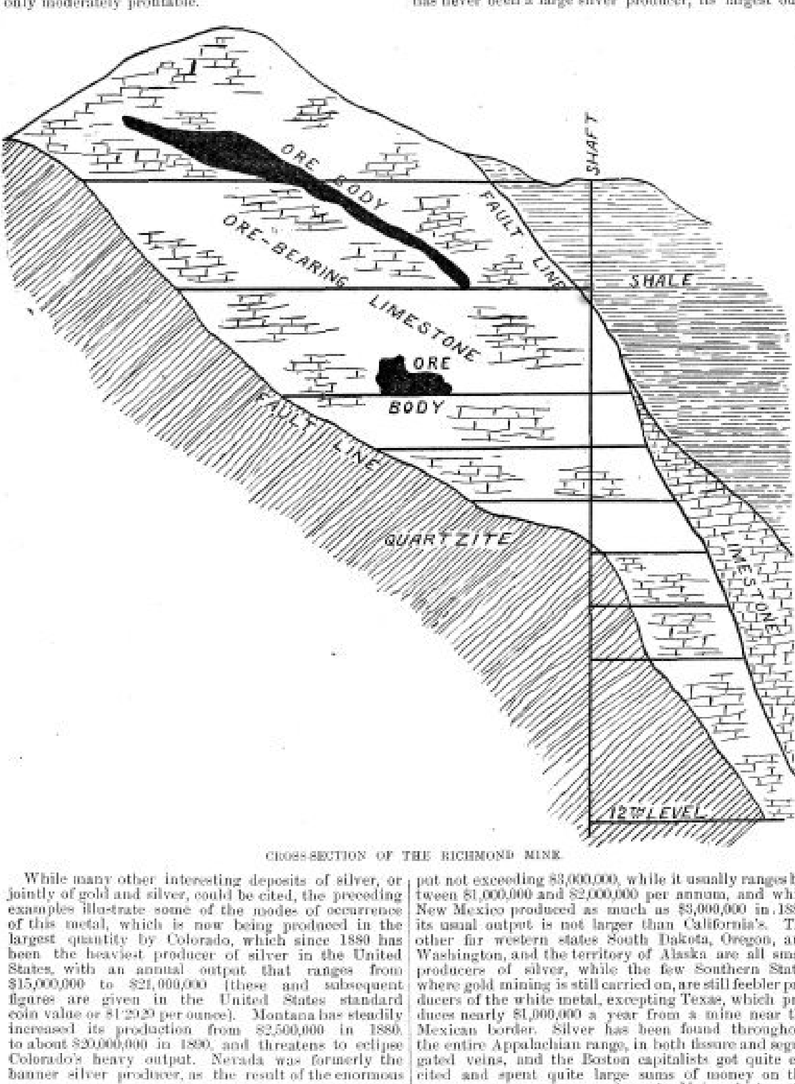
CROSS-SECTION OF A LEADVILLE ORE BODY.

A series of chamber deposits of silver-lead ore that have been the cause of famous litigation occur in the Richmond-Eureka belt of lime-tone at Eureka, Nevada. The Richmond and Eureka-Consolidated are adjoining mines that work a series of chambers of gold and silver-bearing carbonate of lead that occur in a narrow belt of limestone. The chambers are very irregular in their size and occurrence, and are not always entirely filled with ore, quite large caverns being of common occurrence. The ore assays from $40 to $70 in gold and silver and 15 to 30% in lead, and usually occurs in such large bodies as to be very profitable, the Richmond Co. having declared $4,332,887 in dividends, and the Eureka $4,892,500. The limestone in which the chambers occur varies greatly in width, or from a few feet to 450, having an average width of about 250, being underlaid by quartzite that dips about 45° to the north, and overlaid by shale, and the attempt was made in the big law suit in which the above two companies were involved to prove that the ore-bearing limestone belt, which is dolomatized or magnesian limestone, was a lode or vein. The sketch shown is through the Richmond vertical shaft, taken across the formation, after Curtis.

As a type of the stockwerk class of ore-deposits may be cited the Silver King Mine, in Pinal Co., Arizona, which seems to consist of a central mass or chimney of quartz about 200 feet in diameter, carrying innumerable radiating veinlets bearing a great variety of rich silver ores, the whole occurring in a dike of porphyry. The ore has been very rich, milling as high as $200 per ton, but is not holding out in depth, the mine having produced but little below the 500 foot level, and at a depth of 900 feet the outlook thus far is very discouraging; it has paid dividends that aggregate $1,950,000.

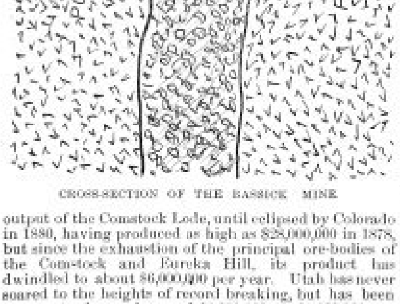
An odd type of ore occurrences is the Bassick Mine, at Rosita, Colorado, which seems to occupy the vent or channel of an old hot spring. The ore occurs as thin films and incrustations on boulders and pebbles that fill a funnel-shaped, nearly vertical opening or conduit of 20 to 100 feet in diameter in volcanic rock (trachyte). These boulders seem to have fallen in and choked up the outlet of this old hot spring during its expiring efforts, and the ore-bearing solutions have afterwards deposited gold and silver with quartz in the interstices between the boulders. The ore is very rich, it partly occurring as tellurides, and though shipments have been made assaying from $200 to $5,000 per ton, the financial history of this company is not a bright one, as no large quantities of this rich ore have been found, and the low grade ore, as the boulders are found to be more or less permeated by the precious metals, has not thus far built up a big dividend record.

An interesting occurrence of disseminated deposits is found at Silver Reef, in Southern Utah, where triassic sandstone is found impregnated with horn-silver that assays from $5 to $30 per ton. The horn-silver is often quite invisible, while again it is found replacing stems and leaves. Though there is no trace of vein formation, the silver follows certain channels and seems to be intimately connected with neighboring dikes of intrusive rock, and was probably brought up from below by mineral-bearing solutions that readily permeated the porous sandstone from small fissures or dislocations that followed the outburst of the volcanic rocks. The silver changes to the sulphide condition below the water level, and as the average value of the ore has always been low, no very heavy dividends have been paid by any of the mines of this camp, as the best of them have been only moderately profitable.



CROSS-SECTION OF THE RICHMOND MINE.

While many other interesting deposits of silver, or jointly of gold and silver, could be cited, the preceding examples illustrate some of the modes of occurrence of this metal, which is now being produced in the largest quantity by Colorado, which since 1880 has been the heaviest producer of silver in the United States, with an annual output that ranges from $15,000,000 to $21,000,000 (these and subsequent figures are given in the United States standard coin value or $1·2929 per ounce). Montana has steadily increased its production from $2,500,000 in 1880, to about $20,000,000 in 1890, and threatens to eclipse Colorado's heavy output. Nevada was formerly the banner silver producer, as the result of the enormous



CROSS-SECTION OF THE BASSICK MINE.

output of the Comstock Lode, until eclipsed by Colorado in 1880, having produced as high as $28,000,000 in 1878, but since the exhaustion of the principal ore-bodies of the Comstock and Eureka Hill, its product has dwindled to about $6,000,000 per year. Utah has never soared to the heights of record breaking, but has been a very steady producer of $6,000,000 to $9,000,000 per year for the past twelve years. Arizona has produced as much as $7,500,000 in 1882, when the Tombstone mines were in bonanza, but since they have reached the water level, together with the exhaustion of the Silver King Mine, in Pinal Co., its annual product has fallen to about $2,000,000 in 1889. Idaho has come up from a product of about $500,000 in 1880, to about $4,500,000 in 1889, and promises to at least continue to do as well as the last figure for some time. California has never been a large silver producer, its largest output not exceeding $3,000,000, while it usually ranges between $1,000,000 and $2,000,000 per annum, and while New Mexico produced as much as $3,000,000 in 1884, its usual output is not larger than California's. The other far western states South Dakota, Oregon, and Washington, and the territory of Alaska are all small producers of silver, while the few Southern States where gold mining is still carried on, are still feebler producers of the white metal, excepting Texas, which produces nearly $1,000,000 a year from a mine near the Mexican border. Silver has been found throughout the entire Appalachian range, in both fissure and segregated veins, and the Boston capitalists got quite excited and spent quite large sums of money on the numerous prospects opened up in Maine during the mining fever of 1880 and later, but no profitable mines have resulted from the explorations thus far conducted. Missouri, and Arkansas, in the Mississippi Valley, can also show quite an expenditure of money in prospecting silver-bearing veins that as yet have given no encouragement for profitable returns.

The total silver production of the United States has grown from $2,000,000 in 1861, when we first really entered the world's market as a producer, to about $65,000,000 in 1889, and it has exceeded $50,000,000 since 1885.

The United States stands well in the lead as the world's heaviest silver producer, and the only other country which approaches us in the output of this metal is Mexico, which turned out the unusually large amount of $55,500,000 in 1889, its usual quota being between $30,000,000 and $40,000,000. Following Mexico in importance comes Bolivia, which produced about $9,500,000, in 1889, while Chili turned out about $8,000,000. The Australasias produced $6,000,000 in 1889, which was largely the output of one mine, the famous Broken Hill's Mine, in New South Wales. Spain and Austro-Hungary each produced about $2,000,000 in 1889, which completes the important outputs of the world's silver producers for that year (1889), the total amounting to $161,287,927, which on account of the product of Mexico and ourselves being unusually large, is decidedly above the usual amount, or from $120,000,000 to $140,000,000 per annum.

H. Ward Leonard & Company now have on exhibition at their offices in the Electrical Exchange Building, 136 Liberty St., New York, a Crocker-Wheeler motor operating under Mr. Leonard's new principle for controlling the speed, torque, and direction of motors. The motor is made to perform various work in such a manner as to clearly show the principle used and the facility with which either the speed or torque is controlled. The exhibition is extremely interesting.

An Appeal to the Public for Aid for the Miners' Hospital, at Ashland.

The Board of Trustees of this State Hospital desire to place before the public certain information regarding it, in order to draw attention to its needs, and if possible, secure contributions to aid them in carrying on its work of healing the wounds and saving the lives of the unfortunate men entrusted to their care.

The Hospital was built in 1883 under an act of the Legislature of the Commonwealth, by Trustees appointed by the Governor, in accordance with its provisions. It was handed over to the Trustees, our predecessors, appointed to administer the charity, in an unfinished condition. Nor have the Trustees to this time been able to secure the means necessary for the finishing and furnishing of the buildings and the proper enclosing and grading of the grounds.

The number of patients treated in this Hospital last year was 1,414, and since its opening, 4,831 inside patients, and 3,876 outside patients have received treatment.

Being located in the Anthracite mining region, and under the act of the Legislature required to give preference, first, to persons employed in and about the mines, second, to persons employed on or about railroads, third, to persons employed on or about workshops, and having its sphere limited to the treatment of injured persons, its patients are often persons suffering from injuries of the most serious character, fractures of the skull, ribs, spine, and limbs, and severe burns of the whole body from explosions of gas in the mines. During the past year 567 operations were performed, many of them of the most delicate and difficult character, and with wonderful success.

The Hospital was built to accommodate 56 patients. It has now crowded into it 90 beds, always full, and at times during the past year has had as high as 110 in-patients, besides out-patients, treated in the Hospital.

For various reasons the appropriations asked for the proper support and continuance of the work of the Hospital were cut down by the recent Legislature and the Executive to the mere maintenance and treatment of patients. Appropriations asked, for a ward for the separate treatment of patients burned by explosions of gas in the mines, who on account of the offensiveness of their wounds, and their ravings in delirium often lasting for days and weeks, should be kept separate, for the erection of a vestibule shed at the Hospital entrance under which patients might be taken from the ambulance and carried on a level into the operating room without exposing them when in a weakened condition to rain and winter storms, for a large, better lighted and equipped operating room, for repairs to the buildings, for finishing the buildings, and for enclosing and grading the grounds, were wholly cut off.

Under this condition of affairs the Trustees find themselves confronted with the fact that additional funds are needed to preserve the property from decay, and keep it in condition to enable them to properly care for the unfortunate patients who are committed to their charge.

A supplement to the Act creating the Hospital was passed by the Legislature on the 19th of May, 1887, under which the Trustees are empowered to receive contributions or donations from any person, firm, or corporation to aid in the support and maintenance, and for improving the property of the Hospital.

The Trustees present this statement of the needs of the Hospital, and refer to the act of the Legislature authorizing them to receive contributions from individuals, firms, or corporations by will, deed, gift, or otherwise, for the information of the public, and earnestly call upon persons, firms, or corporations whose employes are taken care of by it, and upon other charitably disposed persons to come forward and contribute for its support.

They would be glad to have persons contemplating a gift, or others interested in this great charity to visit the Hospital, to see the work done by it, and ascertain its needs by their own personal observation.

William Lilly,
President of the Board of Trustees.

E. C. Wagner, Secretary.

An Enterprising Company.

The Star Drilling Machine Company, of Akron, Ohio, has just increased its capital stock from $50,000 to $100,000. Its business has increased so rapidly during the past two years that this step was necessary.

They have just purchased the entire plant of the Norwalk Foundry and Machine Company, of Norwalk, Ohio, and will move it to Akron, and connect it with their present works as soon as suitable buildings can be erected. The Norwalk Company has been manufacturing for the past six years the famous "Standard" governors, horizontal engines, stone planing machines, and has been doing a general business in brass founding. The stone planer referred to is the only machine for the purpose which has ever been designed and built in the world. It is a wonder in its way, and planes gigantic stones of all sizes and dimensions so that after the stone is removed from the planer it has a surface as smooth as the floor. To give an idea of the magnitude of this machine, Berea stone 16 feet long, eight feet wide, and one foot in thickness, are planed to a smooth surface, and are being shipped to Chicago, for a walk on what is known as the boulevard on Michigan Avenue. The consolidated companies will continue to manufacture the "Star" drilling machine, horizontal and "Star" upright engines, "Standard" governors, stone planing machines, hoisting engines, Dowell pin machines, drilling tools, and will also make a specialty of building anything in the line of machinery from drawings which can be produced in any machine shop in the country.

AN APPARATUS FOR TESTING THE SENSITIVENESS OF SAFETY-LAMPS.

BY FRANK CLOWES, D. SC.,

Professor of Chemistry, University College, Nottingham, England.

[Proceedings of Royal Society, London, June 18, 1891.]

It is generally acknowledged that the Davy safety-lamp cannot with certainty detect less than 3% of fire-damp in the air of the mine. Gas indicators of much greater sensitiveness have been invented; among these the electrical apparatus of Liveing and the spirit safety-lamp of Pieler take first rank. The objection to these special forms is, however, a serious one. They do not serve for illuminating purposes, and, therefore, it becomes necessary to carry an ordinary safety-lamp together with the testing apparatus. Many attempts have been made to obviate this inconvenience by producing a safety-lamp which will serve the double purpose of illumination and of detecting minute percentages of fire-damp. The invention of such a lamp would be of great value to the miner, in view of the fact that very low percentages of fire-damp have been proved to be dangerous in the presence of coal dust.

The following apparatus has been devised to render easy the process of testing the sensitiveness of different forms of safety-lamps when used for detecting fire-damp. To enable satisfactory tests to be made in the laboratory, it was necessary to insure (1) the easy and rapid production of mixtures of fire-damp and air in known proportions; (2) to insure economy of the artificially prepared methane, which represented fire-damp; and (3) to examine the flame of the lamp under conditions similar to those existing in the mine.

A wooden cubical box of about 100 litres capacity was constructed so as to be as nearly gas-tight as possible. It was then made absolutely gas-tight by painting it over with melted paraffin wax, which was afterward caused to penetrate more perfectly by passing an ordinary hot flat-iron over the surface. This testing chamber was furnished with a small inlet tube at the top, and with a similar outlet tube below. It had a plate-glass window in front for observing the lamp in the interior, and a flanged opening below for introducing the safety-lamp. This opening was closed by a water-seal consisting of a small zinc tray supported by buttons, and containing about 2 inches depth of water, into which the flange dipped. A mixer was arranged, which consisted of a light flat board, nearly equal in dimensions to the section of the chamber and suspended by an axis from the upper corner of the chamber. The mixer was moved rapidly backward and forward from the side to the top of the interior of the chamber by grasping a handle projecting through the front of the chamber.

When a mixture of air with a certain definite percentage of fire-damp was required, the methane prepared and purified by ordinary chemical methods, was introduced into the chamber in the requisite quantity by the top inlet. It displaced an equal volume of air which escaped through the lower outlet, the exit end of which was sealed by being immersed just beneath a water surface. A vigorous use of the mixer secured a uniform mixture of gas and air throughout the interior of the chamber in the course of a few seconds. The lamp was then introduced into the chamber, and placed in position behind the glass window. The simplicity of arrangement of the water-seal rendered the necessary opening of the chamber very brief, and the introduction and removal of the lamp many times in succession were not found to produce any appreciable effect upon the composition of the atmosphere inside the chamber. The appearance and dimensions of the "cap" over the flame were noted as soon as the cap underwent no further change. A lamp was left burning in the chamber for a considerable length of time, and its indications underwent no change owing to the large capacity of the chamber and the very limited amount of air required to support the combustion of the small flame always used in gas-testing. The whole interior of the chamber and mixer were painted dead black, so as to render visible pale and small caps against a black ground.

The methane was introduced from an ordinary gasholder. A volume of water, equal to that of the methane to be displaced, was poured into the top of the gasholder. The gas tap of the holder was then momentarily opened so as to produce equilibrium of pressure between the methane and the atmosphere. The gas tap having then been placed in connection with the upper inlet of the chamber, the water-tap was opened and the measured volume of water was allowed to flow down and drive the methane into the chamber. As soon as bubbles of air ceased to appear through the water at the outlet, the chamber was closed; the mixer was then vigorously worked for a few seconds, and the mixture of gas and air was ready for the introduction of the lamp. Before introducing the methane for a fresh mixture, the atmosphere of the chamber was replaced by fresh air by removing the water-tray from beneath the opening at the bottom of the chamber, and blowing in a powerful stream of air from a bellows to the top of the chamber.

The chamber was supported on legs, which were arranged so as to place it at a convenient height for observations through the window, and also for the introduction and removal of the safety-lamp.

The accuracy of this method was tested by introducing the Pieler lamp into the chamber, which was charged successively with a series of mixtures containing proportions of methane varying from 0·5% to 4%. The height and appearance of the cap over the flame absolutely corresponded with a series of standard tests already published, and made by a different method in which fire-damp was used instead of methane.

The observations were usually made in a darkened room, but the flame caps were easily seen in a lighted room, provided direct light falling on the eye or chamber was avoided.

The capacity of the chamber was 95,220 c. c.; accordingly the following volumes of methane were introduced: for ½% mixture 476 c. c., for 1% 952 c. c., for 2% 1904 c. c., for 3% 2856 c. c., for 4% 3808 c. c., and for 5% 4760 c. c. It will be seen that a series of tests, in which the above mentioned percentage mixtures are employed, involves an expenditure of only 15 litres of methane, a quantity far smaller than that required by any other method of testing as yet described.

Of many forms of safety-lamp tested in the above apparatus, the one which most satisfactorily fulfilled the two purposes of efficient illumination and delicacy in gas testing was Ashworth's Improved Hepple-white-Gray lamp. This lamp is of special construction, burns benzoline from a sponge reservoir and its flame is surrounded with a glass cylinder, which is ground rough at the hinder part; this latter device prevents the numerous reflected images of the flame, and the generally diffused reflections which are seen from a smooth glass surface, and which render the observation of a small pale flame cap very difficult, if not impossible.

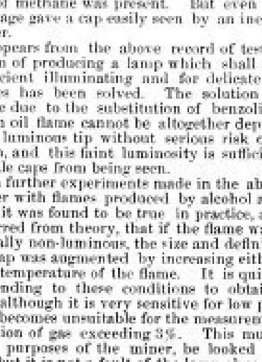
The wick of this lamp, when at a normal height, furnishes a flame of great illuminating power. When lowered by a fine screw adjustment the flame becomes blue and non-luminous, and does not interfere therefore with the easy observation of a pale cap. The following heights of flame cap were observed, which fully bear out the unusual sensitiveness of this flame. With 0·5% of methane 7 m. m.; with 1% 10 m. m.; with 2% 14 m. m.; with 3% 20 m. m.; with 4% 25 m. m.; and with 5% 30 m. m. The cap, which with the lower proportions was somewhat ill-defined, became remarkably sharp and definite when 3% and upwards of methane was present. But even the lowest percentage gave a cap easily seen by an inexperienced observer.

It appears from the above record of tests that the problem of producing a lamp which shall serve both for efficient illuminating and for delicate gas-testing purposes has been solved. The solution is in some measure due to the substitution of benzoline for oil, since an oil flame cannot be altogether deprived of its yellow luminous tip without serious risk of total extinction, and this faint luminosity is sufficient to prevent pale caps from being seen.

From further experiments made in the above testing chamber with flames produced by alcohol and by hydrogen it was found to be true in practice, as it might be inferred from theory, that if the flame was pale and practically non-luminous, the size and definition of the flame cap was augmented by increasing either the size or the temperature of the flame. It is quite possible by attending to these conditions to obtain a flame which, although it is very sensitive for low percentages of gas, becomes unsuitable for the measurement of any proportion of gas exceeding 3%. This must, for the general purposes of the miner, be looked upon as a defect, but it is not a fault of the lamp already referred to. It is of interest to note that with the Pieler spirit lamp a flame cap an inch in height was seen in air containing only 0·5% of methane.

A Good Grease Cup.

You might as well expect a man to live without food as machinery to run efficiently without grease. Food may be of the best quality, yet not accomplish best results in man if not partaken of properly. It is the same with grease and machinery, to secure best results, grease must be applied properly, and this can only be done by the use of a simple, practical, and efficient cup, such as the Lunkenheimer Plain Brass Grease Cup shown below.



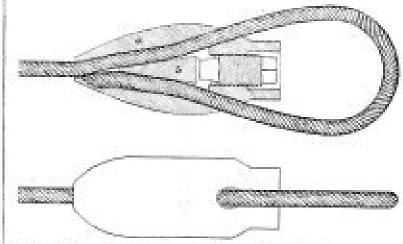
Referring to the illustration, E E is an adjustable leather washer that can be compressed and spread by the ring C C, thereby insuring a tight joint, and preventing the grease from oozing out. This cup is extensively used on mining machinery. It is made of the best materials and has great advantages over iron cups which usually rust and are liable to break, thereby causing great annoyance.

They are fully warranted and can be purchased of any dealer, or from the Lunkenheimer Brass Mfg. Co., of Cincinnati, Ohio, who also manufacture a full line of brass and iron body steam goods; regrinding globe, angle, and check valves; "Handy" gate and lever throttle valves; pop safety-valves; sight feed lubricators; and glass oil and grease cups, all strictly first-class and warranted. A handsome and complete catalogue illustrating and describing the above will be sent free to any address, if requested on a postal card addressed to The Lunkenheimer Brass Mfg. Co., Cincinnati, Ohio.

We have received from Messrs. H. Ward Leonard & Co., of 136 Liberty St., New York, advance pages of a neat little pamphlet entitled "The Value of the Services of a Consulting Electrical Engineer to Persons Investing in Electrical Plants." This little work contains much of value to present or prospective owners, of electrical plants, and we advise them to drop a postal card to Messrs. H. Ward Leonard & Co. for a copy of it.

Strobach's Wire Rope Holder.

An ingenious device, designed for making a loop at the end of a wire rope without the tedious and difficult operation of splicing, is now being introduced by Messrs. Thomson & Co., Westminster, Eng. The holder consists of a cast-iron block *a*, with four holes, the rope being passed through the end of the block and out by one of the holes at the side. The end is then curved round to form the loop and passed through the other hole at the side of the block and out at the end, as shown in the engraving, for which we are indebted to *Engineering*. In this way there is a tapered space between the two portions of the rope in the block. A cast-iron wedge *b*, hollowed at its sides to fit the rope, is passed into this space, and driven home by a screwed plug *d* which passes through the fourth hole in the block as shown.



When this plug is driven home it grips the rope so firmly against the sides of the block that it is impossible to draw it out. In certain instances it is not considered advisable to carry the end of the rope quite through the block, and in such cases a block is used in which the hole in the end is partially blocked, so that the rope can only pass through it once. When properly made the joint is just as secure and its appearance is improved, but the plan of passing the end quite through the block renders it certain that the plug shall wedge the rope properly, whereas in the other case a careless workman may not push the end of the rope sufficiently far into the block for the wedge to properly grip it. To take the wear and preserve the rope a liner of galvanized iron (not shown) is placed inside the loop. This liner can, of course, be replaced when worn through, and the wear of the rope entirely prevented.

Wiring for Mines—An Ingenious Cable that Cannot Spark when it Breaks.

A brief note was recently made in these columns of a safety cable for mining work which does not throw a spark when by any accident the cable is broken. The inventor now makes public the secret of his invention, which consists practically in transferring the breakage of the wire to some place at the top of the mine where its action is not important.

The cable contains an inner core of closely coiled spiral wire insulated by braid, and an outer core which is joined in parallel with the inner. In case the cable parts the inner spiral pulls out to a considerable distance and takes the whole current.

As soon as the exterior main is broken the fuse at the switch-board burns out and releases a switch which cuts out the whole current.

In case the cable should be completely severed as by an ax, thus crushing the two conductors together, a small resistance coil is placed in the circuit, and any contact between the two wires causes the fuse to melt as before.—*Philadelphia Record.*

A Novel System of Coal Hoisting.

The Mt. Pleasant *Journal* says the Southwest Coal and Coke Company will introduce a novel system of coal hoisting when it gets the new air shaft at its Tarr's plant completed, as that work will be done by water. The big fan and part of the machinery are already in place awaiting the erection of the house and the sinking of the shaft which, at this point, will reach the coal at a depth of some twenty-five feet, although it is the basin for a goodly portion of the company's 2,500-acre coal field, and from it the drainage will be pumped. One of the cages will not differ from those in general use, while the other will have built on it a tank. When a wagon of coal for the boilers has been placed on the cage at the bottom, water from a pump discharge pipe will be turned into the tank until it is heavy enough to sink to the bottom, drawing the cage up as it descends. An automatic valve will then let the water run out, when the tank, being lighter than the cage and empty wagon, is in turn drawn to the mouth by them.—*Connellsville Courier.*

THE PRINCIPLES AND PRACTICE OF COAL MINING ON THE PILLAR SYSTEMS.*

BY W. S. GRESLEY, M. E.

[Written for the Colliery Engineer]

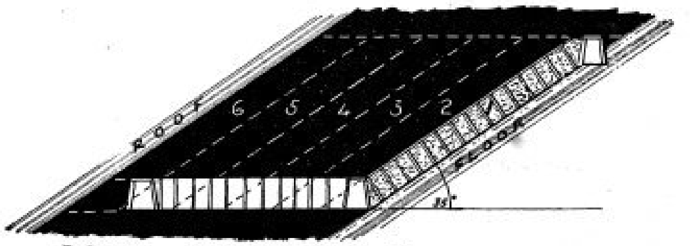
Figs. 40 and 41. These are cross-sections of workings in a 45 ft. thick coal seam, also in France. The dip or pitch here is 35°. The coal is removed in successive parallel cuts or slices of about 7½' thick each, on same pitch as that of the seam, commencing with the one next to the foot-wall or floor and working across, entry or haulage road, either removed or to be removed. The main road or central gangway-level pillars are got out last. Of course, while one side of the shaft is being exhausted, the other side is being opened out; this in order to regulate and keep up the hoistings. Such work as this makes a very clean job of the saddle coal; every foot of coal is mined with method and plan, and great security of property is obtained by the filling-in business, so essential to a complete exhaustion of the coal bed.

Figs. 45 and 46 are cross-section and plan of mode of working a pitching deposit of coal in France, varying between 47 and 56 feet in thickness. This particular and remarkable bed is at Blanzy. It is divided into two splits or benches by a seam of sandstone (see both Figures) which contain quartz pebbles. The system of working is removing the coal in sections in descending order, about 50 ft. in vertical height being taken out at a time, divided into about seven horizontal cuts or slices, each about 7 feet high (see Fig. 45; 1, 2, 3, 4, 5, 6, 7). The upper end of this Figure shows all gob—gob packed full from top rock to bottom rock; and the lower end of Figure shows the coal all solid at present. The method of work may be briefly as follows: Shafts are sunk outside the coal seam and tunnels put across the measures at suitable vertical intervals to cut the coal. To each section or lift of 50 ft. is a tunnel which intersects it about the middle, as at 1, Fig. 45. Out of this tunnel, levels or gangways are driven in, right and left, on the strike of the seam, in both splits. Inclined planes are also driven, both to the rise and to the dip in each split, that to the rise to serve the cuts or slices, 2, 4, 6, above the central tunnel; and that to dip to serve the three bottom cuts, 3, 5, 7, respectively. These inclined planes are operated by compressed air engines, placed about the center of the district or section. With them the packing material is raised to the upper cuts, and the coal hoisted from the lower ones. Working the coal goes on continuously in both divisions of a district. The middle cut, 1, is first of all exhausted; then 2 off top of gob of 1, and then 3, 4, and 5; 6 and 7 being taken out last. The rooms or working places are laid off square with the levels or gangways and are driven up narrow, about 50 ft. apart, and timbered systematically; they are driven on one side only of each gangway (see plan Fig. 46). When a room strikes the hanging or foot-wall, as the case may be, a skip or rib is worked back towards the gangway, the spaces behind the men being lightly filled in with rock, etc., taken in for the purpose, or, it may be quarried in another part of the mine. Then another skip is worked off, and so on until the block between the rooms is all removed and the entire excavation closely gobbed. The central seam of sandstone is not touched save where the tunnels or airways have to be driven through it.

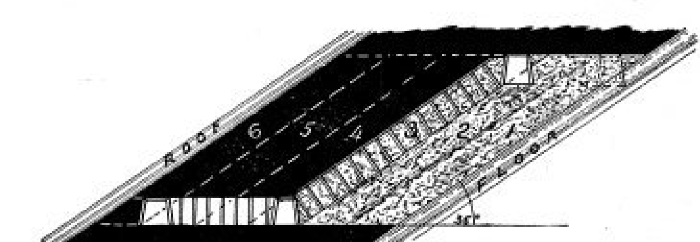
As one side or district is being exhausted another is being opened up. In this, as well as in other somewhat similar systems of coal mining, steel props and cap pieces, bars, collars, etc., are very widely used, especially in place of heavy timbering. They cost rather more than timber at first, but their greater strength, smaller bulk, lighter weight, greater durability, reliability, and efficiency, facility of fixing and replacing, have induced coal operators in European countries to use them with great economy and in large quantities of late years. The system of conveying the packing material into the working levels by air machines, does away with the objection to and difficulty of keeping open a special incline from a higher lift for the purpose as was, until a short time ago, the practice at Blanzy.

The ventilation is conducted on the diagonal or ascensional system; the air current entering a lift by a tunnel and passing around and across the working levels, etc., ascends by a special airway on the foot-wall at the end of the district, not shown in Figures, to surface. In this mine each room is lighted by "electrics," as are also the cross-cuts or tunnels communicating with shafts. Mechanical haulage is used on these tunnels. The coal or refuse in it, being rather liable to spontaneous combustion, the dimensions of each lift or section (50 feet in height by a few hundred feet in length) are regulated or set out so that the entire body of coal in it may be removed and the district abandoned, within a few months, at a certain speed of working and at a given output per day.

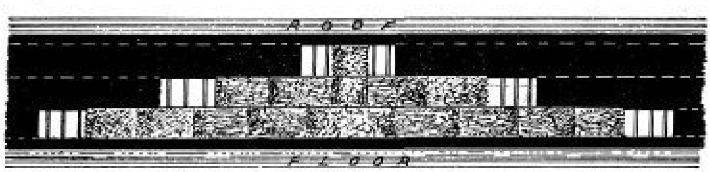
[THE END.]



CROSS SECTION Fig. 40.



CROSS SECTION Fig. 41.



LONGITUDINAL SECTION Fig. 42.

Reference.

Direction of Air-currents

Doors D C

Stoppings II

Overcasts

Dip of coal &c., by large white or black arrows

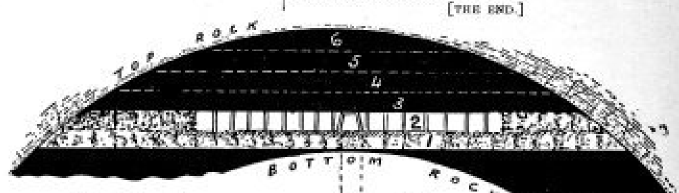


Fig: 43. SECTION THROUGH A B

Scale 50'

slice after slice, to the hanging wall or roof, or top-rock. Here again the close-packing system is carried on systematically, the rock, etc., for filling, entering by the higher gangway or level, while the coal goes out along the lower one. Fig. 40 shows slices 1 and 2 exhausted, and 3 being worked.

Fig. 42 is a longitudinal section through the workings in a thick coal seam, say 20 to 25 feet thick. The plan of excavating the coal is to consider the seam as three seams lying one on top of the other, and to work away the lowest cut first, the middle one on top of gob (close-packing as before) of first cut, and the upper one on top of gob of middle cut; the faces being stepped or worked forward as shown right and left; then all the seam is worked. If the pitch is heavy, the coal is mined out from one wall to the other across the natural stratification of the seam as in Fig. 39.

Figs. 43 and 44 are cross-section and plan respectively showing a French method of working the saddle or crown of an anticline in a seam some 45 feet thick. The general system is the same as the last few described, viz., removing the coal in slices of not more than 7½ ft. at a time, and systematically stowing rubbish in every working-place as the work goes forward. Thus the horizontal slice No. 1 is removed first, then 2 on the packing of No. 1, and so on upwards to top of the saddle in 6. The plan Fig. 44 shows how the work is opened up in each slice and how the pillars or panels are worked back from the top slate or hanging walls towards the central gangway; the black and white dotted lines represent the cuts, ribs, or skips, between each

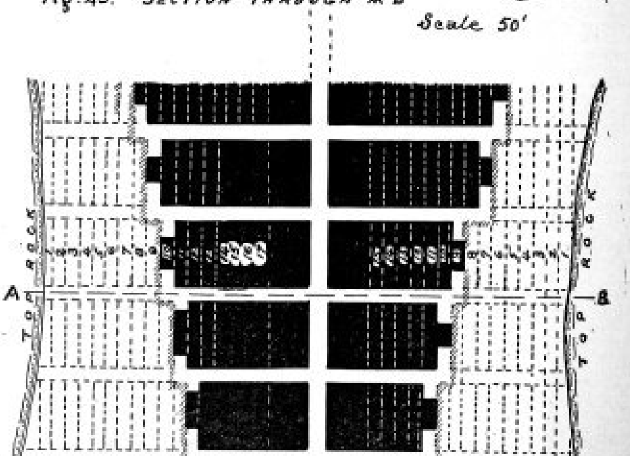


Fig: 44. PLAN OF SLICE 2 Fig:

Scale 50'

*Commenced in No. 8, Vol. XI., i. e., the issue of March, 1891. Back numbers may be had by addressing The Colliery Engineer Co., Coal Exchange, Scranton, Pa.

THE PREVENTION OF ACCIDENTS IN MINES.

An Essay on Practical Means to Insure Safety in Coal Mines.

(The following is Inspector Thomas K. Adams' paper, which is one of the four essays recommended for publication by the committee of judges in the *Pittsburgh Times'* prize competition contest. Mr. Adams resides at Mercer, Pa., and is Inspector of the Third Bituminous District.)

The object to be attained in presenting suggestions concerning methods in coal mining is to diminish the number of fatal accidents, and to mitigate in the future, if possible, such disasters as occurred at the Dunbar and Mammoth mines. The results due from mine explosions and from mine fires fall upon the people of the State with appalling effect, yet when we consider the aggregate number of lives lost from such disasters, and compare them with the total number of deaths resulting from other causes, such as falls of coal and roof and miscellaneous causes, they almost sink into insignificance, if we consider the results for at least a period of ten years, consequently in dealing with this subject we must not lose sight of the latter class of fatalities.

The present mining act contains some excellent provisions for the protection of the miners which have been the means of producing most beneficial results, as far as giving them healthful places in which to labor, yet such has been the wonderful development in the coal mining industry in the Bituminous region of the State for the last ten years that the dangers to life and limb have increased greatly. The mine regulations that afforded the miners ample protection when the Bituminous mining law was enacted are insufficient to meet the emergencies of to-day.

What additional regulations or precautions other than what are now required by law at mines producing fire-damp, (CH_4), etc., would we suggest to insure the greatest degree of safety to the workman, keeping in consideration the economical operation of said mine.

MINING AND FIRE-BOSSES. Mining bosses and fire-bosses should be sober, steady, and reliable men, and any known case of intemperance by such persons should disqualify them from holding said position. Neither should examining boards grant certificates of competency to persons for the position of mining boss and fire-boss if they had been known to have been under the influence of alcoholic, spirituous, or distilled, or fermented liquor within two years of the date of making application for examination.

If fire-damp exists in any part of a mine the fire boss must examine every working and temporary abandoned place within three hours of each shift going to work, and permanently abandoned places to be securely fenced off and examined as far as practicable.

A fire-boss should only examine 60 rooms within the three hours, provided they are reasonably contiguous, and after having made his report in a properly prepared book, at the surface, he should return to the mine, and it should be his further duty to again examine all pillar workings where squeezes exist, if any, and the narrow work of the mine frequently during the day.

The fire-boss can examine about 60 rooms in three hours thoroughly, but should there be more, his duties will be done in a perfunctory manner, which would not insure safety.

If fire-damp is produced and mine ventilated by a single air current or said current divided in the interior of the works, every person in said mine should work with a locked safety-lamp of the most approved type, such as the Gray, Marsaut, Evan Thomas No. 7, and Bonneted Mueseler. The Davy and Clanny lamps, commonly used in this country, are unsafe, especially in currents of air where the velocity exceeds six feet per second.

Every mine producing fire-damp and employing more than 50 persons should be operated in separate and distinct sections, with not more than 50 persons to work in any one section. Each and every section of mine to be ventilated by a separate current of air, conducted in separate and distinct air passages from a point as near as practicable to the bottom of the inlet shaft, and return air of said section to be conveyed in independent air courses to near outlet. All overcasts used in carrying out the system should be driven in the solid strata. The coal in front of the currents at overcasts, where said currents take their ascensional direction to be left in a solid condition; all permanent "stopping" used to conduct the air to face of works to be built of brick or stone, and doors used in guiding the ventilation should be double, and have an attendant.

By working a mine on this "split" air system, if fire damp is produced in one section all the men working therein would be required to work with locked safety-lamps, but should no fire-damp exist in one of the other sections, the men in it could work with perfect safety without the use of safety-lamps; but the great consideration of this mode of working is the increased safety given to the workingmen. Each division or section of work having, practically speaking, its separate ventilation, should an explosion take place in one section the probability would be that little damage would be done to the other sections of the mine, resulting in a saving of lives and property.

SAFETY-LAMPS AND THEIR USE. The safety-lamps used in the mines should be cleaned and thoroughly tested by a competent person, employed in whole or in part to perform that duty, every day before they are placed in the hands of the workman.

No person should be employed to work in any mine producing fire-damp who cannot detect the same, and who is not familiar with the use of the safety-lamp, and in no case should any persons be engaged who do not understand the instructions given by the mining boss or fire-boss, or who can not communicate their knowledge, if they have any, on such matters to said officials.

To employ any person who does not possess the above

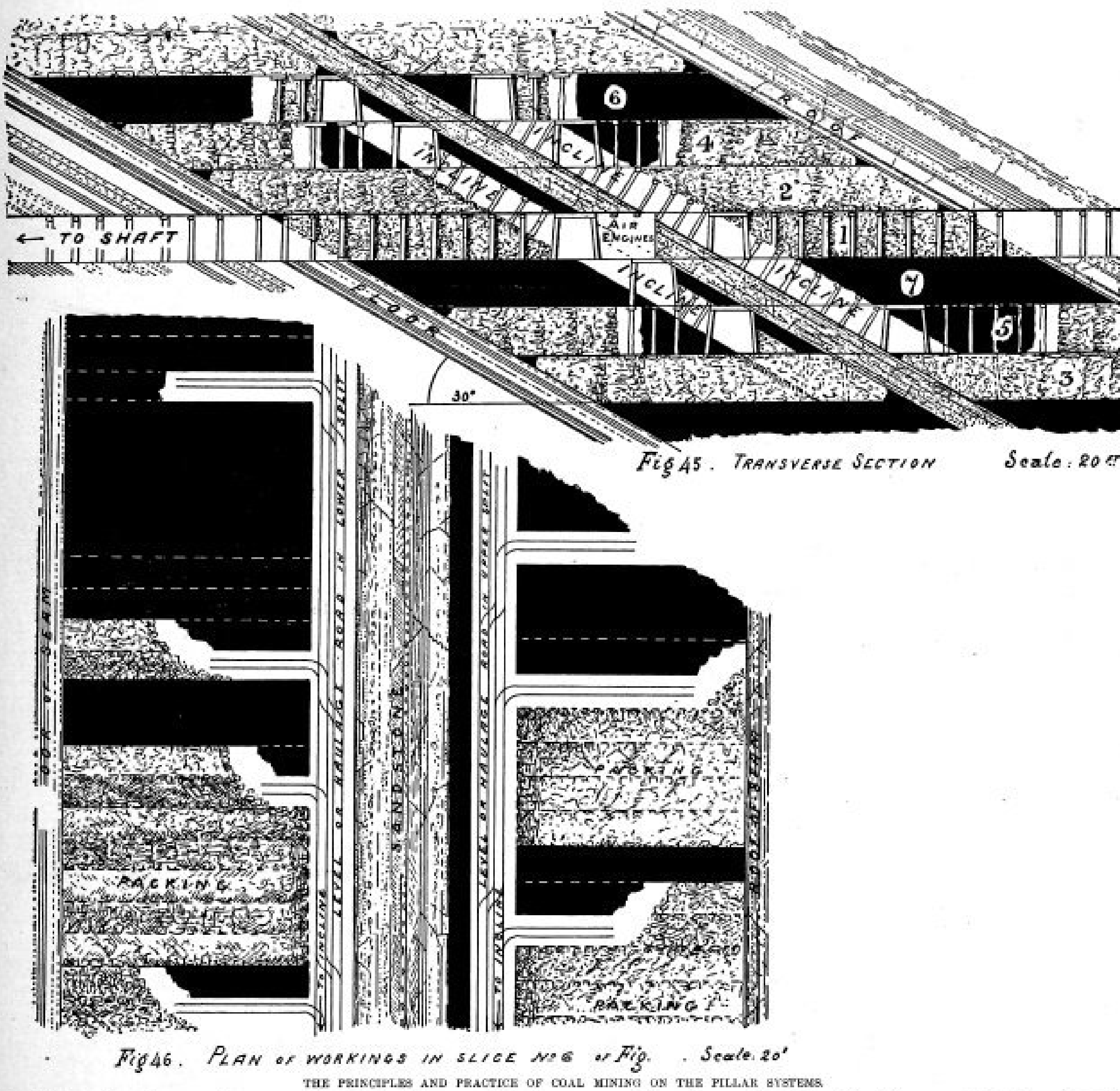


Fig 45. TRANSVERSE SECTION Scale: 20 FT.

Fig 46. PLAN OF WORKINGS IN SLICE No 6 of Fig. . Scale. 20'

THE PRINCIPLES AND PRACTICE OF COAL MINING ON THE PILLAR SYSTEMS.

knowledge or requirements would be simply putting the other employes' lives in jeopardy.

All shots or blasts to be fired in a gaseous mine should be done by a skillful miner at the end of each shift, when the miners have retired from the said mine; under no circumstances should shots be fired in any section of a mine where fire-damp exists, until such place, where the blast is to be fired, and contiguous places have been thoroughly inspected by the mining boss or fire-boss. Shot-firing has been proven to be a very fruitful source of causing mine explosions.

The fine coal-dust in fire-damp mines should be dampened by sprinkling it with water as far as practicable.

When the air of a mine is laden with fine dust or a cloud of it is raised by a "blown out" shot, if from one to two per cent. of fire-damp be present and ignition takes place, a violent explosion may occur. An explosion happening under these conditions might be more deadly in its effect than if there had been ten per cent. of fire-damp present with said mixture being free of dust, so as one to two per cent. of fire-damp in the air can hardly be detected with any safety-lamps when working with them under ordinary conditions it therefore becomes imperative that the dampening of the dust in mines should be a lawful regulation.

PRECAUTIONS AGAINST CLAY VEINS.

In all narrow work (headings, entries or air courses) that is being driven in solid or new territory, when clay veins or other disturbances are encountered in the coal seam, the clay veins should be penetrated by drilling two or three bore-holes through and into the solid coal beyond them.

Sometimes, in meeting with those disturbances in the coal bed, fire-damp is produced copiously in the shape of strong "blowers," or in such quantities as to very suddenly "flood" that portion of the mine; but, were those clay veins to be tested by bore-holes, if much gas were found, it could be safely controlled and dangerous consequences avoided. The inflow of gas could be regulated and sufficiently diluted with air, so as to render that portion of the mine safe.

The minimum volume of air should be 200 cubic feet per minute per person employed, and from 500 to 600 feet per mule employed. The ventilating power of fire-damp mines should be a fan, the casing and housing to be built of iron, placed at a short distance off the top of shaft, and have a secondary engine in place to be used in case of accident to the other.

Large volumes of air should be constantly provided for fire damp mines, conducted through double headings, or through a single heading with a parallel airway, the circulating currents of air to be conducted into the working places (rooms) by means of "check doors" (canvas cloth), hung about every 200 yards apart on the headings.

The above mode of ventilation will be a safe, healthful, and advantageous system for diluting all kinds of gases, whether they are explosive or non-explosive, in all mines.

All entrance to slope or drift mines producing fire-damp should be provided with doors or gates and kept locked until mine has been examined by the fire-boss and his report made that the mine is safe.

In all slope mines which are driven down in the coal seam and have men working on both sides of the same, the employes working on the side not provided with a separate and continuous traveling way to the surface should be provided with a suitable and convenient escape-way (size not less than 5 x 5 feet) at convenient distances, made as the sinking of the slope progresses, said means of escape to consist of safe passage-ways from the interior works to the overcasts, said overcasts to be driven in the solid strata over the top of slope to main manway.

Had such means of escape been provided for the men at the unfortunate Dunbar mine no such number of lives would have been lost.

All bore-holes that have been drilled from the surface to the coal, if persons are working to approach them, should be tapped by boring holes of a small diameter to them when they are near the location of the holes. Such work, and work advancing to old and abandoned works, containing explosive gas or water, should be done at night when the other men are not at work.

STORAGE OF EXPLOSIVES.

The storage of powder and other explosives, kerosene and other illuminating oils, straw, hay, or other material saturated with oil in mule stables in mines should be prohibited, and all brattice-cloth used in mines should be incombustible. Miners or other persons delegated to fire flashes, after such has been done should return to the places to examine them, and if fire exists to see that it is put out before leaving said place. Lodgements for the accumulation of water should be provided in each entry or heading, so that water could be had in case of fire in any of the working places. In very fiery mines a three or four-inch diameter pipe should be connected with the main pumping system or machinery, and conveyed to main portions of the works, so that water could be forced to fires with necessary connections.

A miner should be furnished with at least five sprags of at least eight inches in diameter and of suitable lengths, and required to be set to the undercut coal not more than five feet apart, and the point of the opened cut of coal must be made secure by a sprag or by leaving the coal solid.

The inspector of mines should be furnished with a copy of all mine maps by mine operators, and all extensions to be added thereto, as the law now directs.

Owing to so many accidents happening through incorrect maps, the inspector should have a copy of all such, so as he could thoroughly examine them and thereby familiarize himself with the workings of each mine, which would enable him to make a more thorough examination or inspection of it.

When a second opening has been made (as now considered by law) a traveling way leading therefrom of at least five feet high and five feet wide should be extended into the body of the workings and to the boundary lines of every mine, and when said traveling way is being driven in the coal seam or other strata it should be separated from the hauling ways by a solid pillar of coal or other strata of at least 25 feet in width, but said traveling way may be used as a haulage road if allowed by the mine inspector. No miner or other employe should be allowed to work in any place in any mine beyond any point therein, unless there are two separate passage-ways by which he can travel to and from his working place. Such traveling ways must be kept free from stagnant water, so as not to accumulate on bed of roads, free from debris and in a safe condition.

Locomotives driven by steam should be excluded from the mines when they enter near to the workings thereof; steam boiler, steam lines, and fires in "baskets" or fires on unprotected grate-bars should be prohibited.

The law should require all mines to be ventilated by artificial means (a fan or properly constructed furnace); they should be erected immediately after the opening of said mines; no person to be allowed to work ahead of an air current more than a distance of 30 yards or less if so ordered by the inspector, and miners should be prohibited from turning rooms of an entry beyond the air current; every door placed upon an entry or heading used in directing the air currents and every furnace for producing the same should have an attendant.

The mine inspector should be given the power to temporarily close down any part of a mine if he thinks there is immediate danger to any of the workmen, or if their health is likely to be injured by working in an impure atmosphere. He should be given police powers.

An inspector having such powers, whenever he observed any willful violation of the law, could prosecute the offenders upon sight, instead of having to give all such five days notice as now required by law, which has proven to be a very convenient means for evading the law.

The mining boss should have exclusive charge of all the inside workings of the mine; provide the ventilating power and all necessary supplies (at the expense of the company) for the safe and economical operation of said mine, and he should not be interfered with directly or indirectly in the performance of his lawful duties by any person whatever. Neither should any agent or superintendent direct a mining boss in matters pertaining to the safe and healthful operation of the mine, unless such agent or superintendent has proven his competency to give instructions by having passed an examination before a lawful board of examiners, and holds a certificate of competency.

CONCERNING FINES FOR DISCIPLINE.

The penal clause or section of the Mining act should provide for a graded fine and Justices of the Peace be given jurisdiction of trifling offences.

I consider the above a very important requirement to insure proper discipline at the mines. Unless discipline is maintained at the mines they cannot be operated with a favorable degree of security, and the best way to maintain it is by imposing a fine commensurate with the nature of the offence upon all mine officials and other workmen for the violations of the provisions of the laws. The minimum fine now, whether or not the offence is of a trifling or of an important nature, is $200, consequently, owing to the severity of the fine, offences are condoned; but were the fines to be graded, say from $5 and upward, and the law compelling the mining boss to prosecute all employes who in any way violate the rules and regulations of the mine, and the justice of the peace to have jurisdiction of such cases so that summary punishment could be had, the discipline would soon improve at the mines, and lives be saved.

The question might be asked why not suggest the introduction in all fire-damp mines of the use of electric lights or the use of the Shaw signal and gas detecting machine? With the knowledge we have of those appliances as to their practical utility, we would not be warranted in advising their introduction into the mines by legislative action. Arc lights can be successfully used at top of mines at night, and also the glow lights may be successfully applied in pit bottom or on haulage ways leading from the bottom for short distances; but such stationary lights cannot be successfully or practically used in the working places of the mine. It would be an impossibility to keep the large number of small insulated wires connecting with lights and main conductors in proper condition, and the fact of their being stationary is a very serious defect and have been proven, beyond doubt, to be very inefficient. There has been patented, however, by J. Wilson Swan, of England, and manufactured by the Edison-Swan Electric Company, a self-contained lamp with a glow light or a portable secondary battery sweep which in the near future may become of great practical benefit to the mining public. Owing to their weight (7 pounds) and first cost (about twice the price of the very best safety manufactured), it will be some time before they are generally used in mines. However, there are three large companies in England using them in their mines exclusively.

The Shaw machine is only in its experimental stages of development in a practical sense, and of very doubtful efficiency. The multiplicity of pipes used in its operation in an extensive mine is a serious defect; it is only supposed to give indications of gas from a point at the extreme face of the working place, leaving the old abandoned and other portions of the mine between the surface and innermost point of working place without any means of inspection and detection for gas. The pipes are one fourth of an inch in diameter and in an extensive mine will be from 3,000 to 4,000 feet long, and might be double that length in some cases. So an expert miner can judge of the effect such a pipe hung up in a chamber would have on a body of fire-damp being produced a few yards away from the mouth of the pipe. If a sudden inflow of gas should take place and a miner working with an open light the machine would not afford any protection. The pipes would be constantly out of repair by roof falling upon them and holes would wear in them by the action of the mine water. The machine would create a false idea of security among the workmen and mine officials, thereby creating gross carelessness among them. It would by the introduction of such an appliance impose a heavy tax upon the coal mining industry of the State without insuring greater safety to the miners; therefore, the State should not legally require mine operators to provide expensive precautions where there are so many doubts existing as to their efficiency.

GENERAL RULES.

In order that any mine rules may have lawful effect, they must be passed by the Legislature and become a part of the act itself, and as we have none such regulating the working of Bituminous mines, I offer the following amended general rules, to become part of the act, which have been culled from rules now in existence:

A majority of the persons employed in a mine may from time to time appoint two of their number who are practical working miners to inspect the mine at their own cost, and the persons so appointed shall be allowed once in every month, accompanied, if the owner, agent, superintendent, or mining boss of the mine thinks fit, by any one or all of them to go to every part of the mine and to inspect the shafts, headings, traveling ways, planes, working places, ventilating apparatus, airways, old works, and machinery. Every facility shall be afforded by the owner, agent, superintendent, or mining boss, and all persons in the mine for the purpose of inspection and the person appointed shall forthwith make a true report of the result of the inspection and that report shall be recorded in a book to be kept at the mine for the purpose, and shall be signed by the persons who make the inspection, and if the report states the existence, or apprehended existence of any serious danger, the owner, agent, superintendent, or mining boss shall forthwith cause a true copy of the report to be sent to the mine inspector.

The following general rules shall be observed in every mine to which this act applies:

Rule 1. The owner, operator, or superintendent of a mine or colliery shall place the underground workings thereof and all that is related to the same under the charge and daily supervision of a competent person who shall be called "mining boss."

2. Whenever a mining boss cannot personally carry out the provisions of this act so far as they pertain to him, the owner, operator, or superintendent, shall authorize him to employ a sufficient number of competent persons to act as his assistants, who shall be subject to his orders.

3. The mining boss shall have charge of all matters relating to ventilation, and the speed of the ventilators shall be particularly under his charge and direction.

4. All accessible parts of an abandoned portion of a mine in which explosive gases have been found shall be carefully examined by the mine foreman or his assistant at least once every week, and all danger found existing therein shall be immediately removed. A report of said examination shall be recorded in a book kept at the colliery for that purpose and signed by the person making the same.

5. In mines generating explosive gases the fire-boss shall make a careful examination every morning of all working places and traveling roads before the workmen shall enter the mine, and such examination shall be made with a safety-lamp within three hours at most before time for commencing work, and a workman shall not enter the mine or his working place until the said mine and part thereof and working place are reported to be safe. Every report shall be recorded without delay in a book which shall be kept at the colliery for the purpose, and shall be signed by the person making the examination.

6. The person who makes said examination shall establish proof of the same by marking plainly the date thereof at the face of each working place.

7. A station or stations shall be established by mining boss at the entrance to each mine or different parts of each mine, as the case may require, and a workman shall not pass beyond any such station until the mine or part of the mine beyond the same has been inspected and reported to be safe.

8. If at any time it is found by the person for the time being in charge of the mine or any part thereof, that by reason of noxious gases prevailing in such mine or such part thereof, or of any cause whatever, the mine or the said part is dangerous, every workman, except such persons as may be required to remove the danger, shall be withdrawn from the mine or such part thereof as is so found dangerous until the said mine or said part thereof is examined by a competent person and reported by him to be safe.

9. In every working approaching any place where there is likely to be an accumulation of explosive gases or in any working in which danger is imminent from explosive gases no light or fire other than a locked safety-lamp shall be allowed or used. Whenever safety-lamps are required in any mine they shall be the property of the owner of said mine, and a competent person shall be appointed for the purpose, shall examine every safety-lamp immediately before it is taken into the workings for use and ascertain it to be clean, safe, and securely locked, and safety-lamps shall not be used until they have been so examined and found safe, clean, and securely locked, unless permission be first given by the mine foreman to have the lamps used unlocked.

10. No one except a duly authorized person shall have in his possession a key or any other contrivance for the purpose of unlocking any safety-lamp in any mine where locked safety-lamps are used. No lucifer matches or any other apparatus striking a light shall be taken into said mine or parts thereof.

11. No blast or shot to be fired in any mine where locked safety-lamps are used, except by permission of

the mining boss, or his assistants, and before a shot is fired the person in charge must examine the place and adjoining places and satisfy himself that it is safe to fire such shot or blast before such permission is given.

12. The mining boss, or some other competent person or persons to be designated by him, shall examine at least once every day all slopes, shafts, main roads, traveling ways, signals, pulleys, and timbering, and see that they are in safe and efficient working condition.

13. The mining boss shall cause a blackboard of suitable form and size to be hung in some conspicuous place, near the entrance of the mine, whereon a copy of the mining law and general rules shall be placed.

14. The mining boss shall also cause to be constructed a blackboard or slate large enough, and shall have it placed in some building, near the entrance of the mine, upon which shall be the numbers used by miners, and space sufficient to each number, so that the miners can write plainly the quantity of props, their length and size, number of caps and other timbers they require, with the time and date of the order, etc.

15. The miner when in want of props, caps, or other timbers shall give his order at least twenty-four (24) hours before needing them, and in no case shall he allow himself to run out of props and caps before ordering a new supply.

16. It shall be the duty of the mining boss to direct and supervise the whole of the inside work of the mine; to instruct all workmen and boys in their several duties, and to every employe employed by himself or superintendent he shall read to such employe the general rules of this act as far as they pertain to him.

17. The quantity of air in circulation in the mine shall be measured or ascertained by the mining boss with an anemometer.

18. Whenever a place is likely to contain a dangerous accumulation of water or explosive gases, the working approaching such place shall not exceed eight feet in width, and there shall be constantly kept at a distance of not less than 12 feet in advance at least one bore-hole, near the center of the working place, and at least one flank bore-hole on each side.

19. Not more than 10 persons shall be hoisted or lowered at one time in any shaft, whenever five persons shall arrive at the bottom of any shaft (if it is not within one hour of the time set apart when the shift shall expire or stop hoisting coal, or if any one person should be sick or have received bodily injuries), in which persons are regularly hoisted or lowered, they or he shall be furnished with an empty cage and be hoisted.

20. An engineer placed in charge of an engine whereby persons are hoisted or lowered in any mine, shall be a sober and competent person not less than 21 years of age.

21. An engineer who has charge of the hoisting machinery by which persons are lowered or hoisted in a mine shall be in constant attendance for that purpose during the whole time any person or persons are below ground, and he shall not allow any person or persons, except such as may be deputed by the owner, operator, or superintendent, to handle or meddle with the engine under his charge or any part of its machinery.

22. When any person is about to descend or ascend a shaft or slope, the headman, or footman, as the case may be, shall inform the engineer by signal or otherwise of the fact, and the engineer shall return a signal before moving or starting the engine. In the absence of a headman or footman the person or persons about to descend or ascend shall give and receive the signals in the same manner.

23. Any miner or other workman who shall discover anything wrong with the ventilating current or with the condition of the roof, sides, timber, or roadway or with any other part of the mine in general, such as would lead him to suspect danger to himself or to his fellow workmen or to the property of his employer shall immediately report the same to the mine foreman or other person for the time being in charge of that portion of the mine.

24. Any person or persons who shall knowingly or willfully damage or without proper authority remove or render useless any fencing, means of signaling, apparatus, instrument, or machine, or shall throw open or obstruct any airway or open a ventilating door and not have the same closed or enter a place in or about a mine against caution, or carry fire, open lights, or matches in places where safety-lamps are used, or handle without authority or disturb any machinery or cars, or do any other act or thing whereby the lives or health of persons or the security of the property in or about a mine or colliery are endangered shall be guilty of an offence against this act.

25. No person shall be employed to blast coal or rock unless the mine foreman is satisfied that such person is qualified by experience and judgment to perform the work with ordinary safety.

26. A person who is not a practical miner shall not charge or fire a blast in the absence of an experienced miner, unless he has given satisfactory evidence of his ability to do so with safety, and has obtained permission from the mine foreman or person in charge.

27. An accumulation of gas in mines shall not be removed by brushing where it is practicable to remove it by brattice.

28. When gas is ignited by blast or otherwise, the person igniting the same shall immediately extinguish it if possible and notify the mine foreman or his assistant of the fact, and workmen must see that no gas blowers are left burning upon leaving their working places.

29. Every fireman in charge of a boiler or boilers for the generation of steam shall keep a constant watch of the same. He shall see that the steam pressure does not at any time exceed the limit allowed by the outside foreman or superintendent. He shall frequently try the safety-valve and shall not increase the weight on the same. He shall maintain the proper depth of water in each boiler, and if anything should happen to prevent this, he shall report the same without delay to the foreman for the time being in charge and take such other action as may under the particular circumstances be necessary for the protection of life and preservation of property.

30. At every shaft or slope in which provision is made in this act for lowering or hoisting persons, a headman and footman shall be designated by the superintendent or foreman, to be at their proper places from the time that persons begin to descend until all the persons who may be at the bottom of said shaft or slope when quitting work shall be hoisted. Such headman and footman shall personally attend to the signals and see that the provisions of this act in respect to lowering and hoisting persons in shafts or slopes shall be complied with.

31. No person except the mule driver shall couple or uncouple loaded or empty mine wagons or cars while the same are in motion.

32. When mine cars or wagons are running on gravity roads by brakes or sprags, the runner shall only ride on the rear end of the last car or wagon, and when said cars are run by sprags a space of not less than two feet from the body of the car shall be made on one or both sides of the track wherever it may be necessary for the runner to pass along the side of the moving car or cars, and said space or passage-ways shall always be kept free from obstructions. The regulations of this rule shall also apply to drivers with mules bringing a trip of cars over any graded road in the mine.

33. Safety-blocks or some other device for the purpose of preventing cars from falling into a shaft or running away on a slope or plane, shall be placed at or near the head of every shaft, slope, or plane, and said safety-blocks or other device must be maintained in good working order.

34. The engineer in charge of any ventilating fan must keep it running at such speed as the mining boss directs, and on no account shall he slacken its speed except by proper instruction from the mining boss, which shall be given in writing. If repairs to the fan or machinery become necessary he must give timely notice to the mining boss and await his instructions before stopping it. He shall also examine, as often as it is necessary, all the fan bearings, stays, and other parts, and see that they are all kept in proper working order.

35. Every miner shall examine his working place every morning and take down all loose and dangerous slate, and otherwise secure the sides and roof by properly timbering the same before commencing to dig or load coal, and he shall at all times be very careful to keep his working place in a safe condition during working hours.

36. Should a miner at any time find his place becoming dangerous, either from gas or roof, or from any unusual condition which may arise, he shall at once cease working and inform the mining boss or his assistant of such danger, and before leaving such place to search for the boss he shall place some plain warning at the entrance thereto to prevent others from entering into the danger.

37. Every miner shall use great caution in the care and handling of his powder, and when making a cartridge, he shall not keep his lamp on his head nor have a lighted pipe or cigar in his mouth, he shall place his lamp at least four feet from him and at a point at which the air would carry a spark away from him.

38. A person when charging a hole for a blast, if his cartridge sticks he must remove it carefully and reduce its size or enlarge the hole so that he may push it in easily; he must not ram or force the cartridge with a drill, and when firing a shot with a patent or other squib, he must not break off or bend the end of the squib, or light it at any part other than the extreme end, or do any other act that would tend to cause the shot to go off before he could reach a place of safety.

39. In driving cross-cuts through pillars, before firing his shot, the miner must give ample warning to the workmen in the room toward which he is driving so that they may find a place of safety.

40. Tamping bars must be tipped with at least six inches of copper or other soft metal when used for tamping a hole for the purpose of blasting coal, rock, or slate, and no iron or steel pricker or needle shall be used.

41. A charge of powder or other explosive which has missed fire shall not be withdrawn or the hole reopened, but, where necessary, a new hole shall be prepared.

42. After a shot has been fired, the miner must exercise great care in examining the roof and coal and securing them safely before resuming work.

43. The miner shall not go into any old or abandoned parts of the mine or into any other place which is not in actual course of working without permission from the mine boss or his assistant, nor shall he, under any circumstances, travel to or from his work, except by the traveling way arranged for that purpose.

44. It shall be the duty of every miner to undermine his coal properly before blasting it down, and to set sufficient sprags under the coal while undermining to secure it from falling, and the said sprags not to be further apart than five feet and the point of all opened ("cut") coal to a secured sprag or solid coal.

45. Any miner or other person who is about to explode a blast or shot by use of a patent or other squibs or matches shall not shorten the match nor saturate it with mineral oil, nor turn it down when placed in the hole, nor ignite it except at its extreme end, nor do anything tending to shorten the time the match will burn.

46. No person is allowed to travel to or from his work on the locomotive roads during working hours, nor shall they travel such roads after the locomotive has ceased running unless they have the permission of the mine boss; but no locomotive using fire shall be allowed in any mine where the miners are at work.

47. The fire-boss shall see that all dangerous places are properly fenced off, all across and danger signal boards so hung on such fencing that they may be plainly seen.

48. No person in a state of intoxication shall be allowed to go into or loiter about the outside of the mine.

49. The fire-boss shall frequently examine the edges and accessible parts of new falls and old gobs and air courses, and should he detect gas of an explosive nature or find any place rendered dangerous, from any cause whatever, he shall fence off all entrances leading to such places, on which he must either place a danger board or write intelligently a warning, and should the men be at work he shall immediately withdraw them from any place rendered dangerous, and have the place fenced off until the danger is removed, and should the danger arise on account of the presence of gas, the same to be removed immediately.

50. Any workman who shall disobey or fail to carry out any order given, or willfully violate any rule whereby his own life or the lives of other persons may be endangered, or any employe or other person who shall willfully deface, pull down, or destroy any notice board, danger signal, general or general rules or mining laws, will be prosecuted as provided for in the section of this act.

Other rules could be added, but the different points are covered by the general suggestions I have made and by the present Bituminous mining act. All matter has been omitted from the suggestions and rules given that is already the law regulating the Bituminous mines of the State. I could have treated on the topic of how to work the coal seam, but I think I have given *The Times* enough of matter of which to construct a good and efficient mining law.

A Fine Haulage Plant.

Messrs. J. & J. B. Milholland, of Pittsburgh, Pa., have just erected for the American Coal Company, at their Jackson Mine, No. 5, in the George's Creek, Maryland region, an excellent haulage plant that is doing good work. The engines are of 200 H. P; the cylinders are 14 inches in diameter, and the stroke is 24 inches. They are strongly built, and are guaranteed to do twice the work at present required of them without strain. They are not reversed at any time, and are connected to two drums with two gear wheels placed in front in the center between the engines. The drums are each five feet in diameter, and work free on the main shaft; they are connected or disconnected by clutches, as may be desired, by the engineer, and a brake is attached to each drum. They are made to carry 4,500 feet of ¾ inch wire rope. Two ropes, made by the Williamsport Wire Rope Works, are used. The tail rope is ⅝ inch in diameter, and 9,000 feet long. The hauling rope is ¾ inch in diameter and 4,500 feet long. The tail rope leads from the right hand drum around a bull wheel placed at the mouth of the mine, and continues along the side of the track, and at the fartherest point passes around another bull wheel. From the mouth of the mine to Station No. 1, the track is perfectly straight, and the grade is with the load. From Station No. 1, there is a 15° curve, and a grade against the load for 2,500 feet. The ropes are guided around this curve by pulleys, and they are wound on the drums from the bottom. An electrical signaling apparatus is used.

The steam plant consists of two return flue tubular boilers, each sixteen feet long in the clear, fifty-four inches in diameter, and are guaranteed to carry a pressure of 150 lbs. Sixty three-inch tubes are in each boiler, and they have all necessary fixtures now attached to high grade boilers. A steam pump furnishes water for both. Both boilers can be used at one time if necessary or disconnected at will.

This plant, on a test trial, hauled a trip of 45 loaded mine cars, weighing 6,200 lbs. each, up a 4% grade with ease. The Messrs. Milholland, who rank among the leading makers of haulage machinery, are naturally proud of this plant. They are now at work placing a similar plant in position at the Koontz mine of the New Central Coal Company in the same region.

Sphincter Grip Steel Armored Hose.

Hose, for water, steam, or compressed air is largely used in all mining operations, and in no other industry does it receive harder usage. To make it more serviceable the Sphincter Grip Armored Hose was introduced. Already over half a million feet of it are in use at British collieries, and its use is rapidly being extended in American mines and industrial establishments. It is so strong that it will stand practically unlimited pressure, and long use and crucial tests have proved its superiority over ordinary hose, both in strength and durability, and as these desirable qualities are guaranteed by the makers, its cost in the end is much less than any other. A peculiarly valuable feature of this hose is, that it cannot be kinked. More hose is destroyed by the sudden concussion through kinking, when a full velocity of water is rushing through it than by actual wear. It is more flexible than unarmored hose, and perfectly protected from abrasion. It can be cut at every wind of the wire without loosening or uncoiling, as the Sphincter grip is self-holding through its entire length. It is especially adapted for use at collieries, coke works, and for steam and compressed air transmission, and is in fact the most serviceable hose made for any use.

Strong evidence of its worth is found in the fact that inferior imitations are being made, and placed on the market.

The Waterbury Rubber Company, 49 Warren Street, New York, are sole owners of the patents, and are the only manufacturers of the genuine Sphincter Grip Armored Hose in America, and they place brass plates under the wire, marking each coil, so that purchasers may readily distinguish the genuine from spurious imitations. They are also manufacturers of plain hose, belting, packing, and mechanical rubber goods of all descriptions. Catalogues and price-lists are sent on application.

Correspondence

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ *Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.*

Ventilation.

Editor Colliery Engineer:

SIR:—In answer to "A. B.," of Hanna City, Ill., I submit the following:

(1). An airway 8′ × 8′ × 1000′ is passing 40,000 cu. ft. of air, what diameter should a circular airway 1200′ long be to pass one-half the quantity, the pressure remaining the same?

(2). A mine is ventilated by natural ventilation passing 10,000 cubic feet of air per minute with a pressure of 5·5 pounds, the temperature in the downcast being 42°. The air current is reversed by erecting a furnace at bottom of the downcast producing 14,000 cubic feet of air per minute, what is the effect on the pressure and temperature?

In neither of the questions does there seem to be sufficient data given, and I do not think the first can be worked out correctly unless by chance; I may be mistaken, however, if so, I would be pleased to see "A. B.," or any one else solve it in the columns of THE COLLIERY ENGINEER for the benefit of your readers.

To the second question we will supply sufficient data, viz., depth of shafts, as it is necessary to have the depth of upcast, and as both shafts are upcasts in turn it is necessary to have the depth of both, we will assume the depth to be 600′, then the 5·5 lbs. pressure will have to be neutralized by a counter pressure in what was the upcast shaft by raising the temperature and making the air lighter to the extent of 5·5 lbs. in the downcast, and then as the pressure varies as the square of the quantity we have

$10^2 : 14^2 :: 5{\cdot}5 : x$, or 10·78 lbs., = the pressure shown on the other side or leg of the water-gauge.

Then,

$$10{\cdot}78 + 5{\cdot}5 = 16{\cdot}28 \text{ lbs.},$$

= total pressure to be maintained, which would require a motive column equal to

$$\frac{p}{w},$$

where p = pressure and w = weight of a cubic foot of air at 42°, the temperature of the air in motive column

$$w = \frac{1{\cdot}3253 \times 30}{459 + 42^\circ} = {\cdot}07936, \text{ then}$$

$$\frac{16{\cdot}28}{{\cdot}07936} = 205{\cdot}14 = \text{motive column.}$$

Then

$$T = \frac{D\,(459 + t)}{D - m} - 459 =$$

$$\frac{600\,(459 + 42)}{600 - 205{\cdot}14} - 459 = 302{\cdot}28^\circ.$$

Therefore the temperature of the upcast will equal 302·28°, downcast 42°, and the pressure to be maintained 16·28 lbs. The pressure shown on the opposite leg of the water-gauge = 10·78 lbs.

Yours, etc.,
T. S. C.

Gardner, Ill., September 26th.

Ventilation and Mining.

Editor Colliery Engineer:

SIR:—I submit the following in reply to questions by "S. U. P.," of Red Bank, Pa., in your October issue:

(1.) By the formula

$$P = \frac{K\,s\,v^2}{a}$$

the pressure is found thus, substituting their given values we have

$$P = \frac{{\cdot}0000000217 \times 24{,}000 \times 250{,}000}{128} = \frac{12{\cdot}97}{128}$$

= ·101336 + lbs. the pressure required.

In the next case we have the following formula to find the quantity:

$$q = a\sqrt{\frac{P\,a}{K\,s}}$$

by substituting their values and solving we have

$$\frac{{\cdot}101336 \times 64}{{\cdot}0000000217 \times 16{,}000} = \frac{6{\cdot}485504}{{\cdot}0003472} = \sqrt{18682{\cdot}32}$$

$$+ = 136{\cdot}6 \times 64 = 8742{\cdot}4, \text{ and}$$

$$8742{\cdot}4 \times 2 = 17{,}484{\cdot}8 \text{ cu. ft.},$$

the volume required.

(2). If a breakdown should occur caused by the engine or fan, the result would be the same whether it be an exhaust fan or a blower, as the one could not take any air out of the mine, and the other could not send any in. In a gassy mine there should always be two fans, so that in case anything happened to one, the other would be ready to be started up to keep a current passing through the mine.

In case a large fall should occur the greatest danger would arise where an exhaust fan was used, as it would take all the air from the mine and the gas would rush out from the strata, fill up the mine, and, no doubt, cause a loss of life and property. A blower would press more and more weight upon the pent-up gas, and thus more time would be given for the men to escape.

Suddenly removing the obstruction in the first case would leave a mine full of gas to contend with, and the air would have to force it all out before it, or make a path through the gas, as has happened in some cases when the current is not strong enough. In the second case the current would go on as before the fall had happened, as the pressure of the air would keep the gas in the strata and the mine would be free from it.

Yours, etc.,
L. P. H.

Avoca, Pa., October 7th.

Correction.

Editor Colliery Engineer:

SIR:—I made a slight mistake in my answer to "S. U. P.," in your last issue, which was caused by my statement that

$$P\,a \times q = u.$$

It should have been

$$P \times q = u,$$

which would change the h. p. in the 3d and 5th questions to the same as found by "T. S. C.," of Gardner, Ill., in the same issue.

Yours, etc.,
J. K.

Connellsville, Pa., October 5th.

Examination Question.

Editor Colliery Engineer:

SIR:—I notice by your last issue that "J. W. S.," of Westville, N. S., is not satisfied with the replies he received to his question, and solves the problem himself, finding the temperature to be 145°.

Now, as he wishes, I will try to show the error and its source. In the first place he makes a mistake in the data used to find the motive column, when he assumes water to be 833 times heavier than air. A constant cannot be found for weight of H_2O as compared with air, since liquids are not so sensitive to heat as gases, with the exception of CO_2. The specific heat of air is found to be 4·2 times less than H_2O. The co-efficient of expansion of H_2O from 0° C. to 100° C. is ·000466, while the co-efficient of gases is ·00366, or $\frac{1}{273}$ of its volume for every degree C., or $\frac{1}{490}$ for every degree F. Also the expansion of gases is nearly uniform, while H_2O is not, for its maximum density is at 4° C., or 39° F., weighing at that temperature nearly 62·5 lbs. per cubic foot. Now you will observe 40° is the temperature of the downcast or 1° from the maximum density of H_2O. If "J. W. S." would work out the formula

$$\frac{62{\cdot}5}{{\cdot}07966}$$

he would find that a cubic foot of H_2O is 784 times heavier than air at 40° F., which is the temperature of downcast. By using the formula below we find the length of the motive column

$$\frac{784 \times 1}{12} = 65{\cdot}3' \text{ m.},$$

which would alter his answer, as he reckons the *m.* to be 69·5. By multiplying ·07966 the weight of one cu. ft. of downcast by 69·5′, we obtain 5·5 lbs. pressure, but by multiplying it by 65·3′ we obtain 5·2 lbs. (within $\frac{1}{1000}$ part of a lb.) I think "J. W. S." has followed Mauchline too closely. Is it necessary to find the *m.* at all? It may be correct enough, but too long a method. I will assure "J. W. S." that the temperature of upcast is 137·29°; if he will find the *m.* thus

$$\frac{5{\cdot}2}{{\cdot}07966}$$

he will find it to be 65·3′; also if he tries to find the depth of upcast shaft from the temperatures—upcast 145°, and downcast 40°, he will find it to be deeper than the downcast shaft.

Yours, etc.,
J. V.

Punxsutawney, Pa., October 9th.

Correction.

Editor Colliery Engineer:

SIR:—In my answers to "S. U. P.," in last month's issue, I took the wrong area and, in consequence, my quantity was too large, although the principles used were all right. I would refer "S. U. P." to "T. S. C.'s" answers which were correct.

Yours, etc.,
J. V.

Punxsutawney, Pa., October 9th.

Effect of Gas on the Flame of a Safety-Lamp.

Editor Colliery Engineer:

SIR:—In answer to "R. P.," of Greensburgh, Pa., in the October issue, I would say:

(1.) That if a Davy lamp were subjected to a mixture of one part CH_4 to 13 of air, it would cause a blue column to extend from top of flame to crown of gauze tapering outward full width of gauze at top while at bottom it would be slightly wider than the flame.

(2). With one part CH_4 to 5 parts air, the gauze would be filled with a blue flame and continue to burn long enough to bring the gauze to a red heat if it is not withdrawn.

Yours, etc.,
J. K.

Connellsville, Pa., October 5th.

Coal Mining in No. 6 Seam, St. Clair Co., Ill.

Editor Colliery Engineer:

SIR:—Permit me through your columns to thank Mr. Leo Gluck, E. M., for his very practical paper on the above subject in your October issue, p. 53. Would that he or others would contribute articles specifically describing the details of underground coal mining in other sections of the country, where the natural conditions are very similar or dissimilar to those obtaining in the Belleville Seam, Ill.

Mr. Gluck gives figures at the end of his article that are very significant, and in regard to which I feel constrained, with your permission, to make a short comment.

We are told that the quantity of coal that is actually hoisted is only 51·15% of the seam, *a trifle over one-half*, and further, that of this 51·15%, 8·33% is slack, having but little value. An explanation of this startling statement of fact is partly found in Mr. Gluck's remark that 38% of the seam is left as pillars, as shown by the maps of the workings, and further that of this 38% in ribs and pillars one quarter or 25% is mined when these are *robbed*. It does not appear therefore, that the pillars are "drawn" or *cleaned out* entirely, and consequently the loss of coal in them is enormous.

Now, there may be good reasons why these pillars are not taken out, but as none are given in the article, I presume the real reason is because of the *method of working* the coal.

If the full explanation is that, if the pillars were robbed more than 25%, the surface water would come down and cause trouble with the floor to such an extent as to practically close the mine, I have nothing further to say, but, on the other hand, if it would be cheaper to pump the water than to leave nearly half the coal in the pit, would not some other method of working, some *better system of laying out the mine to suit the local conditions*, be worth while adopting?

This looks as if it were a place—a district—where the *Longwall withdrawing* system of working might be practiced with profitable results, and make a far better showing as regards *yield of coal*, together with much easier and cheaper digging, less slack produced, less shooting, with much more compact workings and infinitely better ventilation than is possible in room and pillar mining.

It seems to me that if the operators in this region or their superintendents, would think this Longwall "pulling back" system well over, and give it a trial, as Mr. MacDonald did (see COLLIERY ENGINEER, August 1890), they would no. want to go back to the old system. I don't wish, however, to be understood to say that the way Mr. MacDonald laid off his entries is the best, for his was merely an experimental or trial place more than anything else, but what I do claim is that in *principle* his system is the correct one to work upon if cheap digging, a well ventilated and compact, mine and all the coal worked are objects to be attained.

And let me make myself clearly understood on another point, which is that there is *no necessity* (as some seem to suppose) to drive entries right to the limits of the property before beginning to extract the bulk of the seam. That to do so in the case Mr. Gluck writes about would seem to *be* necessary, but then, look at the extra percentage of coal that would have been available in his case had the method I am anxious to see adopted in these moderately thick seams been in vogue.

The following appears in Mr. Martin's official report on his mine inspection of South Western district of Great Britain for last year. The paragraph has reference to the Llanerch Colliery explosion inquiry. "The system of working was 'pillar and stall,' which is the old-fashioned system of the district. The reason for adopting it when reopening was probably a matter of convenience, and because it always had been the system worked in this mine. The seam being 7½ to 9 ft. thick, and apparently without any important rubbish for stowage purposes, it was said that the *Longwall* system would not suit. This is the old story, but experience has found it wrong in the cases of the Black Vein, at Risca, Abercarn, Celynen, and other places where Longwall has given more satisfactory results than pillar and stall. An attempt has since been made to introduce Longwall work, but the men looking upon it as an innovation, have resisted it. I, however, hope that before long it will be got over, as I am confident the change would be advantageous to all."

I think it is to the Longwall *advancing* (the "gob road" system) that Mr. Martin has reference to here; a system I do not advocate for wet, shallow, thick seams, unless the seam itself carries ample slate, etc., of a suitable kind for "building" material, and the floor were hard.

Considerable space might be occupied in your columns in quoting statements of *fact* as well as of eminent mining men's *opinions* in regard to the relative economy and safety of the Longwall over pillar methods; and your readers will have noticed in last month's COLLIERY ENGINEER that the former system has been put in practice in an Anthracite mine in the Wyoming-Lackawanna coal field, Pa., where the chamber and pillar system would have been unsuited. And, only the other day, the remark was made to me that "Longwall must come before long; it is only a question of a very few years before operators will have to abandon the wasteful system of to-day."

If there is one system of working that suits undercutting machines better than another surely it is a Longwall system and I was pleased a few weeks ago to find a Longwall face in the Bituminous region of Pa. in which the bearing-in was done by machinery.

Those operators who are first in the field to adopt Longwall (where the conditions favor that method) will be first to reap the good results to be had from it.

I should like to see this much-neglected system discussed more and more in your paper, and trust my reference to it will call up correspondence.

Yours, etc.,
W. S. GRESLEY.

Erie, Pa., October 9th.

Examination Question.

Editor Colliery Engineer:

SIR:—"J. W. S.," in your July issue, gives the following problem:

"A furnace at bottom of shaft 400 ft. deep produces 15,000 cu. ft. of air per minute with 5·2 lbs. pressure per sq. ft. Temperature in downcast is 40° F. What is temperature in upcast?"

Various solutions have been published, including those from "H. L. D. W." and "J. W. S.," himself. As the last-named asks "to be corrected if in the wrong," I venture to attempt to point out his error, which lies in the assumption that water is 833 times heavier than air. This assumption is true only for one certain temperature; but the true relation between their weights at the given temperature may be determined easily. From Molesworth 1 cu. ft. distilled water at 39° F. weighs 62·425 lbs. The co-efficient of expansion for water being very small may be neglected in this case and 62·425 lbs. taken as weight of 1 cu. ft. water at 40° F. To determine weight of 1 cu. ft. air at 40° F.,

$$W = \frac{1·3253 \times 30}{459 + 40} = ·0797 \text{ lbs.}$$

Dividing 62·425 by ·0797 we find water to be 783 times heavier than air at the given temperature. If "J. W. S." substitutes this for the figure he used his results will agree closely with those of "T. S. C.," "A. B.," and others.

"H. L. D. W." has not used the given temperature; but if he had, his result would have still differed from the correct one, since he has not used the proper formula for this case.

The term motive column is applied to the length of column *in the downcast* which would be equal in weight to the difference of the weight of air in the two shafts. To find this motive column we use the formula:

$$M = D \times \frac{T - t}{459 + T}$$

The formula employed by "H. L. D. W.,"

$$M = D \times \frac{T - t}{459 + t}$$

gives the length of motive column in feet of air of the temperature *in the upcast*. Now, as "H. L. D. W." calculates his M in the first place on the basis of the *downcast* temperature he cannot rightly substitute the value thus determined in a formula based on the *upcast* temperature.

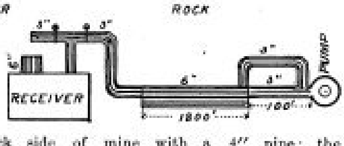
Yours, etc.,
JOHN DOE.

Tennessee, October 9, 1891.

Pumping.

Editor Colliery Engineer:

SIR:—In reply to J. T. Roger's question on page 11, of the August issue, I would say that good results would be obtained by connecting the receiver and 6″ pipe on



the rock side of mine with a 4″ pipe; the valve may then be closed on the present connection of 3″ pipe, and the pipe removed, the T could be plugged, which would leave a 3″ connection for the Sumner independent of the other side. The 4″ pipe on Rock side is in area nearly equal to two 3″ pipes for

$4^2 = 16$, and $(3^2 + 3^2) = 18$;

then the pump could be connected as suggested with a 3″ pipe to the 6″ pipe.

Yours, etc.,
F. B.

Maccan, N. S., Sept. 21st.

Blasting.

Editor Colliery Engineer:

SIR:—In answer to John Kane, in your September issue, I would say that the fire-damp will burn at the outer end of needle-hole as fast as the pressure of the blower can supply it. Fire-damp is not inflammable until mixed with air, and air could not enter the needle-hole against the pressure of the gas-blower.

Yours, etc.,
F. B.

Maccan, N. S., Sept. 21st.

Trigonometry.

Editor Colliery Engineer:

SIR:—I submit the following in reply to question (1.) asked by Richard Lewis, in your July issue:

Sin. = 250′; cos. = 600′;
Cos.² = 360000
Sin.² = 62500
422500, and
$\sqrt{422500} = 650$ = hypothenuse.
250 ÷ 650 = sin. ·384615, and
Sin. 22° 37′ = ·38456.
·000055.

Now as
22° 37′ = ·38456, and 22° 38′ = ·38483,
then ·38483 — ·38456 = ·00027
therefor ·00027 : ·000055 :: 60″ : *x*, or 12″ +,
so the angle is 22° 37′ 12″ +.

Yours, etc.,
W. G. ROGERS.

Wilkes-Barre, Pa., Sept. 28th.

Mensuration.

Editor Colliery Engineer:

SIR:—I would like to send another brief solution to T. W. Hale's question in your May issue, as my answer in the July number is a trifle too large. I find in working it over and carrying the decimal places out farther.

A horse is tied to the corner of a barn 25′ square, by a rope 100′ long. How many square feet of surface can the horse graze over?

$200^2 \times ·7854 \times \frac{3}{4} = 23,562$ square ft.

$$\frac{\sqrt{(25^2 + 25^2)}}{2} = A\ N = 17·8868993,$$

and

$$\frac{17·8868993}{75} = ·23570226 = \sin.$$

13° 37′ 58 $\frac{2510''}{2827}$ therefore the angle of

sector = 58° 37′ 58 $\frac{2510''}{2827}$; area of sector equals

$$\frac{(150^2 \times ·7854) \times (58°\ 37'\ 58\ \frac{2510''}{2827})}{360°} =$$

2878·124001638. Area of triangle =
$75^2 - 17·6776695^2$, or $\sqrt{75^2 - 312·5}$ =
(72·8868993 × 17·6776695) — 312·5 =

975·97051670518135 area of triangle,
2878·133366787988 area of sector,
2878·133366787988 area of sector,
23562· area of ¾ circle

described with radius = 100′. 30,294·23725028115735 = area.

Yours, etc.,
F. B.

Maccan, N. S., Sept. 21st.

Sustaining Life Under Pressure of Air.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to "Rescuer," of Jeanesville, Pa., who asked the following questions in your June issue:

(1.) There is a slope 624 feet long having a perpendicular depth of 160 feet and it is filled with water. Breasts are driven up 416 feet in length and 100 feet perpendicular height from a gangway which is level from bottom of slope. The compressed air holds the water back 80 feet from face of breast.

How many cubic feet of air is in one of the breasts which is 4 feet high and 30 feet wide, and what would be the volume of this air if the pressure of water were removed? Allow the temperature to be 62° Fahr., the weight of a cubic foot of air to be ·0763122 lbs., and of water 62·355 lbs.

(2.) How long would the amount of air contained in a breast, as above described, maintain the lives of four men? I gave a similar question which was published in the *Mining Herald* five years ago, taking figures and conditions from an accident in Wales where the shaft workings broke into a creek and some of the miners were enclosed for ten days. By cutting through a pillar 40 yards thick from an adjoining colliery all were rescued alive, but one of the rescuing party was killed by the pressure of the air driving him against the side of the opening as they broke through.

(3.) When the water is taken out of above workings, and exploration is being made, if lamps refuse to burn, what is the probable cause?

The above questions arose in connection with the Jeanesville disaster, and upon their solution depended the lives of several men.

First

416′ — 80′ = 336′ of water in the breast.

Then

416′ : 336′ :: 100′ : *x*, or 80·793′ = vertical head of water in breast.

160′ = head of water in slope,

then

160′ — 80·793′ = 79·207′ vertical head of water in slope above water line in breast.

79·207′ × ·434 = 34·3758 pressure per sq. in. exerted by head of water;

34·3758 + 14·7 = 49·075838 lbs. total pressure on air confined in breast.

14·7 : 49·075838 :: 80 : 267 feet, length of breast which would be occupied by air if pressure were reduced to one atmosphere;

(267 × 30 × 4) = 32,040 cu. ft. of air.

According to Kirk's Physiology a healthy man from young to middle age, at rest, requires under ordinary circumstances 686000 cubic inches of air in 24 hours, and will exhale 32,304 cubic inches of carbonic acid gas in the same time. Now, if we assume ten per cent. of carbonic acid gas to render air unfit for sustaining life we have

$$323040 + 686000 = (1009040 \times 4) = \left(\frac{4036160}{1728}\right) = 2335·74 \text{ cu. ft. of air required}$$

per day for 4 men, then

$$\frac{32040}{2335·74} = 13 \text{ days, } 17 \text{ hours, } 13 \text{ minutes.}$$

I may say that if the water were pure as from a lake, or river, some of the carbonic acid gas would be taken up by the water which would slightly extend the time but if from an old mine would likely be so charged by acids and gases that it could not take up any more. In such cases it is best for the men to place themselves at the highest points to escape the exhaled carbonic acid gas which would settle in the lower section of the place also to escape drowning when an opening is made and the pressure decreased, however there should be all the pressure possible maintained. This could be best accomplished by driving a small place to tap and have two strong air-tight stoppings with small tight fitting doors, then let all the men be taken between the stoppings, the inner door securely closed before proceeding out.

Yours, etc.,
F. B.

Maccan, N. S., Sept. 21st.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following in reference to ventilation in your Correspondence Department:

For the safety of mines and those employed therein, I would say that in a large and extensive mine giving off much explosive gas, that the return current of air should be conducted to the upcast shaft without coming into contact with any open or naked lights. In the past we have read of some very heavy explosions and large losses of life supposed to have been caused by the highly charged return current of air igniting at the furnace. As a safeguard in such cases the dummy drift was brought into use, so that the return current could be passed through it into the upcast shaft without coming into contact with the furnace. The furnace being supplied with enough fresh air from the downcast shaft or intake airway.

No person should be allowed to enter into the main return airways of any extensive or large mine except the fire-boss or some other official whose duty it should be to travel the return airways, at least once a week, to see that there were no falls or anything to impede the free flow of the return air current. Also, he should use no other light except the safety-lamp.

Mr. Austin King says, in his essay, that he would make the hoisting shaft the upcast shaft, so as to keep it free and clear of ice. It is my opinion that it would be better to try and devise some other means of keeping the ice out of the hoisting shaft aside from making it the upcast, since if there were any open light in use it would probably be at the bottom of the hoisting shaft, and the return air current being charged with gas to an explosive point it would ignite from a small lamp blaze as readily as from a furnace, and serious consequences would follow.

Yours, etc.,
ROBERT ROCHESTER.

Robbins Station, Pa., Sept. 28th.

Mechanics.

Editor Colliery Engineer:

SIR:—Please insert the following question in THE COLLIERY ENGINEER:

Two compressors, 20″ in diameter, are each light in boiler power, what advantage is to be gained by condensing one or both. Also, what size pump is required for one or both?

Yours, etc.,
A. RITCHIE.

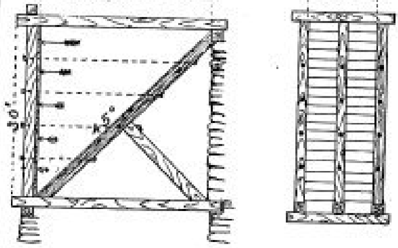
Lebanon, Ill., Oct. 9th.

Mensuration.

Editor Colliery Engineer:

SIR:—I submit the following in reply to question by "J. C. B.," in your May issue:

Ore weighs 116 lbs. per cubic ft. Please give me



the formula for determining the pressure on face of bin as shown in sketch.

The angle which line of rupture makes with vertical is half of angle which line of natural slope, or angle of repose makes with same vertical line. When material is level on top its pressure may be ascertained by considering it as a fluid, weight of a cubic foot of which is equal to weight of a cubic foot of the material multiplied by square of tangent of half the angle included between natural slope and vertical.

When co-efficient of friction is known it may be used instead of square of tangent of half angle included between natural slope and vertical. Morin gives the co-efficient of iron on wood at ·62 which I think is proper to use in this case.

Rule for finding pressure on face of wall: Multiply together the area in square feet of the surface pressed; the vertical depth in feet of its center of gravity below the surface; the weight of material, and co-efficient of friction.

It follows from foregoing rule that the amount of pressure of material against any surface is entirely independent of the quantity so long as the area pressed and the vertical depth of the center of gravity below the surface remains unchanged. The wall 30 feet high by 12 feet wide, would sustain as great a pressure from a layer only one inch thick behind it as if the material had extended back for miles.

The tabulated results are given below, giving the pressure for each space beginning from the top of "J. C. B.'s" sketch:

Division.	Area Pressed.	Depth of center of gravity.	Weight of a cu. ft. of material.	Co-efficient of friction.	Result.
First	6 x 12	3	116	·62	15534·72
Second	6 x 12	9	116	·62	46604·16
Third	6 x 12	15	116	·62	77673·60
Fourth	6 x 12	21	116	·62	108743·04
Fifth	6 x 12	27	116	·62	139812·48

Exact solutions of problems of this nature must be in a great measure experimental, and even then the results given might be called in question, unless more than ordinary care is exercised by the most competent in determining the co-efficient of friction.

Theee remarks are open for criticism and it will give me satisfaction and more knowledge on the subject if some more able than I will treat the question.

Yours, etc.,
H. L. D. W.

Lethbridge, Alta., N. W. T., Canada, Sept. 21st.

Miscellaneous Questions.

Editor Colliery Engineer:

SIR:—Will you kindly insert the following questions in the next issue of THE COLLIERY ENGINEER?

(1.) How is a water-gauge affected when the air course is suddenly contracted or enlarged?

(2.) By what means is density increased and diminished?

(3.) It is proposed to increase the quantity of air circulating in a mine, 10,000 cubic feet per minute, by building a chimney on to the upcast shaft; the original volume is 60,000 cubic feet, and the upcast shaft is 400′ in depth, what must be the height of the chimney?

(4.) There is a cistern 20′ square, and 10′ deep placed on the top of a tower 60′ high, what power is required to fill this cistern in 30 minutes; and what will be the diameter of pump, when the length of stroke is 2′, and making 40 strokes per minute?

Yours, etc.,
S. W.

Irondale, Jeff. Co., Ohio, Oct. 16th.

Fans.

Editor Colliery Engineer:

SIR:—Please publish the following questions in your valuable journal, which I hope will be answered fully by some of your able correspondents:

(1.) Is there any difference between the "Initial" and "Theoretical" head due to a fan?

(2.) How is E. O. of a mine found?

(3.) How is E. O. of a fan found, and what is the difference between them?

(4.) If the size and number of revolutions and the water-gauge is given, can the different heads and orifices be found?

(5.) How many different "heads" are there used in connection with the fan?

Yours, etc.,
T. S. C.

Gardner, Ills., Oct. 10th.

NOTE.—Considerable correspondence is unavoidably left out of this issue on account of lack of space. It will all be inserted in our December number.

Those who have noticed by comment in our paper the results which Mr. H. Ward Leonard is able to accomplish by his new method of operating electric motors, will be interested to learn that Mr. Leonard announces that he has now perfected his method to such an extent that, by a slight modification in a central station plant, which will not in any way affect the operation of existing devices, he will be able to control any motor upon the circuit so that it will operate in either direction and automatically at any desired speed and torque and with perfect efficiency under all conditions.

Mr. Leonard's first development of this method made it necessary, when using his motor from a central station circuit, to use the equivalent of a transformer of the energy. In his latest development no transforming of the energy is required; consequently, the first cost will be no higher than for shunt motors in use today, and yet all the advantages will be secured of the perfect control obtained by his method. No change in the generators, conductors, or translating devices of the present stations will be required in order to accomplish this result.

BARRIER PILLARS.

An Important and Well Arranged Plan for the Establishment of Barrier Pillars.

To avoid all trouble and complications likely to arise in the adjustment of barrier pillars, the engineers of several of the larger companies, in conjunction with Inspector Williams, of the former Third, but now Fourth Inspection District, arranged the following agreement and table, which have been mutually agreed to. For the benefit of readers in other districts we publish both in full.

TABLE OF BARRIER PILLARS TO BE LEFT BETWEEN ADJOINING PROPERTIES.

DEPTH BELOW WATER LEVEL—ALL DIMENSIONS IN FEET.

FORMULA: Thickness of workings × 1% of depth below drainage level + thickness of workings × 5 = width of barrier pillar.

THICKNESS MINED FROM SEAM.	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700
3	15	17	18	20	21	23	24	26	27	29	30	32	33	35	36
4	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
5	25	28	30	33	35	38	40	43	45	48	50	53	55	58	60
6	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72
7	35	39	42	46	49	53	56	60	63	67	70	74	77	81	84
8	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96
9	45	50	54	59	63	68	72	77	81	86	90	95	99	104	108
10	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
11	55	61	66	72	77	83	88	94	99	105	110	116	121	127	132
12	60	66	72	78	84	90	96	102	108	114	120	126	132	138	144
13	65	72	78	85	91	98	104	111	117	124	130	137	143	150	156
14	70	77	84	91	98	105	112	119	126	133	140	147	154	161	168
15	75	83	90	98	105	113	120	128	135	143	150	158	165	173	180
16	80	88	96	104	112	120	128	136	144	152	160	168	176	184	192
17	85	94	102	111	119	128	136	145	153	162	170	179	187	196	204
18	90	99	108	117	126	135	144	153	162	171	180	189	198	207	216
19	95	105	114	124	133	143	152	162	171	181	190	200	209	219	228
20	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240
21	105	116	126	137	147	158	168	179	189	200	210	221	231	242	252
22	110	121	132	143	154	165	176	187	198	209	220	231	242	253	264
23	115	127	138	150	161	173	184	196	207	219	230	242	253	265	276
24	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288
25	125	138	150	163	175	188	200	213	225	238	250	263	275	288	300

THICKNESS MINED FROM SEAM.	750	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500
3	38	39	41	42	44	45	47	48	50	51	53	54	56	57	59	60
4	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80
5	63	65	68	70	73	75	78	80	83	85	88	90	93	95	98	100
6	75	78	81	84	87	90	93	96	99	102	105	108	111	114	117	120
7	88	91	95	98	102	105	109	112	116	119	123	126	130	133	137	140
8	100	104	108	112	116	120	124	128	132	136	140	144	148	152	156	160
9	113	117	122	126	131	135	140	144	149	153	158	162	167	171	176	180
10	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200
11	138	143	149	154	160	165	171	176	182	187	193	198	204	209	215	220
12	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234	240
13	163	169	176	182	189	195	202	208	215	221	228	234	241	247	254	260
14	175	182	189	196	203	210	217	224	231	238	245	252	259	266	273	280
15	188	195	203	210	218	225	233	240	248	255	263	270	278	285	293	300
16	200	208	216	224	232	240	248	256	264	272	280	288	296	304	312	320
17	213	221	230	238	247	255	264	272	281	289	298	306	315	323	332	340
18	225	234	243	252	261	270	279	288	297	306	315	324	333	342	351	360
19	238	247	257	266	276	285	295	304	314	323	333	342	352	361	371	380
20	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400
21	263	273	284	294	305	315	326	336	347	357	368	378	389	399	410	420
22	275	286	297	308	319	330	341	352	363	374	385	396	407	418	429	440
23	288	299	311	322	334	345	357	368	380	391	403	414	426	437	449	460
24	300	312	324	336	348	360	372	384	396	408	420	432	444	456	468	480
25	313	325	338	350	363	375	388	400	413	425	438	450	463	475	488	500

Each adjoining owner is to leave one-half of the pillar thickness required.

AGREEMENT.

In compliance with the requirements of Section 10, Article III, of the Act June 2, 1891, entitled "An Act to provide for the health and safety of persons employed in and about the Anthracite Coal Mines of Pennsylvania, and for the protection and preservation of property connected therewith," it is hereby agreed between the Engineers of the..and of..and the Inspector of Mines of the................ Anthracite District of Pennsylvania, that the barrier pillars to be left, one-half (½) by each owner, between the workings ....on their adjoining properties, are to be, as nearly as practicable, of the thickness to be determined as follows:

First. That after this date the width of barrier pillar between the workings of adjacent properties is to be five times the thickness of seam mined out from floor to roof at the water drainage level; and that at all points below such level its width shall be equal to the thickness mined out at that point multiplied by one per cent. of the depth below drainage level added to five times the said thickness mined out. Thus: Thickness of workings × 1% of depth below drainage level + thickness of workings × 5 = width of barrier pillar. And as further illustrated by the attached table of pillars to be left between adjoining mines of different thicknesses of workings at different depths.

Second. That the water drainage level shall be understood to mean the level at which water would drain off from any abandoned workings, and that where the level is higher in one mine than in an adjoining one the higher level shall be taken, and where there is but one mine opened it shall determine its drainage level, and if the drainage level of a mine subsequently opened upon adjoining lands is higher, the additional thickness required shall be left by the owner of said mines.

Third. That these thicknesses shall be subject to such modifications as may be deemed advisable under varying conditions of the strata and seams due to proximity of other seams, faulty nature of seam or strata or other conditions shown by the development of the workings.

Fourth. That on notice of either party that any modifications of this agreement are desirable, a meeting shall be forthwith held to decide the same.

Fifth. That copies of this agreement and modifications thereof shall be furnished the Mining Superintendents for the instruction and guidance of those in charge of the workings. And there shall be marked on the map used at the mines the formula and such portion of the table as is applicable to the workings.

And It Is Further Agreed that the duplicate surveys and certified map to be furnished the Inspector shall consist of independent maps of surveys made by the Engineers of the adjoining properties, each map showing the land line and the workings, stations, monuments, etc., on both properties in the vicinity of division land lines.

In Witness Whereof, the said parties have hereunto set their hands this..........................day of..........................A. D. 189...

....
....
(Signed in triplicate.) ....
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NEW MINING COMPANIES.

Names and Post-Office Addresses of the New Mining Companies Incorporated in the United States Since our Last Issue.

Suwanee Phosphate Co.,	Anthony, Marion Co., Fla.
El Sueno Gold and Silver Mining Co.,	Oakland, Cal.
The Colorado Mining Drill Co.,	Denver, Colorado.
The Washington Mining and Milling Co.,	Denver, Colo.
The Electric Mining and Milling Co.,	Denver, Colo.
The Exodus Mining Co.,	East Liverpool, Ohio.
Wall Street Mining Co.,	Helena, Mont.
Bunker Hill & Sullivan Mining and Concentrating Co.,	Portland, Oregon.
Margerum Mining Co.,	Webb City, Mo.
The FredoniaConsolidated Mining Co.,	Buena Vista, Colo.
Cyanide Process Gold and Silver Extraction and Mining Company for Baker County, Oregon,	Jersey City, N. J.
Palatacha Kaolin Company,	Riverside, Fla.
The Texas Coal and Coke Mining Co.,	San Antonio, Texas.
Santiago Canyon Silver Mining Co.,	Los Angeles, Cal.
The Sutton Mining and Milling Co.,	Denver, Colorado.
Pandora Mining and Milling Co.,	Butte, Mont.
Argenion Mining Co.,	Missoula, Mont.
Gold Group Gravel and Quartz Mining Co.,	Salt Lake City, Utah.
Butte Mining and Milling Co.,	Butte, Mont.
The Cumberland Consolidated Mining and Milling Co.,	Aspen, Colo.
Wilderness Gold Mining Company of Oakland, Cal.,	Oakland, Cal.
Tepeonta Copper Mining Co.,	San Francisco, Cal.
Virginia Block Marble Co.,	Fincastle, Va.
Burkeville Granite Company,	Roanoke, Va.
The Fall River and Colorado Mining and Milling Co.,	Fall River, Mass.
The Wainwright Coal Company,	Wellston, Ohio.
The Cleveland Coal Company,	Cleveland, Ohio.
The Anaconda Mining and Milling Co.,	Denver, Colo.
The Red Raven Consolidated Mining Company,	Romley, Colo.
The Salem Coal Company,	Salem, Ill.
Blaine Mining Company,	Helena, Mont.
Shasta Gold Extraction Co.,	San Francisco, Cal.
Southern California Mining Co.,	Los Angeles, Cal.
Gold Thread Mining Company,	Los Angeles, Cal.
North Clinton Gold Mining Co.,	San Francisco, Cal.
The Golden Hope Mining and Milling Company,	Chicago, Ill.
Western Mineral Company,	East St. Louis, Ill.
The Lick Creek Natural Gas, Minerals and Mineral Water Co.,	Indianapolis, Indiana.
The Colorado and Utah Mining and Investment Company,	Denver, Colo.
The Silver Chord Mining Co.,	Chicago, Ill.
Jefferson Gold Quartz Mining Co.,	Marysville, Cal.
Los Angeles and Utah Mining and Improvement Company,	Los Angeles, Cal.
The Bonaventure Industrial Co.,	Silver City, New Mexico.
The Golden Eagle Mining Co.,	Leadville, Colo.
Alba Company,	Saco, Me.
The Comstock Gold-Silver Mining and Milling Company,	Denver, Colo.
Richland Coal Company,	Altoona, Pa.
Frazier Mining Company,	Los Angeles, Cal.
The Lime City Co.,	Lime City, Ohio.
Eastern Oil Company,	Buffalo, N. Y.
The Silver Brick Mining Co.,	Wheeling, West Va.
The Ella Coal Company,	McKeesport, Pa.
Basin Mining and Concentrating Co.,	Helena, Mont.
Boulder Smelting Company,	Helena, Mont.
The Stonewall & Greenwood Mineral Company,	Denison, Texas.
Dunbar Phosphate Company,	Citra, Marion Co., Florida.
The Boulder County Lode Mining and Milling Co.,	Boulder, Colo.
The Mine Owners' Trust, Limited, (English),	Ouray, Colo.
The Red Mountain Silver Mines, Limited, (English),	Ouray, Colo.
Clear Creek Co-Operative Coal Co.,	Springfield, Ill.
Consolidated Morning Star Mining Company,	Butte, Monta.
Marshall County Oil and Gas Co.,	Moundsville, West Va.
Juneau Mining Company,	San Francisco, Cal.
Pahrump Mining Company,	San Francisco, Cal.
Mexican Importing Company,	San Francisco, Cal.
The Lemhi Placer Gold Mining Co.,	Denver, Colo.
Sheridan Consolidated Mining Co.,	Chicago, Ill.
The Chariton Coal and Mining Co.,	Kansas City, Mo.
Coaldale Mining & Manufacturing Co.,	Coaldale, West Virginia.
The Hope Splint Coal Co.,	Ferguson, West Virginia.
The West Virginia & Ohio Gold and Silver Mining Company,	Parkersburg, West Va.
The Pinon Mining Co.,	Santa Fe, New Mexico.
The Pitkins Mining Company,	Gunnison, Colorado.
The Eurydice Mining Company,	Denver, Colorado.
The Jicarilla Placer Mining Co.,	La Vegas, New Mexico.
Iron City Sand Company,	Pittsburgh, Pa.
The Blanche Coal Company,	Collins, West Virginia.
The Zieger Coal Company,	Chicago, Ill.
King Solomon's Mining Co.,	Grass Valley, Cal.
Land and Mining Investment Co.,	San Francisco, California.
Glenwood Heights Company,	Charleston, West Va.
Henry Coal & Coke Company,	Piedmont, West Va.
The Silver Mountain Mining and Milling Company,	La Veta, Huerfano Co., Colo.
The Scandinavia Mining Co.,	Marble, Gunnison Co., Colo.
Montgomery Tunnel & Mining Co.,	Roseburg, Oregon.
Victor Mining Company,	Chicago, Ill.
The Little Eagle Gas Company,	Cornel, Hamilton Co., Ind.
The Beaver Valley Stone and Clay Co.,	New Brighton, Pa.
The Edgar Union Mining Co.,	Denver, Colorado.
Thompson Hill Mining Co.,	Clinton, Indiana.
The Butternut Land Co.,	Butternut, Wisconsin.
Pacific Mining & Milling Co.,	Great Falls, Mont.
Claney Creek Mining Company,	St. Paul, Minn.
Eureka Mining and Lumber Co.,	Grass Valley, Cal.
Cleveland & Aurora Mineral Land Co.,	East St. Louis, Ill.
Palisade Mining Company,	Minneapolis, Minn.
The Queen's Gulch Mining Co.,	Aspen, Colo.
The Miami Company,	Xenia, Ohio.
The Riverton Coal Company,	Wellston, Ohio.
Claremont Land Association,	Claremont, Va.
Savernake Steel & Tin Plate Co.,	Savernake, Va.
Challenger Mining Company,	Cumberland, Me.

MR. WILLIAM COULSON has resigned his position as General Mine Foreman for the Davis Coal and Coke Co., at Coketon, West Virginia, and has accepted a similar position for the H. G. Davis Coal Co., at Thomas, Tucker Co., West Virginia, where they have two mines.

MR. MATTHEW TAYLOR was appointed manager of the vast coal, iron, and railway interests of the late W. L. Scott, of Erie, Pa., by the latter's will. The estate is estimated at from $20,000,000 to $25,000,000.

THE LATE HON. WM. L. SCOTT.

Wm. L. Scott was a brilliant example of the highest type of self-made Americans. Left an orphan without means, early in life, he successfully fought his way upwards until he ranked among the wealthiest men of America, and had gained an enviable reputation as a clear-sighted and far-seeing business man. He was genial in his manners and enjoyed the respect and admiration of all his subordinates in his numerous business enterprises. He was a man of positive views, but he always satisfied himself that his views were right before he expressed them. He was charitable, and his charity knew no race or sect. He was patriotic, and in the dark days of rebellion, he not only raised and equipped an artillery company for the defense of the Union, but subscribed for Government bonds to half the extent of his fortune.

He was a man of great mental ability as is evidenced by the great fortune of $25,000,000 left by him, and the fact that the immense interests which this sum represents, whether in coal, iron, or railroads, were all thoroughly understood by him, and he held them all under his personal supervision. The portrait we publish with this article, is an excellent likeness, and no student of physiognomy will take it for the face of any but a shrewd, careful, and kindly man. In politics he was a Democrat, and was justly regarded as one of the ablest leaders of that great political party. He was the personal friend of Tilden, Cleveland, and other eminent Democratic statesmen. His social friendships were not confined to prominent men in his own party. His public life and services threw him in personal contact with many of the eminent Republican leaders, and they justly esteemed and enjoyed his personal friendship.

He was born in the city of Washington, on July 2d, 1828, of Virginian parentage. His father, Major Robt. Scott, was a graduate of West Point Military Academy in the class of 1812. His grandfather, Hon. Gustavus Scott, was a delegate from Maryland to the Continental Congress, and by appointment of President Washington, he was the first commissioner of public buildings in the City of Washington. Gustavus Scott was one of the three men who endorsed the Government bond, guaranteeing the payment of a loan of $300,000 borrowed from the State of Maryland, which was used to complete the National Capitol at Washington. This cancelled bond was one of William L. Scott's most highly prized historical papers.

Mr. Scott's parents both died while he was a mere boy, and as they were in poor circumstances he was thrown on his own resources. Early in his teens, he secured a position as page in the House of Representatives, and by his obliging and polite manners he made many friends among the congressmen. Gen. Charles M. Reed, who then represented the Erie district, was particularly interested in the bright young page, and at the close of the session took him to Erie, where he installed him as shipping clerk on his wharves. Gen. Reed at the time was one of the principal owners of shipping on the great lakes. For three years he worked as a clerk, fish merchant, and at any employment he could find, and in 1851, in connection with Mr. John Hearn, he established the firm that is now known as W. L. Scott & Co., but which was then known as Hearn & Scott. This firm was eminently successful and is now the largest coal producing and shipping firm in the world, owning thousands of acres of both Pennsylvania Anthracite and Bituminous coal lands, as well as thousands of acres of coal lands in Illinois, Iowa, and Missouri. The output of the mines owned by this firm aggregate about 10,000 tons per day.

At the time of his death Mr. Scott was the principal owner of the Youghiogheny Coal Co., and the Union Coal Co., of Pennsylvania, and the Spring Valley Coal Co., of Illinois, and he was a large owner in the Northwestern Fuel Co.; the Missouri Iron and Coal Co.; the Sligo Furnace Co., of Missouri, and the What Cheer Coal Co., of Iowa. He also recently purchased 2,000 acres of first-class iron ore land in Algona, Province of Ontario, Canada.

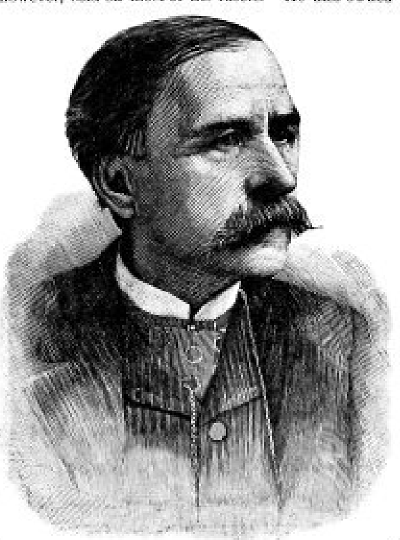
On Sept. 19, 1853, Mr. Scott was married to Miss Mary M. Tracy, a daughter of the late John A. Tracy. By the marriage Mr. Scott was placed in control of considerable property, and shortly afterwards secured an introduction to the New York Stock Exchange. There he became acquainted with the late Commodore Vanderbilt, and Hon. Samuel J. Tilden. These great financiers were quick to recognize his ability as a financier and manager, and from this time his progress towards great wealth and influence was rapid. He became interested in the construction and operation of railroads as well as in the mining of coal and the manufacture of iron, and at the time of his death, either as a director or president, he controlled more miles of railroad than any man in America, with the possible exception of Jay Gould.

Mr. Scott commenced his railroad career with the construction of the Erie and Pittsburgh Railroad in 1861-'64. In 1862 he built the extension of the Chicago, Rock Island and Pacific Railroad from Grinnell, Iowa, to the Missouri. This was the first railroad that had ever been built to the Missouri River. He was largely interested in the establishment of the Elevated Railroad in New York City. He was also one of the most prominent men in the construction of the New York, Philadelphia and Norfolk Railroad in 1884, and was its first president. At the time of his death he was the oldest and only living original director in the board of the Lake Shore and Michigan Southern Railroad. He was a director and member of the executive committee of the Chicago and Northwestern Railway, and a director in the following corporations: The New York, Philadelphia and Norfolk Railway; the Pittsburg, Cincinnati, Chicago and St. Louis Railway; the New Castle and Beaver Valley Railroad; the Michigan Central Railroad, and the Albermarle and Chesapeake Canal Co.

Mr. Scott was elected Mayor of Erie in 1866, and again in 1871. In 1884 he was elected to Congress, overcoming a large Republican majority, and made a record on the Chinese question.

His home life was particularly pleasant. The family mansion in Erie being very plain outwardly, but furnished inside in a luxurious and tasteful manner. He was a great reader, and his library is a particularly fine one. In religion he was an Episcopalian, but of very broad views, and the charitable organizations of Erie, of all denominations, had a warm friend in Mr. Scott.

He took great interest in farming and raising fine stock. His race horses, chief of which was Rayon d'Or, imported from Normandy at a cost of $33,000, were his special pride, and many of the best racers in the country were bred at his stock farm. He recently, however, sold off most of his racers. He also owned



HON. W. L. SCOTT.

a fine herd of blooded cattle, which were successfully exhibited at fairs in Northwestern Pennsylvania.

Mr. Scott is survived by his widow and two daughters, the elder of whom, Mary S., is the wife of Mr. Richard D. Townsend, a wealthy banker and broker, of Philadelphia, and the younger, Anna W., is the wife of Mr. Chas. H. Strong, president of the Union Coal Co.

In his character there was nothing false or superficial. He was plain in his tastes and outspoken in his language. In fact, "he was a man."

DIESCHER PATENT COAL WASHER.

For many years past the comparative scarcity of first-class coal has occasioned the frequent use of washing jigs and other apparatus for the purpose of utilizing inferior coals by removing the slate, pyrites, and other impurities they contain. The have been especially useful in improving the quality of coke for blast-furnaces and other purposes. All of these machines operate on the principle that if the coal, by crushing or otherwise, is reduced to parts of approximately one size, and with the impurities detached from the coal, the latter can be separated from the former by agitating the mass in water, and allowing the different parts to arrange themselves according to their specific gravities. Iron pyrites will form the lowest stratum, slate will come next, and the coal will rise to the top, whence it can be carried to its place of storage.

A well known type of washing machine used in Europe, and frequently copied in this country, is a jig consisting essentially of a box containing a screen on which the raw coal is placed; a reservoir for water under the screen, and a compartment back of the latter containing a piston or plunger with a reciprocating motion, which communicates its oscillations to the water, and thence through the screen to the coal. One great defect of this type of jig has been long felt, but never as yet fully remedied, notwithstanding numerous devices for the purpose; viz.: the imperfect and unequal action of the water at different parts of the screen, due to the location of the plunger at the back of the screen, thus reducing the effectiveness of the separation, and the quantity and quality of the washed product.

The Diescher Patent Washer effectually overcomes this defect by placing the plunger or piston immediately below the fixed screen, and making it equal in size to the latter. This arrangement renders the machine not only more effective, but much stronger, more compact, of simpler construction, greater washing capacity, and increased durability. The accompanying engraving represents two Diescher boxes or washers operated by one shaft on which the eccentrics are so arranged that the plungers balance each other. Each box consists of heavy and rigid cast-iron standards and cross-pieces to which are bolted 4'' planks, planed, tongued, and grooved so as to form a water-tight compartment. At the top of this compartment is a screen 4 feet square, while within it and below the screen is the iron plunger mentioned above. This plunger is of strong and simple construction, and is connected with the eccentric straps by two stout suspension rods having bronze bearings at the upper end. The straps receive their motion from two eccentrics keyed to the main shaft, which is driven by the pulley shown on the left.

The stroke of the plungers varies with the size and specific gravity of the coal to be washed, the larger the coal the greater the stroke required. For washing slack in Western Pennsylvania, they usually have a stroke of 1½ inch, while the eccentric shaft makes 60 to 80 revolutions per minute.

In the center of the front edge of the screen is seen a small cast-iron box called the slate valve. It has two rectangular openings parallel to the sides of the washer and closed more or less by slides operated by a hand-wheel and screw. All impurities in the coal pass through these openings into the triangular compartment seen in front of the washer. From time to time as the compartment becomes filled, the slide-valve at the bottom is raised by the lever, so as to allow the escape of the slate and other impurities. When there is no suitable place for these below the level of the washer, the latter is so arranged that the impurities are continuously discharged into an elevator which carries them either to a bin or a car. Below the water reservoir is a long casting carrying a valve which serves to allow the escape of water when the washer is emptied, or of fine heavy impurities which pass the screen and plunger.

One of the principal parts of a washer is the screen. In the Diescher jig it is made effective and durable consisting of a strong wrought-iron frame carrying a series of hardened brass wires placed parallel and very close to each other, and held by small copper wires protected by solder. This arrangement allows the easy passage of water through, and of coal along the screen, while preventing very nearly all solid material from passing through it.

The feed-water enters through a three-inch pipe at the back of the washer and between the screen and the plunger. This arrangement helps to keep the water in the box from excessive agitation—an object also aided by the equilibrium chamber between the two boxes, and by the alternating motion of the two plungers where two or more boxes are connected. In the case of a single box there is a larger equilibrium chamber at one side, and the driving pulley is weighted to balance the weight of the plunger. This machine is so rigid and self-contained that it can be set on almost any kind of foundation, although there are advantages obtained by having solid supports.

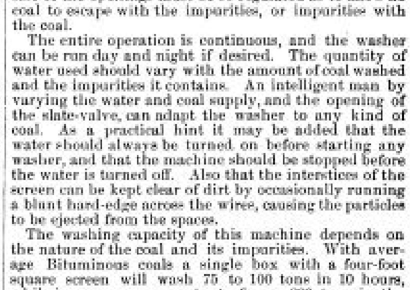
The operation of washing coal is as follows:

The coal is occasionally crushed and classified before washing. It is then carried from a bin or elevator to the back of the washer where it falls on the screen, over which it is at once spread by the oscillating water. The pure coal rises to the top as it advances along the screen, and on reaching the front of the washer, passes through the discharge spout to a receiving elevator or bin. Sometimes a close mesh screen, similar to that of the washer, is placed in front of the spout to drain off the water from the washed coal.

The slate, pyrites, and other impurities sink down to the screen under the action of the water and gravity, and when they reach the front of the screen, they are discharged through the side openings of the slate-valve into the compartment in front of the washer. The size of the openings must be so regulated as to allow no coal to escape with the impurities, or impurities with the coal.

The entire operation is continuous, and the washer can be run day and night if desired. The quantity of water used should vary with the amount of coal washed and the impurities it contains. An intelligent man by varying the water and coal supply, and the opening of the slate-valve, can adapt the washer to any kind of coal. As a practical hint it may be added that the water should always be turned on before starting any washer, and that the machine should be stopped before the water is turned off. Also that the interstices of the screen can be kept clear of dirt by occasionally running a blunt hard-edge across the wires, causing the particles to be ejected from the spaces.

The washing capacity of this machine depends on the nature of the coal and its impurities. With average Bituminous coals a single box with a four-foot square screen will wash 75 to 100 tons in 10 hours, while in some cases an output of over 200 tons in the same time has been attained. The cost of washing will also vary according to circumstances, but in every case



it will be greatly inferior to the benefits derived from the increased value of the coal or coke and the saving of freight on the eliminated impurities. An engineer, superintendent, and one assistant can operate a washing plant of 800 to 1,000 tons capacity in ten hours, while the cost of maintenance and repairs is very slight where the plant is properly constructed.

The Diescher Washer is manufactured by the Scaife Foundry and Machine Co., Ltd., of Pittsburgh, Pa. It has been in successful operation for ten years, and at the present time is to be found not only in all sections of this country, but in Mexico, British Columbia, and Australia, where, owing to its simplicity, it has been erected and operated by men who had previously never seen a coal-washer.

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STEAM PLANT AND ENGINES AT COLLIERIES.

AT the recent meeting of the American Institute of Mining Engineers, Hon. Eckley B. Coxe made a statement that is worthy the consideration of every colliery owner and colliery manager, when he said that the engines and steam plant used at coal mines were wasteful and tended to greatly increase the the cost of coal production. That every cent or fraction of a cent added to the cost of production means a corresponding decrease in the narrow margin of profits is evident to every man, and the fact that colliery managers have for years gone on erecting wasteful steam plants and engines, does not tend to increase their reputations for progressiveness gained in other lines.

The probable reason for this, lies in the fact that the excessive amount of fuel consumed is not purchased direct, but is produced on the ground. Nevertheless its cost of production, and the cost of handling an excessive amount of coal and of disposing of an excessive amount of ashes must be considered. Coal is coal, whether it is in the shape of lump coal, or culm, or slack. It has a money value because it cost money to produce, and it brings money in the market. Every ton of salable coal burned costs the operator just as much as he would get for it if he sold it, for he not only loses the cost of its production but the small margin of profit he would make on it, if he sold it, as well.

Besides, as stated before, he pays an excessive amount for labor in burning it, and in removing the ashes. If he does not burn salable coal, these items of expense still obtain.

Notwithstanding the great improvements that have been made by the skill and ingenuity of inventors and machinists, the average colliery steam plant is almost as primitive as were those of thirty or forty years ago, and very few approach anywhere near the possibilities in efficiency and economy. It is doubtful if there is any other portion of a colliery plant in which so little attention has been paid to improvements. The consequent inefficiency of steam plants cannot rightfully be blamed on the fireman at all times, for it is oftener due to a want of proper information and of good judgment in the general construction of the plant.

Mr. William Harrison Bailey, in his excellent little work entitled "Making and Using Steam," says:

"In order to obtain the greatest success in constructing a steam plant, a man must not only possess mechanical ability and intelligence to understand the requirements of the case, but he must have a large and varied experience in testing and observing the practical operation of all the different types and designs of the several parts that go to make up a complete plant; also, good judgment and experience to enable him to properly proportion and connect them for the service to be required. All this cannot be learned from books and drawings in an office, but must be acquired by visiting and making tests at many different plants, running under different conditions, with different kinds of fuel and water, and varying draughts. A special investigation by such an expert, together with the guarantees of makers, properly written to contain discounts or forfeitures, in case of failures to fulfill stipulations, can hardly fail to secure the best and most economical apparatus for any purpose, and save to those who pay the bills an amount of money and annoyance little imagined by the uninitiated. It is not so much what a man knows, as what he thinks of at the right time, that makes him valuable; and, in order to think of the right thing at the right time, he must be in constant practice and familiar with the details of his business or profession."

The boiler is the fundamental apparatus of every steam plant, and requires the most careful consideration in purchasing, and the most intelligence, experience, and skill in its management.

The three essentials in a good boiler are safety, durability, and economy. The first of these is more generally observed, we are glad to say, than either of the others, but they are entitled to consideration also, and they are features that should be secured in every colliery steam plant. The old-time cylindrical boiler and primitive furnace that is at present generally used is wasteful and must make way for the more effective and more economical tubular boilers with improved grates and furnaces. But, even if the cylindrical boiler, under certain conditions that may exist, is the cheaper and more economical, there is no reason why the furnace arrrangements should not be improved on.

There are numerous patented grates, furnaces, and smokeless settings for boilers, which are far superior to the old-time arrangements, but boiler makers do not care to recommend them for fear they will be required to furnish them, and be held responsible for their performance, without any extra compensation.

Some of the devices are really valuable for their simple and scientific methods of regulating the admission of air in correct proportion to secure good combustion, and are worthy of careful investigation.

This is especially true of mechanical stokers, which admit of the profitable use of coal and coke dust screenings, and other cheap fuels.

Quoting again from Mr. Bailey's excellent little work, we have the following advice, which is well worthy of attention:

"Fires should never be regulated entirely by the amount of air admitted beneath the grate, nor by the amount of coal shoveled into the furnace, but by air ducts, terminating on top of the fuel, and above all a damper in the smoke flue, regulated automatically by the pressure of steam carried in the boiler. Any good damper regulator will repay its cost many times in the saving of fuel and repairs to the furnaces. Excellent ones can be purchased for $75 or $100, and it is money well expended.

"The construction of a furnace, including the style of grates, should, of course, be adapted to the kind of fuel to be burned, although to some extent, openings for the admission of air may be made adjustable, so that, by careful observation and experimenting, a fireman may burn several different kinds of fuel in the same furnace economically."

The traveler through the Anthracite region cannot help noticing, after dark, the beautiful blue flames playing around the tops of the boiler stacks, and rapidly destroying them. These blue flames are evidence that coal is being shamefully wasted, and that the carbonic oxide, which by intelligent firing and the use of proper appliances could be utilized, is allowed to waste. In the Bituminous fields the combustible gases are allowed to escape in the same way, but they cannot be so plainly seen on account of the dense smoke.

We have mentioned but a few of the many wasteful methods employed, but they are enough to convince any intelligent man that there is room for improvement, and abundant room. Some few operators have realized this and they are arranging their steam plants so as to secure the best results with the least cost, and we hope many more will follow their example.

The average engines used at collieries are but little better, as far as economy is concerned, than are the boilers. They require an excessive amount of steam to perform their work and this means excessively large steam plants with all the corresponding increase in cost of erection, maintenance, and operation. In conversation with a prominent builder of high grade engines of great merit for efficiency and economy, a representative of this journal asked him why he did not try to introduce his engines for colliery use. His reply was, "My experience with colliery owners has been that they are satisfied with any old rattle-trap, no matter if its cost of maintenance and operation per year is excessively high, and they will not pay a small increase in the initial cost due to better workmanship and economical devices."

This experience had led the engine builder to believe that the colliery owners were either making tremendous profits, or they were very poor business managers, and it is hard to blame him for this belief, notwithstanding we know the profits to be small and the colliery owners to be men of superior business ability.

We were recently told of one European colliery where the coal burned under the boilers was charged to the colliery at the *market price* and the result was, that within a year things were so changed that a decided saving was affected, and this saving was so apparent that a number of neighboring collieries adopted the same plan. If this was a good plan in Europe with cheap labor, and lower prices for machinery and materials, it ought to be a better plan in America.

THE SCHOOL OF MINES.

THE announcement of The Colliery Engineer School of Mines has been received with great favor by persons interested in the advancement of education among miners in all parts of the country. Already a large number of students are enrolled, and every mail brings new enrollments and inquiries.

Inquiries have been sent in regarding the standard of the diploma to be given those who finish the course, and to meet such inquiries we would state that the diploma will not be granted until the student is capable of passing any examination, required by the various State governments.

Each student will be kept on in the several departments till he thoroughly understands the branches taught, no matter how long a time it takes. If he can get through in three months, it will be all the better, but if it takes him three years, owing to lack of time, and of earlier advantages, we can assure him that he will not be given the diploma till he proves his fitness for it. Therefore, it is within the power of every man who really desires educational advancement to obtain it.

The first papers will be ready and will be sent out on the first of November. Students can begin at any time, and all inquiries will be promptly answered.

EDITORIAL NOTES.

MR. C. C. Woodson, State Mine Inspector of Missouri, in a report to the Commissioner of Labor concerning a violent explosion in Mine No. 7, of the Keith and Perry Coal Co., at Rich Hill, on the 7th ult., states that the mine was well equipped both outside and inside, and that ventilation was produced by a ten-foot fan designed to run up to a speed of 150 revolutions per minute, and to furnish about 40,000 cu. ft. of air.

The explosion occurred after the miners had quit work, and there were but two shot-firers in the mine, one of whom was killed, and the other seriously injured. The eight mules in the mine were all killed. If all the miners had been in the mine at the time of the explosion, it is probable that 60 or more men would have been killed.

Mr. Woodson found from personal examination, and an interview with the injured shot-firer, that all the shots on the South side of the hoisting shaft, and those in six rooms on the two West entries on the North side had been fired. Three of the latter were located on the back entry and three on the front entry. He is of the opinion that one or more of the shots in the back entry were "blown out" or "cyclone" shots, the fire from which ignited a keg of powder in a box near by.

The explosion of the powder contained in this box, added to the flame from the shot, carried the fire to two or three boxes containing powder which were distant probably 200 to 250 feet and located in a small entry turned off near the north end of the mule stable. This, in turn, caused the explosion of the powder contained in five or six boxes, located in a passage-way connecting the mule stable with the first east entry on south side of shaft. Doubtless the explosion of the powder in the last-named boxes brought about the greatest damage and killed the mules. It would be well to state just here, that this mine is very dry and dusty, and Mr. Woodson had no doubt but that the coal-dust suspended in the air, which had been set in motion by previous shots, played quite an important part in the disaster by adding fuel to the flames.

The evidence taken before the coroner's jury goes to show that the mine was in good condition prior to the explosion, and that there was no explosive gas in the mine, and that the company employed a fire boss to examine each working place every morning before any one was permitted to enter. Mr. Woodson considers that entirely too much powder was used in the mine in proportion to its production, and severely condemns the practice of careless miners having their powder-boxes within 40 or 50 feet of the faces. He advocates the passage of a law restricting the amount of powder to be taken in by each man to 10 or 12 lbs., and further recommends that a sufficient interval between the firing of shots be given, to allow the dust raised by the previous shot to subside or be carried off in the ventilating current.

JUDGE WHITE, of Allegheny County, recently rendered two important decisions affecting coal mines in oil and gas producing districts.

Inspectors Blick, Louttit, Jenkins, and Duncan, of the First, Second, Fifth, and Seventh Bituminous Districts of Pennsylvania, filed a bill in equity against J. D. Sauters, owner and operator of a coal mine in North Fayette Township, Allegheny County, to compel him to cease operating it on account of the oil wells bored through it and the accompanying danger of escaping gas. While Judge White commended the action of the Inspectors as a very proper one, he did not think, from the evidence, that there was any immediate danger, and refused to interfere at present. However, he allowed the application to stand open for further action of the court, if at any time it was deemed necessary.

J. B. Robbins, owner of another mine in the same county, asked for an injunction against the Wheeling Gas Company, J. M. Guffey, and others, to restrain them from boring oil or gas wells through his coal. Robbins owned the coal under land of which the defendants had leased the oil and gas rights. The plaintiff maintained that the defendants had no right to bore wells through his coal, and that to do so would damage the coal and endanger his property and the lives of his employes by reason of gas escaping into the mines. The defendants asserted there would be no danger, and that they had as much right to bore for oil as the plaintiff had to dig for coal.

In his opinion Judge White said that the owner of the coal must suffer loss if it is allowed. On the other hand, the owner of the land may have mineral wealth below the coal vein of more value than the coal. He was of the opinion that the owner of the land should have a right of way through the coal, but not to an indiscriminate extent. He refused the preliminary injunction asked for as to the wells producing or in process of boring because there was no immediate danger of loss or damage to the plaintiff. They do not interfere with the mining of coal at present and may not for years and probably never. The damage caused by a hole through the coal was merely nominal. If a block of coal must be left around the pipe it could be compensated for. He thought that with proper appliances the wells could be bored with all reasonable safety to the mines and miners, and when abandoned can be securely plugged to prevent danger thereafter. He would not, however, concede the defendants' right to have as many wells as they thought proper. It might work irreparable damage. In consequence he granted an injunction to restrain the defendants from boring new wells or proceeding with any except those now below the Pittsburgh seam of coal. They were also to give a bond in the sum of $10,000 to the plaintiff to secure damages and as security that they would use all possible care, etc., in guarding against damage to the plaintiff.

THE Biennial Reports of the Inspectors of Mines for the State of Iowa, for the two years ending June 30th, 1891, have been submitted to the Governor, and are now in the hands of the printers. They are the most complete reports that have ever been issued by the Inspectors of Iowa, and show that Messrs. Binks, Gildroy, and Thomas have been vigilant and thorough in their work.

A summary of the statistics shows the following interesting figures:

Average No. of Mines in operation	362
Number of tons of coal produced	7,702,483
Average number of miners employed	7,665
Average number of other employes	1,877
Average price paid per ton for mining	63⅝ cts.
Total amount paid for labor	$8,192,294.22
Average selling price per ton at mines	$1·413
No. of fatal accidents	43
No. of non-fatal accidents	180

These figures show that there were 809 tons of coal mined per employe; 179,127·5 tons mined per fatal accident; and 42,791·6 tons mined per non-fatal accident.

THE expenses of the Board of Examiners, who recently examined applicants for the position of Inspectors of Mines for the First and Second Anthracite districts were $910.20. This includes advertising, stationary, and postage. This is not a great cost when it is considered that members of the Board reside at different points in Luzerne County, and that the examination occupied several weeks.

The Anthracite Trade.

The Anthracite trade during the past month was active, and this month opens with the markets in good condition and the demand fully up to the supply for all but the small steam sizes. Most of the coal now being disposed of goes West, and to the line trade. Shipments to tide water are light, and the result will be that Eastern markets will be in excellent shape when navigation on the Lakes closes, which will naturally be the case in a week or two. Circular rates are firmly maintained by the companies, and the increased demand has stiffened the prices of independent operators. The advent of cold weather will still further increase the demand and enhance prices. The output for October has been considerable in excess of the allotment, and at a meeting of the sales agents held in New York on the 28th ult., the output for November was placed at 4,000,000 tons, which practically means no restriction.

The Bituminous Trade.

The Bituminous coal trade is in excellent condition. Prices are firm, even though shipments for the past six months have been largely in excess of those of last year. While transportation facilities have been fairly good they have not been up to the demand. Contract coal, however, has been supplied as fast as called for. The outlook for the trade is good for the entire winter. The only disturbance to the general harmony prevailing, of any account, is the strike of the railroad miners in the Pittsburgh region, and this is on its last legs.

The Coke Trade.

The coke trade continues in fair condition though prices continue the same as they have been for several months past, and a slight restriction in production is adhered to. The Connellsville *Courier*, of the 22d ult., says: "Quite a number of new ovens are nearing completion. It is probable that the new year will see the Connellsville region grown to the magnificent magnitude of 18,000 ovens. Cars are in good supply. The strike at the Pittsburgh district coal mines has thrown a great many coal cars idle, and, in case of shortage, these could be utilized. There is a car famine in the West, but no serious trouble is feared in the coke region. If the coal strike above alluded to continues long, the coke operators may profit by it. Already the latter have received inquiries from dealers in coal. The coke operators do not, as a rule, sell coal, but in the present state of the coke market a coal trade at fair prices won't be despised by any of the coke men. The only drawback is the fact that the Connellsville region is outside the 40-mile radius, and the freight on her coal will be higher."

OBITUARY.

E. W. WESTON.

Mr. E. W. Weston, ex-General Land Agent, and ex-Superintendent of the coal department of the Delaware & Hudson Canal Co., died at his residence on North Main Avenue, Scranton, on the 28th ult., in the 68th year of his age.

Mr. Weston was born in Salem, Wayne Co., Pa., on December 5, 1823. His early years were spent on a farm and in teaching school at Salem. In 1884 he removed to Honesdale, and entered the office of his uncle, John Torrey, who was then the agent for the principal land proprietors, and the most active and prominent land surveyor in Northeastern Pa. In 1857 he removed to Carbondale, and took charge of the land and mine surveys of the Delaware and Hudson Canal Co., and in 1861 his office and residence were removed to this city. In 1874 he succeeded the late Thomas Dickson as Superintendent of the coal department of the company, which at this time was being rapidly developed into its present large proportions. He gave his personal attention to the opening of new collieries, the purchase and development of lands and the erection of breakers. In 1884, the extension and expansion of the business of the company made it necessary to divide into two departments the work which had been under Mr. Weston's control. In the division Mr. Weston retained control of the real estate department as General Land Agent, Mr. A. H. Vandling being made Superintendent of the Land Department. Mr. Weston continued in the position of Genl. Land Agent till February last, when failing health compelled him to withdraw from the active management of the department. In addition to his official connection with the D. & H. Co., Mr. Weston was largely interested in many of the other industries and corporations of Scranton. At the time of his death he was President of the First National Bank; Chairman of the Weston Mill Co.; President of the Northern Coal and Iron Co.; and Vice-President of the Dickson Mfg. Co. He was also connected with a number of lesser mining and manufacturing enterprises, both in and out of Scranton.

He was a man of broad intelligence, keen business sagacity, fertile in resources, and tireless in his industry. He was a prominent member of the Providence Presbyterian Church, and was a large contributor to it. He was married in Honesdale on June 4, 1852, to Miss Susan S. Moore, who with a daughter and son, Miss Caroline S., and Charles S., who succeeded his father as Genl. Land Agt., survive him.

Some Great Coal Hoisting.

The Lehigh & Wilkes-Barre Coal Co. since general superintendent E. H. Lawall has assumed control, with general inside superintendent Morgan R. Morgan as his able assistant, runs along very smoothly, and the condition of the workings is such that they are able to work the extensive collieries to their utmost capacities. There have been no serious accidents to record. Such a record shows that everything in and around the collieries is properly systematized, which can only be accomplished by the selection of competent foremen both in and out of the collieries.

The celebrated Nottingham Colliery, Plymouth, inside foreman William Leckie, and outside foreman George Connor, made another remarkable run yesterday. They hoisted 1,313 cars in nine hours. J. B. Hammond, the driver boss, made things hum below the surface. The engineers who handle the throttle valve and brake, and who have made such remarkable records in hoisting are William Jenkins and Louis Wagner. At No. 11 colliery of the same company, yesterday, in a day of nine hours, 993 cars were hoisted. Such a showing as this must assuredly make the present management feel proud.—*Wilkes-Barre Record.*

The Providence Steam Engine Co., Providence, is changing the drums of the Moore boilers (which were recently set up at the Narragansett Electric Light Co.'s station by the National Water Tube Boiler Co., of New Brunswick, N. J.) to the Babcock & Wilcox system. The Babcock & Wilcox Co., of New York, has the contract for the alterations, which have been delayed until the job of putting in of 1120-horse power of its own boilers was completed.—*Boston Journal of Commerce.*

ANTHRACITE COAL STATISTICS.

Statement of Anthracite coal shipments, for month of Sept., 1891, compared with same period last year. Compiled from returns furnished by the Mine Operators, by John H. Jones, Chief of Bureau of Anthracite Coal Statistics.

	Sept. 1891.	Sept. 1890.	Difference.		For Year 1891.	For Year 1890.	Difference.	
From Wyoming Region, - -	1,741,272·08	1,788,650·14	Dec.	47,378·06	15,020,092·01	13,151,724·07	Inc.	1,868,367·14
From Lehigh Region, - - -	531,507·09	585,488·04	Dec.	53,980·15	4,514,357·11	4,627,318·09	Dec.	112,960·18
From Schuylkill Region, - -	1,060,624·13	1,053,939·02	Inc.	6,685·11	8,701,823·11	7,616,719·15	Inc.	1,085,103·16
Total - - - - - - -	3,333,404·10	3,428,078·00	Dec.	94,673·10	28,236,273·03	25,396,762·11	Inc.	2,840,510·12

The stock of coal on hand at tide-water shipping points, Sept. 30th, 1891, was 568,833 tons; on August 31st, 1891, 648,900 tons; decrease, 80,067 tons.

THE AMERICAN INSTITUTE OF MINING ENGINEERS.

A Successful and Enjoyable Meeting at Glen Summit, Pa.

The sixtieth meeting of the American Institute of Mining Engineers was called to order on Tuesday evening, October 6th, in one of the large parlors of the Glen Summit Hotel, by Hon. Eckley B. Coxe, one of the Vice-Presidents, and Chairman of the Local Committee.

Mr. Coxe welcomed the Institute to the Anthracite Region in a brief address, which was responded to by Mr. John Birkinbine, President of the Institute, who briefly, and in an interesting manner, reviewed the formation of the Institute at Wilkes-Barre in 1871, and referred to the development of the coal fields of America, and quoted statistics from an advance bulletin of the U. S. Census.

On behalf of the *Deutscher Verein Eisenhuttenleute*, Dr. Rossiter W. Raymond, Secretary of the Institute, presented to the Institute a magnificent testimonial of the appreciation the German engineers felt for the hospitality extended them by the Institute during their visit to America last fall. The testimonial was in the form of a massive volume bound in leather and metal. It contained a beautiful title page in which black and white formed a work of art that more resembled a fine steel engraving than pen and ink work. The thanks expressed were engrossed on handsomely illuminated pages of parchment and were in both the English and German languages. Taken as a whole, it is doubtful if a more artistic and beautiful piece of similar work was ever produced, even in the mediaeval days of illuminated text.

At the close of Mr. Raymond's remarks, he read the applications for membership from a large number of engineers, representing almost every state in the Union and seventeen different foreign nations, all of whom were unanimously elected to membership.

The following papers were then read by title only:

"Electricity in Mining as Applied by the Aspen Mining and Smelting Company," by M. B. Holt, Aspen, Colo.; "Electric Locomotives in German Mines," by Karl Eilers, Berlin, Germany; "The Manufacture of Liquid Sulphurous Acid in Upper Silesia," by Karl Eilers; "A Chinese System of Gold Mining," by Henry Louis, Singapore, Straits Settlements; "A Survey of the Planches de Plata Mine, Sonora," by Henry M. Stanley and Henry O. Flipper, Nogales, Arizona; "Co-Ordinate Surveying," by Henry O. Flipper; "Cordwood in the Matting Blast Furnace," by Herbert Lang, Mineral, Idaho; "The Bendigo Gold Field," by T. A. Rickard, Allemont, Isere, France; "Apparatus for the Manipulation of Iron and Steel Plates During the Process of Finishing," by Gram Curtis, Pittsburgh, Pa.; "The Handling of Ingots and Moulds in Bessemer Steel Works," by Gram Curtis; "Tandem Tanks for Hoisting Water from Flooded Slopes," by J. H. Bowden, Wilkes-Barre, Pa.; "The Utilization of Anthracite Waste by Gasification in Producers," by W. H. Blauvelt, Philadelphia, Pa.; "The Mining Resources of Honduras," by W. A. Thacher, Leadville, Colo.; "A New System of Ore Sampling," by H. L. Bridgman, Blue Island, Ill.; "The Iron Ores of Danville, Pa., With a Description of the Longwall Method of Mining Used in Working Them," by H. H. Stock, South Bethlehem, Pa.; "Mining at Guanaguato, Mexico," by W. P. Blake, Shullsburg, Wis.; "The Determination of Nickel in Nickel Steel," by Albert Ladd Colby, Bethlehem, Pa.

Prof. R. H. Richards of the Mass. Inst. of Technology then read a paper entitled

"A HAND TELESCOPE FOR STADIA WORK."

He illustrated it with two telescopes fitted up for the purpose. This is a discovery by Prof. Richards of a device for the measurement of distances by the stadia method, and it possesses an advantage over the old method as it can be applied to a hand telescope, and it is much simpler than the ordinary stadia method.

Over the object glass of the telescope Prof. Richards fixes an achromatic prism so as to cover one-half of the lens, one edge of the prism coinciding with the diameter of the lens. A graduated rod is used. In sighting at this rod two images are seen standing parallel. By rotating the glass the images are made to overlap each other, and the graduations as read off the rod shown by the overlap, gives the distance from the front of the glass to the rod. With a rod specially graduated the distances may be read off the rod; with an ordinary rod it may be determined by multiplying the reading by a constant. By careful tests up to distances of 800 feet, Prof. Richards had found that the maximum error did not exceed 0·1%. In reply to inquiries, Prof. Richards said this system of measurement, as far as the principle was concerned, should be accurate for any distance, and its range was only limited by the visual power of the observer. In commenting on this discovery, Mr. Coxe said that like many other valuable discoveries it was remarkable on account of its simplicity, and it was marvelous that its had not been discovered sooner. Dr. Raymond added that it was not the first unexpected result obtained by the use of the prism. Some years ago when Bunsen announced his great discoveries with the spectroscope, Prof. Richter, of Freiburg, with a small toy telescope and a prism made of five pieces of glass, filled with carbon bi-sulphide, discovered a new element called indium.

Mr. F. H. Newell, of Washington, D. C., then read a most interesting paper on

"STREAM MEASUREMENTS AND RESULTS OBTAINED BY THE U. S. GEOLOGICAL SURVEY."

This paper described in detail the extensive and important measurements now being made by the U. S. Geological Survey to determine the water supply of the country. It was illustrated by a series of charts showing the volume of water flowing in various western rivers each day for the years 1889 and 1890, and some data extending into the present year. Mr. Newell exhibited the instruments used, which were very similar in their principles to anemometers. He described their practical use, and showed an electrical machine that accurately recorded the revolutions of the gauge used in deep waters below the range of vision. In explaining the charts, Mr. Newell spoke of the Yellowstone and Missouri as typical Northern rivers, and took from the charts the following data:

On January 1, 1890, the discharge of the Yellowstone, at a point ten miles below the Yellowstone National Park, was 500 cu. ft. per second; in February it had risen to 600 cu. ft.; on April 5 to 1,000; on May 1 to ,000; on May 31 to 12,000. During the month of June it fluctuated between 12,000 and 10,000 cu. ft. per second. In July it began to fall gradually until December, when the flow was about the same as in January. The plotted lines showing the rise and fall for 1889 showed about the same variations, but the volume of water was at all times less than at the same date in 1890. The Missouri showed proportionately about the same results. Melting snow in the mountains formed the principal source of supply for both these streams.

The Salt River, in Arizona, a tributary of the Gila, was taken as a typical Southern river in which rain forms the principal source of supply, but little water coming from snow, and in consequence it is subject to sudden floods, the maximum volume occurring in winter. Mr. Newell showed by his chart the great flood of some months ago that caused the overflowing of the arid plain and formation of the inland sea which attracted so much public attention at the time. He stated that evaporation was so rapid in this region that the newly formed lake was now almost dried up.

He next described the rise and fall of the Rio Grande, which was measured at three places in Colorado above the big canals in New Mexico, and at El Paso in Texas. Owing to the large amount of water taken out for irrigating purposes, the flow in New Mexico is no larger than in Colorado. At El Paso the river is nearly dry at certain times of the year owing to the use of large amounts of water for irrigating purposes further up the stream.

Dr. Raymond in commenting on this paper, with the iconoclasm natural to scientists, completely knocked the romance out of the Nile, by stating that he visited it while abroad and found it was not the remarkable river we had been taught to regard it. It was remarkable only in the fact that it had no tributary for 1,600 miles of its length, but its rise and fall could not be compared in point of variation with a number of American rivers, and it does not carry in suspension anything like as large an amount of alluvial matter as the Mississippi does. He commended, however, the admirable system of the distribution of the waters of the Nile, and said that during the time of low water, scarcely a drop of the Nile's volume reaches the Mediterranean.

Mr. Coxe stated that the question of water supply was an important one in mining operations, and commended the simple but thorough system as illustrated by Mr. Newell of obtaining the record of volume all the year round. He stated that similar records should be obtained by engineers before the erection of metallurgical works or the opening of mines. Mr. Birkinbine briefly outlined the report of Major Raymond, of the U. S. Engineers, on the recent disastrous floods in the Susquehanna and Juniata Rivers, and endorsed his conclusion that the preservation of timber by the State of Pennsylvania was the only way to prevent their recurrence. Mr. B. E. Fernow indorsed Major Raymond's conclusion also, and cited the action of the recent Irrigation Congress, in Salt Lake City, as evidence that Western men were recognizing this fact.

In reply to questions Mr. Newell stated that observations of the rainfall were being made by volunteers in various parts of the country, under the auspices of the Weather Bureau, but so far the results showed that the amount of rainfall in any one year was not proportional to the volume of water in the rivers.

As the hour of adjournment had arrived, Mr. Birkinbine announced that he would entertain a motion to adjourn and the members and guests left the room unanimously agreeing that the Tuesday evening session was a most interesting and instructive one.

WEDNESDAY MORNING SESSION.

The rain was falling steadily on Wednesday morning, and the outlook for fair weather during the day was not promising, therefore it was agreed to hold three business sessions instead of but two, and to forego the drive to Bear Creek as the guests of Mr. Albert Lewis.

The first paper read was entitled

"THE FLORENCE OIL FIELDS, COLORADO;" BY GEORGE H. ELDRIDGE, U. S. GEOLOGICAL SURVEY.

This paper ably, and in an interesting manner, described an oil field that supplies considerable petroleum, the major portion of which is consumed in Colorado.

It was the first published treatise on the geology of the district, and according to Mr. Eldridge, the oil-bearing zone occurs in the lowest strata of the Montana group of cretaceous rocks, which is here about 4,000 ft. thick, and is known as the Pierre formation. The strata in this field form a synclinal or basin, on one side of which all the productive wells so far opened have been located. The developments have so far been confined to the neighborhood of Florence, and all wells are located within a radius of three miles from the town, and the most productive wells are in the town limits. The field is estimated to be about 14 miles long and 8 miles wide, and as the rocks have been but slightly faulted, if at all, prospecting operations are easy and simple. The oil zone occupies about 1,900 feet in the Pierre formation and the most productive wells are about 1,150 ft. below its top or 2,000 ft. below the surface. Below this there is about 350 ft. of barren ground, and then more oil is found. There is about 350 ft. more of barren ground, and below this, at the bottom of the zone small quantities of oil are found. The wells yield from 5 to 250 barrels per day, and 57½% of all the wells bored have proven productive. During 1890 the average daily yield of the district was about 1,200 barrels per day.

In the discussion of this paper, Mr. Newell stated that the conclusions of scientific men concerning the prospecting of petroleum fields have always been ignored by practical men, and the result has been that by blind prospecting, oil has been found in localities most unpromising, and where according to geological rules it should not have occurred. He further stated that the results obtained by the development of the Florence field were such as to render impossible the deduction of trustworthy conclusions on the subject.

The next topic for discussion was

"THE PRACTICAL USE OF CONCENTRATED IRON ORES."

This discussion was opened by the reading of a paper on "Practical Results of Concentration at the Croton Magnetic Iron Mine," by Mr. Hoffman, followed by Mr. N. M. Langdon's paper on the "Use of Magnetic Concentrates in the Port Henry Blast Furnaces." Mr. Hoffman detailed the methods in vogue at the Croton Mine and stated that the total average cost of mining and concentrating one gross ton of 68% ore from 2·2 tons of 38% ore was but $1 95 per ton. This statement was greeted with loud applause. These concentrates, Mr. Hoffman further stated, have been used in various open hearth and blast-furnaces and have given excellent results.

Mr. Langdon stated that the use of magnetic concentrates at Port Henry had practically demonstrated that there is no difficulty in using at least 80% of high grade concentrate in the blast-furnace, and there is an economy of fuel beyond that which may be due to an increase of iron in the mixture, and this is especially the case when a large percentage of concentrate is used.

The discussion of these papers was opened by Dr. Raymond, who read a communication from Mr. E. K. Landis, who claimed that it was wrong to determine the total iron contents in the tailings from magnetic separators as a basis of judgment on the work of the separating machine. Many of the silicious minerals which go into the tailings, such as hornblende, pyroxene, mica, and apatite, contain iron, but being non-magnetic, it is impossible for the magnets to catch them. Therefore, it is unfair to charge all the iron in the tailings against the machine. There is, however, no satisfactory method of determining the amount of magnetite in these tailings.

Mr. Birkinbine read a letter from Mr. Woodbridge on the same subject, in which the writer stated that he had found, by experience, that all the iron minerals in Old Bed ores were attracted by the magnet when ground fine enough to pass through a 100-mesh, and therefore it was impossible to determine magnetite in this manner, and there was no chemical test that would yield more satisfactory results.

Dr. Raymond stated that Prof. Eggleston had read a paper, some 15 years ago, on a system of mechanical analysis, at a certain stage of which the magnet drew out all the minerals containing iron, and though many chemists doubted this, it had since been proved correct.

Mr. Hoffman stated that he had experimented at the Croton Mine with a view of establishing the proper strength for magnets in the separator, and he had found that the amount of magnetite which escaped those of ordinary strength was very small. The main conditions were that the magnets should be kept clean and a regular feed maintained.

Dr. Dudley suggested that the Thoulet solution might be used advantageously for this purpose; and Mr. Kent thought that a close approximate determination of the amount of tailings might be effected by utilizing the difference in the specific gravity of the minerals. Mr. Firmstone thought that sufficiently accurate results could be obtained by using the Thoulet solution, the specific gravity of which is about 4, provided the ores were not too fine.

In reply to a question Mr. Langdon stated that they used about 2,000 tons of concentrates per month at Port Henry, and the amount of flue dust made, while concentrates were being run through the furnace, did not exceed five tons per month, though it was somewhat richer than the ordinary dust.

THE USE OF MAGNETIC CONCENTRATES IN THE BLAST-FURNACE.

In reply to Dr. Dudley's question, as to whether the use of concentrates had any effect on the regularity of the output of the furnaces, Mr. Langdon said that formerly the Port Henry furnaces had used run of mine ore, and that they were now using concentrates, and the product has been more regular since concentrates had been used. Dr. Dudley stated that the reason he asked the question was that he had once been connected with a furnace which ran very irregularly, and for which no cause could be assigned except that they used a fine ore of a very soft mushy character.

Mr. Moffat stated that the Lackawanna Iron and Steel Co.'s furnaces at Scranton had been run on concentrates for about six years and no irregularity had been noticed. The Lackawanna Co. was the first to extensively use concentrates in the blast-furnace. Concentrates generally formed from ⅓ to 1/10 of the furnace charge and for a very short time 50% had been used. The results have been as a rule satisfactory, and if not so much so as Mr. Langdon's, it was doubtless because a smaller proportion had been used. As for the flue dust, his experience agreed with Mr. Langdon's, it was of very small amount, but he thought it advantageous to moisten the ore, especially if very fine.

Dr. Raymond claimed that magnetic concentrates could only, as a rule, be profitably made from waste dumps. He said that at a former meeting of the Institute he had expressed his opinion that it would not pay to concentrate lean magnetic ore at any American mine, and he was willing to stand by that statement, and would only admit that he was wrong when the Croton mines have been run long enough to furnish regular working figures and not results based on the work of a few months only. He claimed that in Mr. Hoffman's paper no account was taken of royalty on ore or of increase in the cost of mining in the future. He thought the extraordinarily low cost of mining was unusual and by no means represented American mines in general, and the small profits made even there proves how difficult the method is going to be unless everything is in its favor, and therefore magnetic concentration will not likely be profitable, where ordinary conditions prevail. He drew a distinction between the use of concentrates in the shape of fine ore and dust in the blast-furnace and claimed that if dust such as the 60% material from the Ogden mines were used, there would be a great loss in flue dust, and thought that the chief use of magnetic concentrates would be in the open hearth furnace after they had been made into briquettes.

The afternoon session was opened by the reading of a paper entitled

"GOVERNMENT TIMBER TESTS," BY B. E. FERNOW, WASHINGTON, D. C.

Mr. Fernow prefaced his paper by the remark that the present knowledge regarding the properties of our various timbers was not very satisfactory, and that there is not much published information for general use. He gave a general description of the elaborate series of tests which have been undertaken by the Government, and appealed to all men interested in the mining industry to use their influence to secure the proper appropriations for carrying on the important work.

He called attention to the fact that timber of a certain class of trees often varied greatly in strength and other properties, and stated that because one piece of timber of such a class stood certain tests, it was by no means certain that a similar piece of the same kind of timber would do so also. The subject, Mr. Fernow stated, was of the utmost importance to the mining industry and yearly becoming of more importance.

Dr. Raymond commended the thoroughly scientific manner in which Mr. Fernow has started this work, and also spoke of the lack of knowledge concerning the strength of timber.

"TESTS AND REQUIREMENTS OF STRUCTURAL WROUGHT IRON AND STEEL," BY ALFRED E. HUNT.

This paper was devoted to the advocacy of a standard system of tests and methods, and it drew forth the warmest discussion of any paper read at this meeting.

Mr. Hunt stated that the American Society of Civil Engineers, and the American Society of Mechanical Engineers had each appointed committees on "Uniform Methods of Tests of Material Used in Metallic Structures" and "Standard Tests and Methods of Testing," and he suggested that as the iron and steel manufacturers were more largely represented in the American Institute of Mining Engineers than in either of the other bodies, a thorough discussion of the matter would be the best means to lead up to the establishment of a standard system of tests. He spoke of the inconvenience and expense manufacturers were put to by inspections and re-inspections by numerous inspectors and also of the inconveniences inspectors labored under. His idea of what tests should be, he expressed as follows: "Specifications for tests of structural material should furnish all necessary means for excluding all material deemed unsuitable by the engineer. The cost of testing eventually comes from the purchaser, hence the number of tests and the severity of their interpretation should be limited by the engineer as much as possible without sacrificing the idea first stated." Besides the increase of cost by unnecessary tests and too rigid requirements, there is another waste of money through waste of time; rarely, if ever, do the terms of the contract secure to the consumer compensation for the losses by delay caused by the vigilance of his own agent, the inspector. He then offered from the standpoint of an experienced inspector of structural material, some suggestions as to the kind and methods of tests to be adopted, and their interpretation.

Mr. W. H. Morris, of the Pottstown Iron Co., stated that the testing bureaus had worked great injustice to the mills, and criticised Mr. Hunt's paper in several particulars, among others the point that steel should not exceed a certain tensile strength. He also criticised the character of many of the inspectors sent out by the inspection bureaus, and was particularly severe on the young collegian whose swelled head was full of scientific theories, but who had not practical experience enough to apply them. He claimed that no man was qualified to be an inspector unless he has had experience as a manufacturer. He thought the tests made by the manufacturers were full enough, and that those prescribed by the bureaus were too exhaustive. He said that if all inspecting bureaus would agree upon one inspector at each works, it would save time and expense; often there had been as many as five or six in the Pottstown mill at the same time, testing different parts of the same shipment. He suggested that engineers should accept manufacturers' tests where they have been made in the prescribed manner; that surface inspection should be made at the mill; and a standard thickness of test pieces, as well as width, should be agreed upon.

Mr. Kent called attention to the fact that neither Mr. Hunt or Mr. Morris had proposed a standard set of specifications which could be discussed as a basis for a standard code. He thought that the tests, as made at present, might be too severe; the mill men should be heard, and specifications agreed on which would be just to both manufacturers and purchasers.

Mr. Oliver Williams, of Catasaqua, prefaced his remarks by stating that he had heard that Capt. Morris had written an urgent appeal to the Bishop of his diocese, that the Litany be amended so as to contain a new prayer to read "From fresh inspectors—*Good Lord deliver us.*" After the laughter had subsided, he spoke of the greatly improved class of inspectors sent to the mills now, as compared with those of a few years ago. The great difficulty now lay in the fact that we have no settled scale of requirements. Another difficulty was that railroad companies have raised the standard of their requirements and are not willing to pay the increased price. He believed that specifications very nearly like those of standard bridge-makers would meet the manufacturers' views. He agreed with Mr. Morris that present methods were very expensive, and that while the general impression was that the mill pays the bills, the fact is it always eventually comes out of the pocket of the consumer.

Dr. Chas. B. Dudley, of Altoona, stated that the keynote of inspection of any kind is, that the manufacturer knows that he is going to be inspected, and consequently does better work. For this reason he regarded the Pennsylvania R. R. Co.'s testing bureau, with which he is connected, of importance from the mere fact that it existed, if nothing else. Referring to Mr. Williams' remark concerning the increasing requirements of the railroads, he said the Pennsylvania R. R. Co. always had some tangible reason for every requirement in the specifications issued by its testing bureau. He detailed the method in which these specifications were prepared, and referred to a series of boiler sheets that have been in preparation for 16 months and have not yet been issued. In order to get these sheets in proper shape, pieces were taken from 60 worn out locomotive boilers, a record of the life of which had been kept, and tensile and elongation tests of each piece were made, and then a chemical analysis of their constituents was made. From the data thus collected the character of the material was determined, and conclusions regarding the specifications were arrived at but not adopted until the purchasing agents, manufacturers, and master mechanics, had criticised them. These specifications are constantly revised, so as to keep up with increased knowledge gained from practical work and scientific discoveries.

A NEW TEST FOR BOILER IRON.

Continuing, Dr. Dudley stated that in these new boiler specifications an entirely new test, called the homogeneity test, has been introduced. The test is made as follows: The test piece of metal is nicked on one side, put into a vise, and bent until it breaks. The fracture is then examined carefully. If, as is frequently the case, it shows numerous little holes, the piece is rejected. The theory of this test is that it opens out any little gas bubbles there may be in the plate, which have simply been rolled out and not welded. The importance of this test is obvious when it is remembered that these plates are to be used next the fire-box, where the temperature on one side is 350° to 370° and on the other side 3,000°. The heat transmitted through the plate to the water does not pass these rolled out bubbles as easily as it does the homogeneous iron, and consequently those parts of the plate become hotter, and the bubbles expand into blisters, and this is one of the principal causes for taking the affected part out of service.

Dr. Dudley also referred to the reason why steel should not exceed a certain tensile strength, and mentioned the case of the Sherman's Creek Bridge on the Pennsylvania R. R. as an instance.

It was desired to strengthen this bridge, which was a Howe truss, and the iron rods were taken from the first two bays and steel substituted. The steel of these rods was of excellent character; its tensile strength was 96,000 lbs. and its elongation 22%. Yet these rods broke one after another, while the iron rods in the bridge, of far less tensile strength, held as firmly as ever. The fact was, the steel rods were too strong. These rods were held up by nuts, which were not exactly true; that is, the base of the nut did not make exactly an angle of 90° with the side of the rod. As a consequence there was a greater strain on one side of the rod than on the other. The steel being of high tensile strength was very stiff and would not bend, so it had to break. A soft steel of lower tensile strength would not have broken under the same circumstances.

Mr. Coxe agreed with Dr. Dudley that the mere existence of an inspection bureau tended to secure better results from the producer, and stated that formerly, at the collieries of Coxe Bros. & Co., the coal was inspected by the breaker employes, and there were constant complaints from consumers, some of which were made five months after the shipment. Now the inspection is done by the sales department, before the coal leaves the breaker, and every employe from the foreman down, knows that if a lot of coal is rejected, it means more work, to unload the car and prepare the coal properly. Under this system there are no complaints from consumers.

CENTRIFUGAL VENTILATORS, BY R. VAN A. NORRIS, WILKES-BARRE, PA.

This paper was a very long and exhaustive one treating on the efficiency and construction of the various types of centrifugal fans in use for mine ventilation. The paper is too long to be reviewed in the limited space at our disposal, and it together with the supplementary remarks by Mr. A. H. Storrs, of Scranton, will be given more in detail in a subsequent issue.

The figures given in Mr. Norris' table, which embraced a larger number of fans, show a wide divergence in the combined efficiency of the engine and fan. The lowest efficiency given being 23%, and the highest 91·3%, though the latter was marked doubtful. There were eight that showed efficiences ranging between 81%; and 87%; 14 ranging between 70% and 77%; 16 ranging between 60% and 70%; 9 ranging between 50% and 60%; and 20 that ranged from 23% to 50%.

The bulk of the criticism made on Mr. Norris' paper was that the different conditions under which each fan was running and under which measurements were made, rendered it extremely difficult to get results that would give a correct basis for comparison.

The Wednesday evening session was opened with a paper entitled

"NOTES ON A CABLE HOIST AND THE USE OF LOCKED ROPES;" BY E. GYBBON SPILSBURY, TRENTON, N. J.

This paper was a description of a cable tramway across the Susquehanna River at Glen Union, Clinton County Pa., erected by the Trenton Iron Co. for the Glen Union Lumber Co. It was built to convey railway cars loaded with lumber, weighing about twelve tons each, from one side of the river to the other. A tower 70 ft. high was erected on each side of the river, over which were stretched two parallel cables each 2 ins. in diameter. The carriage is suspended from the cables and is large enough to carry one car. The span is 735 ft. The engine used was built by the Lidgerwood Mfg. Co. To reduce the wear on the rope and the wheels of the carriage, Elliot's smooth locked-coil wire rope was adopted, and the desired result was accomplished. Sixty cars of lumber have been transported across the river by this means in a day of ten hours. In reply to questions regarding the use of this locked-coil rope, Mr. Spilsbury stated that it was unquestionably a good rope, and instances that were cited in opposition to this view, were in cases where local conditions were such that made ordinary wire rope more suitable, and the locked-coil rope should not have been put on. The locked-coil rope is largely used in English collieries, and is giving great satisfaction.

"ELECTRIC LOCOMOTIVES IN GERMAN MINES;" BY KARL EILERS, BERLIN, GERMANY.

This paper was read by title, and was not discussed generally, but Mr. H. C. Spaulding, of The Thomson-Van Depoele Electric Mining Co., stated that his company had recently constructed the largest electric mine locomotive as yet produced. It is the same locomotive that was recently illustrated in our columns. It is of 60 H. P., and weighs 21,600 lbs., or about three times the weight of the one described by Mr. Eilers. The dimensions of this locomotive are as follows: 12 ft. 6½ in. long, 3 ft. 6¼ in. wide and 3 ft. 3½ in. high. It is of 3 ft. gauge and has a maximum speed of 10 miles per hour. The armature speed is 1020. Mr. Spaulding exhibited photographs of this locomotive and also of a pair of mine pumps run by electricity. These latter were designed for a 1,500 ft. lift, and under a pressure of 650 lbs. per sq. in. they showed an efficiency of 74%. The pumps were a pair of Knowles pumps and the motor was connected to them by a worm gearing, the pumps being set a little farther apart than usual. The electrical end was specially constructed so as to be water-proof. The statement regarding the efficiency of the pumps was doubted by several members who had made a study of worm gearing. Mr. Spaulding said that at first he and others connected with the company were astounded with the result, but that it had been proven by tests made every fifteen minutes during a period of twenty-four hours.

"THE UTILIZATION OF PUDDLE SLAG FOR PAINT STOCK;" BY AXEL SAHLIN, NEW YORK.

This paper was an interesting description of the manufacture of paint from puddle slag at Boonton, N. J., and the difficulties that were met and overcome before the present excellent results were attained. The slag is ground by means of a Cyclone pulverizer and passed through a simple drum arrangement in which the larger pieces, in themselves very small, are separated from the finer particles conveyed again to the pulverizer and reground. This fine material is then treated with sulphuric acid, calcined and ground a second time to exceeding fineness. It is then mixed with linseed oil and forms the stock of a very permanent paint. Any color except white may be made by the addition of a very small percentage of pigment. The grinding is done for 17 cents per ton.

"THE PREPARATION AND UTILIZATION OF SMALL SIZES OF ANTHRACITE COAL."

This was the subject for a discussion that proved a very interesting one. It was opened by Hon. Eckley B. Coxe, who stated that to secure the best results from Anthracite as a fuel, it was absolutely necessary that it should be well sized. For instance if chestnut, pea, and buckwheat coal was mixed, the smaller sizes would fill the interstices and cut off the draft necessary to support combustion. Anthracite in the fire did not act like Bituminous, and this necessity for air space was an essential feature. He stated that when he first entered in business as a miner of coal, only the larger sizes were shipped to market, and the smaller sizes were utilized for steam purposes at the mines. He spoke of using the major portion of the chestnut production of collieries for steam purposes, but, as the trade learned that it was of value as a fuel, the sales-agents sold the entire product of the collieries and he was compelled to use pea. In course of time Mr. Ely, also sold all they could produce of that, and he had to descend to number one buckwheat. The next year Mr. Ely sold the number one buckwheat and now he was using number two buckwheat. This has in turn been sold and he must now come down to number three buckwheat, and he suppose his next step would be to a smaller size, say mustard seed.

He stated that the use of improved grates such as the McClave and Howe grates, had made it possible to utilize the small sizes. He was using the McClave grate with good results, and had succeeded in burning $\frac{1}{16}$ in. coal. He explained in detail his method of utilizing a maximum proportion of the heat units, by the use of the Dimmick and Smith improvement, and mud drums which were almost surrounded by flame, and which were set under the boilers. He stated that one of the greatest extravaganzas in the coal regions was the use of uneconomical steam plants and wasteful engines. He advocated the use of a better type of boilers and of a higher grade of engines. It was of as much importance to economize in fuel at collieries as at any other establishment, and it was only by the adoption of economic methods that operators could renew their acquaintance with dividends, something that few of the younger men in the trade were acquainted with. Mr. Coxe called attention to the fact that he had succeeded in cleaning and saving coal as small as $\frac{1}{16}$ to $\frac{3}{16}$ in. in size, which was cleaned by jigging in jigs, the bottoms of which were covered with felspar. He had carefully analyzed the refuse after jigging, and found that there was a very large percentage of iron pyrites in it. This pyrites can only be removed by jigging.

Mr. Coxe referred to the exaggerated statements that were continually being made regarding the vast amounts of culm available for fuel in the Anthracite regions, and stated that the banks did not contain nearly as much as was supposed. They often lay on side hills and instead of being trapezoidal in section, they were triangular, and the observer gained a false impression by seeing only the altitude and one of the long sides of the triangle, and imagined that he was looking at a bank with a trapezoidal section. He also stated that some of the banks by deterioration, due to weathering, were useless, and others that contained excessive amounts of refuse were impracticable for use as fuel. He mentioned the fact that culm from different seams and different localities was differently affected by weathering. Some of it, after a few months exposure was very low in value, while other culm that had been exposed for years was comparatively little affected.

In the course of the discussion which followed, attention was called to the use of culm as fuel at the various manufacturing establishments in Scranton. Dr. Raymond stated that the culm banks in Scranton were comparatively new, and jocularly stated that it paid to burn them, as the area covered could afterwards be sold as city lots.

Mr. Foster stated that the reason culm was utilized to a greater extent in the Lackawanna and Wyoming valleys than in other portions of the Anthracite fields, was because the seams lay comparatively level and there was not as much refuse in them as in the other localities. Consequently the refuse was gobbed or left in the mines, whereas in the Lehigh and Schuylkill regions, the seams lay on heavier pitches, and considerably more refuse was necessarily loaded in the mine cars, transported to the surface and eventually thrown on the culm banks. Therefore the culm of the latter regions was not as well adapted for fuel, unless it was prepared in some manner and this would naturally increase its cost. Mr. Moffatt stated that he was using for steam purposes at the Lackawanna Iron and Steel Co.'s Mills from 6,000 to 8,000 tons of culm per month. This was fresh culm from the two collieries owned by his company supplemented by culm from three other collieries located near the works. There were however numerous other establishments that were using culm from old banks. Several members spoke of experiments they had made in burning a mixture of Bituminous coal and Anthracite culm, but the result was not as good as when the two classes of coal were used separately.

Considerable interest was manifested by various members in regard to the practical use of the McClave grate, which had been favorably mentioned in several instances, and Mr. Foster promised to prepare a paper on the subject to be printed in the transactions in connection with Mr. Coxe's remarks and the discussions which followed them.

The meeting then adjourned, and the members and guests retired fervently hoping that the morning would prove fair, so that the social features of the meeting should be as successful as the business sessions.

THE SOCIAL FEATURES.

Thursday dawned cold and threatening, and the outlook for the excursion through the Wyoming region and to Harvey's Lake was most unpromising. However, the train was ready and the party determined to risk it, and it was fortunate this conclusion was arrived at. The rain held off and the day was a most enjoyable one. Harvey's Lake was reached about noon, and observation cars elaborately trimmed were attached to the train which was run down to the boat landing, and thence back to Mr. Albert Lewis' beautiful log residence and picnic grounds. After a stroll through the grounds an elaborate luncheon was provided by Mr. Lewis at his house, which was thrown open for the reception and use of the party. While seated at the bounteous and beautifully arranged tables, a fine orchestra furnished music that added greatly to the enjoyment of the party. Mr. Lewis proved himself a most generous and hospitable host, and after the luncheon was over tendered his guests the use of the steamer for a ride on the lake. On the return from the boat ride, and a visit to Mr. Lewis' saw mills, the cars were taken for the return to Glen Summit. A jovial and happy party filled the cars, and all united in expressing the highest appreciation of Mr. Lewis' pleasant reception and bounteous hospitality. Glen Summit was reached at 5.30 P.M. About seven o'clock, the special train was again occupied by the party and the run was made to Laurel Run, where Gen. Paul A. Oliver had prepared a "Camp Fire" for the entertainment of his guests. The entertainment was a peculiarly unique and enjoyable one. The road from the station to Gen. Oliver's grounds was bordered with blazing torches, after passing through the rustic gates a peculiarly attractive scene met the eye. The grounds were illuminated in every direction by pine-knot torches and pumpkin "Jack o' Lanterns," and a huge bonfire of pine logs. Across the driveway the word "Welcome" appeared on large illuminated pumpkins, each of which bore one letter of the word. Scattered through the woods were hundreds of carved pumpkins that showed up grotesque and humorous illuminated designs. The path down the trout stream to the dam was particularly attractive. The dancing pavilion was so trimmed with evergreens, different colored dahlias in various designs, and Japanese parasols and lanterns that no woodwork but the floor was visible. A band stand adjoining was occupied by the Ninth Regiment Band, one of the best musical organizations in the State. Gen. Oliver, assisted by Mrs. Bunnell, his sister, and a number of other ladies, received the guests at the entrance of the pavilion. After the reception the guests strolled through the grounds, and in a body visited the quaint log chapel, which was decorated for the occasion. Over the chancel the following appropriate quotation, from Job, 28th Chapter, was printed:

"Surely there is vein for the silver, and a place for gold where they find it. Iron is taken out of the earth and brass is molten out of the stone. The flood breaketh out from the inhabitant; even the waters forgotten of the foot; they are dried up, they are gone away from men. As for the earth, out of it cometh bread; and under it is turned up as it were fire. The stones of it are the place of sapphires: and it hath dust of gold. There is a path which no fowl knoweth, and which the vulture's eye hath not seen; the lion's whelps have not trodden it, nor the fierce lion passed by it. He putteth forth his hand upon the rock; He overturneth the mountains by the roots. He cutteth out rivers among the rocks; and his eye seeth every precious thing."

As the visitors entered, a quartette sang "My Country 'tis of Thee," which was followed by "Coronation" and "Old Hundred." The party then returned to the pavilion and bonfire. After all had returned, President Birkinbine stepped on a stump and called the gathering to order and called on the committee on resolutions for its report. Capt. Hunt then read a series of resolutions thanking the local committee and Messrs. Lewis and Oliver for the pleasures already enjoyed, and Hon. Eckley B. Coxe for the pleasures in store for the morrow. They also thanked the Lehigh Valley R. R. Co. for favors and courtesies received not only then but on numerous former occasions. These resolutions were unanimously adopted and cheers were given for Mr. Albert Lewis, Gen. Oliver, the L. V. R. R. Co., Messrs. Coxe, Stearns, and Lathrope, the officers of the local committee, and also for the ladies of Wilkes-Barre. This pleasant duty being ended, dancing, conversation, and strolling through the grounds occupied the time till midnight, when the Institute and its guests left for Glen Summit and the Wilkes-Barre guests left for home. On the road to Glen Summit, Mr. Oliver Williams, of Catasauqua, formed a choir in the front car, and a varied selection of local gems, more popular than classical were rendered in an enjoyable manner.

Friday morning dawned bright and clear, and at 8.15 the special train started for the Lehigh Region. Drifton was first visited and the shops and new iron breaker were examined. From there the train was run to Hollywood Strippings, where the mining of the Mammoth seam by removing the surface was examined. From there, the train proceeded to the new Oneida Colliery of Coxe Bros. & Co. A bounteous lunch was served at the picnic ground, and then the new iron breaker was inspected. The machinery was all in place, and was run so that the visitors could see the actual working of Mr. Coxe's new ideas. It was an excellent chance to witness the method of preparing Anthracite for market, and all availed themselves of the opportunity. The breaker is one of the largest in the region and has an estimated capacity of about 3,000 tons per day. All the appliances are of the latest improved order. Among other striking objects was the new compound hoisting engine, designed and built at the Drifton shops, where, by the way, a Pelzer fan is in course of erection. This will be the first Pelzer fan in operation in America.

At 3.40 P. M. the visitors again boarded the train. At Hazleton quite a number got off to take trains for Philadelphia and New York. At Glen Summit which was reached about 5 P. M. about half the remainder left, and the balance of the party were taken on to Wilkes-Barre, from whence they scattered toward their homes, all being of the unanimous opinion that the Fall Meeting of 1891 was one of the pleasantest and most interesting ever held, and that Messrs. Coxe, Stearns, and Lathrope, were model committee-men.

Don't Get Left.

In the effort to secure the best results in mining and preparing minerals, it is necessary for the man who don't want to "get left," to be thoroughly posted on the most improved ideas, machinery, and appliances. It does not cost much to "keep up with the procession." All you have to do to keep posted is to read THE COLLIERY ENGINEER, and send for the handsome and well illustrated catalogues of manufacturers of mining machinery and mining appliances. Most of them contain information of value aside from descriptions of the machinery, etc., and they should be in the hands of every operator and mine official. Our advice therefore is to

Send for Catalogues and Circulars, of mine cars, wheels, etc., to S. B. Stine, Osceola Mills, Pa.

Send for the handsome illustrated Catalogue issued by the Queen City Supply Co., corner Elm and Pearl Streets, Cincinnati, Ohio.

Send for Circulars relative to "Webster's International Dictionary," which is a revised and enlarged edition of the Authentic "Unabridged," to Messrs. G. & C. Merriam & Co., Springfield, Mass.

Send for the handsome illustrated Catalogue issued by The Lunkenheimer Brass Co., 11–17 East Eighth Street, Cincinnati, Ohio.

Send for the Catalogue of the Philip Carey Manufacturing Co., Cincinnati, Ohio.

Send for the illustrated Circulars and Catalogues issued by the Waterbury Rubber Co., 49 Warren Street, New York.

Send for Catalogue and Circulars descriptive of Packing to Hine & Robertson, 45 Cortlandt Street, New York.

Send for Catalogue issued by the Phillips Mine Supply Co., Pittsburgh, Pa.

Send for Catalogue and Circulars of the Scaife Foundry and Machine Co., Limited, Pittsburgh, Pa.

Send for special Catalogue just issued descriptive of Slate Channeling Machines to The Ingersoll-Sergeant Drill Co., 10 Park Place, New York. This is the only practical channeling machine on the market.

All the above Catalogues are sent free, and you cannot afford to not have them.

Engineering Association of the South.

The first regular meeting of the Engineering Association of the South since the summer recess was held on Thursday evening October 8, in the Y. M. C. A. Building, Nashville, Tenn., the Cumberland Publishing House in which are situated the future headquarters of the Association not yet being ready for occupation. Vice-President W. L. Dudley and President John B. Atkinson presided in turn with about twenty members and visitors present.

Communications were read from the Secretaries of the Am. Soc. C. E. from the American Society of Swedish Engrs., from the Am. Institute M. E., and from the Illinois Soc. Surveyors & Engrs., each notifying the Secretary that a system of exchanges of their publications with this Association would be adopted. The subject of the series of tests of American woods, recently inaugurated by the U. S. Dept. of Agriculture and now being carried out at St. Louis, Mo., and Ann Arbor, Mich., was discussed, and at the suggestion of Mr. John MacLeod of Louisville, Ky., the Secretary was instructed to communicate with the Secretary of Agriculture expressing the interest taken by the Association in this important undertaking and urging that the necessary appropriation of funds be secured for fully carrying out the series now undertaken.

Mr. R. L. Cobb, Chairman of the Committee on Nomination of Officers, submitted the names of two nominees for each office to be balloted for at the coming annual election in November.

Messrs. R. C. Lewis and W. L. Dudley were appointed tellers to canvas the ballots for new members which resulted in the election of the following gentlemen: Frank Cawley, Mechanical Engineer for the St. Bernard Coal Co., Earlington, Ky., Benjamin W. Robinson Mining Engineer for the St. Bernard Coal Co., Earlington, Ky., and Thos. D. Kemp, Engineer and Superintendent of the improved Wood Pavement Company, Mobile, Ala.

An application for membership was received from Lucien S. Johnson, Supt. and Engr. of the Great Western Mining Co., Peach Orchard, Ky.

The paper of the evening entitled "The estimation and Measurement of Earth-Work," was then read by Mr. W. B. Roes of Nashville, Tenn., member of the Association. The paper after a general analysis of the requirements and difficulties of earth-work estimation, presented a comparison of the several methods now in use for determining volumes, expressing the error of the several methods as compared with the geometrically rigorous prismoidal formulae. One of the conclusions of the paper was that owing to the fact that earth-work excavations are usually bounded by a concave profile, either in the road-bed cuts or in borrow pits, the prismoidal formulae gives results less than the actual volume taken out by an amount approximating to the error of excess of the method of "averaging end areas" and therefore the latter was believed to be the more accurate and just method of estimation than the prismoidal method which while giving results rigorously true for the imaginary solid on which it is supposed to be applied still gives results too small when applied to the usual form of earth solid which is rarely a prism, but usually has a middle section larger than that assigned it in the prismoidal treatment. The author presented for inspection some tables divined by himself for rapidly taking out the volumes of "three level" ground and also exhibited some graphical scales for the same purpose and to be used in finding the center of a mass of an excavation.

The next regular meeting of the Association, which will be the annual meeting, will be held on November 12th, at Nashville, Tenn., and without doubt in the new headquarters.

A Valuable and Cheap Book.

We have received an advance copy of a valuable little volume with a title page that contains in its few lines so much information regarding its contents that we reproduce it. It is as follows: "Common Sense in Making and Using Steam. Facts for the consideration of Proprietors of Steam Plants, by One Who has Paid for His Experience."

The author, Mr. William Harrison Bailey, M. E., of Rochester, N. Y., has in this little volume, compiled a vast amount of data arrived at after years of experience in steam engineering, in an interesting and popular form.

The question and utilization of steam in all industrial establishments is one of the heaviest items of expense, and collieries are no exception to this rule. Badly designed and poorly managed steam plants require annually a large expense in labor, in costs for repairs, and for fuel that could be materially reduced if proper attention were paid to the subject, and new ideas gained from practical experience were utilized. The little volume under review contains many hints whereby steam users can effect economies, and its nominal cost of 25 cents post-paid should induce every steam plant owner, engineer and fireman to purchase. It is neatly bound in leatherette, contains no advertisements, and will be sent post-paid for 25 cents, either in stamps, currency or postal note, by the Mason Regulator Co., No. 10 Central St., Boston, Mass.

PRIMARY EDUCATIONAL DEPARTMENT

FOR CANDIDATES FOR

MINE FOREMEN'S CERTIFICATES

AND FOR

STUDENTS OF MINING.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the sciences related to mining and to learn how to answer the questions in ventilation, surveying, and mechanics which are asked at the examinations for mine foremen's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine foremen and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and many calculations are worked out at length for the benefit of those who are not familiar with figures.

PENMANSHIP.

We shall be heartily glad to learn that our readers are profiting by the lessons on Penmanship, not only in being able to execute figures that are pleasant to look upon, but we also hope to learn that the observing faculty is by this means being developed through a process of a "Love of the Beautiful."

The first letter to engage our attention in this article

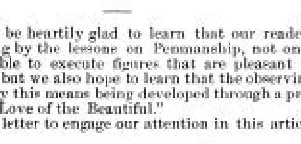


Fig. 22.

is the Capital G. At the left hand of Figure 22 the letter is shown as it ought to be drawn or written; the second letter from the left hand side of the Figure shows the development of the parts of the letter out of a series of elliptical curves. First let us notice that the stem of the bottom loop must be parallel to the major

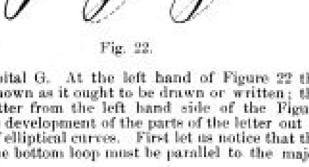


Fig. 23.

axis of the large ellipse, and that the major axes of the top and bottom ellipses must also be parallel. The third letter from the left is a deformity arising out of the non-parallelism of the respective ellipses; the same occurs in the first letter of Figure 23. The second letter shows the ellipse of the bottom loop to be so small as to offend the eye and the feelings in a remarkable manner. The bottom loop of the third letter is generated by an ellipse having its major axis too long.

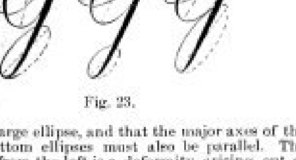


Fig. 24.

Figs. 24 and 25 illustrate the correct and incorrect development of the capital letter H. The first letter on the left hand side of Figure 24 is correctly written or drawn; the second letter from the left shows the development of the letter from elliptical curves; the first

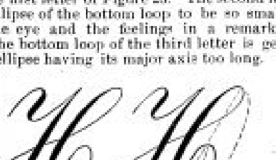


Fig. 25.

letter of Figure 25 shows two deformities, the one contrary to the first law of penmanship, and the other contrary to the third law of penmanship, namely, all strokes must be parallel, and all strokes must be proportionate in size. The stem of the initial hook of the letter is not parallel to the main stem of the letter, and the bottom loop and scroll are both too small. The second letter shows that the stem of the hook is not parallel to the main stem of the letter, but the secondary principal stem is also not parallel to the first, and the final scroll is not only not parallel but abuses the third law of penmanship by not being proportionate in size.

ARITHMETIC.

MULTIPLICATION AND DIVISION OF FRACTIONS.

The common idea is that if one value be multiplied by another the result or product will be greater in numerical value than either the multiplier or the multiplicand; this statement, however, is only true in relation to whole numbers (excepting cases where the multiplier or multiplicand is one), that is when the multiplier and multiplicand are both whole numbers; but if 2 be multiplied by $\frac{1}{2}$, the product or result is equal to 1, we now find that if a whole number be multiplied by a fraction the result or product is greater than the multiplying fraction and less than the whole number, *e. g.*, if 1 be multiplied by a $\frac{1}{2}$ the result or product is a $\frac{1}{2}$, or less than the whole number and exactly equal to the multiplying fraction; from this we learn that if a whole number be multiplied by a fraction the product will be greater than the fraction, but is always less than the whole number that has been multiplied.

When a fraction is multiplied by a fraction the product or result is always less than either of the multiplying figures, for instance, a $\frac{1}{2}$ multiplied by $\frac{1}{2}$ produces a $\frac{1}{4}$, the meaning of this is that $\frac{1}{2}$ times a $\frac{1}{2}$ must be a $\frac{1}{4}$, and it is often written "$\frac{1}{2}$ of a $\frac{1}{2}$ equals a $\frac{1}{4}$." Perhaps we cannot do better to impress these facts on the mind of the student than show a few examples; first then we will multiply wholes by wholes and show that the products are greater than either of the factors. Now the word factor is derived from *factor*, to make. If 3 be multiplied by 4, the 3 and the 4 are said to be the factors or makers of 12; $5 \times 4 = 20$, the 5 and 4 are here said to be the factors or makers of 20. Now here follow examples to show that the products of whole numbers are greater than either of the factors, except when one of the factors is 1, thus

$$4 \times 7 = 28$$
$$8 \times 9 = 72$$
$$6 \times 8 = 48$$

Now let us show that when a whole number is multiplied by a fraction the product is never less than the fractional factor, but never greater than a whole factor, as observed by the following examples:

$$3 \times \tfrac{1}{3} = 1$$
$$2 \times [illegible] = [illegible]$$
$$4 \times [illegible] = [illegible]$$
$$1 \times [illegible] = [illegible]$$

Again, two fractional factors generate a product always less than either of the factors, as shown by the following examples:

$$[illegible] \times [illegible] = [illegible] \text{ or } [illegible]$$
$$[illegible] \times [illegible] = [illegible] \text{ or } [illegible]$$
$$[illegible] \times [illegible] = 1$$
$$[illegible] \times [illegible] = [illegible]$$

It is a knowledge of details like these that makes a student sure and accurate in the application of mathematical principles. It is the readiest and surest way to succeed in the study of arithmetical values.

When a series of fractions have to be multiplied into each other they are often expressed as in the following example:

$$\tfrac{1}{2} \text{ of } [illegible] \text{ of } [illegible] \text{ of } [illegible] \text{ or } \tfrac{1}{2} \times [illegible] \times [illegible] \times [illegible]$$

Now if all the denominators be multiplied into each othes the product will be the denominator of the resulting fraction, and if all the numerators be multiplied into each other the product will be the resulting numerator of the fraction.

$$\text{or } \tfrac{1}{2} \times [illegible] \times [illegible] \times [illegible] = [illegible] \text{ or } [illegible]$$

Two words have been employed in this explanation, and let it be noticed that words are signs of ideas, and unless the meaning of the words are understood the ideas that the words express cannot exist in the mind. A good student constantly uses his dictionary, and never allows a word to pass him in reading if he does not understand it. Now the word "numerator" signifies the number of parts that constitute a fraction of a whole, and the "denominator" the number of parts into which the whole is divided, *e. g.*, three-fourths of an apple would indicate that the whole apple has been cut into four equal parts, therefore the denominator is 4, or the number of parts into which the apple has been cut; 3 is the numerator or the number of parts at our disposal, consequently this expression might be graphically written as follows:

3 the numerator.
4 the denominator.

Division of fractions presents us with conclusions the opposite of those we discovered in our investigation of multiplication of fractions. When the dividend or divisor consists of other values than unity the quotient is always larger than either divisor or dividend; if a $\frac{1}{2}$ be divided by a $\frac{1}{2}$ the quotient or result is 1, and elementary reasoning would teach us that a $\frac{1}{2}$ must be contained in a $\frac{1}{2}$ one time. A portion of the process of division of fractions is similar to that of multiplication, with this difference, the dividing fraction is always inverted, that is a $\frac{1}{2} \div \frac{1}{2} = 1$, or proceeding as in multiplication $\frac{1}{2} \times \frac{2}{1} = 1$.

The following remarkable results occur which show clearly how cautious the learner ought to be to invert the correct fraction, for example, $1 \div \frac{1}{2} = 2$, or $1 \times \frac{2}{1} = 2$, but the $\frac{1}{2}$ divided by 1 equals a half; 1 might in this case be made into an improper fraction, then $\frac{2}{2} \div \frac{1}{2} = 2$ as before, and half divided by 1, $\frac{1}{2} \times \frac{1}{1} = \frac{1}{2}$ as before.

CHEMISTRY RELATING TO MINE VENTILATION.

MINE GASES (CONTINUED).

The compound gases ought to be known and understood by the miner by their symbols or chemical expression, as follows:

Marsh gas or methyl hydride -	CH_4
Silver gas or hydride of ethyl -	C_2H_6
Sulphureted hydrogen or, hydrogen sulphide - -	H_2S
Carbonic acid or carbon dioxide	CO_2
Carbonic oxide or carbon monoxide - - -	CO

Now it is a matter of daily experience to observe that these gases stratify in air, that is, they form layers above or beneath air according to their respective specific weights. Fire-damp having a specific gravity of ·55 is always found stratified next the roof of the seam; carbonic acid having a specific gravity of 1·52 is always stratified next the floor of the seam; sulphureted hydrogen stratifies with difficulty, it being very little more than the weight of air, or 1·17. The same may be said of carbonic oxide in after-damp.

Gases diffuse into each other, that is, by some force not yet clearly understood, fire-damp will diffuse and form a mechanical mixture with air; the same may be said of all the other gases, and what is equally remarkable the gases have a power of diffusion among themselves. Now it does seem extraordinary that hydrogen gas, which is only about a fifteenth of the weight of air, should, contrary to the commands of gravitation, sink and mechanically unite with the heavier gases which constitute air, but the difficulty is partly removed when we consider that this diffusion is closely allied to another principle, viz.: solubility. Now common salt has a specific gravity of 2·1; this means to say it is a little more than twice the weight of water, nevertheless, when dissolved in water it remains suspended, notwithstanding its superior weight. Now we do not understand the operation of a natural law that comprehends what takes place when salts are dissolved or when gases are diffused. But in all cases solubility is only possible within sharply defined limits, *e. g.*, to all salts there are points or limits of saturation which never vary at given temperatures and given pressures. We know that 21 volumes of oxygen will diffuse into 79 volumes of nitrogen, or the converse, 79 volumes of nitrogen will diffuse into 21 volumes of oxygen, such proportions being the limits of the diffusion of these gases. That diffusion is limited by a point of saturation is clear from the circumstance that atmospheric air is always the same, whether found on the tops of mountains or in the depths of valleys. It is the same in all climates, and as far as we know, under all conditions of temperature and pressure. That diffusion and solution are the same in principle is shown by the solubility of air in water, but when air dissolves in water a portion of its nitrogen is rejected, showing that when three bodies dissolve or diffuse into each other, the triple diffusion to some extent alters the relationship.

The law of diffusion already known refers to the velocities with which different gases diffuse into each other, *e. g.*, the specific gravity of hydrogen being 1, and that of oxygen 16, hydrogen will diffuse into oxygen with a velocity four times greater than that of oxygen into hydrogen. The law of such diffusion is as follows: The velocities of diffusion of different gases are inversely proportional to the square roots of their densities. Now as the ratio is an inverse one, the square root of the density of oxygen is proportional to the velocity of the diffusion of hydrogen into it. The same relationship will be found true in other cases. In all the experiments tried, the velocities of diffusion were ascertained by placing a bottle of one kind of gas in an unmeasured volume of another.

That the limits of saturation are sharply defined cannot for a moment be doubted. On entering old working places of a mine where the ventilation is "slack," or even where no air current is passing, fire-damp will be found next the roof and air beneath it, showing that diffusion can only proceed within very definite limits. Any intelligent student will realize the importance of the investigation of this matter when we point out the fact that with an unlimited diffusion explosive mixtures would constantly be found, not only near the roof, but near the floor. The intelligent miner, however, never expects to find explosive mixtures near the floor, but seeks for gas near the roof, as he knows by practical experience mine gases and air stratify according to their specific weights. Where air and gas are mixed by current agitation, separation at once takes place, where the current passes under large holes in the roof; so much is this the case that screens of canvas called "sconces," or "dash doors," are erected to throw the current upwards and thus wash out the gas. We do hope, before long intelligent efforts will be made to ascertain correctly the points of saturation for diffused gases.

Pressure of fire-damp *in situ*. The following facts are taken from the North of England Mining Institute papers supplied by Lin. Wood, Esq., and Geo. May, Esq.: The experiments showed conclusively that the pressure of the gas *in situ* (in its original place) was proportionate to a water head nearly equal to the depth of the seam, that is in cases where the seams were found at considerable depths, but where the seam was shallow and the overlying strata porous and jointed, the pressure found did not coincide with this law exactly; again, even for the same depth, the pressure was greater in new workings than in the workings of old collieries. In the bore-hole experiments where the pressure was tested by gauges, it was found that the pressures increased proportionally as the square roots of the lengths of the holes. Suppose an example by way of illustration, and let the cover of the seam be equal to 1,500 feet, but let the depth from the drainage level to the seam be 1,260 feet, here the pressure of the gas *in situ* would be 546 pounds on the square inch. It will be clear to the observer that the undulations of the surface will greatly affect the law of depth. The closeness or otherwise of the strata, the age of the colliery, and the extent of the workings, will all moderate the pressure of gas *in situ*.

This matter is very important to the miner from three points of view: First. The quantity of gas or fire-damp given off by a seam will be less where the cover is thin than where it is of considerable thickness. As has been noticed a broken thin cover allows the fire-damp to freely escape from a seam; the same conditions of cover equally allow a free entry of water, so much is this the case that we may often say—much water, little gas, or little trouble from gas means much water. In the deeper seams overlaid by closer strata, and especially much further below the level of the district, we find much gas and very little water.

Second. But for the presence of fire-damp at great pressures in the coal, in many cases the seams would be very expensive to work, so that we are presented with the following apparently, opposite conclusions: first, fire-damp is a source of danger to the miner; second, fire-damp by its pressure assists the miner.

Third. In working a series of seams of different depths, great skill and sound judgment is required to retain the pressure of the confined fire-damp in the separate seams during the course of working, so that the taking out of one seam shall not entirely eliminate the gas from the other.

The range of explosive mixtures and the maximum effects are in the direct ratios of the pressures or densities of the gases. It is said that the range of explosive mixtures at sea level lies between 5 of air, and 1 of gas, and 15 of air and 1 of gas, but this range will be considerably increased under conditions of increased pressure. So much is this the case, that we have no doubt, that under a pressure of two atmospheres, 20 of air and 1 of gas would set up an explosive force equal to 10 of air and 1 of gas at ordinary pressures. But a mixture of 9½ of air and 1 of gas, under a pressure of little more than half an atmosphere or 8 lbs. on the square inch, ceases to be explosive. Here it would not be out of place to define what we mean by an explosive mixture. We mean then such a mixture of fire-damp and air, as will, if ignited, almost instantaneously produce a volume of flame equal to the volume of the mixed gases; from this intense heat a pressure is set up that may be safely called the explosive force. This force in many cases amounts to a pressure (supposing the mixture to be confined) of 90 pounds on the square inch. We may safely from this infer that the pressure set up in the neighborhood of the point of ignition in some of our great mining explosions has not been less than 50 pounds on the square inch. These deductions are founded on the supposition that explosions take place at pressures of about 30 inches of mercury, but no doubt in some of the deepest pits explosions have occurred at pressures equal to 32 inches of mercury, and should the mixture at the moment of explosion be nearly a maximum one, pressures of even 60 lbs. or more on the square inch might be produced. Supposing a pressure due to a confined volume to be 90 lbs. per square inch, under a pressure of 30 inches of mercury, the same mixture under a pressure of 32 inches of mercury would develop a static force of 96 pounds on the square inch. We mean by this that the intensity of the temperature of the mixed gases at the moment of explosion is directly proportional to the pressure of the gases at the moment before ignition.

High temperatures rarify gases, consequently a mixture previously expanded by heat is not so explosive as a relatively colder one; *e.g.*, a mixture of 9½ of air and 1 of gas at a pressure of 30 inches of mercury, and at a temperature of 700° F. will not explode. An atmosphere saturated with watery vapor, when mixed with fire-damp, is relatively safer than pure dry air.

SCIENCE RELATED TO MINING.

STEAM.

The conservation of energy is one of the greatest problems that has ever been solved by the human mind; the indestructibility of matter has long been known and understood, but the conservation of energy is a modern problem that is receiving a modern and final solution. Energy has its modes, fashions, or states, and all these modes, fashions, or states are convertible into each other; heat is convertible into light, light is convertible into heat, electricity is convertible into heat, and light and heat are convertible into electricity, mechanical energy is convertible into all the modes previously mentioned, and all the modes previously mentioned are convertible into mechanical energy; this being so the study of the subject of heat is full of interest, and confers upon the student an amount of intelligence which enables him to deal efficiently with other matters, in the daily duties of life, that would be inscrutably vague or mysterious. The modes by which heat is communicated from point to point are full of interest. In the raising of steam we first observe how heat is transported from point to point by radiation, the heat from the burning embers passes in direct radiant lines to the shell of the boiler, now the conveyance of heat from the burning embers to the boiler, let us bear in mind, is by the process of radiation. Perhaps some student might inquire for a definition of the mode, or any atomic laws by which heat is transported through space from one point to another? An answer to this query would involve a somewhat abstruse and lengthy explanation, but let it suffice for us to say that heat is the result of molecular or atomic movements by which one atom or molecule communicates its movements to another, and thus the heat is carried forward through a series of moving atoms in a brief space of time, until at last these moving atoms of air or gas impart their heat motion to the molecules of the air and plate that receives them; the heat is now passed through the plate by the process of conduction, that is to say one atom of the plate gives up its heat after another, until the heat arrives at the inner surface of the plate, when the heat is given up to the water.

Now, water is a very bad conductor of heat, that is to say, heat cannot be passed through it as it is through the shell of the boiler, but the small particle of water resting on the bottom of the plate being heated expands, and this increases its volume, becoming at the same moment lighter than the other particles of cold

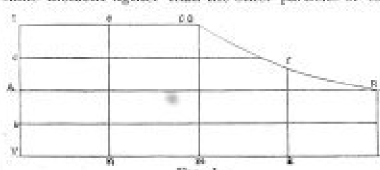


FIG. 1.

water, the result is that the heated particle of water rises or floats, while the cold particles sink and take its place. That this is so is easily shown by a Florence flask, if clear water be put in the flask with some fine particles of oatmeal, the heated particles of water carry with them particles of oatmeal upwards, until at last they are relatively cooler than other particles that are ascending. The cooler particles of the oatmeal are seen descending down the sides of the glass; this mode of conveying heat is called *convection*, and by convection the whole of the water in the boiler at last reaches boiling point, when heat still continues to act and cause the particles resting on the plate to take up so much heat that the inelastic fluid called water becomes an elastic fluid called steam.

Steam, in common with all gases, expands in conformity to the principles of Boyle's law, that is to say, the volume is inversely as the pressure, or the pressure is inversely as the volume. If a cubic foot of air was confined in a cylinder having a movable piston, and the enclosed air was situated beneath the piston and above the bottom, and if the piston be moved upwards until the volume of the space in the lower portion of the cylinder was increased to two cubic feet, the air would expand and fill this increased space, but while the air had increased its volume it would correspondingly be reduced in pressure. Suppose the pressure at first to be 15 pounds on the square inch, after the volume is doubled the air will be found to manifest a pressure of only 7½ pounds on the square inch; hence the statement, as the volume increases the pressure reduces; or, as the pressure increases the volume reduces. Suppose the same conditions as in the former illustration, and let the piston be thrust down until a cubic foot of air is compressed into the volume of half-a-foot—here the volume has been reduced and the pressure has been increased to 30 pounds on the square inch.

In the working of steam engines great advantages are obtained from the expansion of steam; the steam is said to be cut off at quarter stroke, half stroke, or two-thirds of the stroke, or at whatever fraction of the stroke the steam is cut off; the remainder of the stroke is completed by the expanding steam at a reduced pressure, capable of doing considerable work.

Watt discovered the gain to be derived from expanding the steam in a cylinder, and took out a patent to secure to himself advantages remunerative of his skill in applying Boyle's law. He not only did this, but he invented an indicator, or instrument to show on a paper diagram the varying pressure of the steam throughout the stroke, and it is to this diagram that we wish to draw the attention of our readers.

Referring to *Fig. 1*, *A L* represents the atmospheric line, or the line corresponding to the pressure of the

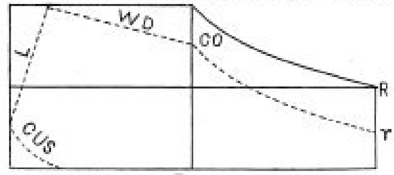


FIG. 2.

atmosphere. Now, as the pressure of the steam indicated at the boiler is not total pressure, but partial pressure, or the pressure above atmospheric pressure; to this portion of the subject the reader must confine his attention for a moment or two, otherwise, what follows will be a perfect mystery.

The zero of pressure will be about 14·7 pounds below atmospheric pressure, and this zero is represented by *V L* or the vacuum line, the zero line or the line of no pressure. Such a line as this can only be found when a vessel having a hollow space is void of all gas, air, or steam, when there will be no pressure, because pressure is a condition of matter, and if there be no gaseous matter in the vessel there cannot be any pressure, because there is no matter. Now, understanding these two lines, it is possible to make this ideal diagram understood.

From the atmospheric line to the letter *I*, the diagram indicates a pressure of the steam above the atmosphere equal to that of the atmosphere measured from *V* to *A*, therefore, if the vertical line measured from *V* to *A* be equal to the vertical line measured from *A* to *I*, and if *V* to *A* equals 14·7 pounds on the square inch, *A* to *I* also indicates 14·7 pounds on the square inch. Now, *V* to *A* is the pressure of the atmosphere, *A* to *I* is pressure above the atmosphere, therefore, the total pressure of the steam must be equal to the sum of these two pressures, or 29·4 pounds on the square inch.

Now, this 29·4 pounds on the square inch is called the total pressure of the steam. Expansion of steam cannot be calculated on the pressure from *A* to *I* because that is partial pressure. Boyle's law does not apply to a partial, but to a total pressure. Now, just let us discover the mistake we would make if we applied Boyle's law to partial pressure; from *A* to *I* is 14·7, and as the pressure is inversely as the volume, and as the steam is here cut off at *C O* in the diagram, or half stroke, if we double the volume while the piston travels the length of the diagram *B G*, on the completion of the stroke the volume of the steam would be doubled; therefore, the pressure would be halved, or it would be reduced to 7·35 pounds on the square inch. Now, consider for a moment what is this 7·35 pounds? If we consider it total pressure then the pressure of the exhaust steam would be 7·35 above the pressure of the atmosphere, which is totally incorrect, because it will be seen that the curved line in the diagram does not dip below the atmospheric line.

This 7·35 pounds cannot be pressure above the atmosphere, because the curved line terminates in the atmospheric line. Now then, calculate the expansion by Boyle's law on the total pressure, then if the steam is cut off at half the stroke, at the end of the stroke *R* it will have doubled its volume; now

$\frac{29·4}{2} = 14·7$. This is correct, because the expansion has reduced the pressure of the steam to atmospheric pressure, consequently the steam will exhaust from the cylinder at the same pressure as the atmosphere.

This diagram is a picture of the pressure of the steam during every point of the stroke, the vertical or upright lines, called ordinates, are pressure lines; the parallel horizontal lines are volume lines. Now, when the piston begins its stroke the total pressure of the steam is acting on it, that is a pressure from *V* to *I*, not that the pressure *V* to *I* is effective, because if it be a non-condensing engine the effective work done by the steam will be equal to the space enclosed by the diagram above the atmospheric line, and the work that the steam is capable of doing, and is lost, is represented by the space enclosed below the atmospheric

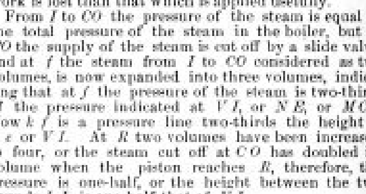


FIG. 3.

line. So that in a diagram of this character more work is lost than that which is applied usefully.

From *I* to *CO* the pressure of the steam is equal to the total pressure of the steam in the boiler, but at *CO* the supply of the steam is cut off by a slide valve, and at *f* the steam from *I* to *CO* considered as two volumes, is now expanded into three volumes, indicating that at *f* the pressure of the steam is two-thirds of the pressure indicated at *V I*, or *N E*, or *M CO*. Now *k f* is a pressure line two-thirds the height of *n e* or *V I*. At *R* two volumes have been increased to four, or the steam cut off at *C O* has doubled its volume when the piston reaches *R*, therefore, the pressure is one-half, or the height between the two pounds *L L* is one-half that of *V I*.

Figure 2 illustrates a theoretical diagram in strong lines, and enclosing an actual diagram in dotted lines. In this case the steam is cut off at one-half of the stroke or at the point *CO* when it expands to the point of release *R*. Now, in the actual diagram there are some very marked defects in the slide motion. At the bottom of the left-hand corner the dotted line is seen to be curved, this arises from the circumstance that the exhaust valve has closed before time. Now, lest there should be any misunderstanding about the explanation here given, let us carefully consider the matter.

To the uninitiated the piston or disc attached to the end of a piston rod reciprocates in a cylinder; that is, it travels from end to end during a stroke. Now, let us suppose that the piston is situated at the left-hand side of the diagram, and it is necessary for steam to propel it to the right, for this to be done there must be provided an entry for steam at the left-hand end of the cylinder, and the steam must enter between the cylinder and the piston, but between the right-hand end of the cylinder and the piston we have the steam which previously forced the piston the left. Now, before the piston can travel to the right an escape for the steam on the right-hand side of the piston must be provided for, this escape is known as the exhaust, or in other words, where one valve opens at the left to admit steam from the boiler, another valve opens to allow for the escape of the steam at the right-hand end of the cylinder. What is called a locomotive slide valve provides for the entry and escape of the steam alternately for both ends of the cylinder.

Now, fortified with this elementary knowledge we may proceed to describe the diagram: At the lower left-hand corner of the figure a dotted curve is shown marked *C U S*, this indicates that the exhaust valve has been closed before time, and the little steam there remained in the cylinder has been compressed by the piston after the manner of a "cushion." At the end of the stroke the steam is admitted too late, for it has evidently only been admitted at the moment the piston began its journey in an opposite direction, the result is instead of the dotted line being vertical it inclines to the right, and the whole pressure of the steam is not acting on the piston until it has moved onward in its stroke.

This arrangement of the line indicates that the steam is late, or the slide has what is called "negative lead." Not only so, but instead of the total pressure of the steam continuing to act on the piston until half the stroke has been completed at *CO*, it would appear that the port for the entry of the steam is too small for a fast-running engine, the result is the dotted line falls below *CO*, and this condition of the diagram indicates wire drawing or expansion without advantage. It will be seen that the dotted curve of expansion falls considerably below the normal curve as the result of the steam being wire drawn up to *CO*, further the point of release *r* indicates a final pressure inferior to *R*.

Figure 3 is in all respects the opposite of figure 2; cushioning takes place, not by compressing the exhaust steam, but by admitting the new steam before the piston has reached the left hand end of the cylinder, the result is the dotted line slopes in the opposite direction to that of figure 2, and the valve being amply sufficient for the admission of steam, there is no wire drawing up to *CO*, and the steam expands on the normal curve. It is easy to see that figure 3 is the diagram of a condensing engine, because the atmospheric line *AL* is shown at zero. The exhaust in this case is imperfect, that is to say, the steam cannot exhaust sufficiently quick into the condenser, the result is, instead of the diagram falling to the bottom horizontal line it produces the dotted line, indicating that the pressure in the cylinder at the beginning of the release is considerably above the pressure in the condenser, and this continues until the moment of cushioning, when the dotted line approaches a complete vacuum.

At the left-hand end of the diagram the scale from the atmospheric line upwards indicates pressure above the atmosphere, the scale from the atmospheric line reading downwards indicates pressure below the atmosphere.

The average pressure of the steam throughout the stroke of the piston of a steam engine is usually ascertained by dividing the sum of the lengths of the ordinates by their number, but the most correct method is not to take the sum of the ordinates, but the sum of the means of the ordinates.

The total length of the diagram in Figure 5 is divided into eight equal parts, and the means of the ordinates are shown by dotted lines, *e. g.*, the first mean on the left measures 17 tenths on the scale, but let us first make the reading of the scale clear, beginning at zero and counting to the right we have the numbers, 1, 2, 3, 4, 5, 6, 7. Now, 1 is really ten tenths, and 2 twenty tenths, 3 thirty tenths, 4 forty tenths, 5 fifty tenths, 6 sixty tenths, and 7 seventy tenths and so on, or they might be read 10, 20, 30, 40, 50, 60, and 70, in length; less than 10 tenths is measured on the left of zero. Now each tenth here represents a pound press-

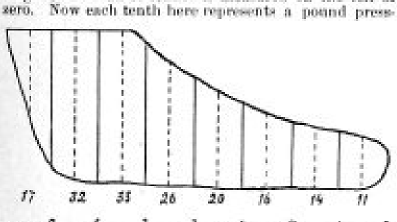


Fig. 4.

ure per square inch in the steam, then the sum of the means of the ordinates will be equal to all these measurements, added together thus:

$$17 + 32 + 33 + 26 + 20 + 16 + 14 + 11 = 169.$$

Now if the sum 169 be divided by the number of spaces included by the ordinates, namely 8, the result will be the mean or average pressure of the steam, as

$$\frac{169}{8} = 21{\cdot}125$$

the average effective pressure of the steam. The best way to measure off the mean ordinates of a diagram is to take a narrow ribbon of paper half an inch wide and twenty inches long, and by placing the extreme end of the ribbon at one end of the first ordinate make a tick with the pencil at the other end of the ordinate; then place the first tick at one of the extreme ends of the second ordinate and make a tick on the ribbon over the end, then take the tick over the second ordinate, and place it on the extreme end of the third ordinate, and tick off the other end of the ribbon, and so on throughout the series. Then measure the length of the ribbon, tick it off by the scale and divide that measurement by the number of ordinates when we have the mean pressure of the steam as before. A very good exercise could be had by measuring off with the ribbon, the ordinates in Figure 4.

MECHANICS IN MINING.

PUMPS (CONTINUED).

In vein mining the conditions for drainage to the shaft are entirely under artificial control. To realize this statement properly the coal mining student must by the aid of an idea conceive of a seam of coal being situated in a nearly vertical position; and to understand how the working galleries in a vein mine are drained, it will be quite in keeping with the description here required, to explain how the vertical coal seams are worked.

A shaft having been sunk to a depth of 1200 feet, a gallery is driven in the seam, the roof and the floor being both formed of coal. Now the student will see that this seam could not be worked by one level, consequently openings are driven upwards in the coal to a height of from one to two chains, and after an upper gallery has been driven and the lower and the upper galleries connected at intervals by vertical openings in the coal, it will be clear that pillars are left, as in horizontal working, such pillars however being on edge instead of lying horizontally. Now, if the student clearly understands what has been here stated, he cannot fail to see that in driving the galleries the gradient or fall to the shaft may be fixed uniformly at, say, half an inch to the yard to cheaply run off water that may accumulate at the working face.

The driving of the levels in vein mining are then under the same conditions as the driving of levels in the vertical coal seams; that is to say, the gradient or fall to the shaft is entirely under human control. The drainage of a horizontal coal seam cannot be effected in this manner, because nature has fixed a gradient for the seam which is often unfavorable to cheap drainage, hence the use of siphons, special pumps, etc. From the statement that has been made it will be seen that the pumps we have to consider in relation to metal mine drainage, as far as the workings are concerned, are that class of pumps used in shafts only.

We now are face to face with an arrangement for lifting and forcing sets used in the inclined shafts of metal mines, where the details are dissimilar to those we meet with in pumping arrangements for vertical shafts. The spears for the pumps in vertical shafts set up very little friction, as they are kept in a vertical position by wood guides. The guides for the spears in an inclined shaft are made as might be reasonably expected to move on rollers. There is another dissimilarity which has to be provided for in inclined shafts, viz., **V** bobs to allow the spears to accommodate themselves to the varying inclination of the shafts. It often happens that lifting sets cannot be used in inclined shafts because the varying inclination of the vein will not allow of the lifting set being straight. In such a case if the hydraulic main was put in crooked, wet spears could not possibly pass down the crooked set; therefore under such conditions dry spears and forcing sets are a necessity.

The student must carefully notice this point, the **V** bob is always fixed on that side of the spears where the two lengths are jointed and make an angle with each other of less than 180 degrees. The forcing set is precisely the same in construction as that previously described and illustrated.

Sometimes the lifting and forcing sets are combined in one arrangement and by this device a continuous flow of water in the hydraulic main is secured. The bucket is attached to the bottom end of the plunger, and to understand the arrangement the student might perform a very simple physical experiment: Fill a basin full to the brim with water and place it within a large dish; now plunge your clenched fist into the basin of water, when if the cubical contents of your fist are equal to half the cubical contents of the basin, half the contents will overflow into the dish. This simple law of displacement is a great feature of the pump in question. The plunger on the up-stroke makes a void for half the water lifted by the bucket. On the down-stroke the plunger displaces the water of the void previously made; this may be proved mathematically: Let the ram be 12 inches in diameter: this will give a sectional area of 144 circular inches, and let the sectional area of the bucket be 288 circular inches. Now, suppose the length of the stroke to be 60 inches, then $60 \times 144 = 8{,}640$ cylindrical inches, or on the descent of the plunger it will force to bank that number of cylindrical inches. Now the bucket will lift $60 \times 288 = 17{,}280$ cylindrical inches. Now study the up-stroke of this pump and you will observe that that portion of the plunger emerging out of the pump is making a void of 8,640 cylindrical inches, but the bucket has delivered into the chamber 17,280 cylindrical inches, but half of this has gone to bank and the other half fills up the void; and on the down-stroke of the plunger this remaining half is also delivered to bank. If the diameter of the ram be twelve inches that of the bucket will be twelve divided by decimal seven, or seventeen inches. If the diameter of the bucket be given the diameter of the ram may be found by multiplying by decimal seven.

MECHANICAL PROBLEMS.

Q. (*a*)—What horse-power of an engine will be required to haul to the shaft 700 tons of coal in nine hours, along an engine plane 3,000 yards long, and having an average rise to the shaft of $2\frac{1}{2}$ inches to the yard?

A.—The horse-power will be found as follows: First, find the force in pounds required to haul one ton up the incline, thus

$$2240 \times \frac{2\frac{1}{2}}{36} = 155{\cdot}55 \text{ lbs.}$$

Taking 30 pounds per ton as an average for friction on a level road for pit cars, then $155{\cdot}55 + 30 = 185{\cdot}55$ pounds of force required to haul one ton up the incline. The total load against the engine will therefore be the weight of the coal plus the weight of the cars, or, 700 tons + 350 tons = 1050 tons. Again, $1050 \times 185{\cdot}55 \times 9000$ (3000 yards $\times 3 = 9000$ ft.) $= 1{,}753{,}447{,}500$ units of work to be performed. Now taking $\frac{1}{3}$ of the time for hauling coal; $\frac{1}{3}$ of the time for hauling empty cars returning, and $\frac{1}{3}$ of the time for hauling, waiting on, and changing, then $\frac{1}{3}$ of 9 hours will be 3 hours, or 180 minutes, and allowing a modulus of ·7 on account of friction of ropes, drum and rollers, and the engine itself, the horse-power will be as follows:

$$\frac{1{,}050 \times 185{\cdot}55 \times 9{,}000}{180 \times 33{,}000 \times {\cdot}7} = 421{\cdot}7 \text{ horse power.}$$

Q. (*b*)—At what speed will the rope travel in the previous question?

A.—The average speed of the rope in main and tail rope haulage is ten miles per hour, or 880 feet per minute.

Q. (*c*)—How many 10-cwt. cars would be required to do the work required in question (*a*) at the rate of speed found by question (*b*)?

A.—To find the number of cars, divide the strain on the rope by the strain due to one car.

To find the strain on the rope, divide the units of work actually performed by the feet or distance traveled in one minute, thus

$$\frac{421 \times 33{,}000 \times {\cdot}7}{880} = 11051{\cdot}2 \text{ pounds strain on}$$

the rope.

The strain due to one car will be as follows: The pounds of force required to haul one ton up this incline are 185·55, and as a full car will only weigh $\frac{3}{4}$ of a ton, therefore

$$185{\cdot}55 \times \tfrac{3}{4} = 139{\cdot}16 \text{ pounds strain for one tub.}$$

Then, $$\frac{11051{\cdot}2}{139{\cdot}6} = 79 \text{ cars.}$$

Another method of calculating this question is the following:

The speed of the rope being 10 miles per hour, the speed per minute will be 880 feet. Now as the engine plane is 9,000 feet long the cars will take

$$\frac{9000}{880} = 10{\cdot}22 \text{ minutes in running to the pit}$$

bottom, and as they are running thus during 180 minutes, it will require

$$\frac{180}{10{\cdot}22} = 17{\cdot}6 \text{ trains per day.}$$

Now, to haul out 700 tons of coal, it will require 1,400 cars, each carrying 10 cwt. of coal, then

$$\frac{1400}{1{\cdot}76} = 79 \text{ cars nearly.}$$

Q. What should be the sectional dimensions of wood spears for a pumping set lifting water 180 feet, the diameter of the bucket being 12 inches?

A. The diameter of the set is 12 inches, or 1 foot; then

$1 \times 1 \times {\cdot}7854 = {\cdot}7854$, the area of the bucket in square feet. Now the length of the column is 180 feet. Then

$${\cdot}7854 \times 180 = 141{\cdot}372 \text{ cubic feet, and}$$

$141{\cdot}372 \times 62{\cdot}5$ (a cubic foot of water weighs 62·5 lbs.) $= 8835{\cdot}75$ lbs.

For every square inch in the section of the spears an allowance of five hundred weights for lifting power should be allowed, or, in other words, every square inch in the section of the spears has a lifting power of five hundred weights. Then, as there are 112 lbs. in a cwt., we find the square inches in the sectional area of the spears as follows:

$$\frac{8835{\cdot}75}{5 \times 112} = 15{\cdot}77, \text{ and the square root of}$$

15·77 is 4 inches nearly, so that the size of the spears required in this case will be 4 inches.

Q. What size of spears would be required for a lift of 240 feet with a 16-inch set?

A. First we will find the square feet, thus

$$\frac{16 \times 16 \times {\cdot}7854}{144} = 1{\cdot}3962 \text{ sq. ft.,}$$

and $1{\cdot}3962 \times 240 = 335{\cdot}088$ cubic feet of water in the column. Now $335{\cdot}088 \times 62{\cdot}5 = 20943$ lbs. weight of water to be lifted, and

$$\frac{20943}{112} = 187 \text{ cwts., nearly, of water to be}$$

lifted; therefore

$$\frac{187}{5} = 37{\cdot}4 \text{ the square inches of area in the}$$

section of the spears, and $\sqrt{37{\cdot}40} = 6{\cdot}1$, or the spears being square will be 6 inches on the side.

Q. What size of spears would be required for a lift of 270 feet with an 18 inch set, the water having ultimately to be delivered at an elevation of 1,560 feet?

A. Here we proceed as before to find the weight or pressure on the bucket, but to this must be added the weight of the spears to find the size demanded. Then

$$\frac{18 \times 18 \times {\cdot}7854}{144} = 1{\cdot}7671 \text{ square feet in}$$

the area of the bucket, and $1{\cdot}7671 \times 270 = 477{\cdot}117$ cubic feet of water to be lifted; and $477{\cdot}117 \times 62{\cdot}5 = 29819{\cdot}8125$ lbs., the weight of water to be lifted. A spear 1 square inch in section, and of a length equal to that given in the question, will weigh 950 pounds, as the specific gravity of spears being 1·4, including saturation and the iron fastenings. Now

$$\frac{29819{\cdot}8125}{112} = 266{\cdot}2483, \text{ the cwts. of water to}$$

be lifted; and

$$\frac{266{\cdot}2483}{5} = 53{\cdot}2496 \text{ square inches, the}$$

area of spears required for the water, but to this must be added

$$\frac{950}{112 \times 5} = 1{\cdot}69. \text{ Now}$$

$53{\cdot}2496 \times 1{\cdot}69 = 89{\cdot}991824$, the square inches in the section of the spears required to lift water and spears, and

$\sqrt{89{\cdot}991824} = 9{\cdot}5$ inches nearly, the measure of the spears in the side, or it may be said the spears ought to be 9·5 inches square.

EXAMINATION QUESTIONS ANSWERED.

CORRECTIONS.

In our September issue, Questions 49 and 50, on page 44, were incorrectly answered. Question 49 was answered in a manner that would give an answer nearly enough correct for practical purposes in mine ventilation, but it was not absolutely correct.

The correct answers are given herewith:

QUESTION 49.—If the temperature of 1,000 cu. ft. of gas be raised from 60° to 90° what will then be its volume?

ANSWER.—We will assume the barometric pressure to be 30 ins.

Then $\frac{1\cdot3253 \times B}{459 + T}$ = weight of one cu. ft.

$\frac{1\cdot3253 \times 30}{459 + 60} = \cdot07660$ lbs. for weight at 60°.

$\frac{1\cdot3253 \times 30}{459 + 90} = \cdot07242$ lbs. for weight at 90°.

The comparative volumes are then found as follows:

·07242 : ·07660 :: 1,000 : ( ) or
·07242 : ·07660 :: 1,000 : 1057·7

While it is true that air expands $\frac{1}{459}$ of its volume for each degree of heat added, it is evident that this expansion commences at 0; and what was 459 cu. ft. at 0 becomes 459 + 60 or 519 cu. ft. at 60°. Hence the proportion should be stated

450 + 60 : 459 + 90 :: 1,000 : 1057·6 Ans.

QUESTION 50.—If a room in a mine, 10 yds. long, 4 yds. wide, and 3 yds. high, be filled with fire-damp, how much pure air will be required to bring the mixture to an explosive point, and if the same was exploded to what area would it extend?

ANSWER.—In our September issue we gave the maximum amount of air that would render the mixture explosive, when we should have given the minimum amount. The correct answer is as follows:

The room being 30 ft. long, 12 ft. wide, and 9 ft. high, will have a cubical capacity of 3,240 cu. ft. To make 3,240 cu. ft. of gas explosive, we must add to it 5·5 times as much air, because as 5 parts of air to 1 of gas merely makes the mixture combustible, and each part of air added up to 9 or 10 parts of air to one of gas makes the mixture more and more explosive, it is evident that an explosion will likely ensue when 5½ times as much air is added.

Then 3,240 × 5·5 = 17,820 cu. ft. of air must be added. The volume then becomes 17,820 + 3,240 or 21,060 cu. ft.

The distance to which the explosion would extend cannot be accurately determined, but it has been found that a violently explosive mixture will expand to about 8 times its volume. As the volume before explosion is 21,060 cu. ft., the explosion will expand it to 8 × 21,060 or 168,480 cu. ft. Then as the height of the workings is given as 9 ft., the explosion will extend over an area of 168,480 ÷ 9, or 18,720 sq. ft.

In our October issue the formula given to answer Question 14, of the Iowa examination, was clearly and correctly stated, but there was an annoying error in the simple arithmetic work of getting the answer. It should have read:

The difference of twelve inches in the reading of the water-gauge shows that to overcome friction a pressure of 12 × 5·2 lbs. or 62·4 lbs. per square foot has been required; and as the velocity is 10 ft. per second in an entry of 48 square feet sectional area there is a current of 10 × 60 × 48 or 28,800 cu. ft. passing. Then the rule to obtain the effective horse power is to multiply the pressure per square foot by the volume of air passing per minute and divide by 33,000.

Thus

$$\frac{62\cdot4 \times 28,800}{33,000} = 54\cdot5 - \text{H. P.}$$

QUESTION 21.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

Supposing a fire should take place in the inlet airway and your men were at work inside of the fire, how would you proceed to rescue them?

ANSWER.—I would stop the fan and send or lead a rescuing party into the mine by way of the outlet, because if the fan was stopped the fire in the inlet would reverse the usual order of ventilation, and the men could be taken out by way of the outlet, which would, for the time being, be the inlet airway.

QUESTION 22.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

What are the disadvantages of having the air travel at a high velocity? Explain fully.

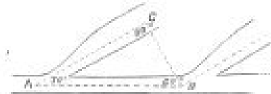
ANSWER.—The most efficient mine ventilation is secured by large airways and slow velocities. The pressure required to increase the velocity of an air current is proportional to the squares of the velocity, so that to double the velocity there must be four times the pressure, or to treble it there must be twenty-seven times the pressure, and so on. If we treble the velocity of the air we thereby cause three times the number of particles to meet the resistance in each moment of time; this alone will treble the resistance, and this with three times the speed, may well be supposed to give rise to a treble treble or twenty-seven resistance.

Again, if the air be so charged with fire-damp as to be explosive, a velocity exceeding 6 ft. per second will force the flame through the gauze of a Davy lamp and cause an explosion.

QUESTION 23.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

Where the gangway is running due East, and breasts are opened 30° North of East, it is desired to maintain a distance of 45 feet for breast and pillar, what will be the distance on the gangway from center to center of breasts?

ANSWER.—The angle formed between the breasts and gangway is 30°. The distance 45 ft. is measured at right angles to the center lines of the breasts, and we thus have to solve a right angled triangle, as shown by dotted lines in cut.



Then as the sine of angle A is to length of line B C as sine of angle C is to line A B we have the following proportion:

Sine 30° : 45 :: Sine 90° : A B or

·5 : 45 :: 1 : 90 or length of line A B.

Or, we can divide the length of the line representing the combined width of breast and pillar by the sine of the angle formed at the junction of the center lines of gangway and breast, which in this case is the sine of 30° or ·5. Then 45 ÷ ·5 = 90 ft.

QUESTION 24.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania on July 6 and 7, 1891.

Which in your opinion is the best method of timbering where the top rock is hard, and inclined to creep, and the vein or seam free and lying on an angle of 10°; and which requires the larger pillar, a hard or soft top?

ANSWER.—The best method of timbering where the top rock is hard and inclined to creep, and the seam free on an angle of 10°, is to timber with double timber, or in other words, with two legs and a collar, set not more than five feet apart, and well lagged back of the legs.

A hard top requires the larger pillar because there is a greater weight to support, and as it will not relieve the weight by breaking it will crush the pillar sooner than a soft top that would break and thus relieve the pillar of some of the weight.

QUESTION 25.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

In opening up a colliery having three workable seams divided by 12 and 25 feet of slate, what system or plan of mining would you adopt, and how would you ventilate the several seams?

ANSWER.—I would adopt the pillar and breast system and open the breasts directly over each other, and would leave every tenth breast in each seam solid so as to form a binding pillar through the three seams. I would ventilate with an exhaust fan having separate splits for each seam and would further sub-divide these splits as occasion and conditions required. I would have cross-holes through the slate at intervals, to assist in dividing the air, if necessary, and also for use as traveling ways.

QUESTION 26.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

Supposing a gangway has been driven due East to the land line running South 40° East, it is proposed to open a breast 40 feet from the face of gangway, how far would the breast go to reach the land line when the pitch is 25°?

ANSWER.—It will depend on the direction in which the breast is driven. If it is driven South it will never reach the land line. If driven North it will reach the land line at a distance of —·- ft.

In the first place we have the land line running S. 40° E, or 40° East of South, which forms an angle of 40° on the North side of gangway. Then if the seam was flat we would have a right-angled triangle with a base of 40 ft., and an angle of inclination of 40°, and we want to find the altitude. Then to find this we multiply 40 by the tangent of 40°. 40 × ·8391 = 33·5640 ft. This would be the distance from the gangway to the land line if the seam was flat, but as it pitches 25° the distance would be 33·564 ÷ the cosine of 25° or ·906308. Then 33·564 ÷ ·906308 = 37·3 + ft.

QUESTION 27.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

What instruments are necessary for a mine foreman, and for what purpose does he use them? Explain fully.

ANSWER.—An anemometer to measure the velocity of the current of air. A water-gauge to measure the pressure. A clinometer to measure the dip of the strata, etc. A thermometer to measure the temperature. A barometer to measure the pressure of the atmosphere. A tape line or chain to measure distances. A compass or transit to make short surveys and to lay off angles. A safety-lamp to test the air for gas. A small set of drafting instruments and any other scientific instruments he can use to advantage in determining the safest and most economical method of mining the coal and securing good and adequate ventilation.

QUESTION 28.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

Which in your opinion is the best safety-lamp, and why does the Davy lamp continue to burn when placed in a body of gas, and why does the Clanny lamp become extinguished when placed in fire-damp?

ANSWER.—In my opinion the Evan Thomas No. 7 is the best safety-lamp because it possesses all the good features of other practical lamps and when tested by various scientific committees it has behaved better than any other. Besides it is simpler in construction than any other of the improved types. The Davy lamp continues to burn in fire-damp because the air has easy ingress and it receives enough to support combustion through the gauze even when the gauze is filled with flame. The Clanny lamp does not have so easy an ingress for air, and if the gauze becomes filled with flame, there is not enough air admitted in the lower part of the lamp to keep up combustion and it necessarily goes out. This is theory, but in practice it is not safe to rely on the Clanny lamp becoming automatically extinguished.

QUESTION 29.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

In a mine employing 300 men, what amount of air is required, and what would be the area of the airway if the velocity is 500 ft. per minute?

ANSWER.—The Anthracite law requires a minimum of 200 cu. ft. of air per minute per employe. Therefore this mine will require 300 × 200 = 60,000 cu. ft. As the velocity is 500 ft. per minute the airway to pass 60,000 cu. ft. must have an area of

$$\frac{60,000}{500} = 120 \text{ square feet.}$$

QUESTION 30.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania on July 6 and 7, 1891.

Which should be the largest airway, the inlet or the outlet airway? Must explain fully.

ANSWER.—The outlet; because the air in its passage through the mine becomes heated and expands, requiring a larger passage-way to carry the same amount as enters the inlet, without increasing the velocity.

QUESTION 31.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

The amount of air produced by a fan is 120,860 cu. ft. per minute, and the water-gauge is 2·4 inches, what is the horse power producing ventilation?

ANSWER.—The horse power is found by multiplying the quantity by the pressure per square foot and dividing by 33,000. For each inch of water-gauge the pressure is 5·2 lbs. per square foot. Therefore we have the following:

$$\frac{120,860 \times 2\cdot4 \times 5\cdot2}{33,000} = 45\cdot7 + \text{H. P.}$$

QUESTION 32.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

Suppose 30,000 cu. ft. of air is produced by a water-gauge of 1·6 inches, what quantity will a water-gauge of 2·5 inches produce?

ANSWER.—The volume varies as the square root of the water-gauge, hence $\sqrt{1\cdot6} : \sqrt{2\cdot5}$ :: 30,000 : ( ) or 37,500 (nearly) cu. ft.

QUESTION 33.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

Where should a furnace be placed so as to give the best results?

ANSWER:—At or near the bottom of the upcast shaft.

QUESTION 34.—Asked at the Examination for Certificated Mine Foremen in the Anthracite Regions of Pennsylvania, on July 6 and 7, 1891.

How could you light a furnace in a mine where the temperature outside is 90° and the temperature inside is 60°, the furnace being built at a point 100 ft. higher than the intake opening? Explain fully.

ANSWER.—Without the use of a furnace the current would naturally be the reverse of what was wanted, and it would be necessary to build as quick and as strong a fire as possible. I would have plenty of combustible material on hand, and after closing the passage-way from the inlet air course I would start a brisk fire, and gradually open the closed passage, so as to give the fire plenty of draft without having the smoke and gases carried back through the workings. As soon as I had the temperature in the upcast shaft raised to a point above 90°, I would throw the passage-way entirely open, and the current would flow in the desired direction

MECHANICAL NOTES

Requirements of a Perfect Steam Boiler

1. The best materials sanctioned by use, simple in construction, perfect in workmanship, durable in use, and not likely to require early repairs.

2. A mud drum, to receive all impurities deposited from the water, in a place removed from the action of the fire.

3. A steam and water capacity sufficient to prevent any fluctuation in pressure or water level.

4. A large water surface for the disengagement of the steam from the water, in order to prevent foaming.

5. A constant and thorough circulation of water throughout the boiler, so as to maintain all parts at one temperature.

6. The water space divided into sections, so arranged that should any section give out no general explosion can occur, and the destructive effects will be confined to the simple escape of the contents; with large and free passages between the different sections to equalize the water line and pressure in all.

7. A great excess of strength over any legitimate strain; so constructed as not to be liable to be strained by unequal expansion, and, if possible, no joints exposed to the direct action of the fire.

8. A combustion chamber so arranged that the combustion of the gases commenced in the furnace may be completed before the escape to the chimney.

9. The heating surface, as nearly as possible, at right angles to the current of heated gases, and so as to break up the currents and extract the entire available heat therefrom.

10. All parts readily accessible for cleaning and repairs. This is a point of the greatest importance as regards safety and economy.

11. Proportioned to the work to be done, and capable of working to its full rated capacity with the highest economy.

12. The very best gauges, safety-valves, and other fixtures

The Antiquity of Wire.

It is not generally known that the manufacture of those metallic filaments or shreds known as wire is one of considerable antiquity, and has been traced by good authorities as far back as the period of early Egypt. A specimen of wire made by the Ninevites some 800 years B. C. is exhibited at the South Kensington Museum. Homer and Pliny referred to similar productions in their writings. From such remote eras up to the fourteenth century wire in its general acceptation was produced by hammering out strips of metal. The operation of wire drawing is mentioned as early as the fourteenth century, for in the chronicles of Augsburg and Nurnberg, of 1351 and 1360 respectively, we find reference to wire drawers, so that it is reasonable to infer that the draw plate was known and used at that period. Rudolf of Nurnberg erected the first wire drawing mill shortly after. About the year 1500 the credit of wire drawing was ascribed in France to one Richard Archal. It was not until about 1565 that machine drawn wire was produced in Great Britain, the manufacture being introduced by a native of Saxony, C. Schultz, and Caleb Bell, who had a mill driven by water power, in Greenfield Valley, Holywell, Queen Elizabeth being supplied with toilet pins from that mill. Inferior hand drawn wire had been and was being made in the neighborhood of the Forest of Dean and elsewhere, but in the seventeenth century the improved manufacture was carried on in Yorkshire and later on in the districts of Warrington and Birmingham, where the industry is still largely located.—*London Iron and Coal Trades Review.*

Another New Nail Machine.

The ordinary wire nail machine bids fair to be superseded if the success of the Pittsburgh Iron and Nail Company in fitting a wire nail attachment to its steel plate nail mill shall prove of general adaptation. In carrying out this plan, the self feeder of a nail plate machine is removed, its place being substituted with an ordinary wire nail machine feed, operating from the left side; the bed plate, gripping and heading dies remain as in the old machine, but from the clamp at the back is attached an arrangement for cutting and pointing the wire similar to the manner in which this process is carried on in regular nail wire machines. It is said that the adapted machine turns out perfectly formed nails at the rate of 250 a minute, and that the heading die performs its work better than characterizes the ordinary apparatus; the heading arrangement of the latter works from above, and fashions the head with a quick blow, while the heading die of the transformed nail plate machine works from the right hand side, and works the heads with a more gradual motion. The nails by this method are represented as thoroughly well made, well pointed, and with large head, and without any indication of splitting. By changing the space block, four, six, eight, and ten penny sizes can be made, and the capacity of the device for wire nails is said to be from 40 to 50 per cent. greater than the common wire nail machine.—*Iron Trade Review.*

Mechanical Drawing a Part of Education.

A good many young men who have been denied the advantages of a technical education, or even a first-class public school education, but who are nevertheless desirous of standing high in their calling, even though they must work their way slowly upward from the bench, the forge, or the foot-plate, sometimes ask if there is any necessity of obtaining a good knowledge of mechanical drawing. To all such, we would most earnestly reply, "By all means obtain a thorough knowledge of drawing." A man may rise to a fair position in any of the mechanical pursuits without it, but if he really wishes to become proficient, and to avoid having his upward progress permanently arrested, his knowledge of mechanical drawing must be considerable. By such knowledge we do not mean the ability to make pretty pictures, or even handsome drawings, but rather a perfect understanding of the principles of the art, and their applicability to every-day work. We have frequently seen the intelligent shop foreman make a drawing which a draughtsman might say looked "tough," but though his lack of expertness in the use of the instruments gave his drawing that appearance, they would be intelligible and correct. Such knowledge always makes it possible for one to communicate his ideas to others, and aside from this convenience there is a drilling of the powers of conception which is invaluable, and can be obtained no other way. A still further advantage accompanying a good knowledge of mechanical drawing, is the better understanding of the fundamental principles of mechanics which almost invariably comes to the student as he becomes proficient in drawing. Every mechanic trying to rise should study drawing, even though he may never intend to work an hour in a draughting room in his life.—*The Railway Review.*

Making and Tempering Spiral Springs.

When the steel spiral spring of an instrument gets broken, it is much more satisfactory to make one than to send the instrument off, and be without it for a week or more.

To make them, use the best spring steel wire; select a smooth iron rod the size of the spring to be made; carefully draw the temper from the wire; fasten the rod and one end of the wire in a bench-vise. Now wind the wire evenly and closely around the rod, until you get the length of the wire required for the spring. Take the rod out of the vise; fasten one end of the spring to the rod; taking hold of the other end, draw it along the rod until the spirals are the correct distance apart. To give the amount of spring wanted, fasten it firmly to the rod, then make the spring and rod red hot, and quickly plunge them into cold water. After drying, rub them all over carefully with oil, and move them about in the flame of a lamp until the oil takes fire, which will give the spring the proper temper. I know there are some who make springs direct from tempered wire; but they are much more durable if shaped and then tempered.—*Dr. Wm. H. Steele, in Items of Interest.*

ENGINEERING

Railroad Matters in Peru.

An engineer engaged on the Central Railroad of Peru writes to us under date of May 6th, giving information of various matters of railroad interest.

Concerning the Inter-Continental railroad surveys he says it is not probable that the amount appropriated will permit more than reconnaissances to be made by parties in the field. He suggests that there may be some trouble from the Indians living east of the Andes, in the heavily timbered country along the headwaters of the Amazon and its branches. The local belief is that the Indians are cannibals, and that they kill their enemies by the use of poisoned arrows blown from blow-guns. He has seen a head that had been treated by these Indians in a manner similar to that employed by the Indians of Alaska. All the bones of the skull were removed, and the skin and muscles were shrunk into a mass about four inches in diameter, but the features roughly preserved. Our correspondent thinks that this will illustrate one of the possible incidents in the life of a Pan-American engineer.

Work on the construction of the Central of Peru is proceeding slowly; fifty miles are building. At the date of the letter work was a good deal delayed for want of timber for timbering tunnels, and also for lack of cement and powder. The Rimac River makes a good deal of trouble every year about the end of the rainy season. No provision was made for this contingency. March 9 the river rose, and two months afterwards no train had got through to the end of the line.

One feature of the country is avalanches of mud carrying down large stones. These sweep everything before them, and it was such an avalanche that carried away the Verrugas Bridge. One of these dammed the Rimac River this year, making considerable trouble.

Most of the laborers are Indians, and at the date of the letter they were off digging potatoes. It all planted at the same time work would have to be stopped, but fortunately there is sufficient difference in the time of ripening of the crop to enable contractors to keep some laborers at work.

It was expected that orders would be received to build a branch to Ceno de Pasco, eighty miles.

In the south Mr. Norris is building about forty-two miles of the Juliaca & Cuzco, from Santa Rosa to Sicuani. This is all light work.

Surveys are being made for an extension of the Trujillo road and others to change the location of the Chimbote. This was located and partly built in the Santa Valley and through a canon in the Black Range. It was washed out badly, and now an effort is being made to cross the range. The lowest pass is 16,000 feet. Then there would be a descent of 8,000 feet, with four-per-cent. grades on both sides of the tunnel, and very heavy work. Going up the Santa would be a continuous grade with a maximum of two per cent. If the road is built on this line it would be one of the best in Peru, as the valley is large and well-peopled. It is fertile and will produce sugar cane in the lower altitudes and wheat higher up. It also has considerable mineral deposits with good coal.

A Steel Bridge Across the Columbia.

The great steel bridge across the Columbia River, at Vancouver, will be a mammoth concern. It will be 6,000 feet from the Washington to the Oregon shore, and it will be double tracked, with roadway on top for teams, and will be erected upon pneumatic piers. The pivotal pier, or draw pier, will support a draw which will give an opening of 200 feet space on either side for vessels to pass, and the span immediately south of the draw span will be 375 feet.

Whole structure to be of steel, built ten feet above the high water of 1876, and forty feet above low water. On account of the sandy formation it will be necessary to go down eighty feet below low water to get a firm foundation. This gigantic structure will cost over $4,000,000. It will be January 1, 1892, before the cars can pass over it. The company is pushing the bridge and also the road as rapidly as men and money and their present perfected plans will permit.—*The Age of Steel.*

Cast Iron Tunnels.

Two tunnels of cast-iron for an electric railway have been built in London and put in operation for rapid transit. They are three miles in length, and lie between forty and sixty feet below the surface of London streets. The tunnels for the up and down lines are formed of cast-iron from beginning to end, save where the stations are built, and their diameter is 10 and 10½ feet. The tubes are formed of rings one foot and seven inches long, made in sections and bolted together. The tunnels are driven by means of a short cylinder, a trifle larger in its inner diameter than the exterior diameter of the cast-iron tunnel lining. This cylinder has a cutting edge, and is forced forward by hydraulic jacks, cutting a circular way into which the lining plates are fitted. The narrow space between the lining and the soil was filled with lime cement forced in under high pressure. In their course the tunnels pass beneath the bed of the Thames and through the bed of an old watercourse, where loose, wet gravel offered some trying obstacles for the engineers to overcome. The entire cost of the line, fully equipped, was less than $3,750,000.

Measuring Strains on Iron and Steel Bridges.

A new method for accurately measuring the strains in iron and steel bridges, has been invented by a prominent French engineer, and is described as follows: Two brackets are attached to the beam to be tested, at some distance apart, on one of which is placed a water chamber, closing by a flexible diaphragm, and connected with an open tube, which serves to register by the height of the tube any pressure that may be made on this diaphragm. One end of a pointed rod is connected with this metal covering to the water chamber, while the other is joined to the other bracket. The most important item of the invention is that any motion of the beam, it will be readily seen, will set the diaphragm in motion, and cause the water in the fine tube to fall. This is a first-rate apparatus, as we are all familiar with the great numbers of railroad accidents that in many cases originate from an unsafe shaky bridge.—*New York Ledger.*

Scientific Advancement

Drunkenness Cured by Dr. Keeley.

In a little town in Illinois called Dwight, on the Chicago and Alton Railroad there has lived and practiced his profession for twenty-five years past a certain Dr. Keeley. The world at large has heard little of him until recently, but during all his professional career he has enjoyed the respect and confidence of his neighbors, and has been a member in good standing of the county and state societies which determine those ethical questions which appear to be of more significance to medical men than to those in other learned professions. He has long been engaged upon investigation as to the cure of drunkenness, and, it is said, these studies have been but a continuation of those made by his father and grandfather in the same direction. For several years past the newspapers in the neighborhood of Dr. Keeley's home have contained more or less full accounts of his having cured by the use of double chloride of gold, men who had long been regarded as hopeless drunkards.

Something like a year ago Mr. Joseph Medill, the venerable editor of the Chicago *Tribune*, had his attention attracted to this new method of treatment, and he had an examination made of it. What he learned influenced him to make a practical test of the alleged cures. He therefore selected several men in Chicago who were looked upon as hopelessly addicted to the habit of drinking liquor excessively, and who also appeared to be wrecked by this long continued intemperance. These he sent to Dwight, and engaged to pay their expenses while undergoing treatment. The result was so satisfactory to him that he endorsed the methods employed by Dr. Keeley in an editorial article in his paper. Naturally enough this endorsement, a most unusual thing from a paper of a class of the *Chicago Tribune*, attracted very general attention, and soon afterwards there was a tide of patients turned towards the little village of Dwight, whither hopeless men traveled in search of something which before had seemed beyond their reach.

Arrived at Dwight these pilgrims found a straggling village, with muddy or dusty streets according to the prevalence of rain or sunshine, and there was only one thing to make it seem different from any other Western village in which twelve hundred persons had their homes. This difference was noted almost at once. There were well-dressed and well-appearing men on the streets in considerable numbers who evidently had never taken any active part in village life, and who were not now of it. These were the pilgrims, these the patients, who had gone to see whether the bichloride of gold treatment could quench their fiery thirst.

The impulse which each new patient brings with him it is said, is to conceal his identity; but as there are men from all parts of the country there—and this is but a very small world, after all, as every man who has traveled away from home has found out—this concealment is all but impossible, and the great majority are soon content to settle down, and acknowledging to themselves that their inebriety is a disease which they as sensible men are trying their best to cure, each in his own personality, and with whatever weight that may add to his words, tries to encourage the new comer," and to contribute his best to the fellowship and comradeship of the community. And, singularly enough, these patients, once dismissed as cured, never, it is claimed make any effort to conceal the fact that they have been treated at Dwight for inebriety. The idea among them seems to be that this form of disease may come as typhoid fever comes, and its cure is a matter for congratulations without any concealment whatever.

The increasing number of patients has necessitated the building of a hotel; but previous to that they boarded around at the various houses and cottages in the village. A new patient, after registering at the Keeley Institute, is given instructions as to the routine of treatment. He is given a bottle of the bichloride of gold mixture. This he must take once every two hours, and four times every day at stated hours he must fall in line with the other patients with bared arm, and receive a hypodermic injection of a medicine the nature of which Dr. Keeley has not announced to the world, but which he explains to his patients is intended as a "bracer," and also to regulate the effects of the bichloride of gold. His method of preparing his gold mixture he also retains as a secret.—*Jno. Gilmer Speed, in Harper's Weekly.*

The Possibility of Mechanical Flight.

Above us in the great aerial ocean stretching over all lands, and offering an always open way to them, yet a way that has never yet been thus trodden. Can it be that the power we have always lacked is at last found, and that it only remains to learn to guide it?

Let me in answering, compare the case to that which would present itself if the actual ocean had never been traversed because it was always covered with fields of thin ice, which gave way under the foot, which indeed permitted vessels to be launched and to float, but which compelled them to move wherever the ice drifted. Such vessels would resemble our balloons, and be of as little practical use; but now suppose we are told, "The ice, which has always been your obstacle, may be made your very means of transport, for you can glide over the thinest ice, provided you only glide fast enough, and experiments will prove not only how fast you must go to make the ice bear, but that it is quite within the limits of your strength to go with the requisite speed." All this might be true, and yet if no one had ever learned to skate, every trial of this really excellent plan would probably end in disaster, as all past efforts to fly have done. Indeed, in our actual experience with the air, men have come to the same kind of wrong conclusion as would have been reached in supposing that the ice could not be traversed because no one had the strength to skate, while the truth would be that man has plenty of strength to skate, but is not born with the skill.

The simile is defective so far as it suggests that man can sustain himself by his unaided strength on calm air, which I believe to be impracticable; but it is the object of these experiments to prove that he has now the power to sustain himself with the aid of engines recently constructed, and by means I indicate, as soon as he has skill to direct them.

If asked whether this method of flight will soon be put in practice, I should have to repeat that what has preceded is matter of demonstration, but that this is matter of opinion. Expressing, then, a personal opinion only, I should answer, "Yes." It is hardly possible that these secondary difficulties will not be soon conquered by the skill of inventors and engineers whose attention is already beginning to be drawn to the fact that here is a new field open to them, and though I have not experimented far enough to say that the relations of power to weight here established for small machines will hold for indefinitely large ones, it is certain they do so hold, at any rate far enough to enable us to transport, at speeds which make us practically independent of the wind, weights much greater than that of a man. Progress is rapid now, especially in invention, and it is possible—it seems to me even probable—that before the century closes we shall see this universal road of the all-embracing air which recognizes none of man's boundaries, traveled in every direction, with an effect on some of the conditions of our existence which will mark this among all the wonders the century has seen.—*The Secretary of the Smithsonian Institution in the Century.*

At an Altitude of 15,400 Feet.

Mr. Imfeld, the Swiss engineer who has been engaged to examine the nature of the summit of Mont Blanc for the construction there of Mr. Janssen's proposed observatory, recounts in a Zurich Journal the difficulties he is experiencing in his preliminary survey. He is staying with eight workmen and two doctors at Mr. Vallot's observatory, which has an altitude of 15,400 feet, and thence they proceed daily to their summit, where they work for several hours a day in the endeavor to ascertain the depth of the snow for the purpose of getting the necessary foundation for the building. Mr. Eiffel has expressed the opinion that the construction of an observatory will only be possible if the snow does not exceed a depth of 40 feet. Mr. Imfeld states that they have encountered traces of a ridge of rock 58 to 65 feet below the summit, and covered with about 3½ feet of snow. They have therefore commenced to make a series of lateral tunnels on three sides, at a distance equal to 40 feet below the summit, to ascertain if the ridge extends to that height. Progress is necessarily slow. Most of the men are suffering from the mountain sickness. Some, however, who are engaged at Mr. Vallot's cabin, are able to work almost as long as in the valley, and they also eat and sleep well. In spite of two coke stoves, the thermometer of the cabin never rises above zero; even ink freezes, and water boils at 83°, and they cannot properly cook meat.

USEFUL INFORMATION

Tuberculosis in Cattle.

"Few scientists now dispute that pulmonary phthisis, the most dreadful scourge of the human race, emanates from milch cattle, and is disseminated almost solely by their agency through the human family."

This broad assertion is made in the highly interesting report of the commission to test the value of Koch's lymph on cattle, as read by Dr. W. L. Zuill at a meeting of the Philadelphia Veterinary Medical Society recently. This commission was appointed by the veterinary department of the University of Pennsylvania early in January last. All through the spring and summer their experiments were carried on and the result of their labors marks an important and most interesting epoch in the study of all that relates to the most fatal of ordinary diseases.

"We all know," continued Dr. Zuill "that the greatest scourge of the human race emanates from milch cattle and is spread by them through the human family. It is an undisputed fact that tubercular diseases are found among people that use the milk and flesh of the bovine race, and that these diseases are not found among those people who do not.

"Few men of science will now dispute that pulmonary phthisis comes from cattle, and that the only people who are free from it are those who do not use the milk or flesh of the cow.

"The Khirgis, who inhabit the steppes of Asia, have no cattle. They drink the milk of mares and eat the flesh of sheep and goats. Phthisis is absolutely unknown among them.

"The Esquimaux who reside in Greenland and other Danish countries have cattle, and hardly anybody is more subject to consumption. The Esquimaux who drive their fleet-footed reindeer over the ice-covered plains of Siberia, and to whom an ox or cow is an animal as rare as an elephant is to us, know not what consumption is.

"On the south coast of Africa are tribes of natives who pride themselves on their vast herds of inbred cattle; who not only drink the milk and eat the flesh, but suck the blood from the jugular vein of living bullocks. These people die like flies from tuberculosis. One hundred miles inland on the plateaus, where the deadly tze-tze fly places a absolute bar to the existence of cattle of any kind, there is no knowledge that even one man ever died of pulmonary consumption or other tubercular disease.

"The people of Ireland have cattle, but they neither drink the milk nor eat the flesh. Among them consumption is practically unknown.

"In Australia and New Zealand, countries by nature utterly unacquainted with the bovine race, there was a time when phthisis had never been heard of. In 1820 the cattle mania seized the people. Cattle were imported in enormous quantities, and to-day these countries are hot-beds of consumption, where the mortality reaches three out of every thousand inhabitants and 6 per cent. of all deaths are attributed to this disease. In New Zealand it has made such ravages that the native Maori is to-day almost an extinct race.

"In Switzerland the carefully kept mortuary statistics show beyond question that consumption reigns in exact proportion to the number of cattle kept and used. When cattle are most numerous the deaths are many. Up in the mountain where only sheep and goats can live, the disease is almost unknown.

"The facts also show that the tendency to tuberculosis is most dangerous in the families of cattle that are inbred.

"With these facts before us, the conclusion cannot be escaped from that it is to the use of the milk and flesh of cattle that the human family owes the existence of consumption among its members. We do not say that this milk and flesh must not be used, for it has been demonstrated that under proper conditions of care and breeding the disease can be eliminated from our cattle, but we must abolish tuberculosis from among them. This can only be done by demanding and obtaining from the national or state government a proper scientific and non-political inspection of our food. This brings to mind the importance of an agency that will bring to view every case of tuberculosis in our cattle."

Success From Small Beginnings.

Too many young men at the present time have an altogether wrong impression of life. Seeing those about them in a prosperous business, employing a large capital with an immense plant, and doing business on a large scale, they are ambitious to do the same. They do not stop to consider that it has taken years, possibly generations, to develop what they see. They only see it as it is, and believe that in order to become successful it is necessary to do business in the same way, upon the same extensive scale.

A writer in the *National Grocer* says that the great industrial enterprises of the world have as it were, developed unconsciously to those who have been their principal manipulators. Many of them have commenced so insignificantly that some of our bright young men of to-day would scorn the idea of commencing life in a similar manner. It is said that one of the largest sugar-refining institutions of the world was commenced by a single kettle virtually over a kitchen fire, and we know positively of one business which was capitalized very recently for a couple of million dollars that was started in a small wash-kitchen, when the stock in trade, fixtures, machinery, and business utensils would not have brought $20 under the hammer, and the man started it lived to see it placed on the market at $2,000,000, and declare several years successful dividends. We know of another business enterprise, which to-day is worth at least $2,500,000, that was commenced on $100, and that was borrowed.

Constant dropping wears away the stone. Constant work, intelligently directed, brings success. It is idle to say that there are no opportunities and things are not what they used to be. The opportunities of to-day are just as great as they ever were, if we only have the ability and the energy to take advantage of them. Mistakes will occur, and bright prospects are sometimes blasted, but the fault generally lies with the individual, and not with the circumstances or with the opportunity. We have heard men say that they have failed to do certain things because circumstances have been against them. Our reply is that they have failed because they did not have the ability to make the most of their opportunities and guard against loss. There are many palliating circumstances, we must admit, but it is the individual who has the ability to get up and get who brings success. Many men fail; some men fail often. Yet all of these ultimately succeed, simply because they do not and will not give up. They are just as ready and eager for the fray as they were before they had been knocked down twice. Indeed the partial failure has only acted as an incentive for increased effort.—*The Manufacturers' Gazette, Boston.*

An Immense Tree.

Nearly a quarter of a century ago the *New York Ledger* gave a description of a "big tree" that was cut down in Calveras County, Cal. According to the statement of a gentleman who saw the tree and danced on its stump, the height of that tree was 302 feet. Across the stump, five feet from the ground, it measured 25 feet in diameter without the bark, and 28 feet with it. It was 96 feet in circumference at the stump. It took five men seventeen days and a half to bore it off the stump with pump augers, and two and a half more to drive and wedge it up with the butts of other trees to make it loose its center of gravity and fall to the earth. Its trunk was so straight and its branches so symmetrical that it stood without a shake even in a high wind, after it had been completely severed by the augers. Thirty-two couples danced a set on the stump, and there was room enough for the musicians and spectators besides. It was perfectly sound clear through.

The Microbe's Lot.

Pasteur's plan of growing disease germs outside the body in broth although of the utmost value, did not allow a convenient separation of different germs; but this can now readily be done by Koch's plan of sowing them, not in a liquid medium, but on solid gelatine spread on glass plates, so that the growth of the germs can be daily watched under the microscope, and inoculations made from single colonies on other plates until pure cultures have been obtained. By thus isolating the different microbes, we learn their life-history, the mode in which their growth is influenced by differences of soil, of temperature, of moisture, by the addition of various substances which either favor or retard their growth, and last but not least, the effect which one microbe has upon another when they are grown together at the same time.

For even among these minute organisms the struggle for existence and the survival of the fittest exist, like that which Darwin pointed out so clearly in the case of higher plants and animals. When two microbes are growing together, one may choke or destroy the other, just as weeds in a garden may choke the flowers; or on the other hand, successive generations of one microbe may render the soil suitable for another, just as decaying algæ and mosses may furnish mold in which higher plants can grow.

But it is not merely between different species of microbes or different cells in an organism that this struggle occurs. It takes place also between the disease germs and the cells of the organism which they invade, and the result of the struggle may be determined, not by some powerful agency which weakens or destroys either the organism or the microbe, but by some little thing which simply inclines the scale in favor of one or the other. Thus, in the potato disease the victory of the invading microbe and the destruction of the potato, or the death of the microbe and the health of the tuber, may depend upon some condition of moisture or possibly of electrical change in the atmosphere which aids the growth of the microbe disproportionately to that of the potato. These atmospheric conditions need not necessarily be antagonistic to the potato; They may even in themselves be advantageous to it; but if they help the microbe more than the plant, the microbe will gain the victory and the plant be destroyed.—*Lancet.*

The Copts—An Interesting People About Whom but Little is Known.

These people esteem themselves to be the true descendants of the ancient Egyptians, as distinguished from the conquering race of Arabians who have now overrun their land. It is a comical idea but they call upon us to note their close resemblance to the mummies. Early converts to Christianity, they have remained faithful to their belief amidst the Mohammedan population all about them. It must be mentioned, however, that they had been pronounced heretics by the Council of Chalcedon before the Arabian conquest; for they had refused to worship the human nature of Christ, revering his divine nature alone. They are the guardians of the Christian legends of Egypt. In a crypt under one of their churches they show two niches. One, they say, was the sleeping place of Joseph, and the other of the Virgin and Child, during the flight into Egypt. Near Heliopolis is an ancient tree, under whose branches the Holy Family are supposed to have rested when the sunshine was too hot for further traveling.

There are between four and five hundred thousand Copts in Egypt. They are the book-keepers and scribes; they are also the jewellers and embroiderers. Their ancient tongue has fallen into disuse, and is practically a dead language. They now use Arabic, like all the rest of the nation; but the speech survives in their church service, a part of which is still given in the old tongue, though it is said that even the priests themselves do not always understand what they are saying, having merely learned the sentences by heart, so that they can repeat them as a matter of form. Copts have been converted to Protestantism during these later days by the American missionaries.

They are not, in appearance an attractive people. Their convents and churches, at least in Cairo and its neighborhood, are so hidden away, inaccessible, and dirty that they are but slightly appreciated by the majority of travelers, who spend far more of their time among the mosques of Mohammed. But both the people and their ancient language are full of interest from a historical point of view. They form a field for research which will give some day rich results. A little has been done, and will done; but much still remains hidden. It has yet to be dug out by the learned. Then it must be translated by the middle-men into those agreeable little histories which, with agreeable little tunes, agreeable little stories, and agreeable little pictures, are the delight of the many.—From "Cairo in 1890," by Constance Fenimore Woolson, in *Harper's Magazine* for October.

ELECTRICAL PROGRESS

Invalid's Electric Chair.

Alexander Johnston, of Washington, D. C., has recently patented an electric chair for invalids which is so simple in its construction and mechanism that any one may operate it without the assistance of an attendant. It consists of an easy chair running on two large wheels, with a smaller movable wheel used as a means of guiding the device. An electric motor is placed beneath the seat and geared to the axle of the large wheels, the magnets being wound for low electric motive force. Electric power is furnished from a storage battery, which is also put under the vehicle, and the current is controlled by means of a switch conveniently placed near the arms of the chair. There is also a powerful brake. It is claimed by the inventor that a speed of eight miles an hour can be maintained for five hours, or a distance of fifty miles can be covered at a lower rate of speed from one charge of the battery. The controlling switch is provided with resistance coils so that any speed up to eight miles an hour can be reached. The weight of the chair when ready for service is but 150 pounds. It is the intention of the inventor to place his invention for the use of the visitors to the World's Fair who can thus be propelled along the aisles by electricity instead of being pushed by a time-consuming attendant, as was the case at the Centennial Exhibition in Philadelphia.

Telegraphical Handwriting.

The writing telegraph instrument, the latest invention in the telegraphic world, was on exhibition at the North American Telegraph Company's rooms, Clark and Jackson streets, Chicago, recently. The test was between Chicago and St. Paul, a distance of more than 400 miles, and despite the damp weather, which as a rule is unfavorable to a satisfactory test, the results were more than successful. The instrument itself is very simple. A case 2 x 2½ inches contains the electrical mechanism, while the only thing visible is an ordinary roll of tape—the same as used in "tickers." The operator takes a pencil and placing the point on this sensitive plate in the opening, simply writes his message, and at the receiving point it is duplicated on the tape. In this manner pictures can be traced, maps drawn, and notes signed at the distance of thousands of miles. Mr. Ethridge, who had the test in charge, said:

"This is undoubtedly the most wonderful invention on record. It will do away with the Morse system, and will soon be in use throughout the world. I can stand here and write to my friend in New York and my message is delivered to him in my own handwriting in a minute. I can send about forty-five words in a minute without much effort."

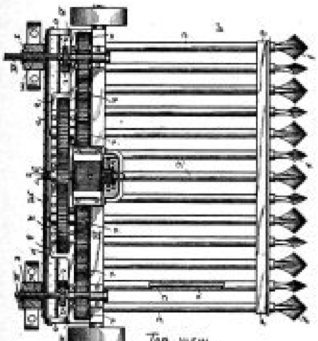
Practical tests have been made in Philadelphia, Baltimore, New York, and other places. Messrs. Cowper and Robinson are the inventors.—*Chicago Journal of Commerce.*

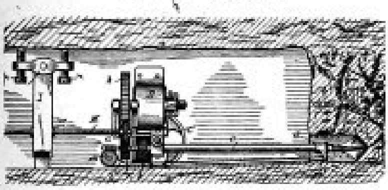
A Large Incandescent Installation.

The electrical engineers who are working on the plans for lighting the World's Fair buildings have a task of unequaled magnitude before them. The illumination of the Fine Arts Building, for instance, will require no less than 15,000 incandescent lamps. This will unquestionably be a larger incandescent installation than any hitherto attempted and will present a very pretty problem in distribution. The more one hears of the World's Fair, the more one is inclined to agree with Sir Henry Wood that at all points it will excel in magnitude all of the great expositions that have been held.

MINING MACHINE.

No. 458,868. Charles J. Van Depoele, Lynn, Mass. *Patented September 1, 1891.* In this machine much of the usual framework is dispensed with, and the machine is thereby lightened. The drills are all geared together at the rear end as shown, and two of the pinions *i i* are driven by the motor through the idler wheels *h h*. Each drill-rod runs through a tube C, and these tubes serve as ties to unite the front and rear frames *d* and B. The machine is supported on two wheels as shown. The chips are swept out of the cut by a belt of wire netting of large mesh, shown in the side

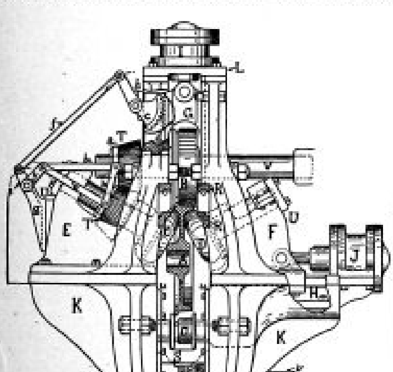




view. This belt is driven by a long roller M, which is supplied with projecting pins in sufficient number to engage the mesh of the netting. The roller is driven by a worm on the rear end of the middle drill-rod. The two outside drill-rods carry small pinions which drive the gears G and turn the feed-screws H. These screws run through nuts *m*, in the jacks or posts I, and serve to feed the machine up to its work. The machine is driven by an electric motor D. The alternate drills run in opposite directions and the cut of one overlaps that of the next, so that no coal is left standing between the holes.

ROLLING MILL FOR CAR WHEELS.

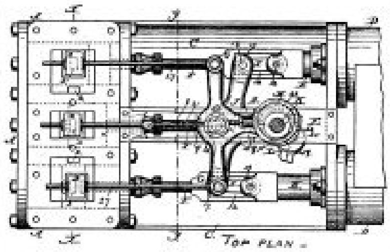
No. 457,922. John R. Jones, Philadelphia, Pa. *Patented August 18, 1891.* A blank is first cast or moulded of somewhat larger dimensions, except diameter, than the finished wheel is to have. When properly heated it is placed between the three rolls B C D as shown in section. The roll B is attached to the shaft V and is positively driven. It is carried by a sliding yoke or cross-head G, and is moved up or down by a hydraulic cylinder I. The roll C is journaled in a fixed housing E and is driven from the shaft V by the bevel gears T, as shown. The roll D is not

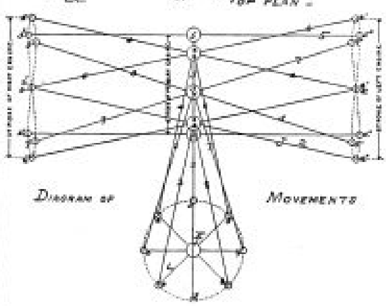


driven, and is journaled in a movable housing F, which is moved by the hydraulic cylinder J. Guide rollers O, carried on a cross-head S, are used to steady the lower edge of the wheel during the rolling operation. By forcing down the roll B, and driving the roll D forward, the metal in the rim of the wheel, and also the web next to the rim can be compressed and condensed to any desired extent. The carrying rollers O are moved downward by the screw and bevel gearing shown at the lower end of the machine, as the rolling progresses, to suit the increasing diameter.

TRIPLE STEAM PUMPING ENGINE.

No. 451,849. James H. Blessing, Albany, N. Y. *Patented May 5, 1891.* Three parallel steam cylinders are employed, all of which may take live steam; or the middle one only may use live steam and the other two receive its exhaust and expand the steam a second time. The middle piston rod is guided by a cross-head running under a guide bar E, and the other two piston rods are guided by the pump plungers H, to which they are coupled by yokes G. The two yokes are connected by links I to the ends of a T-shaped rocking beam J, which rocks on a pin II in the cross-head of the middle piston rod. The whole beam travels back and forth with the middle rod. The third end of the beam takes hold of the wrist pin of the crank L, on the

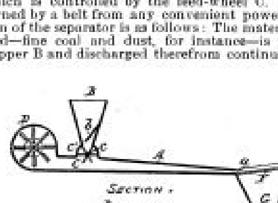


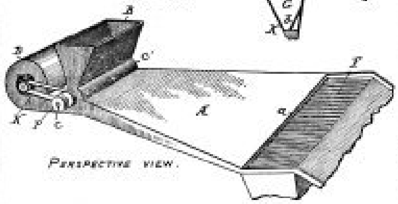


shaft K, which extends through the guide bar E on one side and the main frame C on the other. Two eccentrics M and N serve to move the valves B of the steam cylinders, (the steam chests are omitted in the drawing), and the valve rods are connected by a T-beam in a manner similar to the piston rods, adapted, however, to the shorter stroke. The diagram shows the position of the four pins in the main beam, at eight points in the revolution of the crank. It will appear on examination that two cylinders will be always driving, and that only one piston at a time can be at the end of its stroke—or "on the center." The motion is very uniform, and the stroke is always of exactly uniform length.

FINE COAL SEPARATOR.

No. 454,148. Andrew C. Smith and Marcus K. Bishop, Scranton, Pa. *Patented June 16, 1891.* This machine is designed to separate "buckwheat" and other small sizes of coal from dust, and to dry it, if it is wet. In the drawings, A is a casing or trunk through which the material to be separated is forced by a blast of air from a blower D. The trunk is relatively narrow and deep at one end and wide and shallow at the outlet end *a*. Above the trunk at its narrow end is a hopper B, having converging sides, and at the bottom of the hopper is a feed-wheel C. Near the bottom of the hopper is an apron or deflecting plate *b*, forming a contracted discharge opening at one side of the hopper, which is controlled by the feed-wheel C. This wheel is turned by a belt from any convenient power. The operation of the separator is as follows: The material to be separated—fine coal and dust, for instance—is placed in the hopper B and discharged therefrom continuously into the

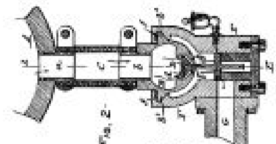


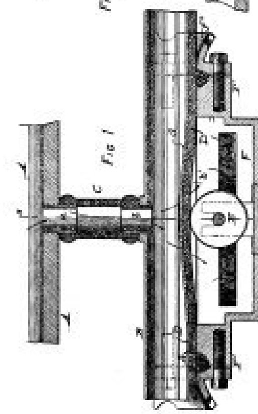


trunk by means of the feed-wheel C. The blast of air generated by the blower drives the material through the trunk and delivers it on the screen in a thin layer with considerable force. As the screen lies directly in the path of the blast, the air and with it the dust and fine particles of coal pass into the chute G, while all of the particles of coal which are too large to pass the screen are shot over it onto the chute H. Should the material be damp, the current of air passing through the particles will dry them and the impact upon the screen will shake off the dust, thus at one and the same operation drying, cleaning, and separating the coal. A second machine may be placed below the hopper G and the fine stuff may be again screened and separated if desired.

PNEUMATIC RAILWAY.

No. 454,318. Harvey W. Wiley, Washington, D. C. *Patented June 16, 1891.* This apparatus is designed to furnish a continuous supply of compressed air to street cars for propulsion. A supply pipe A runs the whole length of the road, just under the surface. A second pipe B is suspended beneath it by means of flexible connecting pipes C. Pipe B, called the "valve pipe," is slotted on the under side at b^1 throughout its whole length. A long V-shaped strip of rubber D lays in this slot and acts as a valve. It is backed by a strip of metal *d*, which stiffens it, and prevents it from being blown through the slot. An air-box F is formed to fit the under side of the valve-tube, and to slide on the flanges b^2. It is provided with soft packing at both ends, and along the gibs *f*, to prevent the leakage of air. This box is attached to the car by a slender bar running in

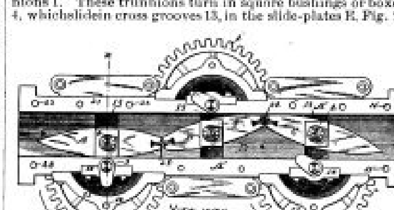




a slotted rail on the surface, like the grip of a cable car. The wheel E lifts a portion of the valve-strip D from its seat, and so permits air to pass out of the pipes into the air-box continuously. The air pipe G is flattened and passes up through the slot rail to the motor on the car above. Thus as the car moves it carries the air-box with it, and the wheel E keeps the valve open and so maintains a constant supply of compressed air to operate the motor. At crossings the valve pipes are interrupted, and the air-box slides off one section of pipe onto another on the other side of the crossing. A small tank on the car carries enough air in reserve to pass over considerable gaps in the supply pipe. It is of course provided with a check-valve to prevent the air from blowing back out of pipe G when the air-box is out of contact with the pipes. In practice the valve-pipe B is made from one and one-half to three inches diameter.

PUMP OR MOTOR.

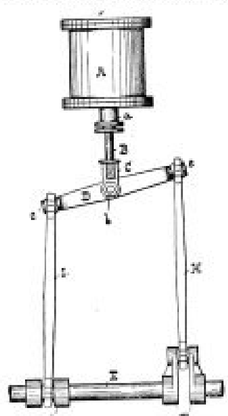
No. 457,303. Edgar Courtright, St. Ignace, Michigan. *Patented Aug. 4, 1891.* Three pistons or paddles A B C, are arranged to move transversely from one side to the other of the square tube D, and in doing so they rock on their trunnions 1. These trunnions turn in square bushings or boxes 4, which slide in cross grooves 13, in the slide-plates E, Fig. 2,



and are also keyed rigidly to the short pitmen 5, which take hold of the cranks 8, on each side of the tube. These pitmen have large flanges as shown in Fig. 3, sufficient to cover the slots 13 in all positions. The cranks are set at angles of 120 degrees apart, and are geared together so as to revolve in unison. The water passes through in the direction of the arrow. When working as a motor the parts operate as follows: Let the paddle A, as shown in Fig. 1, be located at its lower position, the water passing in above the paddle. Paddle B will then be pressed downward, the slides 4 4 moving down in the grooves 13 and the end of the paddle B most remote from paddle A turning down at the same time. This downward movement of the paddle operates through the pitmen 5 5 upon the cranks 8 8 of the shaft and cog-wheels 2^3. As the paddle B moves down and oscillates, the water rushes through, operating not only upon paddle B to press it downward, but also to oscillate the paddle C, turning the end which is connected to paddle B downward until it reaches substantially a horizontal position, and at the same time the paddle C moves downward in the groove until it assumes the position shown in Fig. 1 by A, thus operating upon the main shaft of the wheel 2. While the paddle C is moving down the paddle B oscillates upon its journals, turns the end of the paddle A which is connected to B upward, and when the paddle C has reached its horizontal position the paddle A is tilted into the position shown by C in Fig. 1 and is ready to begin its upward stroke and is moved by the power of the water bodily upward, acting through the pitmen and cranks upon the shaft 3. As the pitmen vibrate in following the crank they give the paddle a rocking motion at the same time that they move it across the tube. The up-stream ends of the paddles are always horizontally in advance in their vertical travel, thus the upstream ends of the paddles always reach the opposite side of the trunk first. The cranks, being set at angles of one hundred and twenty degrees apart, cause the downstream end of the paddle C to leave the side of the tube at exactly the same time that the upstream end of paddle A reaches it. In this position the water in the chamber formed above the paddles, having exerted its entire force against the paddles, is discharged downstream.

CONNECTION FOR STEAM ENGINES.

No. 454,814. Ambrose E. Parsons, New Berne, N. C. *Patented June 23, 1891.* The object of this device is to overcome the dead centers in a single cylinder steam engine. The cross-head C takes hold of the middle of a beam D by means of a pin *b*. This beam runs between guides of any suitable kind, and is connected to the connecting rods I and

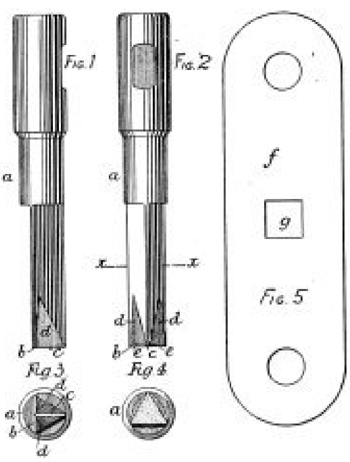


H by ball joints as shown. The main shaft E, has two cranks at right angles, to which the rods are also connected by ball joints. It will be seen that when one crank is on the dead center the other is on the quarter, and will continue the rotation of the shaft. Thus one crank relieves the other alternately.

DRILL FOR BORING SQUARE HOLES.

No. 456,258. David B. Hutton and Archibald F. Daniels, Essex, England. *Patented July 21, 1891.* The drill is provided with a shank adapted to the socket of the drill-holder. The body is made triangular, but the sides are made slightly rounding instead of flat. These rounded sides are found in practice to have a very decided advantage, as they prevent the jarring which takes place when a flat-sided drill is employed. The end of the triangular shank is ground or beveled off to form one or more cutting edges, but in such a manner that the drill shall have no central point upon which it can rotate.

As shown in Figs. 1 to 3, the drill may be provided with



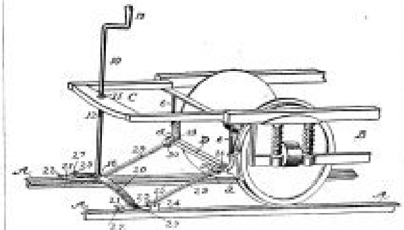
the cutting edge *b* on one of the triangular sides and with another cutting edge *c* at right angles thereto, the latter being formed by notching the other two sides of the triangular shank, as shown at *d d*. The halves of the edge *b* are beveled in opposite directions, as indicated most clearly in Fig. 2 at *e e*, and the edge *c* is also beveled in such a manner that during the rotation of the drill it will cut with the other edge. In some cases the edge *c* is dispensed with, in which case the whole of the cutting is effected by the edge *b*.

Now *f* is the guide-plate through which the drill works, the said guide-plate being provided with a square hole *g*, the sides of which are of slightly greater length than the sides of the triangular shank, the result of which arrangement is that when the drill is rotated in the hole in the guide-plate the angles of the said drill will be caused to enter the angles of the said hole, and thus insure the cutting out of the whole surface exposed inside the hole. This guide-plate may be fixed to the table of a drilling machine or attached to the rest of a lathe or to the article to be drilled. It is obvious that when rotating in the hole of the guide-plate the drill will have no central point, and it is therefore necessary to provide for a slight lateral play of the drill. This may be advantageously accomplished either by allowing the drill to fit loosely in the socket of the drilling machine spindle or by mounting the drill in an independent socket carried upon the drill-spindle by means of a universal joint. In this latter case, however, the guide-plate *f* is made of great thickness or depth so as to hold the drill at two points in its length.

Although this drill is intended for drilling square holes, it is obvious that if the drill is used without the guide and is rigidly fastened in the socket of the drilling machine it will drill round holes.

CAR BRAKE.

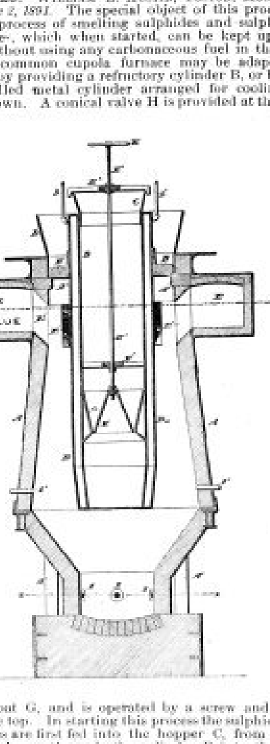
No. 456,130. William L. and Elias A. Antrim, Davenport, Iowa. *Patented July 21, 1891.* In addition to the ordinary brake beam and shoes *d*, a pair of slippers 21 are employed, which rub on the track rails as shown. They are connected by a rigid cross-bar 20, and are connected to the ordinary brake beam D by stout bars 29. The screw 12 and crank handle 11 serve to force the slippers down against the rails, or to lift them up the necessary



height to clear. At all times they serve as a pilot or "cowcatcher" to throw obstructions off the rails and prevent them from passing under the wheels. The friction of these slippers on the rails, tends to force the brake shoes *d* against the wheels, and the application of the brake to the track and the wheels is simultaneous. By applying this brake at each end of the car, the whole weight of the car can be thrown on the slippers to create friction, and the wheels will be relieved of their load, thus avoiding the evil effects of skidding.

PROCESS OF SMELTING SULPHIDES.

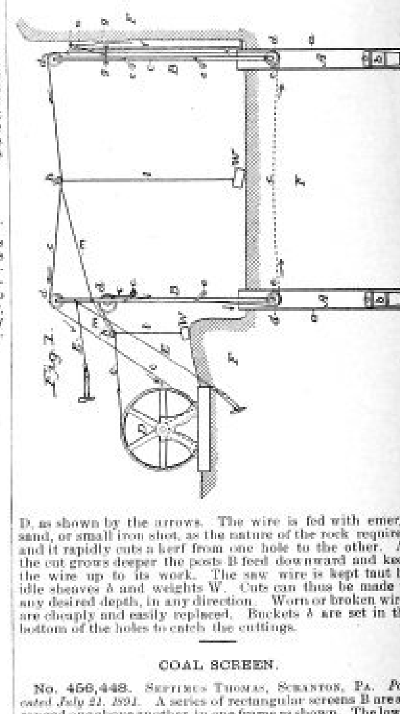
No. 453,529. William L. Austin, Toston, Montana. *Patented June 2, 1891.* The special object of this process is to provide a process of smelting sulphides and sulphurets of all varieties, which when started, can be kept up continuously without using any carbonaceous fuel in the furnace. Any common cupola furnace may be adapted to this process by providing a refractory cylinder B, or better, a double-walled metal cylinder arranged for cooling by water, as shown. A conical valve H is provided at the con-



tracted throat G, and is operated by a screw and hand-wheel at the top. In starting this process the sulphides and combustibles are first fed into the hopper C, from which they pass down through the cylinder B into the body of the furnace, the rate of their flow being dependent upon the adjustment of the bell H with reference to the hopper formed within the cylinder by contraction G, or of some other desired regulating device. When this preliminary mingled charge of sulphides and combustibles has been fired and the furnace has become heated up in the ordinary way, the normal charge containing no carbonaceous fuel is gradually introduced into the hoppers C and D. Sulphurets and other compounds which are liable to fuse and stick together, when exposed to heat and furnace gases, are fed into the hopper C, so as to be inclosed and kept away from the heat of combustion in the furnace by the cylinder B until they can reach the smelting zone of the furnace. By this means and in this manner it is possible to introduce the sulphurets and said other compounds into the furnace and feed them continuously to the smelting zone without danger of the sticking and clogging up of the furnace, which is sure to take place where it is attempted to feed them down in the usual way exposed to the furnace heat and gases before they reach such zone. Silicious ores, fluxes, and coarse material generally, which will not fuse, soften, or stick together, are fed into the outside hopper D and pass down into the body of the furnace. On the way down the annular space between the furnace walls and the cylinder B they are subjected to the action of the escaping gases, heat, and products of combustion, so that they are beneficially prepared for the subsequent fusion upon reaching the smelting zone and being subjected to the blasts from the tuyeres. They act also in their passage downward through the gases and vapors to catch and hold volatilized solids. The height of the furnace should be such that the gases and vapors rising from the combustion and smelting shall be in a comparatively cool state when they pass into the downtake, it will be observed that the object is to keep certain ingredients of the charge from the action of the heat and gases before they reach the smelting zone, while allowing the other ingredients to be acted upon by the heat, vapors, gases, and products of combustion before they reach the said zone. The two parts of the charge are kept separate until just before they enter the zone of fusion, when they commingle and descend together. The molten products pass the main tuyeres I I and immediately run out of the furnace into a receiver. They are not allowed to collect so as to form a bath in the furnace or to assist in keeping up or supporting combustion, but are continuously drawn off as soon as formed. Through the main tuyeres I I is introduced a hot blast, while through tuyeres I' I' air is admitted to consume any sulphur or other volatile product which tends to collect upon the furnace or cylinder sides.

STONE SAWING APPARATUS.

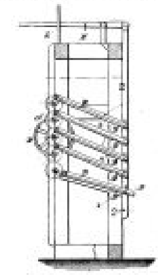
No. 454,712. George F. Clark, Rutland, Vt. *Patented June 23, 1891.* This apparatus is designed for sawing stone in place in the quarry. Two round holes A of sufficient size to admit the sheaves *d* are first drilled at the ends of the proposed cut, by a hollow core drill. These sheaves, together with other guide sheaves *a*, are attached to posts B, which are guided by guy ropes E, or by temporary timbers, in any convenient manner. An endless wire *c* runs around the guide sheaves and around the drive wheel



D, as shown by the arrows. The wire is fed with emery-sand, or small iron shot, as the nature of the rock requires, and it rapidly cuts a kerf from one hole to the other. As the cut grows deeper the posts B feed downward and keep the wire up to its work. The saw wire is kept taut by idle sheaves *h* and weights W. Cuts can thus be made to any desired depth, in any direction. Worn or broken wires are cheaply and easily replaced. Buckets *b* are set in the bottom of the holes to catch the cuttings.

COAL SCREEN.

No. 456,448. Septimus Thomas, Scranton, Pa. *Patented July 21, 1891.* A series of rectangular screens B are arranged one above another, in one frame as shown. The lower end of each screen is provided with a pin on each side which enters a slot in the hanger-bar 2. By means of a lever H the hanger bars can be moved up or down, and the pitch of all the screens can be changed simultaneously. A



separate adjustment for each screen is also provided, consisting of a rod *k* having eccentrics which bear under each edge of the screen. The screens are shaken by cams on the shafts shown under their upper ends. The shafts are geared together, and are driven by a belt on the pulley shown on the middle shaft. The lower screen receives a horizontal movement in addition to the vertical movement, being provided with hooks which engage small eccentrics on the lower shaft.

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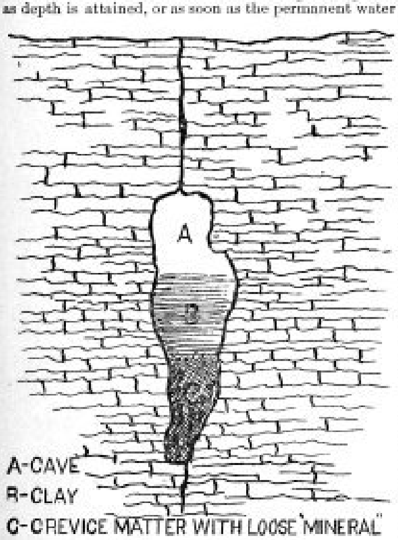
VOL. XII.—NO. 5. SCRANTON, PA., DECEMBER, 1891. WITH WHICH IS COMBINED THE MINING HERALD.

THE ECONOMIC GEOLOGY OF LEAD.

The Mineralogy, Mode of Occurrence, and Production of Lead.

BY H. A. WHEELER, E. M., OF ST. LOUIS.

Although there are a large number of minerals that contain lead, there are only three which occur in sufficient quantity as to be of any importance as lead ores, or the sulphide, sulphate, and carbonate. By far the larger portion of the world's lead supply is obtained from the sulphide or galena, and both the sulphate and carbonate are secondary products arising from the surface alteration of galena, so that deposits of these oxidized ores of lead are almost sure to change into galena as depth is attained, or as soon as the permanent water



SKETCH A—A CLAY GASH VEIN.

level is reached. The following descriptions give the prominent characteristics of these minerals:

Galenite, or galena, is a sulphide of lead carrying about 87% of lead, when pure. It is very heavy (specific gravity is 7·0 to 7·5), quite soft, has a bright metallic luster and lead-gray color, and has an eminent cleavage or splits readily into leaves, plates, or cubes. The usual miner's term for galena is simply *mineral*.

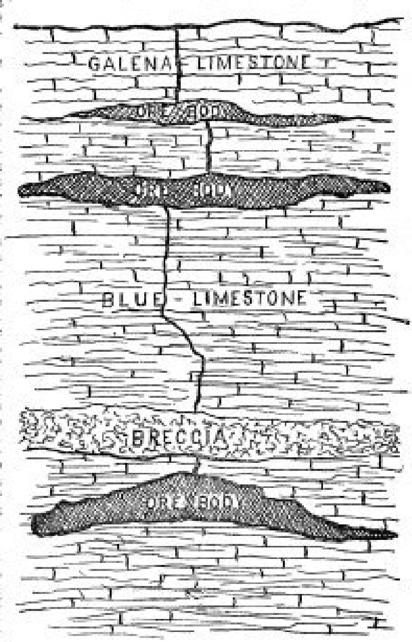
Anglesite, or "rock carbonates," is a sulphate of lead that contains about 68% of lead when pure. It is a soft, heavy, non-metallic, white to brown colored mineral that is usually very compact, and never has the loose granular or sandy structure that is so characteristic of the carbonate. The miner's name of "rock carbonate" very appropriately distinguishes it from the cerussite or true carbonate.

Cerussite, or "sand carbonate," is a carbonate of lead that contains about 78% of lead when pure. It very much resembles anglesite in all its properties, except that it nearly always occurs as soft, earthy masses, or as crystalline or granular slightly coherent masses that resemble a coarse, heavy sandstone, while it does not occur in the compact, rock-like condition so characteristic of the sulphate.

Lead occurs so extensively in association with silver and gold in the deposits of the West, that a study of the mode of occurrence of the ore deposits from which most of the lead produced in the United States is obtained would be largely a repetition of what has been previously treated under the occurrence of silver in THE COLLIERY ENGINEER of October and November. It should be mentioned that the so-called "blanket" or contact veins of Leadville and Aspen have been and, especially at the latter camp, are still very heavy producers of this metal, while the chamber deposits of the Richmond and Eureka Mines and the contact lode of the Horn Silver Mine have each been phenomenal producers of lead in the past, while a group of mines in the Coeur d'Alene district, of Idaho, are at present turning out very large quantities of lead from low grade argentiferous ores that first require concentration before they can be profitably smelted.

Colorado and Utah have been the principal lead producers of the West, making up their heavy output from a large number of silver-lead mines scattered through their respective mountains, and according to the returns of the *Engineering and Mining Journal*, the former state produced 62,000, while the Utah mines produced 24,000 tons of pig-lead in 1890. Nevada, which practically means the Eureka district, produced only 2,500 tons in 1890, whereas the former output used to amount to 30,000 to 40,000 tons per annum, while the Coeur d'Alene district has come up from a very minor output to about 22,000 tons per year, with a promise of a still greater increase.

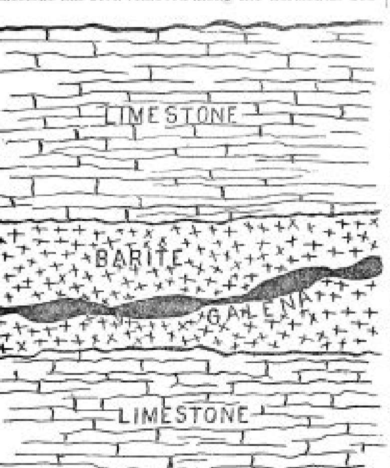
Montana, New Mexico, and Arizona contribute much smaller amounts from their lead-bearing silver mines, and the total production of the far Western mines, in which the lead is obtained as a by-product in working the ores for silver, amounted to about 130,000 tons in 1890, which is more than two-thirds of the entire product of the United States. Large as this Western production now is, and which has brought the United States up to the first rank in the world's production of lead, as it now exceeds the enormous product of Spain, and the large outputs of Germany and England, it is of comparatively recent growth, and dates from the opening up of the low grade class of Western silver mines, or say from about 1860, which have steadily increased the quantity until now their by-product has grown to the above quantity and this country is at last about able to be independent of the foreign lead miners and supply its own market. Previous to this rapid development of the silver-lead mines of the far West, the home supply of lead was practically all derived from the Mississippi Valley, which is still actively producing, though since it has been so completely eclipsed by the Rocky Mountain mines, it has lost its former importance. The Mississippi Valley lead ores carry no silver in paying amounts (or less than five ounces per ton), with few unimportant exceptions, and generally make



SKETCH B—CROSS-SECTION OF "FLAT" VEINS.

a very pure, soft quality of lead. The mines of this region can be roughly divided into three groups, or (*a*) the Upper Mississippi Group, (*b*) the South-Eastern and Central Missouri Group, and (*c*) the South-Western Missouri Group.

The first, or Upper Mississippi Valley group of lead mines, occur in a particular limestone formation, where the three states of Wisconsin, Iowa, and Illinois adjoin. This limestone, which is about 200' thick, is known as the "galena limestone" and belongs to the Trenton period of the geologists or to one of the very old formations. The lead occurs as galena, in association with zinc-blende and iron pyrites, and is found as gash veins in the limestone, with clay and calcite or lime-spar as the gangue. Sketch A illustrates a very common type of gash-veins found in this region, in which the "crevice," or "gash," is not entirely filled, and the "mineral," or galena, occurs loose as fragments in clay or crevice matter. If the "gash" is a horizontal one, it is called a "flat," or sheet vein, or a "floor," as shown in sketch B, but whose origin is identical with A, only the limestone has been removed along the horizontal bed-



SKETCH C—LONGITUDINAL SECTION OF A "PIPE" VEIN.

ding planes, instead of the vertical joint planes, before the mineral matter was deposited. Sometimes the galena occurs as long, thin, continuous threads or sheets, especially associated with barite, or "heavy spar," when it is locally called a "pipe" vein as shown in sketch C.

[TO BE CONTINUED.]

PIT-BROW LASSIE OF WIGAN, ENGLAND.

The accompanying cut is from a photograph from life, and shows an English colliery woman, dressed and equipped for work on the pit-brow. "Ow's a good un an' can do a shift wi' ony on un." To the American, the employment of women around the mines is repugnant, and we are glad to state that the number so employed in Great Britain is steadily diminishing. When Queen Victoria ascended the British throne, women were employed inside British mines, both as laborers and for hauling the small cars of coal from the working face to the main haulage roads, but to the

credit of the Queen, it must be said, she secured the passage of laws, soon after her accession, that effectually remedied the matter. Many of our older readers of British birth will recognize the familiar figure. During recent years efforts have been made to secure the passage of Acts of Parliament prohibiting the employment of women on the pit-bank as well as in the mine, and these efforts would have been successful, had it not been for the opposition of the women themselves who protested that it would deprive them of their means of livelihood.

THE PREVENTION OF ACCIDENTS IN MINES.

An Essay on the Best Methods to Secure Safety to Life and Property in the Operation of Collieries.

(The following paper is by Mr. Augustus Stinner, late Inspector of Mines, and was one of the four recommended for publication by the Committee of Judges in the *Pittsburgh Times'* Prize Competition Contest.)

How to avoid mine disasters, or at least lessen them to a great extent. To do so we must commence at the root of the evil under the system of ventilating and mode of mining. At present in the Bituminous region, no practical person will be much astonished to learn of accidents in the various forms.

I shall first and mainly treat on accidents by mine explosions, and their prevention. You will please notice plan of a drift mine containing about 370 acres; and the plan of a large shaft mine. The shaft mine consists of four different splits of air (when all worked), but in the plan, so to say, I only use the one split of air and show you two sections of work. The face entries in these sections may be 1,600 or 1,800 yards in length, and the butt (cross) entries about 400 yards wide each from face to entry. Certainly a pretty good sized mine in itself.

As you will see, I have not drawn the plan with any scale, but merely made it so you will understand it practically, and in view of that end, will reason the matters on the plan in order to prevent accidents, or to a great extent, at least, lessen them. But before I draw your attention to the plan let me say here to you, or rather ask, what causes the fearful slaughter of the men in a mine explosion? I will answer: the after gases. There are very few men in general killed by the force of the explosion, and why are there so many killed by after gas? Because we cannot get air to them in time. We have to prepare and fix stoppings and doors, which the force of the explosion has destroyed, and I know from practice the time required to fix up and patch these many blown-out stoppings and destroyed doors; and then, about the time you get the ventilation in some kind of shape, "the souls of the unfortunates have gone to eternity." The pure air was too long in coming. The after-gas had done its work. Yes, because the pure air did not come soon enough; it took too long to prepare stoppings and doors which the force of the explosion destroyed. I think humanity requires a remedy of that matter of stoppings and doors which causes mainly the death by after-gases. (I honestly believe, from my practical experience in the Bituminous region, 90 per cent. are killed by after-gases.) Just think of the idea! A lot of doors in a gaseous coal mine to direct the ventilation—I will say frankly and freely, doors are a nuisance and dangerous in mines of this kind and, besides after-gases in many cases, doors increase danger. The more doors under our present system of mining, the greater the danger. However, I don't want to be understood that there must not be a single door in the entire mine. There may be one here and there, such as I have shown in my plan, in the cross entries.

The Intake. You will notice in my plan I make the hoisting shaft the intake of air. I calculate this shaft to be dry enough to make no ice, and make the other shaft the outcast of air, that shaft being the suitable place for our pumping machinery, &c.

Of course, we can change the plan and make it a force fan. We could also sink another shaft for intake or outcast of air, but I will only treat on two shafts, such as you see them on the plan. I know it is not requested to show necessary roads, &c., about shaft, for the handling of cars, &c., consequently I have paid no attention to it. I merely want to show, as is requested, the safety of the mine, and here I will show the meaning of the marks used on the map.

For convenience and easy explanation I will call the three parallels, from which sections Nos. 1 and 2 are started north of hoisting shaft, and the face entries, and return air way thereto west.

The double door, near outcast shaft (or roadway) is for the purpose of getting to the escape shaft, and also into the return air way. Nobody is allowed to do any traveling of any kind in any part of any return airway, except men for the inspection of it; it is there for the purpose of the return air, and nothing else. None of the entries are drawn to any scale, nor any of the pillars; however, in all cases, I would make return airways as large as I could with safety and entry pillars should be left plenty strong and more so, to make matters perfectly safe so no squeeze can happen, since a squeeze in a gaseous mine is a danger in itself, and from practice it is well known that it has caused the generating of gas, and also serious explosions. In all of our mine operations we should avoid squeezes to come on our entry pillars of any kind. You will notice two overcasts in the return airway before you get into the first section. You will notice two doors into the return airway. It is made for the purpose of a small road to get into return airway, and clean airway out once in a while when required. Now, you will notice cross entries Nos. 1 and 2. That is the first entry that I would drive for room work. It is a good 200 yards from the north parallels; and from there, a good 200 yards to the shaft. I do this in case an explosion should occur, so that then the force of the explosion would do no damage to the shafts. On the south side of my hoisting shaft, when I would get ready and start my work, I could start my cross entries. I would not need to be afraid. Any gas explosion there would face my shafts, it being at least 700 yards from the shafts. I would remark here, I would drive my cross entries 400 yards in length, on each side of face entry, and make that the end of section. You will notice a door between Nos. 1 and 2 cross entries, and that is the only door used in this system. I break the entry pillar once for every 100 yards. The less the pillar is cut through, the less the danger in explosion, since the fewer cut-throughs we have the sooner we can establish the ventilation again. You will plainly see the overcast from No. 2 into the return air course.

A Different Cross Entry system. In No. 3 and No. 4 you see a different cross entry system. No door is required, but it requires an additional entry to be driven, and I know in many places that would cause an extra expense, consequently I will not advocate that cross entry system. From the explanation that I will make, regarding doors and stoppings, I will not drive three cars parallels, causing both expense, and rather weakness to the entry pillars, if they are not made additionally strong "regarding three parallels." You will also notice the cross-entry on left hand side of face-entry. Nos. 5 and 6 are about midway of the others. I would not make it opposite of Nos. 1 and 2 for the reason that if an explosion should occur in No. 2 or 1, it might blow over the overcast into 5 and 6 cross entries, and *vice versa* from 5 and 6 into Nos. 2 and 1. But if we get the force of the explosion from No. 2 into the return air course, ordinarily it will not affect cross entries Nos. 6 and 5. Hence the reason I would make the first cross entry on that side there, and where you see it marked on the plan I would work it for reasons shown upon the plan. The same reason holds good for that piece of coal on the opposite side, near north parallel, on the side of Nos. 1 and 2 cross entry, but has to be worked as is explained by writing, where the coal is located.

You will notice, I will not make any (holes) break pillars from face entry into room workings, which at last becomes pillar work, and falls, and danger is there, consequently I keep the pillar solid. A man that would direct in making holes from face entries into room workings for one cause and another, is a person with no foresight and creates danger.

This first section we can mine a great deal of coal from. For instance, when we consider that the boundary line is 1,600 yards distance on the face from north parallels, and each cross entry in this section 400 yards wide, to that strip of coal left on the plan would amount to about 280 acres of coal, or if we would work three of those sections on each side, west and east of parallels, both north and south of shaft would make a coal tract of about 1,680 acres, and the additional amount of coal contained in the pillars of north and south parallels; and I might remark here that as to the break-throughs in the north and south parallel entry pillars, I would make them apart as far as possible, say from 150 to 200 yards, and if need be, would use brattice to take the air with me to drive those distances. We might also find gas here in driving those distances, and then would need air to dilute the gas, etc. I would further remark in this and all other cases where I would need brattice, I would have it incombustible. That point, incombustible, would have prevented the late Dunbar disaster.

The regulations in this plan are so well understood by ordinary practical miners that I will not say anything on it. It might also be reasoned by some that those doors leading into the return airway should be securely locked, and the same with regulators, but since there are reasons that such should not be done I will keep silent on the matter. It will plainly be seen we can go from one part of the mine to the other by the aid of the overcast and return way and roadways shown by doors.

Cross Entries. I will now explain the workings of Nos. 1 and 2 cross entries in section 1, and the same will hold good of all the rest of the cross entries in this mine. In the first place, you see the cut-through and the door, which is needed in this system for the driver to get into No. 2 cross entry. The door must be so hung that it will require some power to open it toward entry No. 1, and will well shut itself, and in that case the air pressure will press against it. Then you see the break-throughs 100 yards apart in the pillar, and stoppings in about the middle of them, I drive the 400 yards, or to the end of the section, and commence my room work until my entry is finished, and then when I do commence room work I commence at the end of the section, say start from 10 to 12 rooms, in No. 1 entry, and the same amount of rooms in No. 2 cross entries, drive the rooms up the required distance, bring back room pillars and afterward entry blocks. And then again I would start another batch of rooms, as stated before, until the cross entries are worked out, or sufficiently worked close enough to the face entries.

That system of working would have saved the lives in 1884 of the people killed at Leisenring in an explosion. Just look at the absurdity of a system of mining to commence room work in both cross-entries, near those "face entries," rooms driven up, pillars taken out, falls taken place, doors in the face-entries and pillars broke through every 30 or 40 yards, and men working at the end of the section. Shame and disgrace to such a system! I would like to know what safety there is provided for those men who work beyond, or at the end of the section, when an explosion occurs about 100 yards from the face-entry, caused by squeeze, or falls of pillar drawing? Men, under such circumstances, are like mice caught in a trap. Why not change this ridiculous system of mining? Anybody knows danger is not so bad in the rear of you, and when you can run away from it, as when fronting you, when you must go through the danger, which in this case can seldom be done. This is part of the system that has taken the unfortunates, lives.

Stinner's System. Now, under my system of working I have the danger of an explosion beyond me, to some extent. I can get away from it. I will consider an explosion at the end of No. 2, and one cross-entry from a fall: First—The explosion is confined to this entry alone. It will not effect any of the cross-entries. Its force will go to the return air course; even if the overcast at No. 2 entry should be destroyed, all the intake of air, or at least the most of it, would go out through the overcast, and if small portions of after-damp should want to go toward No. 3 entry, the intake air would have to take it there, and in that case would not hurt the men, and, as I have already said, the great percentage of death is caused by after-gases and in not getting in time pure air to the men. I think I can show you clearly and plainly, by a new, cheap method, how to establish a pure current of air again, so to say, in no time, and I think very few will be killed with ordinary after-gases. Wherever there is a necessity for a door in a mine to direct ventilation, etc., place a door there that no force of any explosion can destroy. For instance, go in the break-through from four to six feet, and make a suitable shearing, say three feet deep on each side, and the required height. Put your half door in each shearing, and push it in even with the coal. Keep bottom clean from time to time, so this double door will work, when needed, and do the very same at every place where there is a stopping in the mine. In case an explosion occurs and destroys the door and stoppings, all one man needs to do is to pull the door (or half door) out of the solid coal, and the break-through is shut up or repaired again. You will see at a glance it will take no time to restore the ventilation again. One man, with such a system, will do more work in one hour than 100 men in two days under the present system. This is cheap and practical, and will work wonders. No practical man that has helped to rescue men in time of an explosion, will oppose this safe system and its simplicity.

Now, the next thing I will construct an overcast, and all the rest of the overcast in the mine to be the same. I will show you two kinds of constructions. In all cases, however, they shall be incombustible. To build an overcast, take suitable sheet iron for "stand-ups" in openings, also suitable stringers of iron, parallel with butt. You may then cut out roof or top, so these iron stringers will rest all along on solid strata. Sink the ends of them suitable lengths in the solid strata (or roof) and place them about one foot above top of roof. Then cover the opening with suitable sheet iron, and a covering of good cement on this iron, and on top of this cement sand, in all a covering on top of sheet iron one and one-half feet in depth, and from the level of this sand layer will be your aperture or overcast.

High Pressure Aerophones. The line you see across, between No. 2 and No. 3 cross-entries, is a small rib left permanently between the rooms of No. 2 and No. 3 cross-entries, in order that the air pressure from one entry may not effect the workings of the other entry, mainly, when the ribs are drawn out. A pressure of air from one entry will not make the gas explosive in the old workings, nor press the gas out into the other entry. By this system I want, if any gas should accumulate in the old workings (when the ribs are drawn) that it will be at rest, and be dead (non-explosive, with black damp). The same reason applies where you see the black line running parallel with the face-entries, between 1 and 2 sections. I think ribs of this kind left, the amount of coal lost hereby would be very small, I don't think in general would amount to more than about 1½ per cent. and some good men should be worked in each pair of double entries, be well drilled in case of danger, and know how to go about it. To pull out doors for overcasts—doors and stoppings. In all cases when workmen see danger of any kind, to report as soon as possible the same to the management of the mine, and every day hand about the mine should be drilled in practice in every shape, way or form, so that he would make a good fire boss, and in that way the work in examining the mine in the morning, no doubt, would be done in a very short time, certainly a sound reform from the present system. I learn some fire bosses start out four hours before the men come in.

Certificates to Fire Bosses. While I speak of the fire boss, I would remark here, a reform is needed regarding giving him a certificate from any single inspector in accordance with the law. I certainly hold and always have, that the fire boss should receive a certificate of competency only after having stood a most thorough examination before a competent board of at least three persons in place of one person, the inspector, as it now is. It has come under my observation that some people hold fire-boss certificates who should not have them, and I think if the inspectors were relieved of the duty of granting certificates of fire bosses, also serving on the board to examine applicants for mine bosses, as under the present law, and in place have one board to examine all fire bosses and all mining bosses in the entire Bituminous region; it would create a healthy reform and make matters uniform, which is not the case at present. The inspector should have power on sight when a violation of law presents itself to him. And he should have discretionary power to visit mines as he thinks necessary. He should not be bound down to visit each mine four times in the year, since some mines need more attention than others. Think of the weakness of the present law. When the inspector sees a violation of it for him to give in writing five days grace to the violators. We might just as well advocate, when the officer of the law catches a thief in the act, to tell him: "You can steal all you want yet for five days, but on the sixth you must quit." I could say more, where reform is needed in the mining law, but this matter is getting too lengthy. However, I will remark about the mining boss, recognized in the law that he must be a man of independence, and allow no strangers, under the law, to dictate to him violation of the law, and when his conscience tells him "the mine is worked on good luck only," he should report the matter to his superior, to have matters put in a shape to be satisfactory to him.

It should be provided by law that each operator leave sufficient coal on all boundary lines, so that no dangerous holing into one another may take place, and cause accidents by both gas and water. The greatest care should be practiced to have the maps of mines made very accurate. Fans, for ventilation, and fan houses, should be made incombustible, and in all cases fans should be placed some distance from the shaft, so that the force of explosions will not destroy them. A weak, tight door should be placed on top of the shaft, so that in case of an explosion it would blow this door off, and thereby save fan and fan house.

The shaft itself might be constructed of iron, but under the present system those shafts should, at reasonable times, be well cleaned of oil and dust.

As to horse stables in mines, no combustible stuff of any kind should be about them excepting, hay and the stable itself should be built of non-combustible material. Nothing but a safety-lamp to be used in the stable, and under no circumstances should any loose hay be sent into the mine; only baled hay.

In Slope Mines. And in slope mines mainly, I will mention again, incombustible overcasts should be built at suitable places to make the mine (or rather connections) safe, the traveling road (or parallel) should always be kept even with the slope. There are slopes in the Bituminous region, which, owing to the manner they are gutted, and to the system by which they are ventilated, should a forcible explosion occur in them nobody could be saved. Under the circumstances in which those mines have been worked in earlier years, openings should be made in the rear of the coal tract and connected with the farthest in end of slope, with a good system of ventilation and good working system established, as I have herein shown; the workmen would have a chance for their lives, which they have not at present.

And let me say once more, the more doors and brattices and stoppings, the more danger, and *vice versa*, the fewer the doors and brattice and stoppings in mines, the less danger. "It was the door" in 1884 in the Youngstown Mine, in Fayette County, that sent 14 men and boys to an untimely grave.

Need of Safety-Lamps. With all the safeguards that I have shown all mines, where explosive gases may make their appearance, should at least, in accordance with locality, be worked with safety-lamps. This would make matters three-fold sure, and under no circumstances should ribs be taken out with open lights. When safety-lamps are used they should, in the true sense of the word, be put in the hands of miners. The Clanny lamp is in general use in the Bituminous region. It has some advantages, it is true, over a safer lamp, but under certain circumstances the Clanny lamp is not a safe lamp. The Mueseler safety-lamp is by far the safest, and if you gentlemen wish it, I will practically prove it to you with both lamps, in natural gas in Pittsburgh. To work with those safety-lamps is no hardship for the miners. They very soon get used to them. All those glass globe safety-lamps show a very good light to work with, and even should there be a little inconvenience, it will be a safeguard if rightly attended to. It should be borne in mind that any instrument that will detect small percentages of explosive gases are valuable about mines. It will put us on our guard and inform us that the enemy is present and even here, if we find small quantities of the gas, it may put us on our guard, calculating what dangerous coal dust we may have in the mine. However, I would say here of coal dust, that without any traces of explosive gas, we need not fear any bad consequences from it.

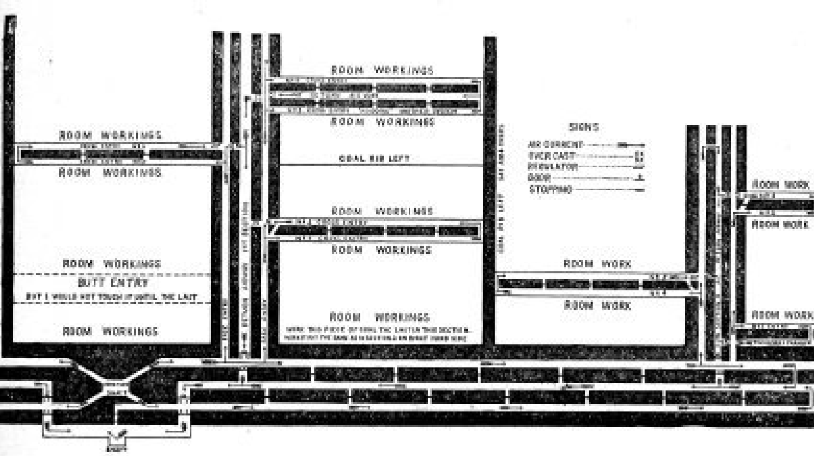


DIAGRAM TO ILLUSTRATE MR. STINNER'S PAPER.

Ventilation of Rooms. While speaking of gas, I would mention here that small room works, in the cross-entries, we should provide with a good system of ventilation, which can very readily be done, say by two canvas doors, placing them 10 or 12 rooms apart, as the case may be. Then the ventilation will go to the cut-through, and through all the room cut-throughs, and come to the cross-entry again on the other side of the canvas door, and not any sooner, because that will be the nearest course the air has to travel. I would follow, where suitable, the good system in use at present in taking out room ribs and entry blocks clean to a suitable distance near the face entry. For instance, in the first section No. 1 cross entry I would build a good, strong, substantial stopping with brick and cement, and leave No. 2 cross-entry open and put up a door, say five or six feet from face-entry in the cross-entry No. 1, and put a wire regulator in it, locked, with enough of air in it so that it may clean out of No. 2 cross-entry any stuff or gas that may press out of it into the return air course. Any stuff or gas that may come out here at No. 2 entry is not explosive. It would only fire when sufficiently mixed with air, and would not get a chance to accumulate, but would be carried away into the return air course as fast as it would press out of the old workings. This is the system that I would use all over the mine in similar cases, and in the face-entries, when near the north and south parallels.

You will notice in the second section and the No. 1 cross-entry no room work on right-hand side. You see the cross-entries laid out between, which reason is already explained. Of course, it is a little differently laid out from first section. The reason practical men will see at a glance, "because we are 1,000 yards from the hoisting shaft."

From the level of that floor make a suitable long grade until it strikes bottom in cross-entry, or entry pillar, in order to save overcast in case of explosion. But having safety in view, we must calculate on the destruction of overcast, and in this case and all other cases, we must not speculate on good luck. To mine on good luck has proven itself dangerous. We always should provide before we complete the permanent overcast, for a temporary overcast, to be used in case the permanent overcast should have been destroyed by the force of the explosion. The construction of it is something similar to that already shown, by placing those safety-doors, namely: Cut in the coal on each side of opening (where the openings are) and shove those doors even with the coal, making the same cut on top on each side of opening horizontal, and shove those temporary doors even with coal, and no force of any explosion will ever hurt any such temporary doors.

Another Style of Overcast. But I will show you a different overcast. Commence about 2½ feet above the top roof of your face entry, and from that level on each side drive three or four yards in the course of your overcast; then cut towards your openings, butt course (or, as the case may be, in different part of the mine); in other words, you leave on each side of this face entry 3 or 4 yards of solid coal to roof, with the addition of 2½ feet high, 3 or 4 yards in length, and from the end of those 4 yards run a suitable grade until you strike bottom in entry. I am certain no explosion will ever blow out those four yard blocks left on each side, and for the top of such overcast construct it in the same manner as mentioned in the overcast before. The temporary construction, also the same on top (those double closing doors on top to be cut in the strata horizontally.) Those top horizontal doors are all that are needed for temporary overcast of this kind. This is the kind of overcast that should be used in the entire mine. I might mention here (for double safety) it would not be amiss in case of overcast destruction to have a few high pressure aerophones at each time to enable us to work in after-gas, etc. The cost of them is but little.

Now there are more things that I could mention, but the matter is getting lengthy and therefore I will say in conclusion that with good discipline about a mine, everybody at his post of duty with military exactness, and independence, and the practical and simple reforms that I have pointed out I would feel myself completely safe and could swear with an uplifted hand "I am not working the mine on good luck."

AUGUSTUS STINNER.

P. S.—I would say any person holding a certificate of any kind to entitle him to a position in or about the mine, and if found guilty of violation of law, said certificate should be taken from him and none to be granted to him again in the State of Pennsylvania.

P. S.—As all practical men can see, the different reforms that I have shown, can well and with good results be adopted in most all of the old mines in operation, and will add very much to their safety, which this miserable system of working, and ventilating is greatly in need of.

A. STINNER.

TANDEM TANKS FOR HOISTING WATER FROM FLOODED SLOPES.

BY J. H. BOWDEN, WILKES-BARRE, PA.

(Glen Summit Meeting, October, 1891.)

The water-hoisting tanks herewith illustrated have been designed for removing large quantities of water from recently-flooded mines, through their hoisting-slopes, with rapidity proportional to the capabilities of the hoisting machinery available, the tanks being adaptable to slopes of small sectional areas and varying pitches.

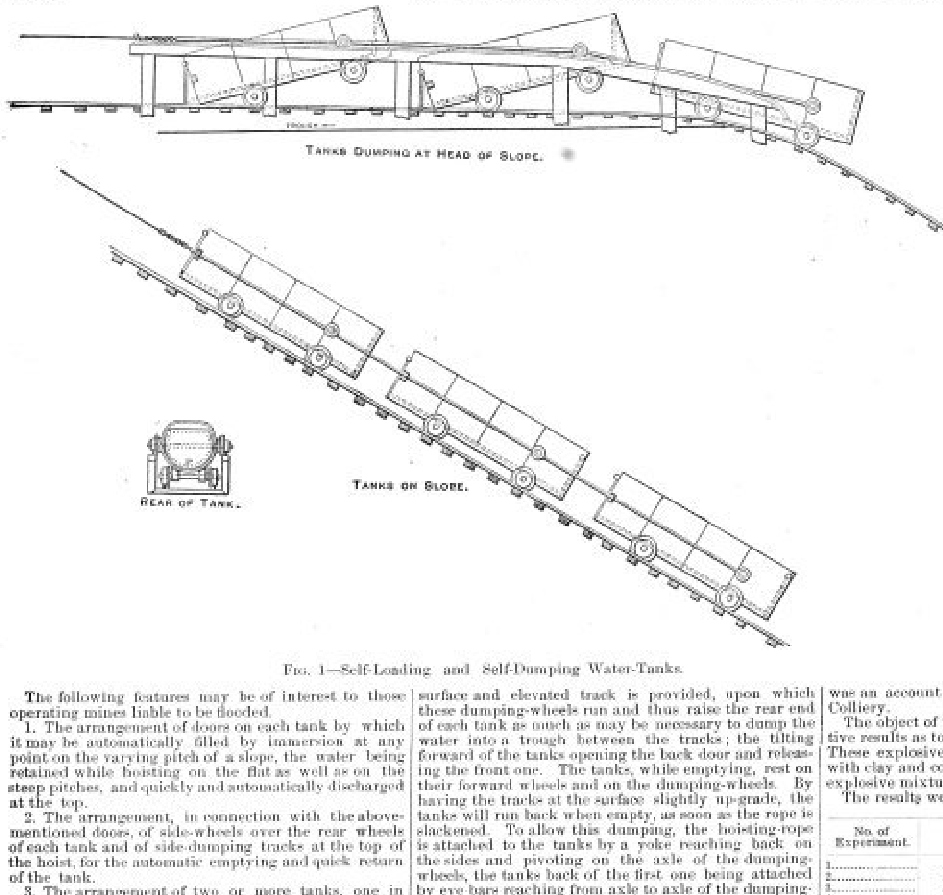


Fig. 1—Self-Loading and Self-Dumping Water-Tanks.

The following features may be of interest to those operating mines liable to be flooded.

1. The arrangement of doors on each tank by which it may be automatically filled by immersion at any point on the varying pitch of a slope, the water being retained while hoisting on the flat as well as on the steep pitches, and quickly and automatically discharged at the top.

2. The arrangement, in connection with the above-mentioned doors, of side-wheels over the rear wheels of each tank and of side-dumping tracks at the top of the hoist, for the automatic emptying and quick return of the tank.

3. The arrangement of two or more tanks, one in front of the other, so as to give as large a capacity in a single hoist as the engine-power will permit, yet without making any tank too large for the sectional area of the slope, or of unwieldly length, or of such a shape that it cannot easily pass over vertical curves; and without concentrating too much weight on any one pair of wheels or on any point of the track.

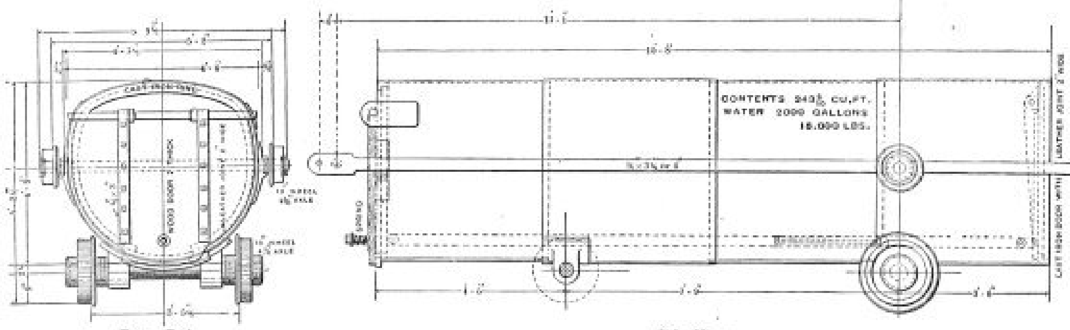


Fig. 2—Self-Loading and Self-Dumping Water-Tanks.

The details of construction and method of operating are shown by the accompanying sketches (Figs. 1 and 2), and the following more detailed description:

At the end of each tank is a large iron door of almost the full size of the end of the tank, opening inwards, so that when immersed the tanks fill almost instantly. To provide for holding the water while it is hoisted up flat pitches, a wooden door is attached to the front of each tank, opening outward. Each front door is attached to the door at the back by an iron rod, provided with a sliding link, so that the back door can open independently of the front; but the latter is held closed as long as the rear door is closed. This connecting-rod, as shown in Fig. 2, passes through the front door and through a spiral spring in front of it, so that the amount of pressure necessary to keep the water from leaking out may be readily applied.

The tanks are mounted on self-oiling closed wheels, so arranged as to exclude water from the bearings while the tanks are immersed, and to retain the lubricant.

Each tank is provided also with side-wheels, vertically over the rear axle, which have a gauge sufficiently wide to clear all other portions of the tank; and on the surface and elevated track is provided, upon which these dumping-wheels run and thus raise the rear end of each tank as much as may be necessary to dump the water into a trough between the tracks; the tilting forward of the tanks opening the back door and releasing the front one. The tanks, while emptying, rest on their forward wheels and on the dumping-wheels. By having the tracks at the surface slightly up-grade, the tanks will run back when empty, as soon as the rope is slackened. To allow this dumping, the hoisting-rope is attached to the tanks by a yoke reaching back on the sides and pivoting on the axle of the dumping-wheels, the tanks back of the first one being attached by eye-bars reaching from axle to axle of the dumping-wheels on the tanks. A stop is provided, to prevent the yoke on the forward tank from dropping and catching in the track when the rope is slackened.

This plan of "tandem tanks" was designed and used to hoist about 25,000,000 gallons of water which had been admitted to extinguish a mine-fire in one of the Susquehanna Coal Company's mines. The slope was small in section, and 3200 feet long, with single track, and with pitches varying from 4 to 20 degrees. The hoisting-plant consisted of a pair of 26 inches by 60 inches direct-acting engines with cast coned drum 9 to 12 feet in diameter, carrying 1½-inch steel rope. These engines had been previously hoisting five cars, weighing about 4 tons each when loaded.

THE PROGRESS IN MINING.

Reviews of the Important Papers Relating to Mining Published in the Proceedings of the Mining Institutes and in the Mining Publications of Europe, United States, and Canada.

Mining Education in England. All over the mining districts of England the local government authorities are awakening to the fact that increased prosperity is best attained by an increase in the intelligence of the working classes. To afford full facilities for improved technical knowledge the County Councils of Notts, Derbyshire, Warwickshire, Yorkshire, and Northumberland have founded a scheme of free lectures. Competent professors are appointed at salaries ranging from $1,500 to $2,000 a year to travel from district to district and deliver popular evening lectures to the miners. We boast of our go-aheadativeness: here is a suggestion for our Legislature.

Coal Cars. The Mining Institute of Scotland has recently published a series of detailed descriptions of forty-one different kinds of "hutches" or cars for conveying coal under ground. These descriptions give full details of the capacity of the "hutch," the material it is made of, the inclination and thickness of the seam it works in, and two estimates of the cost of making each, given by two of the most prominent "hutch" makers in Scotland. There are also detailed working drawings of each "hutch." The inclinations of the various seams where these "hutches" are used run at all angles from vertical to horizontal. The seams vary from 12 feet thick down to 14 inches, and the gauge of the rails from 1 ft. 4 in. to 3 ft. 2½ in. The costs of construction run from $28 for a "hutch," the body of which is made of iron plate, ⅛" thick, to $9 for one made with Larch and Elm.

The Use of Explosives in Mines. At a recent meeting of the North of England Mining Institute two papers were read dealing with the above subject, but from different points of view. The first, was a paper read by Mr. L. W. Chicken, on "Experiments with Explosives" and was an account of some experiments made at Risca Colliery.

The object of the tests was to find out the comparative results as to flame emitted by various explosives. These explosives were fired from a mortar, tamped with clay and coal-dust, into a chamber filled with an explosive mixture of coal gas, air, and coal-dust.

The results were as follows:

No. of Experiment.	Name of Explosive.	Nature and Length of Tamping.	Results.
1........	Ammonite.	6 in. of Coal-Dust.	No Flame.
2........	Ammonite.	4 in. of Coal-Dust.	No Flame.
3........	Ammonite.	2 in. of Coal-Dust.	No Flame.
4........	Dynamite.	6 in. of Coal-Dust.	Flame.
5........	*Gelatine dynamite	2 in. of Coal-Dust.	Flame.
6........	Securite.	6 in. of Coal-Dust.	Flame.
7........	Stonite.	6 in. of Coal-Dust.	Flame.
8........	Tonite.	6 in. of Coal-Dust.	Flame.
9........	†Carbonite.	None.	No Flame.

*Without water cartridge and supports.
†No coal-dust was used in this experiment.

The other paper was one read by Mr. W. J. Orsman "On the Products of the Combustion of Explosives when Strongly Confined."

The experiments were conducted in a hollow sphere with a shell of mild steel ½ in. thick and an internal diameter of 4½ in. There was an outlet valve at one side and an opening on the top closed by a screw-plug to confine the gases generated by the explosion. Ten grammes, ($\frac{22}{1000}$ lbs.) of the explosive were used in each case. They were fired by electricity.

The following are the results obtained:

Name of Explosive.	No. of Experiments.	Total Volume of Permanent Gases from 10 Grammes. Cubic Centimeters.	Mean Percentage Results of Analysis. Carbon Dioxide.	Carbon Monoxide.	Marsh Gas.	Nitrogen.
Carbonite	10	2,100	19	15	26	40
Gelignite (Nobel)	8	4,990	26	7	...	67
Tonite	3	.....	30	8	...	62
Roburite	12	4,790	32	...	...	68

It will be observed that carbonite gives off the greatest percentage of inflammable gases, and by opening the outlet valve on the side of the chamber these gases could be ignited, in which case they would burn with a pale blue flame. This explosive is largely composed of carbonaceous ingredients with the object of damping down the heat generated by the explosion. In the case of roburite a similar result is obtained by the addition of ammonium nitrate, and it will be noticed that in this case the gas freed by the use of roburite contains a large percentage of nitrogen.

Transmission of Explosions. A paper on this subject was recently read before the Manchester (England) Literary and Philosophical Society by Messrs. H. B. Dixon and B. McLean, and was a description of a series of experiments made to test the effects of explosions in transmitting their forces across intervening columns of air. The results showed that for a given mass of a gaseous mixture there is a certain minimum mass of air which will, if interspersed between it and another explosive mixture, guard this last like a shield, and they also found that it was immaterial whether this air was enclosed as a short and broad, or long and narrow column. These experiments are instructive, therefore, as dispelling the idea that the force of an explosion can be transmitted from one isolated accumulation of fire-damp to another across yards of a gallery or working face free from fire-damp and dust.

Boring into Old Workings. Mr. W. Wardle, author of "A Reference Book on Practical Coal Mining," in a letter recently published in *The Colliery Guardian* (Eng.), describes a method of tapping and successfully draining standing water in old workings accomplished under his supervision. A heading was driven in the seam to within 20 yards of the old workings and drill-holes were then pushed forward 9 feet by a Macdermott drilling machine. These holes were sufficient to admit a pipe 3 in. diameter to be driven into them. When the pipe was forced tightly in, a groove was chiselled out of the coal all around the pipe 18 in. deep and ½ in. wide. This groove was wedged up with rope-yarn to make the outer edge of the pipe perfectly water-tight. When the pipe was thus secured a wrought iron flange was attached to it and to this flange was fixed a large plug-tap, the hole in the plug of the tap being sufficiently great to allow 2½ in. bore rods and bits to pass through it; at the front of the tap a piece of timber 12 in. square was fixed with an elastic joint-ring between that and the tap to make a water-tight joint; the ends of the timber piece were well cut into the sides of the heading and secured fast. Before going any further with the bore a line of pipes was brought up from the sump at the pit bottom. Boring was then commenced, the rods being passed through a hole in the piece of timber, through the plug tap, and carried on through the coal seam to the old workings, the water being thus successfully tapped. The rods were then drawn in one length down the head without unscrewing and immediately they were withdrawn, one of the men shut off the plug tap until connection was made with the pipes leading to the sump, when the tap was opened and the entire area of old workings drained without any water being turned loose in the heading.

The Prevention of Overwinding. Mr. Archibald E. Pinching, Vice-President of the Mining Association of Cornwall, describes an ingenious contrivance for the prevention of overwinding, which was inspected by the members of the Mining Association of Cornwall at the Lens Colliery, Lille, during their recent Continental excursion. Mr. Pinching says: "While being shown around the surface works by the chief engineer and director-general, who combines both offices in himself, and watching the fine engines at work hauling the coal with wonderful rapidity from underground, I was electrified to see the gentleman in question—while a large engine was winding on and off a 36 ft. drum a cage containing six full tubs of coal and a cage loaded with men proceeding underground—motion the engine-man away from the handle and make him stand quite clear of the engine—and from the expression of the man's face it was quite evident that this had not been rehearsed—and thus leave the powerful machine entirely to itself. Almost immediately a warning bell rang, and we became aware that a powerful automatic brake—which I afterwards ascertained was on the Westinghouse principle—had been applied to the engine, and the drum was visibly slackening speed. The engine-man, however, was still told to remain where he was. Shortly after another bell rang, steam was completely cut off, and the cage drew up to its platform exactly as if the engine had been controlled by the most practiced driver. The apparatus consists of an arrangement of valves, which come into play directly the cage reaches a certain point in the shaft and, if the engine should at that moment not be under control, immediately apply the powerful air brake. This, however, allows the cage to proceed at a certain speed, but should another point in the shaft be passed and the engine be still out of control, the brake is increased in power, steam entirely shut off, and the cage brought to a standstill. The arrangement imperfectly described above, is the invention of M. Reumaux, who is the director-general of the society or corporation.

A Peculiar Case of Subsidence. The church of St. Chad, at Wybunbury, Cheshire, England, has been destroyed and rebuilt ten times, and it is now about to be restored once more. The cause of this destruction has been some subsidence of the surrounding ground and the committee for rebuilding called in Mr. De Rance, a geologist, to inspect and report. Mr. De Rance has given the results of his investigation in a paper read before the Manchester Geological Society.

At first he thought the displacement was due to removal of sand by springs, but he found a similar disturbance going on in the neighborhood where no such theory could be conclusive. The town of Wybunbury is in the district of the salt works of Cheshire and his next idea was that the pumping operations were causing a cave-in to take place. The nearest works were, however, seven miles distant. In the immediate neighborhood of the church and in various directions from it there are several "meres," or pools of salt water caused by outbursts of brine, and in one case the liquid is so elastic, owing to its strong saline properties, that a stick thrown with full force into the water rebounds back on to the bank, and Mr. De Rance has come to the conclusion that the subsidence is due to a natural solution of the rock salt underneath, independent altogether of artificial conditions brought about by brine pumping. If the solution was due to such pumping the surface springs would cease to flow.

The Premium Plan of Paying for Labor. A paper was recently read before the American Society of Mechanical Engineers, by Mr. F. A. Halsey, of Sherbrooke, P. Q., Canada, on "The Premium Plan of Paying for Labor." As the subject is of interest to both employer and employed, in all branches of industry, we submit the following description of the scheme: The three existing methods of payment are (1) The day's work plan. (2) The piece work plan. (3) The profit sharing plan.

By the first, a workman having no great incentive to exertion settles down to an easy-going pace that causes the employer to pay the highest rate for his product.

The second plan is an attempt to overcome this objection. The employer argues that some piece of work which is costing him a dollar by day's wages could, by an increased effort on the part of the workman, be produced for 80 cents. He, therefore, offers to share the profit from decreased cost by giving the man 90 cents for every piece. This goes very well at first, until either the workman finds that after working hard he cannot make wages at it, or else he produces such a large number of pieces that the employer begins to curtail the price and in this case the workman reduces his exertions until the same evils exist as were before. The *profit-sharing plan* gives to all the workmen an *equal* share in the profits of the business. This very *equality* is the evil of such a system. A hard working man is paid the same share as a lot of lazy fellows and he has no personal gain from his individual exertions. Then there is no provision made for the bad years, and the workman who shares the profits of a good year grumbles at the idea of bearing his share in the losses. From the employer's point of view he is paying the men profits with which they have no connection, such as reduced expenses in the commercial department, or more systematic shop management. The workman when he begins this profit sharing is glad to obtain anything, and welcomes it as a *bonus* over and above what was formerly his entire income, but, as time wears on, he thinks he is not being treated according to the terms of his agreement and the trouble begins. The only way to settle the matter is for the employer to show his books, and even if he is agreeable to do so, which every master is not, there are few workingmen's committees which are sufficiently well versed in profit and loss to comprehend the matter.

The *premium plan* is an effort to cure all these evils, and we will now consider it.

First of all a reasonable estimate is made of the number of hours required to do a certain piece of work and hourly wages decided upon; then for every hour the workman saves in doing the job he obtains a premium based upon a given scale. This hourly premium must be less than the hourly wages, so that if an hour is saved the cost of the piece to the employer is less, and at the same time the earnings of the workman is greater. Take a case based on the following table:

1	2	3	4	5
Time Consumed.	Wages Per Piece.	Premium.	Total Cost of Work = Col. 2 + Col. 3	Workmen's Earnings Per Hour = Col. 4 ÷ Col. 1
Hours.	$	$	$	$
10	3.00	0.00	3.00	0.30
9	2.70	.15	2.85	·317
8	2.40	.30	2.70	·333
7	2.10	.45	2.55	·364
6	1.80	.60	2.40	·40
5	1.50	.75	2.25	·45

If a man takes 10 hours to finish a piece of work and his hourly rate is 30 cents, the amount of his wages would be $3.00. If, however, he finishes the work in eight hours he will receive 8 times 30 cents = $2.40 as his usual wages and in addition the premium of 15 cents per hour for the two hours saved, so that his total earning for the eight hours will be $2.70, or 33⅓ cents per hour, while the cost in wages to the employer for the piece of work will be reduced by 30 cents. In this case the cost to the employer is reduced 10% while the workman's hourly wages is increased at an equal rate. The hourly premium must be fixed carefully and then adhered to, unless improved machinery or like causes raise a new basis for calculation. If the employer be greedy and tries to reduce the premium he will squeeze the lemon too dry and defeat his own object, as the workman will simply take it easier, and on the other hand if the premium be excessive the employer will be paying too high a rate of wages, but still it will be cheaper than before the premium system was adopted.

Safety-Lamp Experiments. A series of tests with various types of safety-lamps has recently been made by Mr. C. E. Rhodes, General Manager of the Aldwarke Main Collieries, Rotherham, England. The lamps tried were divided into two classes as follows:

(1). Obsolete lamps.

(2). Lamps of the most approved type.

Amongst what were termed "obsolete" lamps were the Davy and Clanny lamps, similar to those used in this country, and the wisdom of the mine law which forced the abolition of these lamps in a gaseous mine was proved in that the unbonneted Davy and Clanny *exploded in currents of gas and air traveling at velocities which are now commonly met with in most mines.* The great advantage of the shield or bonnet was amply demonstrated by the protection it afforded lamps which would otherwise have immediately exploded in a strong current.

The most approved types of lamps were those which had been commended by the Royal Commission on Accidents in Mines, and these proved satisfactory in the presence of excessive currents of explosive mixtures.

On the same line of experiment, Prof. Clowes, in a paper recently read before the Chemical Science Section of the British Association, describes an apparatus for testing safety-lamps, for examining their relative merits as fire-damp detectors. The apparatus was a wooden box with an inlet tube for gas at the top and an outlet for air at the bottom. The mixture could be so varied that any desired percentage of gas could be obtained in the air. He was unable to verify the general belief that an ordinary Davy lamp could detect 3% of gas, and indeed, with any of the newer patented lamps, the percentage had to be greater to show any indication on the flame. The one exception was Ashworth's Hepplewhite-Gray lamp fitted to burn benzoline through a sponge. This lamp gives a brilliant light and by a very delicate arrangement the flame can be lowered until it assumes the character of the Bunsen burner flame. The glass of the lamp is also "frosted" a certain distance up so that any minute elongation of the flame can immediatly be detected with this lamp. Prof. Clowes was able to detect ¼ per cent. of gas.

These two series of experiments are only a small item in the many tests which have from time to time been made in various parts of Europe, and the effect of these has been to convince the authorities on the other side that it is positively unsafe to venture into a gaseous mine with such a lamp as an unbonneted Davy or Clanny.

On the other hand, there has never been any tests which show any increase of danger from using a glass in a safety-lamp to replace the part of the gauze.

The only sensible conclusion that we can, therefore, arrive at regarding the Davy lamp is

(1). That while it gives the poorest light it is also the most unsafe in any but a very weak current.

(2). That the substitution of a glass around the flame increases the light and does not add to the risk of explosion.

(3). That it is *not* the best gas detector.

These are the results of so many and varied experiments that we will some time or other have to acknowledge their correctness, and why not now before more lives are lost.

The Utilization of the By-Products of the Coke Industry. Dr. Bruno Terne, in a paper recently read before the Chemical Section of the Franklin Institute, states that the economy displayed in Europe, in the utilization of these by-products, is far in advance of our American manufacturers.

Since 1850 the coke makers of England, France, Belgium, and Germany have been saving their by-products, while in our coal region to-day the sky is nightly illuminated by the fires from the coke ovens, all bearing witness to the waste going on. Our country is rich in resources, but not so rich as to warrant such a continual extravagance, and not only that, but the more careful European coke manufacturer saves his ammonia and sends it over to us in the form of sulphates.

Two years ago a manufacturer visited the Dahlhausen works of Dr. Otto, at the mines of Millensiven, near Dortmund. The ovens there are in two sets of thirty each, which are charged alternately every other day. The gases are conducted by large iron pipes to a large basin, where a part of the tar is condensed. From there it is led to the coolers, where the remaining tar and ammoniacal products are absorbed, and the gas, purified, is returned to a gas holder, and from there is redistributed to the coke ovens or boiler fires, or used in illuminating the works. That part of the gas which is returned to the coke ovens is mixed with hot air.

The coke is excellent, and although it has not the steel color of the Connellsville coke, it is of as good quality. The same gentleman, who is one of the best authorities on the subject, informed Dr. Terne that while the Connellsville Bee-hive oven only yielded 55% to 60% these ovens of Dr. Otto's gave from 70% to 80%.

But here is a sure proof of the value of such a process. Dr. Otto is not a coke manufacturer in the commercial sense of the term. He is a chemist. He constructs the ovens at his own expense, brings the coal from the mines, and delivers the coke to the mine company, simply to enable him to obtain the yield of tar and ammonia. He runs the ovens for twelve years and then hands the entire plant over to the mine owners, so that he must in that time make sufficient from the by-products to pay for the ovens, pay the interest on capital invested, and at the same time secure to himself the legitimate profit of a manufacturer, and he is successful in doing so, why should not we in America?

Taking the results obtained from a similar coal in Europe the by-product of ammonia alone which went to waste in one year at the coke ovens of America was 151,804,838 pounds, which at three cents per pound only is equal to $4,554,746. This was in 1887. In the same year the percentage of coke obtained from coal in Pennsylvania, which is the principal coking district, was 65%. The coal used was 8,938,849 short tons. If the by-products had been secured, as at Dr. Otto's works, the saving would have been $3,432,480, or, in other words, 28,604,316 pounds of ammonia, which has an agricultural value of eighteen cents per pound, have been lost in one year.

If the question be asked if the Connellsville coke would yield the same percentage of ammonia, the answer is given in the result of several experiments made by Dr. Terne which showed an average of 1·70% of ammonia. Dr. Terne gives illustrated descriptions of various kinds of coke ovens which have been tried in Europe to assist in the capture of the by-products and he says the question as to whether it will pay to gain these by-products is practically solved in the affirmative, and the question now before manufacturers is only what kind of oven will best suit the individual requirements of each kind of coal.

In the discussion which followed Dr. Terne's paper the question of first cost was raised and the following figures indicate the comparative costs of the Bee-hive as compared with the improved ovens.

Bee-hive Oven	$ 280.00
Otto Oven (without condensation apparatus)	337.00
Otto Oven and Condensation Apparatus Combined	1,150.20

It must, however, be borne in mind that the condensing plant will outlive the life of the ovens many times, so that the first cost will be limited to the first system erected.

Compound Air Compressors and Motors.

This was the subject of a paper read at a meeting of the South Wales Institute of Engineers by Professor A. C. Elliott, D. Sc., Edin. After giving his opinion that the use of compressed air as a power in underground work, is superior to the slow and cumbrous machinery of hydraulics, and is even preferable to electricity in that it is safer in presence of gas and is at the same time more desirable for its beneficial effects on the ventilation of workings. Prof. Elliot goes on to consider the increased duty obtained by compounding the compressors and motors.

The author compares this method with the ordinary simple system and claims for it that the result is either (*a*) with the same pressure of transmission a substantial gain in efficiency, or (*b*) with a higher pressure of transmission and the same efficiency, a reduction in the size of the supply pipes and the plant generally. In the ordinary system of compressed air transmission, the available energy per pound mass passed through the compressors consists of two distinct parts:

(1.) The reservoir energy.

(2.) The elastic energy.

The reservoir energy is the energy supplied direct by the compressor piston on the surface to the motor piston underground just exactly as if the two pistons were directly coupled by some rigid system of gearing.

This transference of power takes place between the opening of the eduction valve of the compressor and the closing of the expansion valves of the motor, and no part of the energy is transformed into and retransformed from heat. The internal work of a perfect gas like air is practically zero, so that the work spent in compressing up to the time the eduction valve closes is transformed in to heat. This heat is dissipated by absorption in the water jacket and in the long line of feed-pipes leading to the motors, and none of the work spent in mere compression has any counterpart in the work appearing in the motor.

This principle of zero internal work cuts both ways, and the energy gained in the motor by expansion is less than the energy spent in the compressor on mere compression.

It is evident therefore that the work done in compression over and above the actual force supplied to the motors from the moment the eduction valve opens is a waste product transformed into heat, and the system of compression and cooling therefore which will be most economical, is that in which the heat generated is least.

There are two ways of effecting this, (1) by removing the heat as rapidly as it is formed and (2) by compressing completely and then cooling the air. The first is called isothermal compression and the latter adiabatic compression. By the isothermal method the air leaves the cylinder in the state in which it reaches the motor, but with the other system the contrary obtains. Cooling takes place by the adiabatic system practically at constant pressure, and the compressor piston has to follow up the constant shrinkage of volume by sweeping a proportionately larger volume per pound mass of air delivered. From all sides the advantage of isothermal compression is apparent, but the difficulty has been to realize it in actual working. Injecting water into the compressor cylinder has been generally adopted, but opinion is divided as to whether it has any real advantage over the water jacket. The injection of water is the best heat dispeller, but it is objectionable where there is any difficulty in freeing the water from grit.

To obviate these inconveniences it has from time to time been suggested to cool the air by an intermediate process, and it has also been proposed to compress in two or more successive stages and this is the idea of compound compressors.

From tests made Prof. Elliott states the fact that compound compression would require 13 per cent. less and a triple system 16·7 per cent. less horse power than a simple adiabatic compressor, and he points out that to obtain the highest efficiency the exit temperature in each receiver must be as near the temperature of the atmosphere as possible. Taking the cases of an ideal isothermal compressor and an ordinary simple compressor, both accomplishing the same result, between the I. H. P. of each, there is difference which we consider as a dead loss in the ordinary system, and this loss is proved to be 23·8 per cent. The loss on a compound compressor would be 12 per cent., and on a triple and quadruple compressor 8 and 6 per cent. respectively.

Having thus considered the compounding of compressors, Prof. Elliott now turns to the question of compound motors and he suggests that just as in the former case we have the temperatures of the receivers reduced to nearly atmospheric pressure, by application of air or water at that temperature so on the other hand the temperature of a receiver of a compound motor could be *raised* to equality with that of the atmosphere by identically the same means, or in other words, it is possible to derive mechanical energy from atmospheric heat. The work spent in mere compression in the compressor, went as heat to the outside atmosphere, but if by means of some perfect conductor stretched from the compressor to the motor, we could apply this heat as work, after the expansion valves of the motor are closed we thus recover some of this wasted energy. As such a conductor is of course impossible, we must borrow by cutting off the stroke and drawing heat from the surrounding air to raise the cold air to as near the atmospheric temperature as possible in delivering it into the low pressure cylinder. By such a system and upon calculations based on the results of the reduced temperature obtained by compound compression we have for a simple motor an efficiency of 46·1% ; for a compound motor an efficiency of 59·8% ; and for a triple motor an efficiency of 65·2%. In conclusion, Prof. Elliott says that the compound system strikes at the root of three difficulties in the development of compressed air plant, viz.:

(1.) The rapid decrease in efficiency attendant on increase of pressure.

(2.) The small ratio of expansion obtainable in ordinary motors, and

(3.) The formation of ice on the exhaust passages.

The first point has here been dealt with. The second cannot wholly be dissevered from the third. There is a greater difficulty in effecting an early cut-off with an air engine than with a steam engine, as the air has twice the density of steam and shows more marked inertia effects. There are these advantages, however, that by the compound principle a considerable degree of expansion is consistent with fairly late cut-offs, the time given to effect expansion is greater, and the chilling action of the motor cylinder walls is reduced. The ice difficulty will vanish with the adoption of the compound principle as a very large proportion of the moisture originally present in the air will be condensed under the action of cold and pressure in the receivers, whence it can be readily withdrawn.

ELECTRIC LOCOMOTIVES.

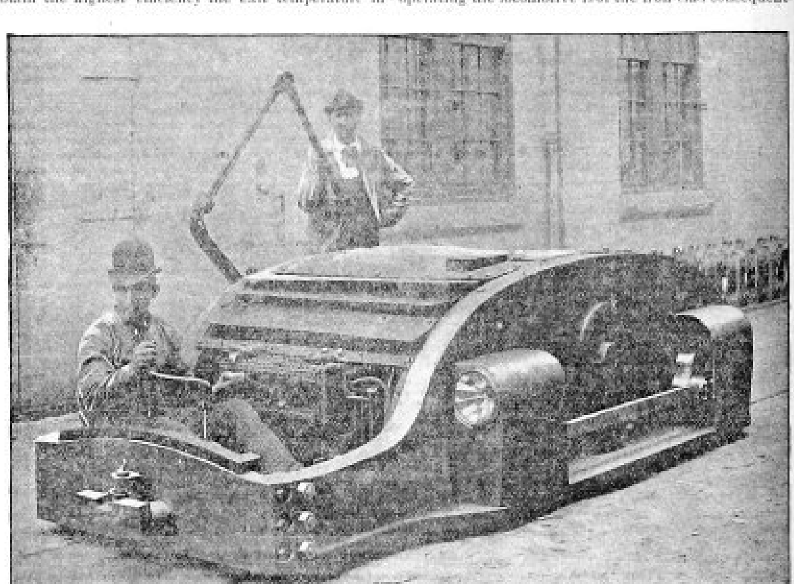
While electricity has been used for some time in mining work for the purpose of lighting mines, it attained no prominence in the field of underground haulage until the Thomson-Houston Electric Company designed and installed in the Erie Colliery, of the Hillside Coal Company, the first successful electric mining locomotive of the country. This was in October, 1889.

Requirements of other mines, however, have led to the production of a locomotive differing essentially from that in the Erie Colliery, a type known as the "Terrapin Back," and which is shown in the accompanying illustration.

It is most substantially and solidly built, the interior mechanism being entirely protected by a heavy iron armor, and possesses in a marked degree the important features of strength and solidity. The motor for operating the locomotive is of the iron-clad consequent-pole type, having a Gramme ring armature.

It is provided with the radial type carbon brushes and elongated commutator segments by means of which the most durable connection with the armature coils is obtained. The motor is situated midway between the axles, the proper speed reduction being attained by means of a train of gears. The locomotives can be run at various speeds, the motors being wound for any speed as a maximum from four to ten miles an hour.

The locomotive is provided with the necessary controlling devices, all placed within easy reach of the operator. A special type of rheostat composed entirely of mica and German silver is employed, and a new and improved brake lever and reversing switch. The trolley arm through which the current is conveyed to the motor is of the double elbow pattern, which accommodates itself automatically to the varying heights of the conductor and permits the operation of the car in either direction. On each side of the locomotive is placed an incandescent lamp, which serves the double purpose of signal and headlight. A 220-volt generator supplies the necessary current. The Thomson-Van Depoele Electric Mining Company, which designed this locomotive has also in process of construction several new types suited for the requirements of different mines, hard and soft coal, iron, and other metals, and for high and low entries, and for gauges varying from eighteen inches to the standard. The company having had such valuable experiences in the field of underground electric haulage is particularly fitted to design and manufacture any locomotive of any type demanded by local conditions. The success of the apparatus already installed has given great impetus to this branch of applied electricity and will result in the still further use of electricity in mining operations.



The Jeffrey Manufacturing Co., Columbus, Ohio, report business as good in their different lines of specialties. They have many large orders on their books for elevators and conveyors for handling material in bulk or package, and have recently purchased a tract of land adjoining their present extensive works, on which they have erected a large and substantial brick building, that they may be better able to take care of their growing business.

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.
All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.
The Editor is not responsible for views expressed in this Department.
Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.

Pumping.

Editor Colliery Engineer:

SIR:—In reply to "Beginner," of Mount Pleasant, Pa., in August number, I submit the following:

The water is to be raised 100′, which will require $100 \times \cdot434 = 43{\cdot}4$ lbs. pressure per square inch; if the pump is 5 ft. from water, discharge $= 95 \times \cdot434 = 41{\cdot}23$ lbs. pressure.

Vacuum in suction $= 5 \times \cdot434 = 2{\cdot}17$; $41{\cdot}23 + 2{\cdot}17 = 43{\cdot}4$ when the pump is 20 ft. from water.

The discharge is $80 \times \cdot434 = 34{\cdot}72$;

Vacuum in suction $20 \times \cdot434 = 8{\cdot}68$, then $34{\cdot}72 + 8{\cdot}68 = 43{\cdot}4$.

The water being pumped 100 ft. high requires 43·4 lbs. pressure per square inch and it does not make any difference whether part of the work is done by creating a vacuum or all done by pressure.

Some are of the opinion that because the pressure of the atmosphere fills the vacuum as it is created that such is clear gain, but it is not so, if we raised water 10 ft. we must create a vacuum of 4·34, if we raise it 20 the vacuum must be 8·68, and 30 ft. will require a vacuum of 13·02 and so on until we reach the perfect vacuum, then the water will not raise any higher.

Yours, etc.,
F. B.

Maccan, N. S., Oct. 12th.

Examination Question.

Editor Colliery Engineer:

SIR:—In reply to "J. W. S.," in the October issue, I would say that his solution is wrong in assuming water to be 833 times heavier than air.

The weight of one cubic ft. of water at 40° temperature is 62·69617 lbs., weight of one cu. ft. of air at 40° temperature $= \cdot0796767$ lbs.

$$\frac{62{\cdot}69617}{\cdot0796767} = 786{\cdot}88 + \text{ times heavier than air.}$$

Now, by apportioning this correction with the assumed 833, and the results of "J. W. S.'" solution, we have

$$\frac{144{\cdot}47° \times 786{\cdot}88 +}{833} = 137{\cdot}29° \text{ temp. in upcast.}$$

If we use an assumed proportion we must remember that the answer is not correct, but is wrong in proportion to the difference of the assumed and correct proportions. I think we cannot find a shorter or more correct solution of the question of "J. W. S." than the following:

$$\frac{1{\cdot}32529 \times 30}{459 + 40°} = \cdot0796767$$

weight of one cubic ft. of air in the downcast.

$$\cdot0796767 \times 400 = 31{\cdot}87068 \text{ lbs.}$$

= the weight of a column one foot square from top to bottom of downcast shaft. Now, the weight of a similar column in the upcast will be 5·2 lbs. lighter $= (31{\cdot}87068 - 5{\cdot}2) = 26{\cdot}67068$ lbs.

$$\frac{26{\cdot}67068}{400} = \cdot0666767$$

weight of one cubic foot of air in the upcast shaft.

$$\frac{1{\cdot}32529 \times 30}{459 + T} = \cdot0666767.$$

By transposition

$$\left(\left(\frac{1{\cdot}32529 \times 30}{\cdot0666767}\right) - 459\right) = 137{\cdot}29 + \text{degrees}$$

temperature of upcast. I am sorry that "J. W. S." could not appreciate some of the several solutions of his question. I have tried to make the work as plain as possible believing that plain mathematics should be used in solutions where algebraic formula is unnecessary.

Yours, etc.,
F. B.

Maccan, N. S., Oct. 12th.

Certificated Mine Officials.

Editor Colliery Engineer:

SIR:—I am pleased to notice the rapid strides THE COLLIERY ENGINEER is making not only in its own improvement but in educating its readers as well. I have sometimes heard it said, by miners, that it is necessary to have a fairly good education before an interest can be taken in the articles that are published in THE COLLIERY ENGINEER. This cannot now be said, as the Primary Educational Department is just the thing that will assist the uneducated to get a clear conception of the laws and elements that are treated upon, and will be the means of overcoming the wrong impressions against certificated officials. Those that have the most to say against certificates are the ones that never try to improve their condition. I was surprised that the miners' convention, held at Columbus, Ohio, should pass a resolution, as reported by Mr. Andrew Roy in THE COLLIERY ENGINEER, not favoring certificated mine officials, also, that the inspectors of the State of Ohio should entertain such a feeling as was manifested at a late meeting of the Ohio Institute. It seems to me that an intelligent comprehension of the natural laws which govern the different elements connected with mining, and the benefit of the experience of others will benefit the operator and miner alike, and raise the standard to a higher level.

The new mining law which was prepared by our last Legislature shows that our operators and miners, after five years' trial, are in favor of the certificate. That some candidates have obtained certificates that are not worthy of them does not prove that the law is at fault. The damage done by the law is so insignificant compared with the good that it has accomplished that it is not worthy of mention.

Yours, etc.,
J. W.

Lindsey, Pa., Oct. 5th.

Pumping.

Editor Colliery Engineer:

SIR:—The following question was asked in the August issue of your journal, and has been answered by "J. V.," of Punxsutawney, Pa., and "T. S. A.," of Anita, Pa.:

In a shaft 100′ deep a pump is placed with 5′ suction and 95′ discharge. Will it require more or less power, if the pump is placed up the shaft with 20′ suction and 80′ discharge?

In their answers they claim there would be a difference in pressure of 6·51 lbs. to the square inch. Now, I am not satisfied with this result. If I understand their answers aright the same powers that "sucks" the water 5′ will "suck" 20′. According to the question the water must be lifted 100′, and 100′ of water weighs 43·4 lbs. on every square inch at bottom of said depth, that is, if we fill a pipe 100′ in height with water, there will be a pressure of 43·4 lbs. on every square inch of area at the bottom of the pipe. When our suction pipe is 20′ long, we must exhaust the air in this pipe until the pressure of air on the water outside will force the water up the pipe 20′, and this is practically the same as if we discharged the full 100′ without any suction. It can be all summed up thus—water is to be lifted 100′ and it does not matter how, as the weight is the same. The "suction" is only an indirect way of lifting it. In the suction pipe there is a pressure of 14·7 lbs. of air to the square inch. Now, without computing anything for friction, in order to get water up to the piston of the pump we must exhaust the air until only a pressure of 6·02 lbs. remain. Twenty feet of water will weigh 8·68 lbs. per square inch of area at bottom of the pipe, and in order for the atmospheric pressure to force the water up the pipe we must exhaust a pressure of air from the pipe of 8·68 lbs., which is the same as if the water were lifted. My experience with pumps has taught me that the 5′ suction would probably give the best satisfaction, and I can't see as there would be any difference of power. This is as I understand the question, if I am wrong I hope to be corrected by some of your able correspondents.

Yours, etc.,
J. N. K.

Mansfield Valley, Pa., Oct. 9th.

Examination Question.

Editor Colliery Engineer:

SIR:—In the October issue of your journal "T. S. C." says I prove one mistake by making another, and says:

$$M = D\,\frac{T - t}{459 + t}$$

Should be

$$M = D\,\frac{T - t}{459 + T}$$

The Colliery Engineer Pocket-Book, on page 73, gives the last rule for finding motive column, but E. B. Wilson, on page 127 of his book on mine ventilation, gives the first rule. Which is correct? I supposed Mr. Wilson was correct and used his formula.

In either case the answer is arrived at by simply reversing the formula, or rather, the known quantities of the formula to find the unknown quantitity. I should have used air at 40° F. and 30″ barometer instead of 60° F. and 30″ barometer.

Yours, etc.,
H. L. D. W.

Dagus Mines, Pa., Oct. 15th.

Examination Question.

Editor Colliery Engineer:

SIR:—In answer to "J. W. S.," I submit the following: In his question the pressure is given as 5·2 lbs., and as the pressure is the weight of the motive column, its temperature being 40°, the weight of one cubic foot of air in the motive column

$= \cdot07967$, and

$$\frac{5{\cdot}2}{\cdot07967} = 65′, \text{ instead of } 69{\cdot}4′$$

as he reckons it to be by assuming the comparative densities of air and water to be as 1 is to 833. In this case it is not correct, as a cubic foot of water divided by 833 $(62{\cdot}5 \div 833)$ equals ·07503, which is the assumed weight of a cubic foot of air and which, as I have demonstrated, is not correct. This difference makes the difference in the answers, that have been given and his own. Hoping that my explanation will be understood by "J. W. S.," I remain

Yours, etc.,
T. S. C.

Gardner, Ill., Oct. 10th.

Mining.

Editor Colliery Engineer:

SIR:—I wish to submit the following question in hope that some of your able correspondents will express their views:

Suppose a mine was to suspend operations for several years, and it was desirous to leave it in condition to resume as quickly as possible, would it be best to close the various openings or leave them open, so as to have no air current, or current due to natural ventilation? Under which condition would most damage occur to sides and roof of gangways?

Yours, etc.,
S. U. P.

Lawsonham, Pa., Oct. 10th.

Pumping and Surveying.

Editor Colliery Engineer:

SIR:—Please insert the following in reply to "T. S. A.," of Anita, Pa., in the October issue:

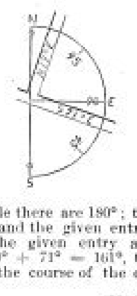
(1.) Six boilers of 288 nominal horse-power would require 288 cubic ft. of water per hour, therefore

$288 \div 60 = 4{\cdot}6$ cu. ft. of water per minute, or, as there are 1728 cubic inches in a foot, we have

$4{\cdot}6 \times 1728 = 7948{\cdot}8$ cubic inches, then,

$7948{\cdot}8 \div 231 = 34{\cdot}41$ gallons per minute.

(2.) The following diagram represents the given entry and cross-heading as it should be:



In the semi-circle there are 180°; the angle between the south point and the given entry equals 71°; the angle between the given entry and cross-heading equals 95′, and $90° + 71° = 161°$, then $180° - 161° = 19°$, therefore the course of the cross-heading will be north 19° E.

Yours, etc.,
J. T. G.

Braidwood, Ill., Oct., 12th.

"Agricultural Phenomenon on Coal Land."

Editor Colliery Engineer:

SIR:—I think if your correspondent, W. W. Cable, had stated the *kind of soil or soils* existing in Jefferson Co., Ohio, where the apple-tree phenomenon referred to occurs, the explanation of it would have been made more easy. In the absence of this data I beg to suggest that it is possible, and even probable, that above the coal seam the soil is "warm" and sandy, whereas that below the coal is "cold" and clayey, which latter causes sterility of the apple trees. I am no horticulturist or agriculturist, but it would naturally seem to me that the quality or character of the soil in which those trees grow, has chiefly to do with the case.

Yours, etc.,
W. S. GRESLEY.

Erie, Pa., Oct. 11th.

Colliery Management.

Editor Colliery Engineer:

SIR:—I wish to submit the following in reply to "S.," of Wilkes-Barre, Pa.:

Where and how can the best results be obtained from a furnace at a coal mine, whether at the top of upcast or at the bottom of upcast and state reason why?

The best results are to be obtained from a furnace at the bottom of the upcast, since the furnace causes the current to move by rarification and the heated air being lighter than downcast air rises, the cool air flowing towards the furnace to be heated and rarified in its turn. The depth of shaft is a measure of pressure produced by the furnace. In a deep shaft the column of heated air is longer than in a shallow shaft and consequently lighter than an equal column of the downcast air, hence the deeper the shaft the greater will be the pressure with the same amount of fuel used. If the furnace were placed at the top of shaft very little current could be produced, as the only heating surface would be at the grate-bars, and the chances are the current would be from the outside instead of from the mine. At any rate the furnace would not give good results, since to be effective the furnace must heat the air in the shaft, thus making it lighter than the downcast or outside air.

Yours, etc.,
S. U. P.

Lawsonham, Pa., Oct. 12th.

Colliery Management.

Editor Colliery Engineer:

SIR:—Please insert the following in reply to "S.," of Wilkes-Barre, Pa.:

The best results can be obtained from a furnace placed at the bottom of the upcast, say 30 or 40 feet from the bottom, when it is possible to have the airway on a rise to the shaft. By having the furnace at the bottom of the shaft the heat is nearly all utilized. If the furnace were at the top of the shaft a large amount of heat would be wasted. Furnace ventilation is reckoned according to the square root of the depth of the upcast shaft, or the height of the column of heated air.

Yours, etc.,
O. K.

Rock Point, Pa., Oct. 20th.

The So-Called "Novel System of Coal Hoisting."

Editor Colliery Engineer:

SIR:—I am rather amused to see this announcement made, which is going the round of the coal mining papers. The introduction of the system described may probably be a *novelty* in the coke regions of Pennsylvania, and possibly in America, but it reads to me very like what in South Wales is called the "water balance"—a method of hoisting coal and other minerals, etc., more or less adopted in Europe from the days of Agricola, (A. D. 1550). See "Mining in the Middle Ages," by George Blake Walker, Barnsley, England, 1888.

For "*novel*," therefore, read "*ancient*."

In order to show that this self same apparatus, at any rate in *principle*, is nothing *new*, I beg to quote:

In "Fossil Fuel, the Collieries, and the Coal Trade in Great Britain," by Holland, London, 1835, p. 204, we read: "It should be mentioned that previously to the application of steam, by what was at first termed the "fire engine," a great variety of expedients for drawing coals were devised. "The most ancient machine to my knowledge now (1797) in use," says Mr. Curr, "is that invented by Menzey; but there are few situations that afford the requisites necessary to that invention. A stream of water with a fall of about half the depth of the pit is necessary, if any business of *consequence* might be done. Its construction consists of two wheels fixed upon one horizontal axis, which are so proportioned to the depths of the water pit and coal pit as to reach the separate depths of the pits by the same revolutions, and the power applied is a tub of water large enough to overbalance the weight to be drawn." This is from "Coal Viewer and Engine Builder's Practical Companion," published in Sheffield in 1797, or nearly 100 years ago.

Again, we find in "A History of Coal Mining in Great Britain," by Robert L. Galloway, 1882, p. 112. "The steam engine being at this time (that of James Watt, in 1768) only a *single-acting* machine, was ill-adapted for producing an even rotative motion directly. The attempts to use its power indirectly in raising coal were more successful. One of the earliest arrangements to effect this—the invention of Mr. Michael Menzies—was applied at Chatershaugh Colliery, Co. Durham, on the river Wear, in 1753. The basket of coals was raised by the descent of a bucket of water, a steam engine being employed to re pump the water to the surface. By this means a basket of 5½ cwt. of coal was drawn from a depth of 50 fathoms (300 feet) in 2 minutes. An arrangement on the same principle, known as the *balance-tub system*, was subsequently largely employed, more especially in collieries where the water used in raising the coals could be run off by an adit without requiring to be pumped up again."

It was about the year 1774 that water-wheels were introduced for hoisting purposes. This was due to one Sorocould, at Alloa, in Scotland. The plan was to fill reservoirs or large cisterns with water on the surface, from which the water engines took their supply of motive power; a double set of buckets, placed in opposite positions on the rim of the water or driving wheel, producing the reversion of the drum.

In the year 1852 was published the second edition of Dunn's celebrated "Mining and Working of Collieries" (a most entertaining and very fully illustrated all-round work on the then state of mining coal in Britain). Mr. Dunn says, on p. 217: "A rude method of drawing coal is practiced in Cumberland, and in some of the southern counties, by means of *water balance*, viz.: that a cistern of water, heavier than the loaded tub of coals, is attached to the opposite rope, so as as to overbalance it and draw it up, the water being discharged at the bottom of the pit, either to pass to surface by a natural level, or to be pumped up by an engine, as the case may be. Accidents are constantly occurring by this description of machinery, and the inconveniences arising from the leakages of water are such as ought to abolish such an antiquated application at a period when steam engines can be so advantageously applied and can be procured so cheaply."

That is what the great Matthias Dunn, of North of England fame fifty years or more ago, said about this thing.

Warington W. Smyth, F. R. S., etc., (in his excellent little popular work, "Coal and Coal Mining, 1866,") said on p. 161: "In Wales another mode of employing water power came into use, which is still to be seen at many of the collieries, as well as some of the slate quarries, where this power is abundant. A large sheave fitted with a powerful brake is fixed above the pit-top, and has a rope or chain passing round it, to one end of which is attached an empty cistern carrying over it a wagon of coal, to the other a cistern which, when filled with water, is heavier than the loaded wagon and empty cistern together. Suppose now the former is at bank, the latter at pit-bottom; the cistern is filled from a tank placed close by, and is regulated in its descent by the brake; when it reaches the bottom a self acting valve is opened, which lets the water flow out, meanwhile the loaded wagon is taken off the empty cistern, and by the time the latter is filled with water from same tank, the cistern at bottom is empty and the load of coals placed upon it, and thus the action is reversed, and a cheap, although slowly working machine, kept in reciprocating movement."

Then, in "Glossary of Terms Used in South Wales, Bristol, and Somersetshire," by W. Fairley, M. E., 1868, p. 3, "Balance Pit, a shaft so called when the coal is drawn by the weight of water," etc., adding "this method of getting coal up a shaft is adapted where water is plentiful, pits are shallow, and on top of a hill, so that the water taken down may run out of the hillside by means of an adit, or when it is raised by a water-wheel near top of shaft."

In Collins' "Principles of Coal Mining" (elementary science series), London, 1877, p. 92, the "water balance" is fully described, in which it is stated that the system is not used for depths exceeding 600 feet. In some cases the machines are placed at different levels so that the same water is used five or six times, over as many successive lifts. Trams holing 12 to 20 cwt. are raised. The water buckets are made of ¼ inch boiler plate, often circular in form, and some have a capacity of two or more tons of water. A speed of 300 to 400 feet per minute is easily attained by the machine, and the total cost of hoisting the stuff is about 1½ d. (3 cents) per ton per 300 feet. Similar machines are in use at some of the iron mines of Cumberland and elsewhere."

The "water balance" is referred to on p. 279 of the writer's "Glossary of Coal Mining Terms," 1883, and doubtless in other books besides. The writer recollects seeing "water balances" in use on the hillsides in the tin mining region of Cornwall, England, in 1873. These were erected and working on the surface, the vertical fall of the water tanks being about 35 feet, wire ropes connected them with hoists or other machinery for raising a load or for doing certain work way back in the levels, etc., or at mine mouths.

It is probably not generally known that most of the mine machinery at many of the iron, copper, and silver mines in Sweden is operated by water power, and in many places applied in the most primitive and yet economical manner. The author of "Mining in the Middle Ages," already referred to, states in a foot-note on p. 16, "A winding machine almost identical with the one here described, is mentioned in a paper by Mr. W. S. Gresley, in vol. VII., of *The Journal of the British Society of Mining Students*, as being still in use at the great Dalecarlia copper mine, in Sweden. From Mr. Gresley's account it would seem that in spite of the invention of the steam engine, water is still used in preference in Sweden for almost all purposes, on account of its greater economy; in fact, speaking generally, it would seem that most of the methods described by Agricola are still practiced in Sweden with excellent results."

It does not, therefore, seem likely that the Southwest Coal and Coke Co., of Pennsylvania, will be doing anything that may be called *progressive* if they adapt the antiquated water balance hoist, especially if they will have to pump back the water to the surface, as the Mt. Pleasant *Journal* implies will be the case.

While on this subject, the fact that Anthracite is hoisted from the mines near Carbondale, Pa., by water power (or was in 1889) may be cited; an over-shot breast water-wheel and drums operated by friction clutches being employed.

Yours, etc.,
W. S. GRESLEY.

Erie, Pa., Nov. 7th.

Certificated Mine Bosses.

Editor Colliery Engineer:

SIR:—A review of the coal mining industries of Western Pennsylvania, for the past six years, gives very little evidence that the ideal illiterate mine boss, of Mr. Hazeltine's standard, who, previous to the passage of the Bituminous Mining Act, of June, 1885, was in the majority, gave as good results as his now better informed brother is giving. The first was a child of favor, in some instances a man of ability full of hard common sense and practical knowledge, or, again, the favorite of some sentimental egotistical superintendent, or the tool of some petty tyrannical one. And the mine went drifting and dragging along in a happy-go-lucky devil-may-care manner too well known to be needful of comment here. And how in all fairness to Mr. Hazeltine's opinions and with due regard for his position he could have made so dwarfed and weak an assertion is beyond intelligent comprehension. Is not illiteracy the very seven-headed dragon which the mining craft have been fighting lo! these many years? And what crime have we committed and what law have we broken that consigns us to toil on in ignorance at our cheerless occupation? Is there any sin save that of omission visited from parent to child? And now that the child's feet are learning to walk should they not rather be guided than tripped up? When the Bituminous act, of June, 1885, became a law, light and prolonged life became the heritage of the miner who seems to have never inherited a birthright. The mine boss who, previous to that time, knew more of drain cutting, mule driving, and road laying than of natural philosophy laid aside the tools of these occupations and became his brother's keeper.

Some one says, is it really necessary for the mine boss to be certificated?

Just as necessary as the licensed pilot who guides the ship safely by the shoal and bar, or the competent educated engine-man who rides his machine and hauls the great thundering express trains safely from daylight to dark and morning. It is also very necessary that the superintendent possess a certificate of competency similar to that of the mine boss. Sometimes it might enable him to know why timber was needed in the mines and why expenses could not be cut down, and would it not help him to co-operate more intelligently with the mine boss instead of being a barrier to his progress? It is not the intention, spirit, or meaning of this article to throw hints to that broad-minded class of well-informed superintendents and managers who thoroughly understand how to manage their work. But the barnacles who know not how to do it, the Uriah Heeps who are promoted from a dry-goods and grocery store with instructions to "keep an eye on the business" at which they sometimes take a shy are here alluded to.

Let every craftsman who toils below the daisy roots, be of good cheer, THE COLLIERY ENGINEER is your friend, do not doubt or dodge that fact. Every department is a treasure-trove for you, and its future holds more and more promises. Give it your substantial support and aid because of the aid it has given you and will give to others.

Yours, etc.,
EYE SEE.

Loyal Hanna, Pa., Oct. 20th.

Pumping and Surveying.

Editor Colliery Engineer:

SIR:—I submit the following in reply to "T. S. A.," of Anita, Jeff. Co., Pa., in your October issue:

(1). Edwards, on page 209 of "Practical Steam Engineers Guide": "Each nominal horse power of boilers require one cubic foot of feed-water per hour." Consequently 288 cu. ft. × 6¼ imperial gallons in one cubic foot = 1800 gallons per hour as required for 288 H. P. in boilers.

(2). S. 71° E + 90° turned to the left = 161°. There are 180° in a semi-circle. The needle points at 71° and a right angle will cover 90° more or 161° of the semi-circle. From the 180° subtract 161° and 19° are left. The semi-circle is in two quadrants which are read from S. to E. and from N. to E., there being 90° in each quadrant. We began at the South and read 71° + 90° = 161°, this brings us into the N. E. quadrant leaving only 190° E. from due North. So the course is 19° N. E.

Yours, etc.,
H. L. D. W.

Buffalo, N. Y., Oct. 18th.

Mensuration.

Editor Colliery Engineer:

SIR:—The following is in answer to "Trackman," of Reynoldsville, Pa.:

A tree 80′ long, 6′ diameter at butt end, tapers to 1′ diameter, how long a rope will it take to coil around it, the coils to be close together, also how long will the rope have to be, allowing 12″ between coils?

First,

$$\sqrt{(6' + 1' \div 2 \times 3{\cdot}1416 \times 960^2 + 80^2)} = 10556{\cdot}07'$$

of rope 1″ in diameter.

Second,

$$\sqrt{(6' + 1' \div 2 \times 3{\cdot}1416 \times 80'^2 + 80^2)} = 879{\cdot}65'$$

nearly of 1″ rope 12″ from center of coils. If "Trackman" wants the amount of rope required at 12″ between coils, instead of from center to center, substitute 73·846 revolutions for 80 in last equation. See Haswell's book, page 355.

Yours, etc.,
H. L. D. W.

Buffalo, N. Y., Oct. 17th.

Arithmetic.

Editor Colliery Engineer:

SIR:—The following problem is given in Fairley's book:

$$\sqrt{25000^2 + 22000^2} = 33{,}301.$$

It is on the combined effect of furnace and steam jet. Thus far I have been unable to solve it, and obtain the same result as given; would some of your able correspondents work it out fully?

Yours, etc.,
A. A.

Buena Vista, Allegheny Co. Pa., Oct. 16th.

Trigonometry.

Editor Colliery Engineer:

SIR:—Will some of your readers kindly explain how the decimal is found for any number of degrees such as 35°? Is it by multiplying by the sine of one degree? ·017452 × 35° is not correct.

Yours, etc.,
R. L. T.

Reynoldsville, Pa., Oct. 20th.

Ventilation.

Editor Colliery Engineer:

SIR:—Please publish the following in reply to questions by "A. B.," of Hanna City, Ill., in your September issue:

(1). An airway 8′ × 8′ × 1000′ is passing 40,000 cu. ft. of air, what diameter should a circular airway 1200′ long be to pass one-half the quantity, the pressure remaining the same?

As the pressure is the same for the two airways, we find the area of the circular one by the following formula:

$$\frac{Q}{v} = a,$$

and from it the diameter, thus

$$20{,}000 \div 625 = 32', \text{ and}$$
$$32' \div {\cdot}7854 = 40{\cdot}71' +$$

the square of the diameter, the square root of which is the diameter, or

$$\sqrt{40{\cdot}71} = 6{\cdot}38' +.$$

(2). A mine is ventilated by natural ventilation passing 10,000 cubic feet of air per minute with a pressure of 3·5 pounds, the temperature in the downcast being 42°. The air current is reversed by erecting a furnace at bottom of the downcast producing 14,000 cubic feet of air per minute, what is the effect on the pressure and temperature?

By erecting a furnace at the bottom of the downcast and reversing the current the temperature of the downcast will remain the same (42°), but by erecting a furnace the upcast is changed to the downcast. For every degree of heat the furnace will add in the upcast the volume will increase at the ratio of $\frac{1}{459}$, and as the volume has increased, the pressure will increase as the square of the velocity.

Yours, etc.,
L. P. H.

Avoca, Pa., Oct. 15th.

Certificated Mine Superintendents.

Editor Colliery Engineer:

SIR:—Your correspondence on certificated mine superintendents is becoming interesting. With your permission I would say this in favor of it: If a compulsory examination for superintendents will cause as much study of mining as the examination of Mine Foremen has, then by all means, let them be examined. The Mine Superintendent in England has to pass an examination and hold a certificate before he can serve. But before presenting a bill to that effect to the Legislature of this State would it not be well to publish it in THE COLLIERY ENGINEER and other mining journals, so that those interested may have a chance to criticise it? Our latest mining laws are a disgrace, as for instance: the law requiring miners to hold certificates. The good this law has accomplished is *nil*. It has done much evil in creating parasites who enforce the law for the paltry fifty cents there is in it for them. A man must be hard up for an office, indeed, when he will accept a place on these Boards. The "fire bosses" now must go through the same ordeal as the mine foremen in order to enable them to hold certificates. The law makers themselves in this case did not understand the law they created.

Suppose a person holds a certificate as a superintendent, as many now hold mine foremen's certificates, what good are they in a community where the mines are owned by large corporations. The appointing power is vested in the hands of one person. The Reading owns forty-five of the best collieries in this region; they have adopted a system of promoting their employes, and stick to it pretty closely. If a person happens to be out of favor with the "powers that be," his name is "Dennis." Some may say to those who are aspiring for such promotions, "get friends." Mark Twain says in the Gilded Age: "You don't need brains, get friends." But I am inclined to think that unless a person *has* brains, friends can not always help him. I know a man who lately took charge of the fag end of what had been for many years an excellent colliery. Of course there is an end to everything, and so there was to the colliery I am alluding to. A change was made, but if it was badly managed before, the change made things ten times worse because friends, not brains, were most influential in making the appointment.

Yours, etc.,
O.

St. Clair, Pa., October 22d.

Answers to Miscellaneous Questions.

Editor Colliery Engineer:

SIR:—Please insert the following solutions to questions by "S. W.," of Irondale, Ohio, in the November issue:

(1). How is a water-gauge affected when the air course is suddenly contracted or enlarged?

ANSWER.—The revolutions of the fan remaining constant, there will be a loss of water-gauge when contracted and a gain when enlarged.

(2). By what means is density increased and diminished?

ANSWER.—The density of air is increased by compression, as with the force fan; and diminished by rarefying the air as is done with the furnace by heating it, or by the use of the exhaust fan in tending to create a vacuum.

(3). It is proposed to increase the quantity of air circulating in a mine 10,000 cubic feet per minute, by building a chimney on to the upcast shaft; the original volume is 60,000 cubic feet, and the upcast shaft is 400′ in depth, what must be the height of the chimney?

ANSWER.—The pressure will be in proportion to the depth of the shaft, the temperatures remaining the same, and the quantity as the square root of the pressure. Therefore, the quantity will be as the square root of the depth, and the depth as the square of the quantity. Then as the height of chimney is equivalent to so much being added to the depth of upcast, the new depth will be as

$$60{,}000^2 : 70{,}000^2 :: 400 : x, \text{ or}$$
$$36 : 49 :: 400 : 544{\cdot}44$$

= new depth, and then

$$544{\cdot}44 - 400 = 144{\cdot}44',$$

the height of chimney.

(4). There is a cistern 20′ square, and 10′ deep placed on the top of a tower 60′ high, what power is required to fill this cistern in 30 minutes; and what will be the diameter of pump, when the length of stroke is 2′, and making 40 strokes per minute?

ANSWER.—The capacity of the cistern is found thus:

$$20' \times 20' \times 10' = 4{,}000 \text{ cubic feet.}$$

Then,

$$\frac{4{,}000}{30} = 133\tfrac{1}{3}$$

cubic feet that the pump must be able to discharge in one minute, and

$$133\tfrac{1}{3} \times 1{,}728 = 230{,}400$$

= the number of cubic inches per minute. Velocity of pump equals

$$2 \times 40 \times 12 = 960$$

inches per minute, and the area of pump is

$$\frac{230{,}400}{960} = 240.$$

Then

$$60 \times {\cdot}434 = 26{\cdot}04 \text{ lbs.}$$

pressure per sq. in. on the water end, and

$$26{\cdot}04 \times 240 = 7249{\cdot}6 \text{ lbs.},$$

load on piston;

$$\overset{p\,a}{7249{\cdot}6} \times \overset{s}{80} = 579{,}968$$

= the units of work. If we add $\frac{1}{3}$ for loss and friction we have 773,290 units, or

$$\frac{773{,}290}{33{,}000} = 23{\cdot}4 \text{ horse power.}$$

$$\text{Diameter of pump} = \sqrt{\frac{240}{{\cdot}7854}} = 17{\cdot}48''$$

or by formula

$$\sqrt{\frac{\text{Galls.}}{3{\cdot}3}} = \frac{230{,}400}{231} = 997 \text{ gallons,}$$

$$\sqrt{\frac{997}{3{\cdot}3}} = 17{\cdot}4'' = \text{diameter of pump.}$$

Yours, etc.,
T. S. C.

Gardner, Ill., November 9th.

Ventilation.

Editor Colliery Engineer:

SIR.—I submit the following in reply to question asked by "S.U.P.", of Red Bank, Pa.:

The pressure is found thus:

$$p = \frac{k\,s\,v^2}{a}$$

substituting their given values we have

$$p = \frac{{\cdot}0000000217 \times 24000 \times 250{,}000}{128} =$$

$$\frac{130{\cdot}200000}{128} = 1{\cdot}017 + \text{lbs.}$$

the pressure required. In the next case we have the following formula to find the quantity:

$$q = \sqrt{\frac{p\,a}{k\,s}} \times a.$$

By taking the total pressure which has been found to be 130·2 lbs. and divide it by k and s, and substituting their values we have

$${\cdot}0000000217 \times 32000 = {\cdot}0006944,$$

and

$$130{\cdot}2 \div {\cdot}0006944 = 187500,$$

and

$$\sqrt{187500} = 433{\cdot}01 +$$

multiplied by 128· the area of the two shafts, we have 55·425 cubic feet, the quantity that will pass. It can also be solved in this way: Air courses will pass quantities in proportion to the square root of their rubbing surfaces. Hence we have the following simple proportion:

$$\sqrt{64} : \sqrt{48} :: 64{,}000 : x, \text{ or}$$
$$\sqrt{4} : \sqrt{3} :: 64{,}000 : x,$$

and by extracting the root it becomes

$$2 : 1{\cdot}73 :: 64{,}000 : 55{,}360 \text{ cubic feet.}$$

The slight difference is owing to not carrying out the decimal places further.

Yours, etc.,
O. K.

Rock Point, Pa., November 11th.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to question (1) asked by "A. B.," of Hanna City, Ill.:

(1). An airway 8′ × 8′ × 1000′ is passing 40,000 cu. ft., of air, what diameter should a circular airway 1200′ long be to pass one-half the quantity, the pressure remaining the same?

Let a denote area airway No. 1 = 64 sq. ft.
Let o denote perimeter airway No. 1 = 32′.
Let l denote length airway No. 1 = 1000′.
Let q denote quantity airway No. 1 = 40,000 cu. ft.
Then,

$$\left(\frac{q}{a}\right)^2 = \frac{q^2}{a^2} = \text{sq. of velocity} = \frac{40{,}000^2}{64^2},$$

and k = co-efficient of friction = ·0000000217.
Let x denote diameter of airway No. 2.
And ·7854 x^2 denote area of airway No. 2.
And 3·1416 x denote perimeter of airway No. 2.
And L denote length of airway No. 2.

And $\frac{q}{2}$ denote quantity of airway No. 2.

And

$$\left(\frac{\frac{q}{2}}{{\cdot}7854\,x^2}\right)^2 = \frac{q^2}{4 \times {\cdot}7854^2\,x^4} = \text{square of velocity.}$$

Then,

$$\frac{k\,o\,l\,\frac{q^2}{a^2}}{a} = p = \text{pressure,}$$

and

$$\frac{k\,3{\cdot}1416\,x\,\mathrm{L}\,\frac{q^2}{3{\cdot}1416 \times {\cdot}7854\,x^4}}{{\cdot}7854\,x^2} = p = \text{pressure.}$$

Hence,

$$\frac{k\,o\,l\,\frac{q^2}{a^2}}{a} = \frac{k\,3{\cdot}1416\,x\,\mathrm{L}\,\frac{q^2}{3{\cdot}1416 \times {\cdot}7854\,x^4}}{{\cdot}7854\,x^2} \quad (1).$$

Canceling k and reducing (1)

$$\frac{o\,l\,q^2}{a^3} = \frac{\mathrm{L}\,q^2}{{\cdot}7854^2\,x^5} \quad (2).$$

Dividing (2) by q^2,

$$\frac{o\,l}{a^3} = \frac{\mathrm{L}}{{\cdot}7854^2\,x^5} \quad (3).$$

Reversing (3)

$$\frac{a^3}{o\,l} = \frac{{\cdot}7854^2\,x^5}{\mathrm{L}}, \quad (4).$$

Dividing (4) by $\frac{{\cdot}7854^2}{\mathrm{L}}$

$$\frac{a^3\,\mathrm{L}}{o\,l\,{\cdot}7854^2} = x^5. \quad (5).$$

Substituting the symbolic values

$$\frac{64^3 \times 1200}{32 \times 1000 \times {\cdot}7854^2} = x^5. \quad (6).$$

Extracting fifth root of (6)

$$\sqrt[5]{\frac{64^3 \times 1200}{32 \times 1000 \times {\cdot}7854^2}} = x, \text{ or}$$

x = 6·98′ diameter of required airway.

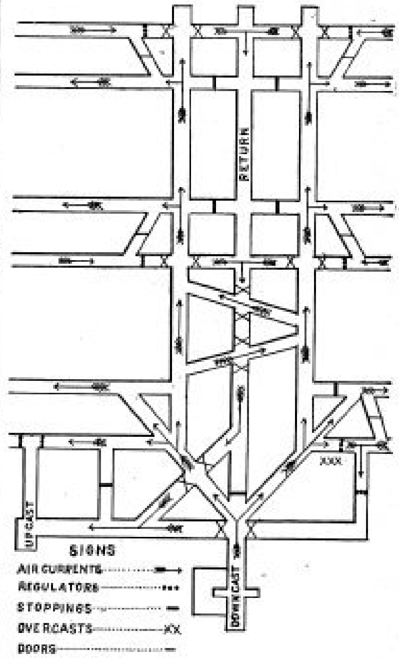
Yours, etc.,
R. M. S.

Wyoming, Pa., November 9th.

Ventilation.

Editor Colliery Engineer:

SIR:—In answer to Joseph Cain, in your June issue, I submit the enclosed plan, which will show the overcasts he speaks of and the method of ventilation I referred to. By close study of the sketch he will understand the reasons for placing the overcasts where they are, also that there is no door in any of the main entries. Again, that all full cars from the right hand entry will come



through the first cross-cut and from that point the left hand entry will be the full track and the empty cars for the left hand entry will pass through the second cross-cut. An equilibrium is maintained in both intake currents when drivers are actively engaged in hauling coal. There are also other reasons which might be mentioned, why they are placed there in case of accidents, etc., which the readers of THE COLLIERY ENGINEER can study out from the plan if they wish.

Yours, etc.,
P. HORNEL.

Moon Run, Pa., Nov. 5th.

Ventilation and Mechanics.

Editor Colliery Engineer:

SIR:—Would some of your able correspondents kindly answer the following questions in the next issue of your journal:

(1.) Assuming that a fan making 80 revolutions per minute produces 40,000 cubic feet of air, how much more would it produce if the revolutions were doubled?

(2.) How would you practically test the safety-catches of a cage in a shaft?

Yours, etc.
J. M.

Morrisdale Mines, Pa., November 20th.

Correction.

Editor Colliery Engineer:

SIR:—Will you allow me to offer a correction to "L. P. H.'s" reply to my questions which appeared in your November issue:

He has misplaced the decimal point in his first proposition and in carrying it out thus makes the entire answer wrong. It should be self-evident that placing a brattice in the shaft would not reduce the volume from 64,000 cu. ft. in the 8′ × 16′ shaft to 17,484·8 in the two 8′ × 8′ shafts.

The answer should be as follows, using the formula $p = \frac{k s v^2}{a}$: substituting values we have

$$p = \frac{\overset{k}{\cdot 0000000217} \times \overset{s}{24{,}000} \times \overset{v^2}{250{,}000}}{128} = \frac{129 \cdot 2}{128} = 1 \cdot 01,$$

instead of 0·101326.

Then

$$q = \sqrt{\frac{p\,a}{k\,s}} \times a, \text{ and substituting the values}$$

$$\frac{1 \cdot 01 \times 64}{\cdot 0000000217 \times 16{,}000} = \frac{64 \cdot 64}{\cdot 0003472} = 183237,$$

the square root of which will be the velocity, or

$$\sqrt{183237} = 428.$$

And

$428 \times 64 = 27{,}392 \times 2 = 54{,}784$, or a difference of 9,216 cu. ft. lost by adding the brattice.

The formula used by "L. P. H." is correct, but by misplacing the decimal point in the first operation and following out the error it makes the entire operation wrong.

Yours, etc.,
S. U. P.

Lawsonham, Pa., Nov. 10th.

Answers to Miscellaneous Questions.

Editor Colliery Engineer :

SIR:—I wish to submit the following in reply to questions 1, 2, and 3, asked by "S. W.", in your November issue:

(1.) When the air course is contracted the water-gauge is raised, since "drag" is increased; and when air course is enlarged, the water-gauge is lowered as "drag" is lessened.

(2.) Density is increased and diminished by fans—increased when fan is acting as a force, or blower, and diminished when an exhaust.

(3.) The volume varies as the square root of the depth, hence we have the following proportion

$60{,}000 : 70{,}000 :: \sqrt{400} : \sqrt{(x)}$, or $60{,}000 : 70{,}000 :: 20 : 23 \cdot 3$, the square of which is 542·89 the required depth, or 400 + 142·89.

Proof

$$\sqrt{400} : \sqrt{542 \cdot 89} :: 60{,}000 : x,$$

solving

$$\sqrt{400} : \sqrt{542 \cdot 89} : 60{,}000 : 69{,}100.$$

The difference is caused by not carrying out the decimal in the first proportion. By making the root 23·4 gives a volume of 70,200.

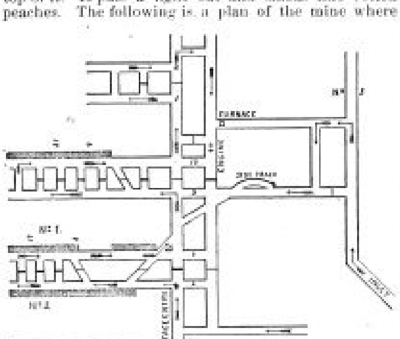
Yours, etc.,
S. U. P.

Lawsonham Pa., Nov. 10th.

A Peculiar Mine Gas.

Editor Colliery Engineer :

SIR:—I wish some of your able correspondents would enlighten me as to the possible name and composition of a gas that would come with a large fall and stay on top of it. It puts a light out and smells like rotten peaches. The following is a plan of the mine where



the gas was noticed, all of the workings being to the rise, with no accumulation of black damp. There is a natural gas pipe line nearly over head on the surface.

No. 1 in the sketch shows where rooms caved in and the gas accumulated. At No. 2 the elevation is about 20 feet from face entry, and at No. 3 the coal is worked out and the space filled with some kind of gas that will put the light out and of a peculiar odor.

Yours, etc.,
JOHN A. CARROLL.

Coal Center, Pa., November 16th.

Fans in Mining.

Editor Colliery Engineer :

SIR:—Please insert the following questions in your journal for solution by some of your correspondents;

(1.) The fan on a certain mine has an equivalent orifice of 37·81 square feet, the mine's equivalent orifice is 19 square feet; the size of the fan is 12 ft., making 90 revolutions per minute. What is the fan's efficiency?

(2.) What size fan giving an efficiency of 50% would you apply to the ventilation of a mine 500' deep, the quantity of air required being 40,000 cu. ft. per minute and the equivalent orifice of the mine being 20 sq. ft.?

Yours, etc.,
E. R.

Hopwood, Pa., Oct. 29th.

Mechanics.

Editor Colliery Engineer :

SIR:—I submit the following in answer to the fourth question asked by "S. W.," of Irondale, Ohio, in your November issue:

There is a cistern 20' square and 10' deep placed on the top of a tower 60' high, what power is required to fill this cistern in 30 minutes; and what will be the diameter of pump, when the length of stroke is 2', and making 40 strokes per minute?

First

$$20 \times 20 \times 10 \times 6\tfrac{1}{4} = 25{,}000 \text{ imperial gallons.}$$
$$25{,}000 \div 30 = 833 +$$

gallons per minute to be elevated.

The length of stroke is given at 2' and number of strokes at 40, which give a piston speed of 80' per minute in a double-acting force pump, therefore,

$$\frac{833}{80 \times 6\tfrac{1}{4}} = 1 \cdot 666,$$

perhaps the cylinder, through leakage, etc., will lose 10%, then we have

$$\frac{1 \cdot 666 \times 100}{90} = 1 \cdot 851 +, \times 144 = 266 \cdot 544 \text{ inches.}$$

And

$$\sqrt{\frac{266 \cdot 544}{\cdot 7854}} = 18 \cdot 4$$

or, say, 19" as diameter of water cylinder.

The final head which the pump will have to deliver against will be height of trestle 60' + height of tank 10' = 70';

$$70 \times \cdot 434 \times 266 \cdot 544 = 8097 \cdot 60 \text{ lbs.}$$

pressure required to elevate water into tank.

If we assume the effective steam pressure at 60 lbs. per sq. in. (which can reasonably be expected under these circumstances because boiler would very likely be placed close to pump) and divide 8097·60 by it we have 135" area of steam cylinder. Making same allowance for leakage, etc., as in water cylinder, we have

$$\frac{135 \times 100}{90} = 150,$$

and

$$\sqrt{\frac{150}{\cdot 7854}} = 14''$$

nearly as diameter of steam cylinder; and

$$\frac{14^2 \times \cdot 7854 \times 80 \times 60}{33{,}000} = 22 \cdot 4 \text{ H. P.}$$

We have found that we will require a 19" water cylinder, but it is just as plain that to use a 19" discharge column would be out of the question. If the water only moves at 80' per minute in the water cylinder we will have to give it a greater velocity in pipes. This will increase the friction and decrease the efficiency of the pump, but I think the allowance of 10% will also cover this defect as the length of discharge column is short.

It might be said in passing that most pump builders, in estimating on ability of pumps, generally make the margin between 25% and 50%; and some make an extra 10% allowance on steam cylinder over water cylinder.

Pump builders adopt different speeds for water in pipes varying from 100' to 400' per minute when determining the size of discharge and suction pipes to be used for a given size of water cylinder of pump. We will take the average and assume a speed of 200' per minute, then

$$\frac{833 +}{200 \times 6\tfrac{1}{4}} = 0 \cdot 66 \times 144 = 95 \cdot 04,$$

and

$$\sqrt{\frac{95}{\cdot 7854}} = 11''$$

as diameter of discharge column.

If we assume a water speed in pipes at 300' per minute this same rule will give us 9" + as diameter of discharge pipe; again, if we assume a speed of 400' this rule gives us 7·8" as the diameter of discharge pipes. Suction pipes to suit these sizes should be about 2" greater in diameter.

On page 37 of "Knowles' Revised Catalogue for 1885," at the foot of the page, the dimensions of a pump are given as follows:

Steam cylinder 18"; water cylinder 14"; stroke 24"; gallons per stroke 16; gallons per minute 640; suction 10", and discharge 8".

Now, if we reverse the formula given for finding diameter of pipe we will get the speed of water in pipe in full per minute.

$$8^2 \times \cdot 7854 \div 144 = \cdot 35,$$

and

$$640 \div \cdot 35 = 1830 \div 6 \cdot 25 = 293 \text{ feet.}$$

There are 16 gallons per stroke, or

$$640 \div 16 = 40 \text{ strokes} \times 2' = 80'$$

piston speed, while the speed of water in pipe is 293 feet. If this example is good practice, then we would be safe in adopting a speed of 300 feet per minute and using the pipe 9 inches in diameter to do the work for "S. W.'s" question.

I have not carried the figures carefully into decimal places considering that the principle and practical results were wanted.

This increased speed of water in pipes over that in cylinder is the answer to Samuel Lewis' question in July issue, viz., what is the reason for reducing the column pipe of air engine, etc.

Yours, etc.,
H. L. D. W.

Cincinnati, Ohio, November 13th.

Ventilation.

Editor Colliery Engineer :

SIR:—I submit the following solution to question by "A. B.," of Hanna City, Ill.:

An airway 8' × 8' × 1000' is passing 40,000 cu. ft. of air. What diameter should a circular airway 1200' long be to pass one-half the quantity, the pressure remaining the same?

$$D = \frac{\sqrt[5]{\dfrac{64^2 \times 3 \cdot 1416 \times 1200 \times 20{,}000^2}{4 \times 8 \times 1000 \times 40{,}000^2}}}{\sqrt[5]{\cdot 7854}} = 7' \text{ nearly}$$

Yours, etc.,
W.

Hornsby, Ill, Nov. 14th.

Ventilation.

Editor Colliery Engineer :

SIR:—On page 9, of the August issue of THE COLLIERY ENGINEER, "S. U. P.," of Red Bank, Pa., in answering the question by "Inquisitive," viz., "Using Atkinson's co-efficient, what would the w. g. be in a mine having 3 circular shafts, two downcast, 11' and 10' in diameter respectively, and one upcast 800' deep, 8' in diameter, the quantity being 100,000 cubic feet per minute";—uses the formula

$$\sqrt{\frac{a}{s}} \times a.$$

Now, I would like to know how he gets the cubic feet (·49502) for the 10' shaft, and ·57175 for the 11' shaft, the figures being the relative quantities for each shaft. If "S. U. P." will work out the above formula as plainly as possible showing how he obtains the above figures he will help a student.

Yours, etc.,
MINER.

Middleport, Ohio, November 21st.

Pipe and Boiler Covering.

The importance of fully protecting the surfaces of steam pipes, boilers, heaters, and other steam using, conveying, and generating apparatus in and about mines is a subject that has not attracted as much attention in the past as it deserved. This state of affairs, we are glad to state, is changing, and all progressive colliery managers recognize the necessity for pipe and boiler covering wherever steam is used, whether in large or small quantities.

There is quite a variety of pipe and boiler coverings on the market, but many are deficient in the great essential of durability. The Philip Carey Mfg. Co., of Cincinnati, Ohio, whose card appears on page z of this issue, have succeeded in producing a covering that meets all requirements.

They claim that their Standard Asbestos Removable Pipe Covering is the highest grade of steam pipe covering on the market, and that it is unequalled in durability, non-conducting qualities, neat appearance, and all other essential features. It lasts as long as the pipe will, and this quality of durability makes it especially cheap. It is made in sectional form, and for every size of pipe from one-half inch to eighteen inches, and can be readily applied or removed by any one, without the use of special tools or previous experience. As a good pipe covering effects a saving in fuel, equalling in a few months the cost of the covering, this saving becomes in a short time a clear profit if this covering which needs no renewal is used.

In addition to the saving in fuel, the covering of steam pipes is the most efficient and economical method of securing dry steam at the cylinders of pumps, hoisting and other engines, for as a rule pumps and other types of engines are located some distance from the boilers, the loss of steam from condensation, and the loss of power in the engine by inability to get dry steam to it is very large. The only way in which these losses can be overcome is by the use of a first-class steam pipe covering, and by covering the boilers, domes, heaters, breechings, etc., with Carey's Standard Asbestos Felting. The manufacturers (The Philip Carey Manufacturing Company, Cincinnati, Ohio,) will cheerfully furnish samples, and quote special prices to all colliery owners or managers.

Mr. John Hale, Inside Foreman of the D. L. & W. R. R. Co.'s Bellevue Mine, this city, states that the production of coal at the Bellevue Mine during the month of October, was the largest of any month since the mine was opened in 1854. The shipments were nearly 32,000 tons, mined and prepared in 27 days. There were no serious accidents of any kind.

Mr. David J. Lloyd, Vice-President of the Edinburg Coal Mining Company of Edinburg, Ill., writes us that he is at present putting in air compressor and coal cutting machines of the Ingersoll-Sergeant type at his colliery.

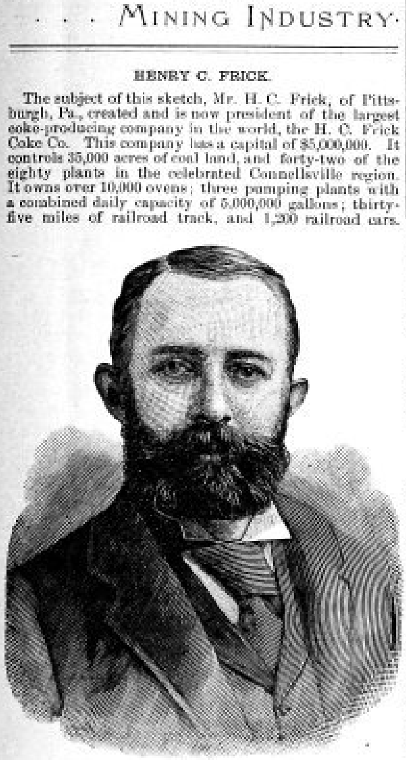
PERSONALS

Mr. Joseph G. S. Hudson, of the International Coal Company, Limited, of Sydney, Cape Breton, Nova Scotia, has been chosen President of the newly-organized association for the advancement and discussion of all matters relating to mines and mining, formed by the colliery officials of Cape Breton County.

Familiar Faces in the Mining Industry

HENRY C. FRICK.

The subject of this sketch, Mr. H. C. Frick, of Pittsburgh, Pa., created and is now president of the largest coke-producing company in the world, the H. C. Frick Coke Co. This company has a capital of $5,000,000. It controls 35,000 acres of coal land, and forty-two of the eighty plants in the celebrated Connellsville region. It owns over 10,000 ovens; three pumping plants with a combined daily capacity of 5,000,000 gallons; thirty-five miles of railroad track, and 1,200 railroad cars.



HENRY C. FRICK.

For the equipment of their plants, they have twenty-three locomotives, seventy-two pairs of stationary engines, 172 steam boilers, and 816 horses and mules. Mr. Frick is also the leading spirit in the Southwest Coal and Coke Co., and is chairman of the combined Carnegie Associations, which give employment in round numbers to 20,000 men. There are few men in America that equal him in executive ability. He was born in the coke region, just forty years ago, and was among the first to recognize the value and importance of the Connellsville coal. He had barely entered his majority when he engaged in the coke business, and from that time has been unflagging in organizing capital, providing transportation facilities, and consolidating and systematizing the business into the superb condition it now is.

Mr. Frick commenced in the coke business in 1871, forming with Messrs. A. O. Tintsman and Joseph Rist, the firm of Frick & Co. They started with 300 acres of land and 50 ovens, known as the "Frick Works." In 1872 they added 50 ovens to the Frick plant, and built the Henry Clay Works of 100 ovens on the Youghiogheny River, near Broad Ford. In 1876 Mr. Frick bought out Messrs. Tintsman and Rist and continued alone. In 1877, at the time of the greatest depression in the iron business, during the long dull period between 1873 and 1879, he leased the Valley Coke Works from Wilson, Boyle, and Playford, which were then idle, and put them in charge of Mr. Thomas Lynch, now General Manager of the H. C. Frick Coke Co. Notwithstanding the dull times and low prices, the works were started and operated every working day during the whole year except Christmas. In the Fall of the same year, Mr. E. M. Ferguson, (who owned a plant on the Fayette County Branch of the Pittsburgh & Connellsville R. R. consisting of seventy ovens) was taken into partnership by Mr. Frick, and they operated under the firm name of H. C. Frick & Co., having at this time the two works at Broad Ford of 100 ovens each, the Valley Works, under lease, of 102 ovens, and the Ferguson Works of 70 ovens. In the Spring of 1878, they leased the Anchor Works, which were at that time idle and in the hands of an assignee, and later leased the Mullen Works, near Mount Pleasant. In the same year, Mr. Walton Ferguson, a brother of Mr. E. M. Ferguson, was admitted into the firm. This partnership was continued until 1882, and during the four years of its existence they continued to buy coal lands and build coke ovens, until the firm owned 1,026 ovens, and 3,000 acres of coal land.

In the meantime, Mr. Frick organized the Morewood Coke Co., Ltd., and built the Morewood Works of 470 ovens, at that time the largest works in the region. In January, 1882, Carnegie Bros. & Co. Ltd., were admitted into the firm of H. C. Frick & Co., and in the following April the corporation known as The H. C. Frick Coke Co., was incorporated with a capital of $2,000,000 and Mr. Frick was made President. In 1883 the capital was increased to $3,000,000 and in 1889 it was further increased to $5,000,000.

During all these years the work of buying coal lands and building ovens was vigorously prosecuted, until now this corporation owns the magnificent property described in a previous paragraph.

The collieries are all supplied with the best obtainable machinery and appliances, and each plant of the H. C. Frick Coke Company is a model one. Mechanical devices are used in every place where machinery can advantageously supersede man or animal power, and the inside haulage arrangements are particularly effective. There is no coal company in America that so extensively uses the most advanced systems of rope haulage.

Mr. Frick is always ready to take advantage of all machinery, appliances, or methods, that will conduce to the health and safety of his employes or the more economical production of coal and coke. Notwithstanding the great labor connected with the business management of the various industries of which he is the executive head, he is constantly in communication with his efficient lieutenant, Mr. Lynch, for whose technical ability he justly has a very high regard. Every plant purchased by the Frick Company has been materially improved after the purchase, and in every case the management exceeds the requirements of the mine laws, and requires that subordinate officials must either have every portion of each colliery in the safest possible condition, or cease work there until it is put in such condition.

Mr. Frick's success in organizing capital and building up the great corporation that bears his name is abundant evidence of his business capacity and managerial skill. He is a very pleasant gentleman socially, and is highly esteemed by men of all classes who have been thrown in personal contact with him.

WILLIAM CONNELL.

Mr. William Connell is an excellent type of the American self-made business man. He was born in Cape Breton, Nova Scotia, on September 10, 1827. His father being a native of Scotland, and his mother a Nova Scotian of Irish and American descent. Though his parents were worthy people, he had few educational advantages, as early in life it became necessary for him to assist in the support of the family. However, he made good use of his meagre opportunities and acquired the rudiments of an education.

In 1844 his parents settled in Luzerne County, Pa., and he found employment as a driver boy in the mines. He worked in various capacities at several collieries in the Wyoming and Schuylkill regions until 1856, when his intelligence, industry and energy secured him a position as superintendent of the colliery owned by the Susquehanna & Wyoming Valley Railroad and Coal Company, at Scranton.

In 1870 the charter of this corporation expired, and Mr. Connell, who had judiciously managed the colliery for fourteen years, purchased the property. Twenty-one years have passed and the business has grown to large proportions, and although others are interested in the firm of William Connell & Co., he owns the controlling interest and is the head and front of the enterprise. The property originally consisted of a single colliery, but for some years past the firm has operated two. Mr. Connell as President and principal owner of the Connell Coal Co., also operates a third colliery at Duryea Luzerne County, Pa. The total salable output

WILLIAM CONNELL.

of these three collieries has up to date exceeded 7,000,000 tons.

Mr. Connell is largely interested in the banking business. He is President of the Third National Bank of Scranton, Pa., and a director of the Scranton Safe Deposit and Trust Company. His enterprise, liberality, and business sagacity have been important factors in the remarkable growth of Scranton, and he is interested in almost every important manufacturing enterprise in the city. He is a director in the Dickson Manufacturing Company, President of the Hunt & Connell Company Limited; President of the Scranton Button Manufacturing Company, Limited; President of the Lackawanna Knitting Mills Company, President of the Weston Mill Company, and Vice-President of the Scranton Forging Company. He is also a large stockholder and director in the Scranton Packing Company, the Lackawanna Lumber Company, and many other business enterprises. He is Treasurer of the Lehigh Salt Mining Company, a new corporation developing an extensive salt property at Le Roy, N. Y. His capital and business knowledge have aided many undertakings and his work in the Scranton Board of Trade has been influential and effective. Thousands of dollars have quietly passed from him to the aid of charitable causes and for every worthy public purpose he may be relied upon for assistance.

He is a man of independent character. He has, therefore, some enemies as all men of force have. His nature is kindly, but he will not swerve from a purpose that he thinks is right. When interested in any undertaking whether it be of a business, religious, or social character, his whole heart is enlisted.

Few men have his capacity for work and probably fewer still the need he experiences for constant activity. When not engaged in business matters he is a great reader of the best works of standard authors. His library, which is large, is a remarkably well selected one.

He is a friend of popular education and has contributed liberally to the Free Library about to be established in the handsome Albright Memorial building now nearly completed in Scranton. His aid and counsel have been frequently sought by various educational institutions and he is a Trustee of the Syracuse University, the Wesleyan University, and the Drew Theological Seminary.

He was President of the commission to revise the Anthracite Mine Laws authorized by the last session of the Legislature, and his name is mentioned in connection with the nomination for congress from the district of which the City of Scranton forms a part.

William Connell is a business man in whom all interested in Anthracite coal mining, either as capitalists, superintendents, or workingmen justly feel proud. He is also one of the citizens who by their liberality and progressiveness are making Scranton a large and important city, and who, long before the coal resources of this neighborhood are seriously impaired will have so advanced its manufacturing interests that its property and future growth will be assured independent of such adventitious circumstances as the gradual curtailments of coal shipments from the neighborhood.

A Great Improvement in Electric Motors.

A most severe and very interesting test was made a few days ago by Wm. Sellers & Co., of Philadelphia, upon a motor operated under the new principle invented by Mr. H. Ward Leonard. The motor used was a 10-H. P. Standard Shunt-wound Sprague Motor; the motor's normal speed was 1500 revolutions a minute. The motor was belted to a counter-shaft, and upon the counter-shaft was placed a brake, and in addition to the brake there was placed on the counter-shaft a large fly-wheel such as is used upon punching machines, the purpose of the fly-weel being to duplicate the inertia and momentum met with in practice in a great many kinds of work.

The motor was made to operate in either direction at any rate of speed desired, and it was found possible to run the motor perfectly and regularly under the full brake load, at 15 revolutions per minute, that is, one per cent. of its full speed. While operating at full speed in one direction the motor could be instantly reversed, the reversal being perfectly gradual and entirely without spark or troublesome feature of any kind.

In order to get the most marked effect in overcoming the momentum of the fly-wheel the brake was taken off, and when the fly-wheel was running at its full speed of 300 revolutions a minute the motor was reversed instantly. In thirteen seconds the motor had brought the fly-wheel to rest, and in thirteen seconds more had it running at full speed in the opposite direction, the entire operation being effected with the greatest smoothness and without any spark whatever. The performance of the motor was extremely satisfactory to all concerned, and showed its perfect adaptability to any class of work met in practice.

We learn from H. Ward Leonard & Co., that among the concerns of importance who have recently retained them as consulting electrical engineers are Wm. Sellers & Co., the well-known machine tool builders, of Philadelphia, Otis Brothers & Co., of elevator frame, and the Ingersoll-Sergeant Drill Co.

No large manufacturing or mining concern whose product involves the use of power can afford to neglect the rapid progress of electrical motor applications.

H. Ward Leonard & Co. charge a definite sum per year for their services as consulting engineers, and the manufacturing concerns seem to like this feature of definiteness rather than a percentage charge or a retainer and individual charge for individual service.

Doing a Large Business.

The firm of J. A. Parker, at Terre Haute, Ind., always being on the alert for something, report recent shipments of Revolving Coal Screens to the Corona Coal and Coke Co., at Corona, Alabama; P. Erlich & Co., Seeleyville, Ind.; St. Louis and Big Muddy Coal Co., Carterville, Ill.; Coal Bluff Mining Co., at their Pratt Mine; Pittsburgh Coal & Coke Co., Old Pittsburgh, Ind. Mining Cars to the Hazel Creek Coal Co., Clinton, Ind.; Thompson Hill Coal Company, Clinton Ind.; Firn Hill Coal Company, Clinton, Ind.; Keelleyville Coal Co., Danville, Ill.; Glendale Coal Co., Danville, Ill.; Eureka Block Coal Co., Carbon, Ind., and have orders on hand for screens for the Great Kanawha Coal Co., Mount Vernon, West Va. Elevators and Conveyors for the Hazel Creek Coal Co., Clinton, Ind. Mining Cars for The New Kentucky Coal Co., Clinton, Ind., and the Norton Creek Coal Co., Clinton, Ind.

The Colliery Engineer.

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ALEX. DICK, MINING ENGINEER, ASSISTANT EDITOR.
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STATISTICS OF COAL MINING IN PENNSYLVANIA IN 1890.

WE have received the "Reports of the Inspectors of Coal Mines of Pennsylvania," for 1890. These reports as they come from the inspectors are, as a rule, full of valuable information, though a uniform system of tabulation would be a great improvement. There has been an attempt on the part of the Department of Internal Affairs to tabulate the statistics from the whole State. It has been only partially done, however, and several important errors detract greatly from the value of the tables published. It is to be hoped that hereafter this work will be done as it should be, and that the reports will be published in such season that they may not so much resemble a last year's almanac in point of usefulness.

The aggregate production of coal in Pennsylvania in 1890, including that shipped from collieries, made into coke, used at the operations, and sold for local consumption, was 80,830,876 tons, of which 40,090,355 tons were Anthracite and 40,740,521 Bituminous. These figures show an increase of 6,715,467 tons in the Bituminous output and 1,116,406 in the Anthracite, a total increase of 7,831,873 tons over 1889. There were 368 collieries in operation in the Anthracite districts and 631 in the Bituminous, making a total of 999 in the State. There were also reported 22,483 coke ovens with a total output of 8,311,941 tons of coke. The number of persons engaged in coal mining was 183,624, of whom 116,232 were employed in the Anthracite mines, and 67,392 in the Bituminous. The average number of tons mined for each employe was 344·8 in the Anthracite, an increase of 19 tons over 1889, and 604·5 in the Bituminous, an increase of 45·5 tons. The average in all the mines in the State was 440·2 tons. The aggregate number of kegs of powder (25 lbs. each) used in the State was 1,116,930. Of these 1,030,710 were used in the Anthracite districts, or one keg for 38·89 tons, and 86,220 in the Bituminous districts, or one keg for 472·5 tons.

The number of horses and mules in the Anthracite districts was 12,892, and in the Bituminous 5,243. There were 235 mine locomotives in use, not counting those in the Fifth Anthracite District and the Sixth Bituminous, which are not reported.

In the Anthracite regions the greatest average number of days worked was 221·5 in the Fourth, or Hazleton District. The smallest was 166·1 in the Sixth, or Ashland District. The average for all the Anthracite Districts was 190·4 days, an increase of 22 days over 1889. In the Bituminous regions the greatest average number of days worked was 242 in the Fifth, which is the great coke producing district. The smallest average number was 181 days in the Second District. The average for all the Bituminous districts was 211·9 days an increase of 11·9 days over 1889.

FATAL AND NON-FATAL CASUALTIES.

The whole number of fatal casualties in the State was 524, of which 378 were in the Anthracite districts and 146 in the Bituminous.

This is in the ratio of 3·25 lives lost in the Anthracite and 2·166 in the Bituminous for every 1,000 employes. In 1889 the ratio of fatal accidents in the Anthracite regions was 3·218 per 1,000 employes.

This year there were in the Third Anthracite District five accidents from fire-damp in which 51 persons were killed. These arose from causes which are uncommon, and not counting these the ratio in the Anthracite districts was only 2·72 lives lost per 1,000, a record which has been bettered only once, and that was in 1886 when the ratio was 2·707 per 1,000. The number of employes per fatal casualty and the ratio of deaths per 1,000 were as follows:

ANTHRACITE.

No. of Dist.	Name of Inspector.	No. of Fatal Casualties.	No. of Employes Per Fatal Casualty.	Ratio of Fatal Casualties Per 1,000 Employes.
1	Patrick Blewitt	64	370	2·695
2	H. McDonald	40	394	2·538
3	G. M. Williams	100	189	5·277
4	John M. Lewis	52	277	3·605
5	William Stein	66	292	3·421
6	William McMurtrie	39	468	2·136
7	Samuel Gay	17	342	2·92
	Total Fatal Casualties	378	Av. 307	3·252

BITUMINOUS.

No. of Dist.	Name of Inspector.	No. of Fatal Casualties.	No. of Employes Per Fatal Casualty.	Ratio of Fatal Casualties Per 1,000 Employes.
1	Henry Louttit	15	442	2·261
2	Wm. Jenkins	20	588	1·7
3	Thomas K. Adams	5	1088	·918
4	James N. Patterson	8	804	1·242
5	Wm. Duncan	50	194	5·146
6	J. T. Evans	15	655	1·526
7	James Blick	9	928	1·077
8	Austin King	24	384	2·602
	Total Fatal Casualties	146	Av. 461	2·166

The number of fatal casualties was again, as last year, proportionally lower in the Sixth than in any other Anthracite district, being in the ratio of 2·136 per 1,000 employes, and it was highest in the Third, which showed 5·277 deaths per 1,000 employes. In the Third, Fourth, and Seventh Bituminous Districts the proportion of fatal accidents to the number employed was very small, but the Fifth District shows a high ratio on account of the Hill Farm disaster, in which 31 lives were lost.

Last year the average number of employes per fatal accident in the Anthracite districts was 311, or a ratio of 3·218 deaths from accidents per 1,000 employes, and in the Bituminous 591, or 1·69 deaths per 1,000. This year it is one for every 307 employes in the Anthracite, or 3·252 per 1,000, and one for every 461 in the Bituminous, or 2·166 per 1,000.

The following table shows the causes of the fatal casualties and the ratio of deaths from the different causes per 1,000 employes:

ANTHRACITE.

	No.	Ratio of Deaths Per 1,000 Employes.
By Falls of Roof and Sides	132	1·135
By Mine Cars	69	·594
By Explosions of Gas	61	·524
By Falling Down Shafts	21	·18
By Explosions of Powder and Blasts	18	·154
By Machinery	11	·094
Miscellaneous	66	·567
Total	378	3·252

BITUMINOUS.

	No.	Ratio of Deaths Per 1,000 Employes.
By Falls of Roof and Sides	81	1·201
By Mine Cars	15	·222
By Explosions of Gas	31	·46
By Falling Down Shafts	2	·029
By Explosions of Powder and Blasts	4	·059
By Machinery	2	·029
Miscellaneous	11	·163
Total	146	2·166

By these accidents 275 wives were made widows and 823 children became orphans.

It will be noticed that the number of fatal accidents and their ratio per 1000 employes is one-third greater in the Anthracite than in the Bituminous districts. This is true of accidents from each of the causes specified with the exception of those from falls of roof and sides of which proportionately more occur in the Bituminous regions, the veins are thinner and each man mines a greater amount and area of coal than in the Anthracite, thus making a proportionately greater extent of working area and of roof to support, which account for the greater relative danger from falls of roof and sides. It is also true that as a rule, the roof is not as strong in the Bituminous as in Anthracite seams.

There were, however, a larger proportion of accidents from mine cars in the Anthracite than in the Bituminous mines. The Bituminous seams are usually flat, and the cars are hauled all the way in and out, while many Anthracite seams are on short pitches in which slants are worked where the empty cars are hauled in by mules and run out by gravity; from this cause many accidents arise.

Owing to the use of more machinery in the Anthracite districts, accidents from being caught by it were proportionately three times more frequent than in the Bituminous. The very large use of blasting materials in mining Anthracite coal also accounts for the fact that accidents from powder explosions are proportionately nearly three times more frequent, though it appears that powder is handled more safely in the Anthracite than in the Bituminous Mines, for while there was nearly 12 times as much powder used in the Anthracite Mines, the proportion of accidents from this cause was not three times greater.

The proportion of accidents from miscellaneous causes was also three times greater in the Anthracite than in the Bituminous mines. This may be partially accounted for by the fact that nearly all the Anthracite coal is mined from openings below water level and that as a rule the Anthracite operations are much more extensive and involve the use of much more machinery than the Bituminous operations do.

There were reported in the Anthracite districts 1007 non-fatal accidents, and in the Bituminous 381, making a total of 1388. In the Anthracite districts the ratio of non-fatal accidents to the number of employes was one in 115, and in the Bituminous, one in 177.

It is, however, unsafe to attempt to draw comparisons from these figures as in some districts only serious accidents are reported, while in others comparatively trivial ones are included.

The average production of coal per life lost in the Anthracite districts was 106,059 tons, against 101,231 tons in 1889, and in the Bituminous districts 279,044 tons against 330,547 tons in 1889, showing a comparative increase in danger in the Bituminous and a slight improvement in the Anthracite Mines. In the Bituminous districts the number of tons mined per life lost varies from 129,421 in the Fifth district to 508,036 in the Seventh, and in the Anthracite from 69,077 in the Third district to 161,197 in the Seventh.

There is much that may be done in the way of increasing the safety of the mines, both in the Bituminous and Anthracite districts of Pennsylvania. It is true since 1870 the production to life lost has increased 95·2% and that the production per life lost was 13·2% more in 1890 than it was in 1889. Yet it is also a fact that the proportion of fatal accidents to the number of employes in this country is greater than in many foreign countries in which more dangerous conditions exist. The best way to secure greater safety in American collieries is to advance the standard of education and intelligence among the superintendents, foremen, assistant foremen and fire bosses, and to establish more strict discipline in the working of the mines. This opinion we have heretofore frequently expressed in these columns and there is no doubt it is correct because there is no reason that can be assigned why accidents should be more frequent in American than in European collieries, except that the officials in charge of them are not as well educated as men occupying similar positions abroad, and that there is greater carelessness and recklessness on the part of the workmen.

AMBULANCE WORK.

THE Mine Laws of Pennsylvania require that proper ambulances and stretchers be provided at each mine to be used in case of accident. Such a provision is wise, but before the benefit of these appliances can be fully utilized it is necessary that instruction on first aid to the injured be given to some men at each colliery.

Doubtless an injured man can be more comfortably carried in an ambulance than by the old-time method of hustling him along rough roads in a springless cart half filled with straw or old sacking, but it is not in this that the first and greatest danger arises. Take the case of a broken leg; unless the limb is first carefully and comfortably placed in a rigid position between splints (even although the man is placed in a well appointed ambulance) what was originally a simple fracture may be aggravated into a compound or comminuted fracture, and the patient runs a risk of losing his leg altogether. Or in a case of a severed artery all the ambulances in the the world are of no use unless the immediate danger of bleeding to death is averted.

We wonder how many men in an average Pennsylvania colliery could be of use in such a case? As matters at present stand we are afraid that for the want of a few simple appliances and a knowledge of how to use them the man's life would be lost.

How do we stand in this matter, in comparison with other countries? In England the St. John Ambulance Association has extended its ramifications throughout the length and breadth of the land until there is not a colliery which cannot at least muster eight or ten men capable of attending to the injured. In the case of fractures they can set the limbs in an easy position; they can stop bleeding; they can aid in restoring the asphyxiated or apparently drowned, and indeed their valuable services in the cause of humanity are daily being recorded in the "case-books" of all colliery doctors. We have been told that the doctors in America would not approve of such a scheme. We refuse to believe it. A similar fallacy arose and was as speedily dispelled in England. If, by the intelligent attention of a fellow-workman, a collier can be made comfortable until medical aid arrives, surely the doctor would prefer it so, rather than to find on his arrival that owing to the blundering of well meaning but ignorant hands a fellow creature had lost his life. A doctor's mission is to save life, and anything which aids him in doing so will obtain his support.

It must be borne in mind that the first instruction of the St. John Association is, "Send for a doctor," and the second is, "Until he arrives, make the patient comfortable," and the ambulance student is not a *substitute* for the doctor, but is his *assistant*.

In June, 1890, General Lord Wolseley reviewed an army of over 20,000 ambulance men at Woolaton Park, Nottingham, and these were principally colliers. Many of them had never before marched in procession, and although they did not look quite as smart as soldiers, and perhaps had not enough music in their souls to enable them to keep step to the beat of the drums, as they marched past the saluting post they presented a living argument in favor of the system such as was never before seen.

All this has been accomplished at such a small cost that the wonder is that it was not done long ago. This is the method adopted in Britain. The aid of the colliery doctor is first obtained, and application is made to headquarters, in London, for the loan of a few illustrative charts and diagrams. Each man is provided with a small text book, and an Esmarch triangular bandage, at a total cost of about 25 cents. The class meets as often as convenient, and the doctor during the course delivers a series of five lectures, each of half an hour's duration, and by the aid of the text-book instruction is given in bandaging, fixing of splints, carriage of the injured, &c. As soon as the class is satisfied of its proficiency, an examining doctor arrives. The members are ranged up in line and put through an examination on the general structure of the human body, the functions of the blood, nerves, and muscles, and the means to be adopted in cases of poisoning, fits, &c. The class is then taken into the open air, men are stationed all over a field with tickets fixed to their bodies, stating the nature of their supposed injury, and on a given signal a squad of students runs to each man, fixes him up, and carries him into the improvised hospital where their work is inspected.

These classes of instruction are carried on for three successive years, and after three annual examinations have been passed, the student is awarded the bronze or silver medal of the Association. The doctor's time will not exceed eight hours in a year. The student can learn all by devoting two hours each week to the instruction given, and the cost per man will not exceed a dollar a year. And what is the result? Let any miner recall the accidents that have occurred in his own knowledge, and after he has gained a little ambulance skill, he will remember some case where a life, or at least a limb, might have been saved, if he had known then what he knows now.

If there is philanthropy amongst our coal operators there is no better opening for its display than in furthering such a cause. If the workmen are of the right grit they will see the advantages and claims for the Ambulance Association, and we venture to affirm that there will be no obstacle thrown in their way by the medical profession when the benefit so manifestly accrues to the doctor.

The St. John Ambulance Association in England, and The St. Andrew Ambulance Association in Scotland, are kindred societies of a purely philanthropic nature, sustained by voluntary contributions, and neither of them is in any way connected with any particular sect or religion, but they are in every respect national in their aims. To these Associations is due the credit of Field Ambulance work, such as was done on the battle-fields of the Franco-Prussian and subsequent European wars, and the good work which was then begun is now being extended to the field of mine labor, where accidents are of every day occurrence.

The philanthropic feeling which prompts the members of such benevolent institutions as the Women's Christian Temperance Union, the Young Men's Christian Associations, and other similar schemes, can have no nobler and no more needy field for work than in the formation of an American National Ambulance Association. It does not need a great capital; much can be accomplished with but little money, and the necessity of such an institution is of the first importance. More especially is this so in colliery districts, and we write this with the hope of inducing philanthropists and others in the great colliery centers to give this important and worthy matter their consideration.

ELECTRIC MINERS' LAMPS.

THAT the electric safety-lamp will eventually be a success is almost a certainty. But those persons, who, unfamiliar with the conditions existitg in mines, try to adapt the ordinary incandescent lamp in circuit to this purpose are on the wrong track. Such a plan will never be successful, for reasons that are too obvious to our readers, to require enumeration at this time.

The ideal electric safety-lamp must be self contained, light in weight, simple in construction durable, and not too expensive.

Except at the bottoms of shafts or slopes, the main gangways or headings do not require much light, as they are chiefly employed for passageways for the trips of mine cars, and their transportation can be effected in semi or almost total darkness. Where the light is most required is where the miner is at work, and as he is constantly shifting his position, it is essential that he should have a portable light. From time to time attempts have been made to produce such a light as is actually needed, and with a view to ascertain how far such attempts have been successful, the French "Society of Mineral Industry" some time ago appointed a committee consisting of Messrs. Fevre, mining engineer, of Place, manager of the Rochebelle mines, Bessard, manager of the Cessons mines, and Lange, engineer of the Rochebelle mines. The trials were conducted at the Rochebelle mines with four types of secondary battery lamps—the Pollak, Edison, Breguet, and Stella. The Pollak lamp is a two-cell accumulator lamp, weighing 4·18 lbs., and it gives one candle power for nine hours before requiring recharging. The Edison lamp has three cells and weighs 24·2 lbs. It yields about two and a half candle power for ten hours, which is more than is actually required, and owing to its great weight it requires alteration before it can be adopted in mines. The Breguet lamp is a three cell lamp, weighs 6·38 lbs., and gives one candle power for eighteen to twenty hours. The Stella lamp, in the opinion of the committee, is the best adapted for mining work. It weighs but 3·08 lbs., and its duration of light is normally twelve hours. No faults as far as the connections were concerned were detected during the month it was under test.

As a result of the tests and comparisons made, the committee regard the Breguet and Stella lamps as those nearest adapted for successful use in the mines. The former, however, as at present constructed should not be put in the hands of the workmen, as it is not easily handled, there is too much exterior copper, the connections are not sufficiently insulated, and the salts formed entail great expense and trouble in maintenance owing to their excessively corrosive action. Nevertheless, the lamp shows a marked progress, and in spite of its excessive weight, the results as regards the amount of light given, and its duration were remarkable, and the faults pointed out can undoubtedly be remedied.

Mr. Petit, in discussing the report, stated that it would have been interesting to know the results obtained had the lamps been tested in a fiery locality. Such tests, however, would be difficult and dangerous, if attempted under circumstances which approach near to what would obtain in practice, therefore experience alone can demonstrate this matter. A good miner's lamp must be of simple and solid construction, as light as possible, and easy to maintain and recharge. It should yield a constant light of one or one and a half candle power for not less than eight hours, and it should be cheap.

The question of expense is closely related to the life of the plates, and the tests were not carried on for a sufficient length of time to furnish absolutely exact data, but approximate figures can be arrived at by calculation. Plates of old lamps, fed by accumulators have been submitted to M. Le Chatelier, engineer in chief of mines, who found them in good condition after two years of service. Therefore, it will not be out of the way to estimate the duration of the plates at one year on a basis of ten hours work per day for 300 days, or 3000 hours in all. These accumulators cost at most $5.50, and the expense of maintenance would therefore be about 2 cents per day of ten hours. The cost of a glow lamp is at most 90 cents, and it will last 800 hours, making this expense about one cent per day of ten hours. The cost per day of charging the accumulators is not much, as the dynamo employed can charge a very large number at one time, and at collieries where there is a dynamo used for lighting the surface at night, it can be utilized in the daytime for charging the accumulators. The average cost for light from portable electric lamps, will not, therefore, on this basis, exceed three or four cents per day of ten hours.

M. Petit, summarizes the advantages of substituting portable electric lamps for the safety-lamps at present in use as follows: The light obtained will be better, as the oil lamps only furnish from ½ to ¾ candle power; the miner will be able to work more easily and will accomplish more work; and the noxious products of combustion from the oil lamps will be dispensed with.

The results arrived at by these tests certainly show a marked advance in the construction of electric safety-lamps, and it is to be sincerely hoped that the day is not far distant when the present oil lamps will be used only for testing purposes, and a cheap, practical, and convenient incandescent lamp, will be used for working.

EDITORIAL NOTES.

IN the United States Circuit Court, held at Pittsburgh, Pa., on the 18th ult. Judge Rice filed an opinion in the case of W. P. Rend against the Venture Oil Co., refusing the injunction asked for, to stop the latter from drilling through certain coal land.

This decision is a very important one as it will affect many tracts of valuable coal land in Western Pennsylvania. Judge Reed bases his opinion on the erroneous idea that because the sinking of oil and gas wells in coal territory in the past has not resulted in accidents in the mines, that there is no danger for the future. This is one of the instances in which a lack of technical knowledge of coal mining, on the part of a Judge, has resulted in injury to the coal interests.

Because there have been no accidents in the past is no assurance that there will be none in the future. The sinking of oil and gas wells through coal is bound to cause more or less gas to flow through the hole in the coal seam, and even if there is a pillar left for the well, there is a likelihood of a leakage of gas through crevices in the rock or coal. This gas will find its way into the workings and accidents from this cause will not only be possible, but probable.

Again, even if the coal formation is solid enough to make it possible, by means of a large pillar, to protect the mines, the establishing of such an arbitrary pillar will be a serious matter. Pillars must always be so located as to not interfere with the profitable working of the mine, and the chances are that many wells will be so located as to require pillars in such localities as will materially interfere with the haulage roads, air courses, etc. But there is another side to the case. In many instances the mine owner has bought only the coal right, and other parties own the oil and gas rights, and, therefore, they are justly entitled to right of way to their property. But how and where this right of way shall be established is a question that requires careful consideration. It is not justice to give them right of way in such a manner as will jeopardize the property of the mine owner and the lives of his employes.

It is to be hoped that the mine owners of Western Pennsylvania, all of whom are more or less interested in this matter, will urge Col. Reed to carry the matter to a higher court than Judge Reed's and also assist him in the contest.

If the mine owners had been foresighted enough to secure the *mineral* right instead of only the *coal* right there would be no dispute, but, as things stand, the question is one that will require careful consideration, and the fact that oil or gas wells through coal territories jeopardize the lives of all inside employes as well as the property of the mine owner, should have great weight with the courts.

IT is announced that Gen. William Lilly, of Mauch Chunk, Pa., is a candidate for one of the Republican nominations for Congressman-at-Large from Pennsylvania—the State under the new census figures being entitled to two new congressmen. Gen. Lilly has been actively engaged in the coal business for many years, and is particularly fitted to represent the greatest industry of the state in the U. S. Congress. The coal interests have frequently suffered because the industry has not been represented in legislative bodies, and now that Gen. Lilly is a candidate, he should receive the unanimous support of all Republicans interested in coal mining. His Republicanism is of the stalwart order, and his time and money have for years been freely spent in the party's service, and if any one has earned honors at the hands of his party, he has.

THE Lehigh & Wilkes-Barre Coal Company's famous Nottingham Colliery has again broken the record. During the month of October, the colliery worked 24·15 days of ten hours each, and shipped 70,152·16 tons of coal, the average hoist per day being 1,318 mine cars.

The depth of hoist is 470 ft. and all the coal came from one opening. The engines are a pair of 22″ × 48″ first motion engines, with conical drums 4 ft. 1 in. long, 7 ft. diameter at small end, and 9 ft. diameter at large end.

This record has never been equalled in any coal field in the world, and Mr. E. H. Lawall, Supt. of the Wyoming Division is naturally very proud of it.

During the past year many important improvements and developments have been made at the company's collieries under Mr. Lawall's supervision, and their capacities have been greatly increased. The shipments from the Lehigh & Wilkes-Barre Collieries in the Wyoming division for the current year will approximate 1,900,000 tons, while the actual working time for the year will be something less than two hundred days. The prospects for the year 1892, are that these collieries will produce about 1,000,000 tons more than the output for 1891, and as the shipments are made over the Central Railroad of New Jersey, the railroad officials are making preparations to handle the coal by increasing their facilities in many directions.

GOVERNOR PATTISON, of Pennsylvania, has at last after an unnecessary delay of several months, issued commissions to Messrs. Edward Roderick and Patrick Blewitt as Inspectors of Mines for the First and Second Anthracite districts respectively. Mr. Roderick is a new man, but has a reputation as a careful, intelligent, and progressive miner. He is a nephew of ex-Inspector James Roderick, of Hazleton, who resigned the Inspectorship to accept the superintendency of the Linderman and Skeer Collieries in the Lehigh Region.

Mr. Blewitt is the former Inspector of the old First District, and will enter on his third consecutive term with this appointment. His new district is much smaller than the old, and he can therefore perform his duties even more efficiently than in the past.

WE have received a copy of the first number of *Cassier's Magazine*, an illustrated monthly engineering publication issued by the *Cassier Magazine Company*, Potter Building, New York, and welcome it to our list of exchanges. It is handsomely gotten up, and contains a number of valuable papers by such eminent writers as Prof. Thurston, of Sibley College, Cornell University; Prof. Alden, of Worcester Polytechnic School; Prof. John E. Sweet; C. H. J. Woodbury; Thomas Pray, Jr.; William Kent, M. E.; F. Merriam Wheeler, M. E., and others. Scattered through its pages are numerous short articles on engineering topics, and the whole make-up is not only interesting but pleasing to the eye as well, the illustrations being particularly good. As a magazine of general engineering literature it is a success.

AS an evidence of the encouragement THE COLLIERY ENGINEER SCHOOL OF MINES is meeting with from employers, we are permitted to state that a prominent superintendent will appoint as fire-boss the first intelligent miner gaining a School of Mines Diploma, and that his holding such diploma will be considered a strong point in his favor when promotions are made.

THE recent disaster at Nanticoke gave The United States Mine Signal Supply & Mfg. Co., an opportunity to rush into print in Philadelphia papers with misstatements calculated to influence the general public in favor of its machine, and thus make it easy to secure legislation to compel its use. This machine, or no other earthly contrivance, with the possible exception of the more improved types of safety-lamps, could have warned the Nanticoke miners of their danger in time to render escape possible. The communication of Joseph R. Wilson, in the Philadelphia *Inquirer* of the 10th ult., and the editorial entitled "Preventible Accidents" in the *Press* of the same date, were inspired by the same mind as is evidenced by the same statistical errors appearing in each. In both articles the number of collieries in Pennsylvania is given as over 8,000, when there are less than 1,000, and the number of inspectors is placed at seventeen, when there were but fifteen until a few days ago, when Governor Pattison commissioned Mr. Roderick, the sixteenth. Other statements contained in the articles are further from the facts, and are written to work up popular prejudice in favor of an impracticable contrivance. The object of such publications is, as we have stated before, to excite popular prejudice in favor of the apparatus. If the apparatus was practicable, it would not need legislation to introduce it. The operators and colliery managers will gladly purchase any contrivance that will give them even a reasonable amount of security from the explosions so destructive to life and property.

The Anthracite Trade.

The Anthracite trade is in fair condition. The enormous production of the past two months has been generally absorbed, but as stocks are fairly large, and purchasers are not so pressing in their demands, the sales agents, at their meeting in New York, on the 24th ult., decided that the production for December should be restricted to 3,250,000 tons.

The meeting was entirely harmonious and there was no evidence of the alleged strained relations between some of the companies out of which so much bear capital has been made in Wall Street. All of the companies were represented.

The prices were fixed at the same rate as in October, viz.: Broken, $3.75 per ton; egg, $4.15 per ton; stove, $4.40 per ton; and chestnut, $4.15 per ton; all f. o. b. The allotment of 3,250,000 tons is to include the shipments of the Pennsylvania and the New York, Ontario, & Western, which are estimated at 500,000 tons. The output in December, 1890, was 3,064,000 tons.

Navigation on the lakes is practically closed, and further shipments West must go by all rail routes.

The quantity of Anthracite shipped West this year was not much greater than that sent last year, but there were fair stocks of coal on hand at the Western distributing ports at the opening of this season. Some shippers, anticipating a severe winter, are of the opinion that the West will take a considerable quantity of coal in addition to that already forwarded, and that the heavy movement of grain East will provide the box-car facilities for return cargoes of Anthracite.

The prospects for the next four or five months, if we have a winter of ordinary severity, are brighter than they have been for several years.

There is no doubt that the Reading Co. will demand a larger percentage of the output next year, and that the Lehigh Valley, and Jersey Central, from whom the Reading takes the Coxe tonnage, will not yield tamely to a reduction of their percentages, as they can make up the Coxe loss from their own resources. This, however, is also true of the Reading's resources. The latter company has never worked its collieries to their full capacity, and has thousands of acres of undeveloped coal that could have been drawn on if the policy of restriction had not wisely been adopted, to keep the market in good shape. The arrangement of the quotas will, therefore, be watched with great interest by the trade, as there promises to be a lively time over it, but that an amicable arrangement will be finally arrived at is not doubted, for none of the companies are anxious for a coal war.

The Bituminous Trade.

The advent of cold weather has resulted in an increased demand, and the trade in general has largely increased. Not only are heavy shipments being made on old orders and contracts, but a large number of new orders have been booked. Owing to low water in the Ohio, there was a scarcity of coal in Cincinnati and lower river markets, dependent on river coal, during the greater portion of last month. There was not enough brought in by rail to supply the demand, and things began to have a serious aspect, until a storm on the 23d caused a rise, and the large fleets lying in the neighborhood of Pittsburgh were floated down. The prospects for the winter in the various Bituminous regions are good.

The Coke Trade.

The coke trade is in good shape, and the business being done is large. During the week ending Nov. 21st the Connellsville region made the heaviest shipments of any week in the year. Prices for Connellsville coke have not changed, and quotations are made as follows: Furnace coke, $1.90; foundry coke, $2.30; crushed coke, $2.65; all per ton of 2,000 lbs. f. o. b. at ovens.

LEGAL.

A contributor from Leechburg, Pa., writes us as follows: "Will you kindly state in your next issue, what the Bituminous Mine Law is in regard to the employment of a mining boss in two different and distinct mines at the same time. Can he lawfully hold both positions? This seems to be the judgment of our Mine Inspector, as we have a mine boss here who is holding the position of superintendent and mine boss of one mine working more than fifteen men, and mine boss of another mine, a half mile distant, owned and operated by another company, and employing some forty or fifty men." Section 5, of the Bituminous Mine Law, requires that the owner or agent of every coal mine shall employ a competent and practical inside overseer to be called mining boss, who shall be a citizen and an experienced coal miner, etc., etc. In no place does it prohibit the employment of one inside boss for two adjoining mines, provided he is able to fulfill the requirements of his position as set down in Section 5. That is, the law can not be construed, in its present shape, to make it unlawful, but it is evident that when the law was framed, such a state of affairs was not contemplated and that the idea was to have a mine boss for each mine. But, as the law does not so state, the Inspector can for no other judgment than the one stated by the contributor.

The *Moniteur Industrielle* recommends the use of a mixture of oil and graphite on all screws in machinery. It says it will effectually prevent them from becoming fixed, and protects them for years from rust, at the same time the mixture facilitates tightening up.

The Joseph Dixon Crucible Co., Jersey City, N. J., have for a number of years prepared graphite mixtures which have found great favor with machinists and steam fitters of this country.

Dixon's Graphite Pipe Joint mixture not only takes the place of red lead, but is infinitely better, while Dixon's Graphited oil is used where a thinner mixture is desired, and also for lubricating bearings. Graphite is the best natural lubricant known.

We have received from Messrs. H. Ward Leonard & Co., Electrical Engineers and Contractors, of 136 Liberty Street, New York, a neat little pamphlet containing testimonials and references regarding past work, indicating the experience and standing of Messrs. Leonard & Co. It will pay those of our readers using electric power, or contemplating its use, to write to Messrs. Leonard & Co., for a copy of this pamphlet.

Mr. John Hale, the inventor and manufacturer of Hale's patent surveying instrument, writes us under date of the 30th ult., that since he has advertised his instruments in THE COLLIERY ENGINEER, he has sold over 100 of them, and that they are now in use in every State and Territory of the Union, and in the British Provinces as well.

ANTHRACITE COAL STATISTICS.

Statement of Anthracite coal shipments, for month of Oct., 1891, compared with same period last year. Compiled from returns furnished by the Mine Operators, by John H. Jones, Chief of Bureau of Anthracite Coal Statistics.

	October. 1891.	October 1890.	Difference.		For Year 1891.	For Year 1890.	Difference.	
From Wyoming Region,	2,320,534·06	2,013,941·15	Inc.	306,592·11	17,340,626·07	15,165,666·02	Inc.	2,174,960·05
From Lehigh Region,	700,155·03	657,558·01	Inc.	42,597·02	5,214,512·14	5,284,876·10	Dec.	70,363·16
From Schuylkill Region,	1,475,845·03	1,221,217·05	Inc.	254,627·18	10,177,668·14	8,837,937·00	Inc.	1,339,731·14
Total	4,496,534·12	3,892,717·01	Inc.	603,817·11	32,732,807·15	29,288,479·12	Inc.	3,444,328·03

The stock of coal on hand at tide-water shipping points, October 31, 1891, was 635,446 tons; on September 30, 1891, 568,833 tons; increase, 66,613 tons.

THE NANTICOKE DISASTER.

On Sunday, the 8th ult., an explosion of gas at the Susquehanna Coal Co.'s No. 1 Shaft, at Nanticoke, Pa., resulted in the death of twelve men, and the serious injury of two others.

The accident was one that is hard to understand, as there are no witnesses alive to give a positive statement of the facts. The two survivors were working at a point that prevented their obtaining a knowledge of the causes, and to this fact they owe their lives.

From the meagre evidence before the Coroner's jury, and the deductions of Inspector Williams and the officials of the company, we are able to give the following explanation of the disaster:

The main shaft at No. 1 Colliery is sunk to the Lee or Red Ash seam, which corresponds to the Buck Mountain seam of the Lehigh and Schuylkill regions. From the workings in the Lee seam a tunnel 1,400 ft. long is driven South to the Ross seam, (corresponding to the Seven Foot seam of the Schuylkill region) overlying the Lee. About 110 yards East of the tunnel, in the Ross seam, an inside shaft was sunk to the Lee seam, and the coal was hoisted by an engine on the surface, the ropes passing from the drum through bore-holes to the head of the shaft.

In the Ross seam, parallel with and close to the East side of the tunnel, two openings were driven North to a point about 200 ft. South of the old workings in the Lee seam, with which they were connected by a rock plane.

The workings in the Ross seam were ventilated by a current of air from the Lee seam workings going up the rock plane, thence through one of these parallel roads to the Ross workings, returning to the upcast in the Lee seam by way of a brattice air course in the tunnel. From the bottom of the inside shaft an air course was driven in the Lee seam, on a general North course to the old workings in the same seam from No. 1 Shaft, the object being to make this the return air course instead of the bratticed way in the tunnel. Stoppings were erected when this hole was finished, and the ventilation was left in its original shape till Sunday, the 8th ult. To guard against accident it was determined to change the course of the air on Sunday, when there would be no men in the mine except those actually engaged in the work. Three of the most intelligent and experienced fire-bosses in the valley, Henry R. Jones, William Jonathan, and John Arnot were placed in charge of the work, and all the men employed were furnished with safety lamps of the Clanny or Davy type. All were specially instructed to use the utmost caution, and the possibility of accident due to carelessness was impressed upon them. The work of removing certain stoppings and erecting others, and clearing up the rubbish in the old workings in the Lee seam was started in the morning and progressed all right for several hours. The stoppings in the new air course were first removed and it was made a downcast, the air after flowing through it and the limited workings in the inside shaft level, ascending the shaft, and going out the Ross gangway to join the current entering by way of the rock plane and with it, flow out the bratticed airway in the tunnel, thence by way of old workings to the upcast. At about 4.00 P. M., when the work was approaching completion, the current flowing down the new Lee seam air course suddenly reversed and the explosion occurred. The two men who escaped with serious injuries were at work on the last stopping to be removed, between the foot of the rock plane and the mouth of the new air course, when they noticed their lamps fill with gas. They gave an alarm and started out toward the tunnel, and thus moved with the current carrying the gas. They are unable to state what the other twelve men did, or what direction they went. If any of them went towards the new air course they walked against the current which had unexpectedly reversed and flowed out the air course, and the flame of a lamp may have passed the gauze.

This reversion of the current in the new air course was one that no man, however experienced, would have expected, and is only to be accounted for on the following supposition:

The current flowing down the Lee seam air course was weakened by the work being done, assisted, no doubt, by a mine car of mortar standing in the air course, and by the gas accumulating in the downcast making the current lighter. This continued till the pressure on the current in the downcast combined with the friction therein, was less than the resistance offered by the return air course to the fan via the tunnel, and the air flowing up the rock plane and down the Ross air course, took the shorter and easier route out via the inside shaft and Lee seam aircourse, and swept a cloud of gas down on the workmen. This is the theory advanced by the officials of the company and other authorities on ventilation, and it is borne out by the fact that the three fire-bosses were experienced men, and would have followed an invariable precedent of removing all men from the course of the return air, had they taken any action, such as shutting a door, that would have effected such a reversion. The reversion was probably due to abnormal conditions existing at the instant of the explosion, and it is doubtful if the same conditions could ever be established again.

At this point, it would be well to explain that the stopping and rubbish being removed at the time of the explosion were at a point between the foot of the rock plane and the connection of the Lee seam air course and the old Lee seam workings, and in the natural order of things nothing but fresh air from either of the two intakes, that is the rock plane, and the air course being opened, should have reached the men.

The Coroner's jury, after hearing all available testimony at the inquest rendered a verdict in which they laid the cause of the reversion of the current to the action of the fire-bosses closing a door and reversing the current while men were working inside on the return airway. This verdict is not supported by any evidence and is not just to the memory of the three unfortunate men. They were men of experience and intelligence, and it is not at all likely that they would deliberately reverse the current without ordering the men to a place of safety, which is a rule invariably followed in such cases.

THE NELSONVILLE FOUNDRY AND MACHINE COMPANY.

Since the incorporation of the Nelsonville Foundry and Machine Company, of Nelsonville, Ohio, in 1882, it has by the excellency of its work, attention to details, and business energy of its officers, gradually risen among the prominent builders of mining machinery, till now it stands in the front rank.

The company owns and controls a number of important inventions, one of which is their patent mine car wheel, which has met with great success, and is now in use in every coal producing state in the Union. On this wheel, which is self-oiling and has a specially fine chill, made by secret process, the company challenges competition, both in quality and price. They sell the wheels either with or without axles and beds.

Another excellent invention, which has revolutionized the handling of coal at the mines is the Mitchell Coal Tipple, the manufacture and sale of which this company controls in the States of Virginia, West Virginia, Ohio, and Kentucky. The success of this excellent invention has been phenomenal. Every mine in the Hocking Valley, of any note, uses it, and we have seen it in successful practical operation in other localities. In reply to our inquiries as to its utility, we have been invariably informed that it fully sustains all claims made for it. In speaking of it some time ago, Mr. T. B. DeArmitt, Superintendent of the New York and Cleveland Gas Coal Company's Mines, at Turtle Creek, Pa., said, "We have adopted it and consider it a most excellent arrangement." With this tipple one man can handle two thousand tons of coal in ten hours.

A chain belting recently patented by the company, was invented by Supt. E. S. Jennings. It has also been very successful in gaining the favor of colliery managers, and is already in use in various parts of the country. Among other large mines using it are those of the Ellsworth and Morris Coal Company, at Brush Fork, Ohio.

This chain belting requires a very short amount of slack to couple or uncouple it. The total length or space being only 1½ inches. The links are slotted, and the couplings provided with shoulders so that they cannot be uncoupled until they are brought in the proper position for this operation. The making of the couplings and links separate results in so many more joints, thus adding to the pliability of the chain.

A friction clutch, also recently patented, possesses peculiar merits that put it far in advance of any other clutch on the market. The sales of this clutch have also been phenomenally large.

One of the most important branches of the business is the manufacture of fine rope haulage machinery. In the manufacture of this class of machinery alone, the company has won a national reputation. The striking features of their engines are in the style of friction and the method of handling them. The friction is very simple and has no complicated work about it to get out of gear. It is handled entirely by steam, the cylinders being placed on the bed-plate in front of the drums. These cylinders are so arranged that friction may be tightened or loosened, as may be necessary, or stopped and held in any position, the cylinders forming a steam cushion for the piston, thus relieving the yoke or lever from all strain. A steam reversing gear is also placed on the engine, thus making very light work for the engineer, and bringing his work in a close space where it is all very easily handled. Everywhere they have been placed these engines have given satisfaction.

They have recently placed in position for the Ellsworth & Morris Coal Company, the largest double engine they have ever produced. Its weight is forty-five tons. They have also put in large haulage plants for the Linton Coal Company, of Linton, Ind., and the Union Collieries Company, of Victoria, B. C. They also put up a large hoisting engine for the Nelsonville Coal and Coke Company, of Jacksonville, Ohio.

The company also manufactures all kinds of bar and revolving coal screens, gear-wheels, etc., etc. Besides their own patents, they also manufacture the Wallace and Brooks Compressed Air Pumps, an automatic machine for pumping water from mines. Before placing orders for mining machinery it will pay our readers to write to the Nelsonville Foundry and Machine Company, whose advertisement appears on another page, for estimates on the required machinery.

Get a "Cinch" on it.

We mean on your business. The only way you can do it is to keep posted on new machinery and appliances. You can't keep posted if you do not carefully watch all new inventions and improvements made in mining machinery and mining appliances. By sending for the catalogues, etc., of the following firms, you will get, free, a lot of valuable data:

Send for samples and prices of Mineralized Brattice Cloth, for doors, air stops, hanging cloths, etc., etc., a very necessary and useful article in all mines. Address, Mineralized Rubber Company, 18 Cliff St., New York.

Send for photographs and price lists of the improved mining machinery, mine cars, and mining appliances manufactured by J. A. Parker, Terre Haute, Ind.

Send for catalogue of steam engine specialties handled by Hine & Robertson, of 45 Cortlandt St., New York. It will pay you.

Send for catalogues and circulars of electric blasting apparatus, explosives, etc., to Ætna Powder Company, 95 Randolph St., Chicago, Ill.

Send for catalogue of Leviathan Belting issued by Main Belting Co., 1219 Carpenter St., Phila.

Send for catalogue of mining machinery, mine cars, etc., etc., manufactured by J. Herbertson's Sons, Brownsville, Fayette County, Pa.

Send for catalogue of Spiral Riveted Pipe for mine ventilation, blast pipe, water supply, exhaust, etc., to Abendroth and Root Mfg. Co., 28 Cliff St., New York.

Send for catalogue and circulars of practical mining machinery, to Robert Allison & Sons, Port Carbon, Pa.

Send for catalogues and circulars descriptive of improved mine cars, Bowden self-oiling mine car wheels, etc., to Bloomsburgh Car Co., Bloomsburgh, Pa.

Send for circulars and prices of mining powder and High Explosives to Henry Belin, Jr., No. 118 Wyoming Avenue, Scranton, Pa.

Send for description and prices of all kinds of steel and iron and mining hardware to Bittenbender & Co., 126 and 128 Franklin Avenue, Scranton, Pa.

Send for descriptive catalogue and samples of the celebrated Selden patent steam and water packing to Randolph Brandt, No. 38 Cortlandt St., New York.

In writing for the above use a postal card and state that you saw the advertisement in THE COLLIERY ENGINEER.

Electric Machinery.

Copy of a dispatch sent by one of the foremost engineering firms of the world in answer to an inquiry regarding the reliability and cost of maintenance of Thomson-Houston apparatus.

"After seven years with Thomson-Houston machinery, one hundred motors and about twenty dynamos, we have had the highest satisfaction and no difficulty whatever. In no single case have we had an armature to replace, and the cost of maintenance is practically nothing. You will make no mistake by adopting their system. We adopt ourselves because by comparison we have found them best."

The name of the sender will be gladly furnished on application to the Thomson-Van Depoele Electric Mining Company, 620 Atlantic Avenue, Boston.

BOOK REVIEW.

MINING DEPARTMENT OF VICTORIA; REPORTS AND STATISTICS FOR THE QUARTER ENDED JUNE 30, 1891. Compiled and arranged by A. W. Howitt, Secretary for Mines. This is a report issued by the government of the British colony of Victoria, and is uniform with the regular blue books issued by the British government. It is excellently arranged and is well illustrated with maps, sections, plans, and other illustrations. It contains a mass of valuable data concerning the mineral resources of the colony, and strange as it may seem, it is typographically a better publication than the blue books issued from London. The text is well edited. It is published by Robert S. Brain, Government Printer, Melbourne, and the price is two shillings.

THE QUARRYMAN AND CONTRACTOR'S GUIDE, or How to Remove Rock at Least Cost. By Arthur Kirk, Pittsburgh, Pa. Cloth, 4 Fo. pp. 147. Illustrated. Price $3.25.

While this volume is published by Arthur Kirk & Son, dealers in powder and high explosives, and thus comes under the head of trade publications, it contains much information very useful to both contractors and engineers. The bulk of the work relates to blasting operations and appliances, and the hints given as to the safe and proper handling of explosives and the prevention of accidents are evidently the outcome of intelligent practice and experience. The book is full of cuts illustrating the plant and methods advocated. Quarrying and blasting machinery take up the latter part of the volume, and the information here given is also very useful.

ROYAL GEOLOGICAL INSTITUTE OF HUNGARY. Vol. IX, Parts 1 to 5 of the Transactions of the above Institute, just to hand, contains papers descriptive of some artesian borings and an account of silver mining in Austro-Hungary.

We append a letter received from Mr. B. W. Cooper, Supt. Machine Dept. of the Litchfield Car & Machine Company, of Litchfield, Ill., which proves two important facts. First—It pays to manufacture first-class machinery, and second—It pays to advertise said machinery in THE COLLIERY ENGINEER.

"We are pleased to inform you that we have closed another contract with the Kansas & Texas Coal Company for a pair of hoisting engines 24" x 48" cylinder with 12' diameter drum. These engines are for their Riverside Mine at Leavenworth, and is the second pair which we have had the pleasure of building for them in the last six weeks.

"We are also repairing the engines for the Brighton Coal Company, at Harkness, Kan., whose machinery was destroyed by fire some two or three weeks ago.

"We have also closed a contract for a pair of our first motion hoisting engines for a new mine to be opened at New Douglas, Ill.

"We are also building cages and shaking screens for the Kansas & Texas Coal Company's No. 46 Mine, at Bevier, Mo., and are also building cages for their mine at Fleming.

"Inquiries are frequent and business generally satisfactory."

Since Mr. W. L. Bellis, of Cleveland, Ohio, introduced to the colliery managers of America, through the medium of THE COLLIERY ENGINEER, his new mining collar, it has met with phenomenal success. It is now in use in five different states and the demand for it is daily increasing. This is the strongest possible evidence of its merit and peculiar adaptation for mine use.

ENGINEERING ASSOCIATION OF THE SOUTH.

The annual meeting of the Engineering Association of the South was held in the Y. M. C. A. Building, Nashville, Tenn., on Thursday evening, Nov. 12, 1891, President John B. Atkinson, Earlington, Ky., presiding, with about thirty members and visitors present.

The President appointed as tellers to canvass the ballots for membership, and officers for the ensuing year, Messrs. W. L. Dudley and E. C. Lewis. A communication was received from Mr. C. H. Armistead, Secretary of the Nashville Commercial Club, extending the courtesies of the Commercial Club to the visiting members of the Association. On motion of Mr. MacLeod a vote of thanks was returned to the Commercial Club for the courtesies extended. A communication was received from the Canadian Society of Civil Engineers notifying the association that it had been placed on its list for exchange of publications.

A communication was received from the General Committee Engineering Societies notifying the Association that its assessment for the fund to meet the expenses of the Engineering headquarters at Chicago, during the Columbian Exposition, had been placed at $200; as this was in excess of the amount assessed at the time this Association voted to join the movement to establish Engineering Headquarters, the Association voted to ratify its previous action and to accept the assessment.

Treasurer W. R. Ross submitted the following report:

Received from former Treasurer	$377 07
Received from Secretary during past year	635 52
Total receipts	$1012 59
Bills paid on approval of Finance Committee	609 72
Leaving balance cash on hand	402 87

Secretary Olin H. Landreth submitted the following report:

MEMBERSHIP.

	At Beginning of Year.	Resigned.	Died.	Additions.	At Present.
Resident Members	21		1		20
Non Res. Members	70	5	1	11	75
Non Res. Associates	3	1		1	3
Resident Juniors	2			1	3
Non Res. Juniors	5			2	7
Total	101	6	2	15	108

DEATHS.

Eben Pardon, resident member; H. S. Butler, non-resident member, of Anniston, Ala.

Papers read, 12; Papers published, 10; Meetings at Nashville, 7; at Birmingham, 1; at Earlington, Ky., 1, total, 9.

ESTIMATED REVENUE FOR COMING YEAR.

Cash on hand	$402 87
Back membership dues to date	376 00
Estimated income on basis of present membership	593 00
Total	$1372 87

Mr. W. C. Smith announced to the Association that a chapter of the American Institute of Architects had recently been organized in Nashville and submitted an application from the chapter for the privilege of holding its regular meetings at the new headquarters of the Association at a rental price to be agreed upon. The matter was referred to the Executive Committee with power to grant the request.

The tellers appointed to canvass the ballots for election to membership, reported the election as member of Mr. Lucien S. Johnson, Engineer and Superintendent of Mines of the Great Western Mining Company, Peach Orchard, Ky., and as Junior, Mr. John K. Peebles, Draughtsman and Assistant Engineer with W. C. Smith, Architect, Nashville, Tenn.

The tellers also reported the election of the following Board of Officers for the ensuing year: President A. V. Gude, Atlanta, Ga.; First Vice-President, James Geddes, Nashville, Tenn.; Second Vice-President, F. P. Clute, South Pittsburgh, Tenn.

Directors from Tennessee—S. C. Lewis, W. L. Dudley, and W. F. Foster, of Nashville, Tenn.

Director from Georgia, Hunter McDonald, Atlanta, Ga.; Director from Kentucky, John MacLeod, Louisville, Ky.; Director from Alabama, Charles R. Percy, Montgomery, Ala.; Secretary, Olin H. Landreth, Nashville, Tenn.; Treasurer, W. R. Ross, Nashville, Tenn.

President John B. Atkinson then submitted the President's annual address, which comprised a very carefully prepared exhibit of the engineering features of productive and industrial development during the past year. The address also gave a brief resume of the most striking developments in engineering particularly in the Engineering of Transportation during the past year. The address will be published in full.

On motion the Association adjourned to the regular December meeting.

Profit Sharing in the Iron Trade.

Sir Alfred Hickman, proprietor of the Spring Vale Furnaces, Wolverhampton, who is the largest pig iron maker in South Staffordshire, has issued a circular to his workmen stating that he proposes to give them a direct interest in their labor by granting each man a substantial bonus out of the profits of his trade during the year ending next June. As soon as the result of the year's working is ascertained he will divide among them a certain share on their earnings. He wishes them to understand that they are not partners, and he reserves to himself the right to deal with them as to retaining their services or otherwise. An iron foundry at Gross-Ilsede, Hanover, employing from 600 to 700 men, has carried on the system of profit-sharing since 1869. All the employed who have deposits in the factory savings bank are participators in it. If the net profits of the firm exceed 5 per cent., a corresponding addition, up to 15 per cent. is made to the 5 per cent. interest given on the savings bank deposits. Hence, those deposits can bear up to 20 per cent. interest. The following table shows the percentage paid from 1869 to 1883: 1869, 8 per cent.; 1870, 9 per cent.; 1871, 10 per cent.; 1872, 18 per cent.; 1873-74, 20 per cent.; 1875, 6½ per cent.; 1876, 6 per cent.; 1877, 6½ per cent.; 1878-79, 10 per cent.; 1880-83, 20 per cent. In the year 1883 the number of depositors was 566, and the total savings amounted to £25,850, a proof that the system had a strong influence on the thrift of the people employed. The factory also has a "workmen's bank," which any of the men may join. It is supported by contributions equal to 6 per cent. of the wages, half of which are paid by the men and half by the firm. The accumulated capital of this bank amounted in 1883 to £15,000. There are also two widows' and orphans' funds—one for the lower class of workmen, and one for the foreman and employes.—*Colliery Guardian.*

NEW MINING COMPANIES.

Names and Post-Office Addresses of the New Mining Companies Incorporated in the United States Since our Last Issue.

Deep Vein Coal Co.,	Cedar Rapids, Iowa.
Union Coal & Mining Co.,	Des Moines, Iowa.
Oro Fino Mining & Milling Co.,	Louisville, Ky.
Lemhi Mining & Milling Co.,	Solomon City, Idaho.
Twin Falls Placer Mining Co.,	Hailey, Idaho.
The Sonora Development Co.,	New Orleans, La.
The Argyle Mining Co.,	Chicago, Ill.
Hermosa Mining Co.,	Camden, N. J.
The Aluminum Mining & Smelting Co.,	Chicago, Ill.
Anglo-Florida Phosphate Co.,	Ocala, Fla.
Star Gold and Silver Mining & Reduction Co.,	Moiden, Fergus Co., Mont.
Traymore Phosphate Rock Co.,	Camden, N. J.
Arlington Natural Gas Co.,	Anderson, Ind.
The Newport Mining Co.,	Milwaukee, Wis.
The St. John Mining Co.,	San Francisco, Cal.
Des Moines Coal Mining Co.,	Des Moines, Iowa.
New York and West Virginia Coal & Iron Co.,	Jersey City, N. J.
The Hornet Mining Co.,	Neihart, Mont.
Royal Fossil Flour Co.,	Portland, Me.
Florence Mining Co.,	San Francisco, Cal.
The Hobbs Natural Gas & Water Co.,	Hobbs, Tipton Co., Ind.
The Duke Mining Co.,	Denver, Colo.
The Arge Mining & Reduction Co.,	Denver, Colo.
The Wizard Mining Co.,	Denver, Colo.
American Aluminum Co.,	San Francisco, Cal.
Cleveland Consolidated Mining Co.,	Red Bluff, Cal.
Braybogle Mining & Milling Co., Consolidated,	San Francisco, Cal.
The Arkansas Coal, Gas, Fine Clay & Mfg. Co.,	Hot Springs, Ark.
The Treasury Mining Co.,	Denver, Colo.
The Citizens' Enterprise Co.,	Muncie, Ind.
Mexico Mining & Development Co.,	Los Angeles, Cal.
Gavilan Mining & Milling Co.,	Riverside, Cal.
Acme Cement Plaster Co.,	Chicago, Ill.
Wm. Rutherford & Co.,	Cuba, Ill.
The Austrian Hill Consolidated Mining Co.,	Chicago, Ill.
The Ore Dell Mining & Milling Co., of Chicago,	Chicago, Ill.
The Ed. Little Mining Co.,	Peoria, Ill.
The Ohio Gas Fuel Co.,	Chicago, Ill.
International Mining & Development Co., of Portland, Oregon,	Portland, Oregon.
Southern Oregon Lime and Marble Mining Co.,	Grant's Pass, Oregon.
Harkness Gold Mining Co.,	San Francisco, Cal.
The New Castle Kaolin Mining & Mfg. Co.,	New Castle, Colo.
The Tidewater Coal & Coke Co.,	Helena, W. Va.
Aluminum, Steel & Alloy Co.,	New York, N. Y.
Enterprise Mining & Coal Co.,	Osage City, Kan.
Merrimac Gold Mining Co.,	Grass Valley, Cal.
Eagle Mountain Mining Co.,	Riverside, Cal.
The Bristol Mining Co.,	Denver, Colo.
The Bastoc Milling & Mining Co.,	Boulder, Colo.
Seven Devil Smelting Co.,	Seven Devil Mining District, Washington Co., Idaho.
St. Helena Consolidated Gold & Silver Mining Co.,	Helena, Mon.
North Point Iron Mining Co., of Ashland, Wis.,	Ashland, Wis.
Alpine Springs Land & Water Co.,	Los Angeles, Cal.
The Yellow Boy Group Mining Co.,	Aspen, Colo.
The Howard Mining & Milling Co.,	Philadelphia, Pa.
The Victoria Oil Co.,	Warren, Pa.
The Citizens' Natural Gas Co.,	Ridgway, Pa.
Lycoming Mining Co.,	Philadelphia, Pa.
Fallston Pottery Co.,	Fallston, Pa.
Reynoldsville Coal Co.,	Falls Creek, Pa.
McDowell Coal & Coke Co.,	McDowell, W. Va.
Flaggy Meadow Gas Co.,	Mannington, W. Va.
The Palatine Coal Co.,	Fairmount, W. Va.
The Elk Knob Copper Mining & Milling Co.,	Chicago, Ill.
Mexican Mining & Investment Co.,	Plainfield, N. J.
Minneapolis and St. Louis Reduction Works,	East St. Louis, Ill.
Gowrie Mining Co.,	Missoula, Mon.
The Citizens' Gas Co.,	Tipton, Ind.
The Grasshopper Gulch Mining Co.,	Denver, Colo.
The Western Union Mining & Milling Co.,	Denver, Colo.
Waverly Coal & Mining Co.,	Waverly, Mo.
West Xenia Real Estate, Oil, Gas & Pipe Line, of Xenia, Ind.,	Xenia, Ind.
The New York & Puerto Principe Mining Co.,	Jersey City, N. J.
Interstate Petroleum Co.,	Jackson, Miss.
The Florence-Louise Mining Co.,	Kansas City, Mo.
White Pine Zinc Co.,	Louisville, Ky.
San Martino Mining Co.,	Missoula, Mon.
The Interstate Consolidated Mining Co.,	Bridgeport, Cal.
Weston Oil, Gas & Mining Co.,	Weston, W. Va.
The Boone and Monroe Natural Gas & Mining Co.,	Summitville, Madison, Co. Ind.
The Austin Placer Mining Co.,	Hailey, Idaho.
Argyle Consolidated Mining Co.,	San Francisco, Cal.
Sutter County Cement Mfg. Co.,	San Francisco, Cal.
The France Mining Co.,	Colorado Springs, Colo.
The Equitable Mining & Prospecting Co.,	Del Norte, Cal.
The Revere Mining & Milling Co.,	Breckenridge, Colo.
The Chronicle Mining Co.,	Pueblo, Colo.
The Lexington Mining & Milling Co.,	Denver, Colo.
Annie Consolidated Mining Co.,	Cottage Grove, Oregon.
The Producers Refining Co.,	Marietta, Ohio.
Oswego Iron Mining Co.,	Portland, Oregon.
Bottom Creek Coal & Coke Co.,	Bottom Creek, W. Va.
The Midnight Mining Co.,	Ouray, Colo.
Gypsum Plaster & Stucco Co.,	Chicago, Ill.
Knoble Mining Co.,	Chicago, Ill.
Vermont Agalite Pulverizing Co.,	Rutland, Vt.
Alaska Mexican Gold Mining Co.,	St. Paul, Minn.
The Pittsburgh Coal Co.,	Pittsburgh, Pa.
The Central West Virginia Coal & Coke Co.,	Clarksburg, W. Va.
Fort Smith Mining & Smelting Co.,	Fort Smith, Ark.
The Sheep Mountain Tunnel & Mining Co.,	Aspen, Colo.
The Tip Top Mining Co.,	Missoula, Mon.
Rocky Mountain Mining Co.,	Boulder, Mon.
The Independence Mining Co.,	Cleveland, Ohio.
The Sugar Creek Gas Co.,	Greenfield, Ind.
Michigan Mineral Paint Mining Supply Co.,	Detroit, Mich.
Domestic & Steam Coal Co.,	East St. Louis, Ill.
Cincinnati Iron Co.,	Duluth, Minn.
The Blue Bell Mining, Milling, & Prospecting Co.,	Colorado Springs, Colo.
Mammoth Vein Coal & Iron Co.,	Philadelphia, Pa.
El Encino Blue Gravel Mining Co.,	Oakland, Cal.
Buckeye Mining Co.,	Marinette, Wis.
The Adams Brick & Clay Co.,	Zanesville, Ohio.
The Belmont Oil Co.,	Martin's Ferry, Ohio.
The Boulder Mining & Milling Co., of Chicago, Ill.,	Chicago, Ill.
Howard Natural Gas, Oil, Mining & Pipe Line Co.,	Plevna, Ind.
The Flodoardo Mining & Milling Co.,	Denver, Colo.
The Backus Manufacturing Co.,	Williamsport, Pa.
The Blaine Gold Mining Co.,	Denver, Colo.
The Mount Clare Coal Co.,	Mount Clare, W. Va.
United Mining Co.,	Wakefield, Gogebic Co., Mich.
The Tom Turner Mining Co.,	Chicago, Ill.

Mining in Missouri.

State Mine Inspector C. C. Woodson, has submitted the fifth annual report to Labor Commissioner Hall for the year ending June 30th, 1891.

The report shows a healthy condition of the coal, lead, and zinc industries of the State, but a depression in the iron product as compared with previous reports.

This report shows the total value of the State's mineral output to have been $8,896,995 against $8,165,865 for the preceding year—an increase of $731,730.

In producing this amount of wealth 30 lives were lost, 16 wives made widows, and 53 children made fatherless, or one life lost for every 413 persons employed—this is based only on the average number of men at work.

An interesting feature of the report is the number of employes at Missouri mines. The average number of which is 12,392, showing that a population of nearly 50,000 people is directly dependent on the mines for support—for a ratio of four to one in this instance is a very moderate one.

Notes on each industry are as follows:

The output of coal during the past year was 2,650,018 tons, the average value of which was $1.31¼ per ton, or a total value of $3,480,867 at the mines, as compared with 2,437,399 tons valued at $3,234,357 for the preceding year, showing an increase of 212,619 tons for the past year. This coal was produced by 385 mines or openings of all kinds, including strip-pits, 141 of which employ ten or more men. These 385 openings furnished employment for the year an average of 6,879 persons. There occurred during same time 18 fatal and 32 non-fatal accidents, showing one life lost for every 147,223 tons of coal produced.

Lead and zinc mines report 5,065 persons employed in and about the 610 shafts which are in operation, together with an output of 123,752 tons of zinc ore; 16,925 tons of lead, and 19,968 tons of pig lead valued at $5,084,462 at the mines, showing an increase of $728,943 over the past year. The value of lead ore has advanced from $45.40 per ton, in 1890, to $49.10, in 1891; while the value of the zinc ore has decreased from $22.51 per ton to $21.60 during the same time. The report also shows that 12 fatal accidents occurred, or one for every 422 persons employed.

St. Francois County continues to lead in the production of lead, while Jasper County produces 77 per cent. of the entire zinc output of the State.

The output of the iron ore during the past year was 138,356 tons against 232,835 tons for 1890, showing a decrease of 94,482 tons.

A Colliery Owned by Miners.

M. Jacques, liquidator of the Monthieux Collieries Company, has consented to a sale of the company's concession to a combination known as the Syndicate of Miners of the Loire, comprising about 10,000 workpeople. The concession, which comprises coke ovens, premises, and workshops, was offered for sale by auction in August at a reserve price of £4,400, but no purchaser was forthcoming. The concession also includes two collieries, the output of which has hitherto reached about 5,000 tons per month. The property is connected with the French railway system at St. Etienne by a branch about three-quarters of a mile in length.—*Colliery Guardian.*

It is sometimes convenient for an engineer to be able to approximate the amount of condensation that will take place in pipes during a certain length of time. From many experiments made on the condensation of steam in wrought-iron pipes when exposed to the open air it is found that 1 lb. and 6 oz. of steam per square foot of pipe's surface was condensed per hour when the difference in temperature between the steam and air amounted to 200°. As this is very nearly the difference of temperature usually found between the steam in the pipes and the air outside, this simple rule will give results sufficiently close for ordinary purposes.

PRIMARY EDUCATIONAL DEPARTMENT

FOR CANDIDATES FOR

MINE FOREMEN'S CERTIFICATES

AND FOR

STUDENTS OF MINING.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the sciences related to mining and to learn how to answer the questions in ventilation, surveying, and mechanics which are asked at the examinations for mine foremen's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine foremen and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and many calculations are worked out at length for the benefit of those who are not familiar with figures.

PENMANSHIP.

In this issue we wish to draw attention to the correct development of the capital letters I and J.

It will be found that the four laws of penmanship control the development, so far as symmetry, harmony, and beauty are concerned, of the whole of the letters of the alphabet.

The capital letter I on the left hand side of Fig. 26 is

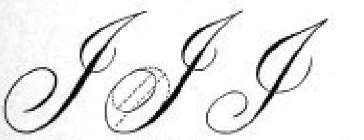


FIG. 26.

pleasant and satisfying.

The second letter from the left illustrates its development out of elliptical curves wherein the major axes are parallel.

The third letter from the left hand side has its parts so disproportionate that they are a violation of the

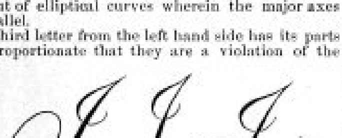


FIG. 27.

third law of penmanship, namely, all strokes should be proportionate in size. In this case the upper scroll is too large, and the bottom scroll is too small.

The first letter from the left hand side of Fig. 27 is also a violation of the third law of penmanship, and in

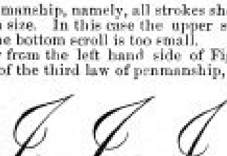


FIG. 28.

it it will be seen the upper scroll is too small and the bottom scroll is too large.

In the second letter from the left hand side it will be seen that the major axis of the ellipse that develops the

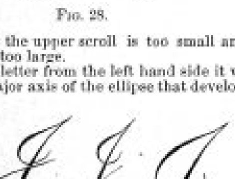


FIG. 29.

bottom scroll has the wrong inclination, and the main stem of the letter is not parallel to the former letters in the series.

In the third letter from the left hand side of the figure the scroll terminates in hair-lines that are neither parallel to the stem or proportionate in distance, according to the requirements of the second law of penmanship.

Figs. 28 and 29 illustrate the development of the capital letter J. The first letter on the left hand side of Fig. 28 has a normal development, and therefore it is pleasing.

The second letter from the left is intended to illustrate the development of the elliptical curves.

In the third letter from the left the bottom loop is too small, and, therefore, does not comply with the requirements of the third law of penmanship.

In the first letter of Fig. 29 the loop is too large, and, therefore, does not comply with the requirements of the third law.

In the second letter the loop is contracted, and, therefore, repulsive.

In the third letter the upper scroll is too large and the bottom loop too short.

From these illustrations, we repeat what we have said before, the elements of beauty are order and harmony, and these can only be secured by adherence to correct laws.

ARITHMETIC.

VULGAR FRACTIONS.

No difficulty would arise in the study of arithmetic and especially that branch of it called "Addition and Subtraction of Vulgar Fractions," if the student would first acquire correct ideas of fractional and concrete quantities. Our intelligence will be bright and sparkling, or dull and opaque, in proportion to the clearness with which we discover the relationships of things. For example, if we add 4 horses, 4 oxen, and 4 sheep, by relationship we cannot make them any other than 4 horses, 4 oxen, and 4 sheep, but we might add them together and speak of the sum as 12 beasts.

It is only then by making our knowledge sharp and incisive, and by clearly discovering the relationships of the subjects of our thoughts, that we can attain to true intelligence.

A fraction then is not a whole, neither is a whole a fraction, a whole is equal to the sum of all its parts, and a fraction is only a part of a whole. This is certainly presenting the matter in a simple way, but let us not forget that it is necessary to use simple illustrations to make difficult matters plain, a step is not a flight of stairs, and it is therefore impossible to describe what we call a flight of stairs without first defining what we mean by a step. A step is a member of a community of steps, the sum of which constitutes a flight of steps. So it is with our study of arithmetic, we first proceed from the simplest factor to discover its relationships with all the factors that go to make the great whole. Whole numbers can be added directly, for instance, 7 and 3 are 10, but a quarter cannot be added to a half until we have first discovered the relationship of a $\frac{1}{4}$ to a $\frac{1}{2}$; what then is the relationship of $\frac{1}{4}$ to $\frac{1}{2}$? The relationship then is that $\frac{1}{4}$ is the $\frac{1}{2}$ of a $\frac{1}{2}$, or that $\frac{1}{2}$ contains two quarters. Now, with this relationship before us we can add $\frac{1}{4}$ to $\frac{1}{2}$ by first noticing that a half consists of two quarters; now two quarters can be added to one quarter and the result is $\frac{3}{4}$.

Now, let us try to add $\frac{1}{3}$ to $\frac{1}{5}$, and we will soon discover that these fractions cannot be added as $\frac{1}{3}$ and $\frac{1}{5}$. Try to make a sum and say that $\frac{1}{3}$ added to $\frac{1}{5}$ would be two somethings. Now, what is the something? Call it $\frac{2}{5}$? But it cannot be $\frac{2}{5}$ because it is a fifth added to a third. Then call it $\frac{2}{3}$; but it cannot be two-thirds because it is a fifth added to one-third. We can, however, add these fractions together by multiplying their denominators into each other, then five three's are fifteen, now, there are three fives in fifteen, therefore, $\frac{5}{15}$ has the same value as $\frac{1}{3}$ because 5 is contained in 15 three times; and $\frac{3}{15}$ will be equal to $\frac{1}{5}$ because three is contained in 15 five times. Again, $\frac{3}{15}$ can be added to $\frac{5}{15}$ and the sum will be $\frac{8}{15}$.

From this reasoning it is clear that two fractions cannot be added together until they are expressed with denominators of equal values, that is, fifteenths can be added to fifteenths, but fifths cannot be added to thirds, although it does seem somewhat paradoxical that we can add fifths to thirds by expressing both as fifteenths. Now the discussion of this matter in this simple way ought to excite in the mind of the student an interest in the relationships of values, and in the relationships of things, because it is only by these means he can become intelligent.

In the same way $\frac{2}{9}$ might be added to $\frac{3}{5}$ by establishing in each a relationship of such a character that a whole is conceived to be broken into equal parts. For instance, suppose we were to chop up an apple, regardless of measurement or volume, no two of the pieces being equal in size; but to make the matter clear let us still further suppose that this apple was approximately broken into nine parts, now if we pick up two of these unequal parts it would be foolish to say that the two unequal parts constitute $\frac{2}{9}$ of the apple. We cannot tell what fraction two parts constitute until we have discovered their relative measure in relation to the volume of the apple itself. The same reasoning applies to the two fractions before us, and the addition of them must be proceeded with on the same lines as those on which we succeeded in adding a third to a fifth.

The same principles are involved in the subtraction of fractions.

You cannot take $\frac{3}{7}$ from $\frac{7}{9}$ because the values are expressed as sevenths and ninths, 3 from 7 leaves 4, but the remainder cannot be designated either sevenths or ninths, so that the 4 in this case has no measurable value, but if we convert both the fractions into sixty-thirds by multiplying the denominators into each other, we can express the same fractional values as sixty thirds as we can express in sevenths on the one hand and ninths on the other; $\frac{3}{7}$ then may be expressed as $\frac{27}{63}$, and $\frac{7}{9}$ may be expressed as $\frac{49}{63}$. Now in each case the same values are expressed in different numbers. $\frac{27}{63}$ is the same in value as $\frac{3}{7}$, and $\frac{49}{63}$ is the same in value as $\frac{7}{9}$; for example, $\frac{1}{2}$ is the same in value as $\frac{2}{4}$, and $\frac{5}{10}$ is the same in value as $\frac{1}{2}$, and $\frac{500}{1000}$ is the same in value as $\frac{1}{2}$.

All these arrangements represent $\frac{1}{2}$; therefore, we can subtract $\frac{27}{63}$ from $\frac{49}{63}$ and the remainder must be $\frac{22}{63}$. Understanding clearly the explanation given, all additions and subtractions of vulgar fractions may be performed intelligently, because the reason for the rule has been made sharp and clear to the understanding.

Then we may now safely enunciate the rule that all vulgar fractions to be added or subtracted must first be converted into fractions having their original value and expressed with the same denominator.

EXAMINATION QUESTIONS ANSWERED.

QUESTION 26.

(This question was incorrectly answered in our last issue, and the error was not only detected by the editor, but by several readers as well.)

Supposing a gangway has been driven due East to the land line running South 40° East; it is proposed to open a breast 40 feet from the face of the gangway, how far would the breast go to reach the land line, when the pitch is 25°?

ANSWER.—It will depend on the direction in which the breast is driven. If it is driven South it will never reach the land line. If it is driven North it will reach the land line at a distance of 52·6 ft.

In the first place we have the land line running S. 40° E., or 40° East of South, which forms an angle of 50° on the North side of the gangway. Then, if the seam were flat we would have a right-angled triangle with a base of 40 ft. and an angle of inclination of 50°, and we want to find the altitude. Then to find this we multiply 40 by the tangent of 50°, which gives us 40 $\times$ 1·191754 or 47·670160 ft. This would be the distance to the land line if the seam were flat, but as it pitches 25°, we have a right-angled triangle with a base of 47·670160 ft. and an angle of inclination of 25°, and we want to find the hypothenuse or pitch distance. We therefore divide 47·670160 with the cosine of 25°, or 47·670160 ÷ ·906308 = 52·6 ft.

CHEMISTRY RELATING TO MINE VENTILATION.

Will coal dust in air make an explosive mixture? To this inquiry we decidedly say yes! Any substance in air that will suddenly, on combining with the oxygen of the air produce a volume of flame equal to the volume of the mixture, cannot do otherwise than produce an explosion, because the force developed by the intense heat is an explosive force. From experiments we learn that coal dust does not ignite and instantly set up an explosion; its behavior is as follows: Take a space whose contents are equal to 1000 cubic feet, cause very fine coal-dust of a flocculent character to be suspended in the air of the chamber; if a strong light be introduced a sheet of flame is set up in the neighborhood of the light. Now let fresh air have access, the first sheet would be succeeded by a second one a little larger, and the second sheet is succeeded by a true explosion. If a continual supply of coal-dust be poured into the air as in the neighborhood of a coal crusher, a great tongue of flame is at once produced.

Will sparks ignite fire-damp in air? If the temperature of the spark be equal to the temperature of the lowest point of ignition of fire-damp, it must produce flame. If a piece of iron pyrites be chipped with a hammer in the neighborhood of an unlighted gas jet, it will light it. Sparks from the points of tools, and sparks set up by the stones rending and breaking in a goaf, are all sufficient to ignite an explosive mixture.

Important relationships of gases. Fire-damp, nitrogen, and carbonic acid, if breathed alone, or in an atmosphere undercharged with oxygen, produce suffocation, but carbon monoxide and sulphureted hydrogen cause death by poisoning. To make the distinction very clear, fire-damp, nitrogen, and carbonic acid, when breathed, bring about no chemical change in the blood, hence the sufferer dies through lack of oxygen. When carbon monoxide and sulphureted hydrogen are breathed they each act chemically on the blood and destroy it, hence the victim is poisoned. A healthy man inhales into his lungs ·35 of a cubic foot of air per minute. Ten per cent. of carbonic acid gas in air extinguishes lights. Ten per cent. of carbonic acid gas is not immediately fatal to life, but by continuing in such an atmosphere death certainly ensues. As has been previously shown, carbonic oxide is always one of the constituents of after-damp when the supply of oxygen is not sufficient for complete combustion, and, we should say, carbonic oxide would be one of the constituents of every after-damp, for the following reason: The air of the mine is not highly charged with coal-dust at the moment of explosion; but the sudden rush of air will lift up clouds of dust, and these being ignited by the great tongue of flame, will undergo partial combustion, and any vital air that may exist will be diluted with the blast of after-damp, and certainly render the succeeding combustion imperfect, thus generating carbon monoxide. Only one half per cent. of this gas is dangerous to breathe, and the unhappy victim seems to be relieved of mental excitement, and has a desire to sit and take things easy. It seems to paralyze muscular action, the poor fellows die standing, sitting, and lying with comparatively pleasant expressions on their faces, and so singular is the chemical action set up in the bodies of the victims, that their flesh does not stiffen when they are dead.

The carbonic acid of our shallow seams is chiefly carried into the mines in solution in water. We do not doubt a little is given off by the coal, but the student who has studied the great subject of the solubility of gas, will quite understand the large quantities carried into the mine by the agency of water. The quantity of carbonic acid produced by the exhalation of men and animals, and the burning of lights is relatively very small to the quantity given off by water. In the deeper seams overlaid with compact strata, through which much water does not find its way into the mine, we find comparatively little carbonic acid or stythe.

It is often a practical question with the miner how much air should be allowed for the efficient ventilating of a given seam. To satisfy this query it is often said that from one to four hundred cubic feet per minute is an adequate supply. Such statements are, however, in the absence of certain important considerations, vague and untrustworthy. It will appear clear that portions of the mine not at present working require ventilating, but the far weightier consideration is that of the height of the seam; a quantity equal to 600 cubic feet per minute per man could be easily supplied in a six-foot seam, but the pressure required to supply the same quantity per man in a three-foot seam would be such that the hap-hazard statement on the face of it appears ridiculous. Quantities can only be approximately calculated, but even then the dimensions of the roads should receive first attention.

Suppose we allow 300 cubic feet per minute per man in the three-foot seam, that quantity would be totally inadequate for a six-foot seam, the velocity not being sufficient to remove fire-damp. It is not so much a question of supplying oxygen for the breathing of men and animals, and the burning of lights, as it is a question of getting sufficient velocity to remove the gas. Perhaps a convenient approximate rule would be the following: For a seam giving off gas in the working places, allow 100 cubic feet per minute per man for every foot the seam is high, so that for a 1, 2, 3, 4, 5 or 6 foot seam the quantities would be respectively 100, 200, 300, 400, 500, or 600 cubic feet per man per minute.

Coal-dust and fire-damp mixed with air. It has been found that an atmosphere heavily charged with particles of fine coal-dust and about two per cent. of fire-damp is in a dangerous and explosive condition. It is sometimes suggested that there can never be sufficient oxygen in the air to burn up a cloud of fine particles that are suspended in it, but this is a serious mistake; an average cubic foot of air contains rather more than a quarter of an ounce of oxygen, and however dense may be the cloud of fine coal-dust that is found in one cubic foot of air, it is very unlikely that it ever will even approximate half the weight of the oxygen. From this circumstance we are convinced that the experiments of Professor Abel are perfectly satisfactory.

A Safety-Lamp may be defined as one that cannot, under ordinary working conditions, ignite an explosive mixture outside of itself, and the principle of its action may be further defined by saying, the gauze cylinder isolates the flame of the lamp from the outside air in the following manner:

The wire of the gauze always being at a temperature below that of flame, chills it. Now, as flame consists of gas at a white heat, and the gauze being much below the temperature of flame, we can see at once why flame does not pass through the meshes of the gauze, but gas moving at a high velocity, when its temperature is equal to that of flame, passes easily through the meshes of red-hot gauze, hence the dangers attending the use of the ordinary Davy and Clanny lamps in the event of an explosion inside of the lamp.—*Tate's Chemistry.*

SCIENCE RELATED TO MINING.

WATER.

The most marvelous story that human language could tell, would be that of a drop of water. Water extinguishes fire, and yet it is composed of the most fiery elements in nature, viz., oxygen and hydrogen. To the unthinking, it would appear that three-fourths of the earth's surface is comparatively lost, as the result of being covered with water; nevertheless, had the extent of the great water sheet been less than it is, very little of the dry land would have been habitable, because it would have been a dry, barren waste. The ocean supplies a large proportion of the food of man, which is both healthful and nourishing. If the British Isles were to lose their fish supplies the flesh of animals could not be found, in sufficient abundance, to compensate for it.

Water is found in three forms, solid as snow and ice, liquid as water, and gaseous as vapor; as the temperature of the air, overlying damp earth, or sheets of water, increases, its power of converting water into gas increases. Air is said to absorb water as vapor; the natural law by which absorption takes place is not at present understood; our knowledge, therefore, extends no further than the fact.

All the water of the clouds is the result of this absorption; the heat of the sun warms the air, the air absorbs vapor, which is carried to the higher regions of the atmosphere, where the temperature of the air is at once lowered, when it parts with its vapor, which now contains in it little particles of water, so small that their surface is enormous when contrasted with their volume, the result is they remain in a state of suspension, countless millions of them forming clouds, which sail along on the wings of the wind, and if this current should meet with counter or cross-currents, the miniature particles collide and coalesce into rain drops, which being too heavy for suspension, at once fall as rain, hail, or snow. These water the land, and act as a solvent of the plant food in the soil.

A portion of the rain constitutes the life-blood or sap of plants, which cannot live without the aid of water. The excess of water goes to form torrents, streams, and rivers, which carry off effete matter, which nourishes the germs of disease that destroy living organisms.

THE AIR WE BREATHE.

The air we breathe is an elastic fluid, that is to say a cubic foot of air might be pressed into the volume of a cubic inch, or a cubic foot of air might expand into the volume of a cubic yard or more. There is a known limit to which air can be compressed or contracted in volume, but we have not yet ascertained any limit to its expansion. It has been said that if a cubic inch of air, at atmospheric pressure, was admitted into the vacuum of a large sphere, whose radius was equal to the mean distance of the planet Neptune from the Sun, the little volume of a cubic inch would expand and fill the whole sphere; if it is so the conclusion is a very startling one. Air in common with all other bodies expands when heated, and contracts when cooled, by a well defined law. It is composed of oxygen and nitrogen, and some other compound gases in very small proportions; by volume it is about 21 per cent. oxygen, and 79 per cent. nitrogen, with small percentages of watery vapor, carbonic acid, etc. Now the presence of carbonic acid in the atmosphere is immediately important to all living beings, although this gas destroys life by suffocation when breathed in sufficient quantities, it is nevertheless necessary to the life of plants, supplying the necessary carbon for the tissues. We exhale carbonic acid to-day, and the carbon in that acid we may eat some days hence in butter, in the flesh of animals, and in the nutritious parts of plants. The composition is invariable; it is anywhere and everywhere the same, excepting where it is locally polluted, or in the neighborhood of the dwellings of men, where it is vitiated by the putrefaction of matter in a state of decay.

THE THERMOMETER.

The thermometer is an instrument for measuring the temperature of bodies, and especially in mining to indicate the temperature of air columns and air currents. The instrument is constructed with a scale of parts and a glass tube, having at one end a bulb. The tube and bulb either contain mercury or spirits of wine. Its mode of action is as follows: First, the ratio of temperature is shown by the expansion or contraction of the mercury or spirits of wine. In the event of their temperature being raised or lowered the column in the small tube is lengthened or shortened.

The expansion of either mercury or spirit is too small, or, in other words, the co-efficient of expansion is too small to admit of being measured by a tube of uniform bore without a bulb; therefore, the cubical contents of of the bulb are at least fifty times that of the tube. Consequently, by the arrangement of a bulb, the expansion of the mercury or spirit is read off by a magnified range of column. The tube is sealed at the top end in such a way that it contains no air to affect the expansion by its varying pressure. Nature has furnished the unit basis of the scale of temperatures.

The French make the zero of their scale freezing point, because water becomes solid as ice at that point of temperature. The other limit of the unit is boiling point at a pressure of 760 m. m., or 30 inches of barometer column. Now, the column or range between the freezing and boiling points is divided by the French into 100 equal parts. Unfortunately, the English divide the range between the freezing and boiling points into 180 equal parts. Still different, the English, instead of accepting nature's gift of a fixed point, an artificial point is set up for the zero, and this is found by mixing salt and pounded ice or snow together, producing a temperature of 32° below the freezing point of water. Then 180 + 32 = 212° F., the boiling point of water. Observe, the French make freezing point 0°C and the English make the same point 32° F.

THE SIPHON.

The siphon is a useful and economical hydraulic appliance of great value in mining, and to understand it you must first study it from the standpoint of a balance. Really in a siphon the resultant action is that of a waterfall; this will appear plain when we state that the level of the intake is always above the level of the delivery, otherwise the siphon would not act. The amount of fall will afterwards be called the motive column. The balance occurs where the bend of the siphon rises above the level of intake and afterwards falls to the same level. This balancing of the rising and falling columns of the siphon is the result of atmospheric pressure. If the pressure of the atmosphere was double what it is, then water could be carried over an elevated point double that of what we ordinarily accomplish. Then let a vertical column of 34 feet balance the atmosphere, and call this balance A, and let the greatest vertical height of the siphon above the level of intake be called S, and let the motive column overcoming the friction of the water in the siphon be called F, then A = S + F; that is to say, the pressure of the atmosphere A is equal to the pressure due to the vertical rise of the water column above the level of intake plus the friction due to the water moving through the siphon, which is equal to the pressure due to the motive column. There is a limit to the successful working of all siphons, and that limit is reached when the friction of the water through a long range of pipes begins to approach the full pressure of the atmosphere. The fact is, although this instrument has been for many years employed in mining, it is very little understood. Ignorance of the laws that govern the action of the siphon has led to great disappointment and often waste of money; the student is therefore desired to give close attention to the operation of the laws affecting the action of it.

The five laws to be especially noticed are as follows:

(1). A 34-feet vertical column of water balances the pressure of the atmosphere.

(2). The motive column must be sufficient to overcome the resistance of the intake valve and the friction of the water passing through the pipes at a required velocity.

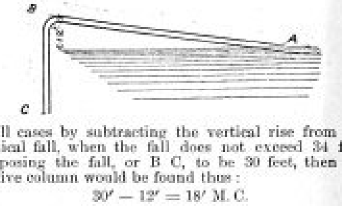
(3). The greatest altitude at which a siphon will act to run off a given quantity of water must be so much less than 34 feet that a sufficient motive column may be obtained.

(4). The delivery end of the siphon must be either bent upwards or dip into water to hinder air from gurgling up the delivery limb.

(5). No advantage is gained when the vertical depth of the delivery end from the highest point exceeds 34 feet.

The student must bear in mind that after the vertical fall reaches 34 feet no advantage whatever can be gained by making the fall any greater. Suppose the rising column to be 20 vertical feet and the falling column to be 34 vertical feet, the siphon must act, because 34 — 20 = 14. Now we have a motive column of 14 feet to overcome the friction due to the intake valve and the friction due to the velocity of water through the pipes. It is true a siphon might act with a vertical rise of 28 feet, a vertical fall of 34 feet, and a motive column of six feet; but if the lead of the siphon was say, half a mile, then the friction through the pipes would exceed in amount this small motive column; nay the six feet might not be sufficient to overcome the friction due to the intake valve alone, and the result would be the siphon would not act. On the other hand, a motive column of six feet might be ample for a short lead.

By referring to the figure it will be noticed that the intake is at A, the highest point, or altitude at B, and the delivery at C. The motive column is found



in all cases by subtracting the vertical rise from the vertical fall, when the fall does not exceed 34 feet. Supposing the fall, or B C, to be 30 feet, then the motive column would be found thus:

$$30' - 12' = 18' \text{ M. C.}$$

MECHANICS IN MINING.

ENDLESS ROPE HAULAGE.

When endless rope haulage is to be calculated in H. P. the following important particulars must be understood:

First, whatever the gradient of the road, the empty cars balance each other; second, any rise in the road only affects the engine so far as the weight of coal is concerned. The traction due to the friction of the road must be reckoned on the coal and the weight of cars equal to the weight of coal, for example: Suppose the weight of a car to carry 8 cwts. (a cwt. equals 112 lbs.) of coal is 4 cwts., and in addition to the car carrying the coal, there is an empty car; from this it will be seen there are two cars for one load. Therefore the coal to be hauled in a given time must be doubled in weight to make a correct allowance for the cars, each being half the weight of the coal, that is, if 500 tons are delivered at the shaft bottom in ten hours; for traction you must double this, or the traction will be due to 1,000 tons. Gravitation due to the gradient must be calculated on the coal only.

Q. What horse power of an engine will be required to haul 500 tons in 10 hours by an endless rope towards the pit bottom, the length of road being 3,000 yards, and the average gradient being 2 inches to the yard outbye?

A. Here the traction will be 1,000 × 28 (the co-efficient of traction being taken at 28 lbs.) = 28,000 lbs. Traction due to gravitation will be found thus: Multiply the pounds in one ton by the ratio of the rise, viz., 2 inches to the yard, and as there are 36 inches in a yard, it would be $\frac{2}{36}$, or $\frac{1}{18}$ for each lb., then for 500 tons it would be found thus:

$\frac{1}{18} \times 2240 \times 500 = 62{,}222$ lbs., and 28,000 × 62,222 = 90,222 lbs. Now if the pounds of force required to do the work of hauling 500 tons up this incline be multiplied by the distance in feet through which the load has to be moved, the result will be the units of work. Now 3,000 yards are equal to 9,000 feet, then 90,222 × 9,000 = 811,998,000 units of work to be done. Then, 811,998,000 divided by the time in minutes gives the units of work done in one minute, thus: 811,998,000 ÷ 600 (600 minutes in ten hours) = 1,353,330. Now as there are 33,000 units of work in a horse power the total horse power would be found by dividing by 33,000. But this amount of work is too large practically and it will be necessary to use the modulus ·7, which represents the amount of useful work done, therefore

$$\frac{1{,}353{,}330}{33{,}000 \times \cdot 7} = 58 \cdot 58, \text{ H. P.}$$

Q. What H. P. of an engine will be required to haul outbye 1,000 tons per day of 10 hours by an endless rope, the lengths of the roads being 1,500 yards, and the average gradient being ¼ of an inch to the yard rise inbye?

A. Here tractions equals

$$28 \times 2{,}000 = 56{,}000$$

therefore

$$56{,}000 - \frac{1{,}000 \times 2{,}240 \times 1}{144} = 40{,}445 \text{ total traction.}$$

Then

$$\frac{40{,}445 \times 1{,}500 \times 3}{600 \times \cdot 7 \times 33{,}000} = 13 \cdot 13 \text{ h. p.}$$

WINDING IN SHAFTS.

When winding in shafts is carried on with cylindrical drums and round ropes, the balance of the rope and the load is disturbed by this cause, but when winding is done with flat ropes coiling on reels, the balance of the ropes and the load is less affected.

The pass-by or meeting of the cages wound with flat ropes does not occur at half the depth, or midway in the shaft in this case however. The best rule for determining the point in the shaft where the meeting of the cages occurs is as follows:

Suppose the shaft to be 1,680 feet deep, the thickness of the winding ropes to be $\frac{3}{4}$ of an inch, and the diameter of the reel when the cage is at the bottom to be ten feet. We may proceed as follows: First find the circular feet in the edge measure of the rope which is 1680 feet long. Now the square feet in the edge measure will be as follows:

$$1680 \times \tfrac{3}{4} = 1260 \div 12 = 105.$$

As the reels are circular, next convert the square into circular measure as $\frac{105}{\cdot7854} = 133{\cdot}69$ nearly circular feet.

Next proceed to find the diameter of the reel when the cage is raised. The empty reel being 10 feet in diameter, the surface area of the end of the reel will be $10 \times 10 = 100$ circular feet, now $100 + 133{\cdot}69 = 233{\cdot}69$ circular feet. The area of the end of the full reel will be 15·28 feet.

$$(\sqrt{233{\cdot}69} = 15{\cdot}28 \text{ feet.})$$

Now to find the diameter of the reel at the moment when the cages meet, add to 10 half of the difference of the two diameters already found, as

$$\frac{5{\cdot}28}{2} = 2{\cdot}64,$$

then 12·64 is the diameter required.

Next call the diameter of the full reel D, and the diameter of the empty reel d, and the diameter at the meeting M, it follows then the cages will meet in the shaft at a distance from top X, and at a distance from bottom, x.

X may therefore be found by the following equation:

$$\frac{(D^2 - M^2) \times L}{(D^2 - d^2)} = X.$$

Let L be the depth of the shaft in fathoms, yards, or feet, and the meeting will be given in fathoms, yards, or feet.

The D^2 in this case equals 233·69, and M^2 will be equal to 159·7696, and d^2 will be equal to 100.

Then,

$$\frac{(233{\cdot}69 - 159{\cdot}7696) \times 1680}{(233{\cdot}69 - 100)} = 928{\cdot}92 \text{ feet from}$$

top, or 751·08 feet from the bottom of the shaft or

$$\frac{(M^2 - d^2) \times L}{(D^2 - d^2)} = x.$$

NOTE.—The following problem employs some principles not yet explained in this department, but is given for the benefit of some of the more advanced students:

TO FIND THE NUMBER OF TONS IN A PILE OF COAL.

Q. How many tons of coal are there in a pile 50 yards 2 feet long, and 30 yards 1 foot broad; the height of the pile from the floor being 10 yards, and the angle of the slope of the pile 45°?

A. There are several methods of determining the weight of such a mass of coal, but as many of them are only approximate solutions, and not correct to hundreds or thousands of cubic feet, we will give the two best and accurate solutions. Before proceeding, however, let us notice that if the slope of the pile makes an angle of 45° with the plane of the horizon, this means that the angle of repose for broken coal on the side of a pile is 45°. By the first solution we proceed to find the contents of a rectangular block situated within the slope of the pile. Finally the contents of four pyramids coinciding with the four corners.

Now the pile is 152 feet long at the bottom, and as the base and perpendicular, or the sine and cosine of an angle of 45° are equal, it follows that if twice the height of the pile in feet be subtracted from 152 the remainder is 92, the greatest length of the top of the pile. The breadth at the bottom of the pile is 91 feet, and if 60 be subtracted from this, the remainder is 31 feet, the greatest breadth across the top. Now as the height of the heap is 10 yards or 30 feet

$$92 \times 31 \times 30 = 85{,}560 \text{ cubic feet.}$$

Now each of the long prisms measure 92 feet, and their contents will be found by multiplying.

$$\frac{92 \times 30 \times 30}{2} = 41{,}400 \text{ cubic feet.}$$

Now the contents of the short prisms will be found by

$$\frac{31 \times 30 \times 30}{2} = 13{,}950 \text{ cubic feet.}$$

There are four pyramids, and the area of each may be found as follows:

$$\frac{30 \times 30 \times 30}{3} = 9{,}000 \text{ cubic feet.}$$

The sum of the contents of the figures, namely, one rectangular solid, four prisms, and four pyramids, is equal to 232,260 cubic feet.

The second solution is as follows: Let the slope of the two ends of the pile be supposed to be cut off, now we can solve the problem by two operations. First, find the mean breadth of the pile which is 61 feet, now 61×30 = the area of section, or 1830 square feet, then $1830 \times 92 = 168{,}360$ cubic feet. Each of the ends will be left in the form of a wedge, having a short edge and two long ones, the sum of the three edges will be $(31 + 91 + 91) = 213$, which divided by 3 gives 71, the mean length. The section may be considered as square, having one wedge resting on the other; the area of the section will be

$$30 \times 30 = 900, \text{ and } 900 \times 71 = 63{,}900$$

cubic feet, now the sum of the two solids will give the same as before:

$$63{,}900 + 168{,}360 = 232{,}260 \text{ cubic feet.}$$

A cubic foot of broken coal weighs 50 lbs., and as there are 2,240 lbs. in a ton, the weight of the coal pile will be

$$\frac{232{,}260 \times 50}{2{,}240} = 5184{\cdot}3 \text{ tons.}$$

MINE VENTILATION.

[From the Report of the Prussian Firedamp Commission, as published by The Colliery Guardian, England.]

Conveying the Air Current to the Working Face.—In order to obtain satisfactory results in ventilation it is not enough to force a great quantity of fresh air into the mine, but this air must be brought in as close proximity as possible to the face of the workings. The solution of this problem is all the more difficult because it varies with circumstances, and also for the reason that it depends on the attention, good will, and intelligence, not only of those who have the supervision of affairs, but also of the men themselves. This explains why it is the relatively short passages through which the current is conveyed to the working faces which are precisely the most dangerous parts of the mine.

The special arrangements for ventilating the working faces consist of air-pipes, partitions, compartments, parallel roads, and borings. The use of air-pipes supposes the mouth of the pipe which reaches the working face, to be received by the air-door, which can either be set up in the gallery which first receives the air current, or in the return airway. But, as a general rule, the use of air pipes is only advisable in large-sized galleries and for short distances.

Ventilating partitions offer much greater security, for by their means two independent currents of air of almost equal section, and reaching the working face, can be obtained. They are made of brickwork, boarding, and sail-cloth, either stretched on frames or hung loosely. Brickwork partitions are specially suited for long cross-cuts, and the sail-cloth arrangements for the working properly so called. The partition should naturally be kept air-tight, and approach as closely as possible to the working face.

In the deep levels and broad roads, the embankment, if sufficient, may serve for partition purposes, but an airway must be maintained in the lower part, to permit of the passage of fresh air, and the gallery proper must be intercepted by a door which will expel the foul air issuing from the working face, in the direction of the nearest heading. But in this case it is absolutely necessary that the embankments should be carefully made, and especially that a facing as smooth and impermeable as possible be made the length of the airway and also of the gallery. But in the event of a violent explosion this arrangement presents the great inconvenience of its being easily destroyed, which might result in the entire suspension of the ventilation of a portion of the mine.

When winning in fiery beds where there is an abundance of gas, it is better to proceed with the deep levels, self-acting planes, and other main galleries, and at the same time also to drive a secondary parallel gallery in the seam or rock, which should connect with the principal gallery by means of shafts which ought not to approach each other too closely. In this case it is best to forward the working face of the parallel gallery (upper) with respect to that of the main gallery (lower), but the air current ought to arrive there in the last place, in order that the gases which are liberated from it may be carried away immediately. Under some circumstances it would be necessary not to drive the two galleries simultaneously, but one after the other, and in portions. In fiery seams it is also strictly necessary to set up a ventilating partition in each of the two galleries from the last cross-cut to the face of the working. Lately, particularly in the coal mines of Westphalia, ventilating cross-cuts have been replaced by bored air-holes, which have this great advantage—that they do away with the always dangerous necessity of driving ascending galleries. But, on account of their small size, it is not usually possible to circulate the air current through them, which, in the event of an explosion, might be the cause of serious danger. Nevertheless, if by boring holes of greater diameter this defect were remedied, they would then answer all requirements.

With respect to the use, according to the different methods of working, of the various means of ventilation enumerated above, the preference is usually given to parallel roads for such operations as shafts, cross-cuts and isolated galleries; but even for these partitions, embankments, air-pipes, provided the latter were of adequate size, might suffice. In any case in fiery mines these works cannot be executed without the help of one of these means of ventilation. All airways which have become useless should be stopped up as completely and in as durable a manner as possible.

Independent Ventilation.—In spite of the attention given to the subject of ventilation, it is not always possible to efficiently circulate either the main or partial current through all the working places, without its becoming either dangerously enfeebled or else receiving a downward direction. Therefore, in narrow mines especially, it becomes necessary to supply badly-ventilated and isolated parts of the mine with independent means of ventilation. The most simple means of effecting this is the method which is adopted in fiery parts of Prussian mines—namely, that of setting up armed fans combined with pipes; but generally speaking it is the Schiele and Kittinger fans which are used for the purpose, and of late years the Pelzer fan, and in some regions the Roots fan, are also being employed.

In each particular case it is necessary to ascertain whether the fans are exhausting or blowing. As a general rule the latter are preferable, because the mechanical effect of the air-current is better able to keep the workings free from gas, and to continually convey fresh air to the miner, whilst with an exhausting fan the air, before its arrival at the working-face, has already absorbed the gases which have been liberated from previous portions of the gallery. On the other hand, it is true that the gallery itself is better ventilated by an exhausting fan. In all cases it is strictly necessary that armed fans shall only be placed in currents of pure air (Art. 20 of *Principles*). When they exhaust there must also be an air return pipe which will lead the foul air as directly as possible into the issuing current—that is to say, into the nearest channel of ventilation.

If a fan of this kind is intended to work for a prolonged period, or if it simultaneously supplies air to several workings, a mechanical motor is preferable but if steam is not to hand, recourse may be had to hydraulic turbines, aeromotors, or to electric transmissions. The numerous accidents which may result from the unsuitable position of armed ventilators, or negligence in their management, combined with their lack of usefulness for long distances, have led, since 1875, to the use, in a great number of fiery mines, of compressed air as a local means of ventilating those portions of a mine which are removed from the general current. This method possesses the great advantage of being independent of the current properly so-called, and of conveying the fresh air, without loss of time, to the working place. Also, when expanding at ordinary pressure it diffuses a refreshing coolness in the mine. It is unfortunate that this method involves great expense.

The method, formerly almost exclusively in use, which consists of simply allowing the compressed air to escape from pipes placed at the working face, may serve perfectly to dissipate the liberated gases, but from an economical point of view, it constitutes a waste of motive power, and consequently should only be employed in workings where a small amount of air only is necessary and which are situated at the end of very long galleries, or where there is a great pressure of earth.

A better use is made of compressed air by allowing it to escape by means of a narrow adjutage or pipe, and then by virtue of its great force exhaust through an open pipe, in the manner of the Giffard injector, a considerable volume of air (at least twelve times that of the compressed air). The Kœrting apparatus, where the air is introduced through several concentric adjutages is the most suitable for this purpose, but a simple and single adjutage will also suffice.

Apparatus of this sort may be used both for blowing or exhausting; for the former, the mouth of the pipe well extended should be in the current of fresh air. Of late years their use has greatly increased, particularly in the Maria Colliery, near Hoengen, Aix-la-Chapelle, and also in several collieries of Westphalia and Saxony. In connection with these an excellent arrangement (differential blowers) has been arrived at, which regulates the escape of the compressed air in such a way that the afflux of air in any working may be increased at all times according to need.

The Commission strongly recommends the use of compressed air and blast pipes as an independent means of ventilation, and also the Kœrting and other apparatus for workings which are difficult to ventilate (Art. 10 of *Principles*). Water under pressure may also in the same manner as compressed air be used to advantage in the Kœrting apparatus. At the Friedenshoffnung and Karl-George Victor Mines, near Waldenburg (Lower Silesia) an independent method of ventilation has been realized in very fiery coal-seams by means of wide blast pipes, and by artificially retaining the fresh air current, and strongly depressing the outgoing current. The fresh air current kept back by the air-doors is conducted to each working-place through wooden pipes (water level and parallel gallery), or by ordinary zinc pipes (winning). After becoming charged with the gases freed from the working, and without passing any other working-face, it is allowed to make its escape without restraint by erections superposed in the upper return airway. These air-gates are placed immediately before the last erections, so that the pipes which commence there are never very long. The erections at the back and also the self-acting plane are carefully intercepted. In order to prevent loss of air, the surplus of depression necessary for the fan to circulate the air in three self-acting planes amounts, in the Friedenshoffnung Mine, to about 12 mm. of water (37 mm. instead of 25 mm.). Although this method of independent ventilation, as compared with others in use, undoubtedly requires a great expenditure of motive power, yet the Commission recommends it on account of its excellent results in all cases where considerable volumes of air may be disposed of with adequate depression.

Explosions of Fire-Damp in Prussian Collieries in 1890.

According to official statistics concerning the coal mines of Prussia during 1890, 116 accidents occurred in consequence of the ignition of coal gas, and of these 32 were fatal and 84 non-fatal. As compared with 1889, the number of explosions with fatal results in 1890 increased by 6, and was greater than in any one of the previous five years. The number of persons killed also showed an increase over the years 1888 and 1889, but was more favorable than the average of the years from 1881 to 1890. On an average 2·44 deaths were caused by each fatal explosion; this compares with 2·62 in 1889, 3·74 in 1888, and 4·89 deaths in 1887. Moreover, the 32 mortal accidents also caused severe injuries to 8 and light wounds to 17 miners. The injuries in 69 of the non-fatal accidents were light, in 8 they were very serious, and in the remaining 7 cases they were both light and serious. Explosions took place in 79 steam coal pits out of the total of 354 operated in Prussia last year.—*Engineering and Mining Journal.*

Mr. Arthur Winslow, State Geologist of Missouri, reports that during the month of October inspections of iron ore deposits, lead, and zinc deposits and of coal beds have been made in the several districts of the State. Detail mapping has been prosecuted and over 230 sq. miles covered in Henry, Benton, and St. Francois Counties. Examinations, covering a large section, have been made for outlining the areas of the crystalline rocks, also the examinations of important clays of the State have been continued. In the office work has progressed rapidly in all the departments.

BORING MACHINE FOR TAPPING WASTES.

BY ROBERT M'LAREN.

(Transactions of the Mining Institute of Scotland).

In a working approaching an old waste known to contain water, bores must of necessity be kept in advance, and in practice it has been found that, with the ordinary method of drill or jumper, the boring of holes of over 20 ft. becomes difficult, owing to their getting stopped up with the *débris* made by the tool, and this difficulty is increased when it is necessary to have a large barrier sufficient to withstand the pressure of water behind, in order to protect the workings to the dip from being drowned. Such a difficulty presented itself at Alloa and Devon Collieries, where there are large areas of waste with water, and to tap these wastes, and leave a sufficiently strong barrier of coal, the machine about to be described was introduced by Mr. Andrew Hunter, manager of Alloa Colliery.

The machine consists of a cylinder C, 1½ inches diameter inside, with packing glands *a a*. At *b* is an opening, to which is attached an india-rubber pipe ⅜ in. diameter, fixed to pump-chest D. Two plunger-pumps *d d*, 1 in. diameter, with 1 in. stroke, are fixed to crank-spindle E, and from *c* is led an india-rubber pipe to a cistern containing water for suction. On the one end of the crank-spindle is a handle 9 inches long, with which to turn the machine, and on the other end F is the part to which the rods are attached. The whole is fixed on to a bogie G (Fig. 3), 3 ft. 6 ins. long × 2 ft. 6 ins. broad × 4 ins. deep, and running on ordinary

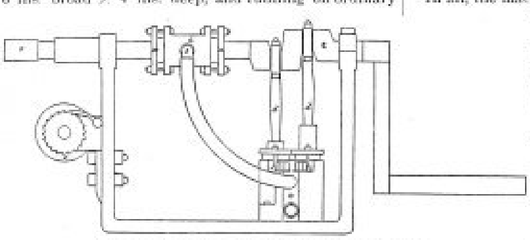


FIG. 1. ELEVATION—SCALE 1½ INS. = 1 FOOT.

cast-iron rails, and set at the inclination of the seam. In order to keep the machine moving forward while the drill is cutting, a chain ¼ in. diameter is fixed to a barrel *e* (Fig. 1), with ratched wheel, and passes round two pulleys *f g* (Fig. 3), 6 ins. and 10 ins. respectively, fixed to prop *h*, and a weight *j* is hung upon a hook at the other end of chain. This hook is so made that a number of similar weights can be placed upon it.

Rods. The rods, which are hollow, are ¾ in. diameter outside, with ¼ in. diameter hole inside, and in 6 ft. lengths. A box F (Fig. 1) is put on the crank-spindle, into which the first rod is screwed with ⅞ in. diameter screw. The other rods are screwed into each other, as is done in the ordinary method of boring. The drill K (Fig. 3), which is also hollow, is 1½ in. outside diameter,

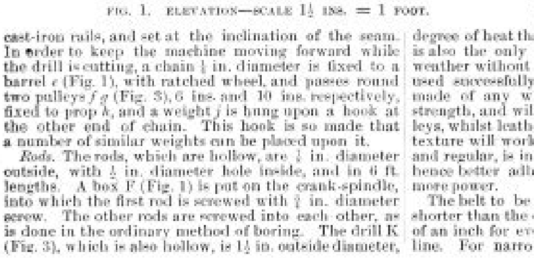


FIG. 2. PLAN—SCALE 1½ INCHES = 1 FOOT.

and of the ordinary description, as used by miners for drilling holes, except that 1½ in. from the point is the hole to allow the water to escape.

Where water enters from pumps at *b* are four small holes drilled through crank-spindle into the hollow—the hollow being continued right out to F. A groove *b b* (Fig. 4) is also cut, into which a set pin *m* (Fig. 2) is screwed to keep cylinder C in its place.

Mode of Application. In applying the machine, the handle is turned, which works the cranks, and water is pumped into cylinder C and forced into hollow rods

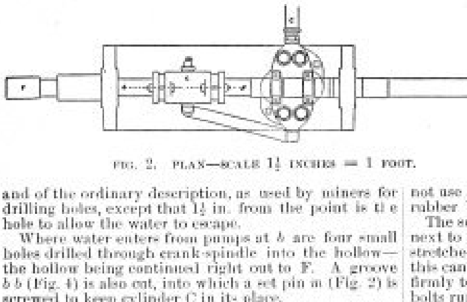


FIG 3. SCALE ½ INCH = 1 FOOT.

to drill-point, and is discharged at the circumference of rods, carrying the *débris* which has been made with it. As the drill cuts, the machine moves forward, and is kept from going back by ratched wheel. When 6 ft. has been cut, the machine is unscrewed from rods, and run back, and another rod fixed. Care must be taken in cutting the rods not to allow them to become empty of water, as, if this is not guarded against, they get filled with small coal and *débris*, and have to be drawn. To prevent this, a small plug is inserted at part where rods are cut. Should the weight *j* reach the floor before the machine is up distance, it is taken up by turning the ratchet handle.

Work performed by the machine. Holes have been bored at Devon and Alloa Collieries. At the former there is a large area of waste in the lower 5 ft. coal, with a pressure of 135 lbs. per square inch, and waste has been tapped at several places—the greatest distance bored for one hole being 168 ft., 50 ft. of which passed through a hard sandstone. Up to 20 ft. or so, two men can easily

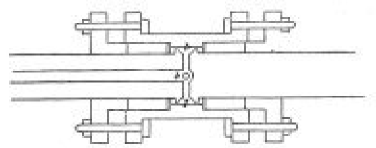


FIG. 4. SECTION THROUGH LINE A B ENLARGED.

bore one foot per minute, while 30 yards, on an average, can be bored in a shift of eight hours by two men. The following is section of seam bored :

Sandstone.	
Blaes	1′ 8″ to 6′ 0″
Cherry coal	0′ 7″
Splint coal	1′ 1″
Cherry coal	0′ 7″
Daugh	0′ 1″
Cherry coal	2′ 0″
Fire-clay.	

In all, the machine has bored in this seam holes to an aggregate distance of 900 yards.

At the latter colliery, three holes were put in, at different angles, a total distance of 46 yards in lower 5 ft. coal in eight hours by four men, which included the shifting and fixing of the machine.

THE USE AND CARE OF RUBBER BELTING.

BY C. A. DANIEL.

Rubber belting properly-made is more uniform in thickness, will endure without injury a greater degree of heat than belting made of other material, and is also the only belting that can be exposed to the weather without injury, and can at the same time be used successfully in damp or wet places. It can be made of any width and thickness, and of uniform strength, and will always run true and smooth on pulleys, whilst leather belting of different thicknesses and texture will work unevenly. Its surface, being smooth and regular, is in more perfect contact with the pulley, hence better adhesion, resulting in the transmitting of more power.

The belt to be adjusted to the pulley should be cut shorter than the distance around the pulleys by ½ to ¾ of an inch for every foot, when measured by a tape line. For narrow belts, butt the two ends together, making two rows of holes in each end (thus obtaining a double hole), and lace with lacing leather. For wide belts in addition, put a thin piece of leather or rubber on the back to strengthen the joint, equal in length to the width of the belt, and sew or rivet it to the belt.

If the belt should slip, from dust or other causes—which seldom happens—moisten it lightly on the side next the pulley with boiled linseed oil. If one application does not produce the desired effect, repeat it. Do not use animal oils or grease, as they are injurious to rubber belts.

The seam side of the belt should never be placed next to the pulley. In putting on belting it should be stretched as tightly as possible; and with wide belts this can be done best by the use of clamps secured firmly to each end of the belt, and drawn together by bolts running parallel with, and outside the edges of the belt.

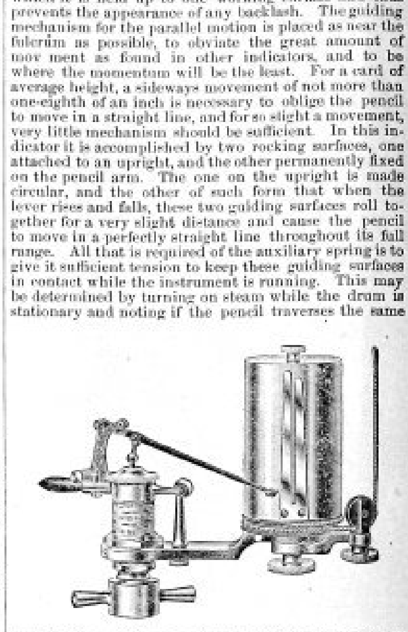
The belts will be greatly improved and their durability increased by putting on with a painter's brush, and letting it dry, a composition made with equal part of red lead, black lead, French yellow and litharge mixed with boiled linseed oil and japan enough to make it dry quickly. This will produce a finely polished surface. A coat of the same composition may be applied, should the rubber get peeled from the surface of the belt.

If the belt is to be shifted from one pulley to another, rollers should be placed on the shipper on each side of the belt in a diagonal position, bringing the upper ends of the rollers as near together as possible to clear the belt, and diverging from each other as far as may be; this plan slips the belt much easier than the old method and entirely prevents the liability of injuring the edge.

The "Quaker City" and "Crown Brands" of rubber belting, furnished by the Quaker City Rubber Co., of Philadelphia, are both high grades and are thoroughly warranted. They are made with a special view to the requirements of mine work and they are now in use at many collieries at all of which they are giving satisfaction, as they are thoroughly warranted and the user takes no risk. Price-list and discounts will be cheerfully furnished by the Quaker City Rubber Co., of 313 Market Street, Philadelphia, whose advertisement appears on another page.

The Straight Line Indicator.

The peculiarity of this indicator lies in the simplicity of its parallel motion and in the auxiliary spring by which it is held up to one working surface and thus prevents the appearance of any backlash. The guiding mechanism for the parallel motion is placed as near the fulcrum as possible, to obviate the great amount of movement as found in other indicators, and to be where the momentum will be the least. For a card of average height, a sideways movement of not more than one-eighth of an inch is necessary to oblige the pencil to move in a straight line, and for so slight a movement, very little mechanism should be sufficient. In this indicator it is accomplished by two rocking surfaces, one attached to an upright, and the other permanently fixed on the pencil arm. The one on the upright is made circular, and the other of such form that when the lever rises and falls, these two guiding surfaces roll together for a very slight distance and cause the pencil to move in a perfectly straight line throughout its full range. All that is required of the auxiliary spring is to give it sufficient tension to keep these guiding surfaces in contact while the instrument is running. This may be determined by turning on steam while the drum is stationary and noting if the pencil traverses the same



vertical line. This spring is intended also to take up all play that may ever appear in the joints and oblige the pencil to always follow in the same path. The first indicator made was subjected to the test of being run continuously, nine hours a day on a high speed engine, for over a month, and showed no appreciable wear, as what there may have been was taken out by the auxiliary spring, and the instrument improved if anything by this hard usage.

The effect of the auxiliary spring on the main spring is to weaken it. This allowance is made in numbering the spring, and the scale of spring, therefore, is the net resistance of the two springs.

The moving parts of the instrument are the lightest weight of any straight line indicator, and that weight is disposed so near the fulcrum that its little movement makes the momentum very little, and specially adapts it for the highest speeds.

Any one wishing any further information relative to the Indicator can obtain it by addressing Messrs. Hine and Robertson, 45 Cortlandt St., New York, who are introducing it.

Mine Pumps.

Not every steam pump, even if its capacity and power are fully up to the requirements, is adapted to mine work. To be durable and efficient, mine pumps must be specially constructed to meet the conditions existing in mines. The celebrated "Yough" pump, manufactured by Messrs. Boyts, Porter & Co., of Connellsville, Pa., is specially constructed for this work, and the result has been that the "Yough" pump is rightfully regarded a great success.

Hundreds of them are now in use in all parts of the country, and as the mine workings of the purchasers are extended and greater pumping facilities are required, they invariably duplicate their orders, if they do not order the same type or pump of larger size.

They are constructed with large ports, and they thus permit solid substances that may be in the water, to pass through without injury to the working parts.

Where the mine water is acidulated special provisions are made to counteract its deleterious action on the metal. As an evidence of the superiority of the pump, Capt. Boyts informs us that they have just shipped the following large pumps to companies that have used the "Yough" pump for years:

One to the Lemont Mine of the McClure Coke Co., which has a 24″ steam cylinder, a 10″ water cylinder and 30″ stroke.

One to the Hecla Coke Company's, new plant, at Hecla, 26″ steam cylinder, 16″ water cylinder, and 48″ stroke. This is one of the two largest pumps in the Connellsville region and is a duplicate of one furnished the same company nearly two years ago, for the Trauger Mine.

One to the H. C. Frick Coke Company's Standard Mine at Mount Pleasant, with 26″ steam cylinder, 14″ water cylinder and 48″ stroke. This is the third of the same type and size furnished for this mine.

They have also just completed a large pump, for the Cambria Iron Company's Morell Mine, of the following dimensions: 32″ steam cylinder, 14″ water cylinder and 48″ stroke. They have also just secured an order from the Tennessee Coal, Iron & R. R. Co., for a Yough pump with 26″ steam cylinder, 12″ water cylinder, and 48″ stroke, for Pratt Mines, Tennessee. The constant duplication of orders on the part of old customers, Capt. Boyts considers the best proof of the efficiency, durability, and economy of the Yough pump.

USEFUL INFORMATION

Birds and the Statue of Liberty Light.

A few evenings ago I took the steamer, with a party of naturalists, to Bedloe's Island, as the electric lights at the top of the statue are known to attract multitudes of birds every Spring and Fall. There had been cold weather for a few days before, and millions of birds were hastening South. We obtained a permit, and went up to the topmost gallery of the statue, and waited. The night had not far advanced when all the heavens seemed to become full of wings, which produced a tempest of whirring sound. Then came the calls of the leaders, and they rang out so clearly that they could be heard for half a mile through the storm. The responses were fainter than the signaling cries, but they were quite definite. The object of the calls, of course, was to keep the flocks together, for, as could be seen through strong glasses, birds of a hundred species were driving along on the breast of the storm. All that came near the statue hovered around the light in large circles, but some of them struck against the bronze or stone. There were sand-pipers of every kind, "peeting, peeting," as they went; golden wings and other wood-peckers, with their loud and rather hoarse cries; warblers of every kind—and their signaling ran through a wide gamut of sounds—thrushes, robins, meadow-larks, nuthatchers, and congregations of bobolinks that filled the air with hurricanes of lovely music as they swept by. Sometimes a huge black cloud passed along, and the glasses showed that they were blackbirds, but they did not chatter as they do on the edge of the forest. The leaders made all the noise and preserved order. I know not how many flocks went by of teal, wood-duck, black duck, mergansers, curlew, snipe, plover, pewees, phœbebirds, and what not; but none could mistake the kingfishers as they went, with their scolding laughter, through the dark.

We caught a score or so of the birds in nets and in our hats, and kept them till the morning, after which we released them. And all through the night bats chased and feasted upon the silly moths that gathered around the spikes of electric flame.

A large number of birds lay dead upon the grass in the morning, having struck the statue. One morning, shortly after the statue was put up, over a thousand birds were picked up; but latterly they seem to be aware of the danger, and not nearly so many are killed against this tall obstruction.—*Edmund Collins, in Harper's Weekly.*

Result of a Superstition.

In China, dead ancestors are held in peculiar and profound reverence. This feeling is sometimes manifested in ways which excite ridicule in more enlightened people. For instance, to cast a shadow upon the grave of an ancestor is considered an insult of so heinous a character that it cannot be permitted to pass unresented. The occupant of the grave is supposed to be disturbed and made uncomfortable by the shadow, and it is superstitiously believed that unless his living descendants protect him against such an indignity, he will make it hot for them both in this life and in the life to come.

This superstition leads to practical difficulties. There being no cemeteries or public burial grounds in China, the dead are buried on the family premises, hence every yard or garden is a receptacle of ancestral remains. When it is remembered how populous China is, and how long the processes of burial have been going on within its domain, it is easy to imagine that the remains of ancestors are sown so thickly that it is difficult to avoid casting a shadow on some carefully-watched grave.

This state of things led, in one instance, to results which were both amusing and beneficial. When the first electric telegraph company in China began to establish its lines, the linemen planted the poles as they had been accustomed to do in other countries. To their surprise, bands of infuriated Chinamen would rush upon certain poles, cut them down, and menace the linemen with bodily harm in case they should set the poles up again. The cutting down of poles was so frequent that it was impossible to establish the line. At first the telegraph men did not know why the Chinamen cut down the poles. But, on investigation, it was found that it was because the doomed poles, at some time in the day, cast shadows on the graves of revered ancestors of the indignant pole cutters.

The telegraph company sought to overcome the opposition of the superstitious Chinamen by persuasion and argument, but their efforts were in vain. They then tried bribery, which was equally futile. The superstition was found to be so deep-seated and so sacred that nothing could overcome it. The result was that the telegraph wires had to be laid under ground, and the Chinese escaped the nuisance of having the streets of their cities and the country at large stuck over with unsightly telegraph poles. Thus did superstition in heathen China effect what public indignation and the power of the courts have not been able to accomplish in this Christian land.—*New York Ledger.*

Four Hundred Millions of Silver.

The Treasury of the United States had in store on the 1st of October, 1891, 348,341,193 silver dollars; $15,848,620 in the form of subsidiary silver; silver bars to the value of $41,579,253; trade dollars (bars), $2,394,260—total $409,161,326, or, in round numbers, $400,000,000. The government, furthermore, is increasing this immense store by buying seven additional tons of silver every working day in the year.

Now what does $400,000,000 worth of silver mean? Stated in figures, or expressed in words, it conveys to minds as ordinarily constituted no definite idea other than that of an incomprehensible something, endowed with certain potentialities—possibly for good, possibly for evil. Yet silver is a physical entity, possessing the properties of length, breadth, thickness, capacity to occupy or fill space, and weight. Let us apply these properties to the $400,000,000, and note some of the results of such application.

Coined into dollars, the product will weigh over 22,000,000 pounds avoirdupois, or 11,000 net tons; and if its movement is desirable, will necessitate for so doing the use of 1,000 railroad freight cars carrying eleven tons each, or 2,200 cars carrying five tons each, or 5,500 two-horse wagons carrying each two tons.

A cubic inch of pure silver weighs about 0·28 pounds, and a cubic foot about 637 pounds. Hence the $400,000,000, if melted into a solid mass, would occupy some 33,590 cubic feet, which in turn would make a solid column of pure silver a foot square and about 6½ miles high—the Washington Monument being 550 feet. Assuming a load of 100 pounds per man, an army of 220 000 men would be required to carry the mass, and would make a file, in close order, 80 miles long, occupying 30 hours in "passing a given point," allowing nothing for halts or "rests."

The Treasury counts its silver by weighing it, which is the part of wisdom, in view of the fact that a man counting at the rate of 200 dollar pieces per minute, steadily for eight hours a day, Sunday included, would be kept busy for considerably over eleven years.

Piled upon one another, the $400 000,000 would attain a height of 675 miles; and placed side by side, they would carpet a room 50 feet wide and nearly 24 miles long.

Great, however, as is the mass of silver at present in the "treasure-houses" of the government, it is being steadily increased by the purchase of 54,000,000 additional ounces every year, or at the rate—as before stated—of seven tons for every working day of the year.—*David A. Wells, in Harper's Weekly.*

How Playing Marbles are Made.

Nearly all the common marbles which drag down the pockets of our boys are made in Oberstein, Germany. They are made from the refuse of the agate and stone quarries in that neighborhood. The stone is broken into small cubes by blows of a light hammer. These small blocks of stone are thrown by the shovelful into the "hopper" of a small mill formed of a bed of stone having its surface grooved with concentrated furrows; above these is the "runner," which is made of hard wood having a level face on its lower surface. The upper block is made to revolve rapidly, water being delivered upon the grooves of the bed-stone where the marbles are being rounded. It takes about fifteen minutes to finish a bushel of good marbles ready for "snapping." One mill will turn out 170,000 marbles per week. The very hardest "crackers," as the boys call them, are made by a somewhat slower process, somewhat analagous, however, to the other.

How Congress Carries on its Work.

In the days of the famous statesmen sketched and delineated by Oliver Dyer in his "Great Senators of the United States," transcendent ability and personal greatness exercised a controlling influence in the halls of Congress. When Calhoun, Benton, Clay, or Webster supported a measure, it was understood that he had made himself familiar with all its bearings and was advocating it because he believed its passage would conduce to the welfare of the country. Moreover, he was acknowledged as a leader; his followers had faith in him, and his eloquence and his arguments had a powerful influence upon the minds of his colleagues.

In those days the bills which came before Congress were so few that whenever a measure of vital interest was introduced it was possible for a great party leader to examine it critically and give ample time to its consideration. Now it is different. The calendars of the Senate and the House of Representatives are so loaded down with important bills that it is physically impossible for anybody to master the details of even a moiety of them. Hence, as a matter of necessity, the work of examining them is divided up between the committees of either House. Every measure is referred to the appropriate committee; the committee examines and reports upon it, and if the report be unanimous, it is usually accepted as conclusive, and the bill is passed or rejected in accordance with the report. The influence of the committees has become so controlling that the constitution of them is of vital importance. They are appointed by the presiding officer of either House—the President of the Senate or the Speaker of the House of Representatives.—*New York Ledger.*

The Story of the Obelisk.

At Heliopolis was the Temple of the Sun, and the schools which Herodotus visited "because the teachers are considered the most accomplished men in Egypt." When Strabo came hither, four hundred years later, he saw the house which Plato had occupied; Moses here learned "all the wisdom of the Egyptians." Papyri describes Heliopolis as "full of obelisks." Two of these columns were carried to Alexandria 1937 years ago, and set up before the Temple of Cæsar. According to one authority, this temple was built by Cleopatra; in any case, the two obelisks acquired the name of Cleopatra's Needles, and though the temple itself in time disappeared, they remained where they had been placed—one erect, one prostrate—until in recent years, one was given to London and the other to New York. One recites all this in a breath in order to bring up, if possible, the associations which rush confusedly through the mind as one stands beside this red granite column rising alone in the green fields of Heliopolis. No myth itself, it was erected in days which are to us mythical—days which are the jumping off place of our human history; yet they were not savages who polished this granite, who sculptured this inscription; ages of civilization of a certain sort must have preceded them. Beginning with the Central Park, we force our minds backward in an endeavor to make these dates real. "Homer was a modern compared with the designers of this pillar," we say to ourselves. "The Mycenæ relics were *articles de Paris* of centuries and centuries later." But repeating the words (and even rolling the r's) are useless efforts; the imagination will not rise; it is crushed into stupidity by such a vista of years. As reaction, perhaps as revenge, we flee to geology and Darwin; here, at least, one can take breath.—From "Cairo in 1890," by Constance Fenimore Woolson, in *Harper's Magazine* for November.

European Industrial Schools.

In almost all the manufacturing towns of Europe during the last half century schools have been opened for apprentices in the industrial arts. In Russia there are no less than 1,200 of these schools, with 20,000 pupils. Among justly celebrated preparatory schools are found the Ambats school at Amsterdam, the technical school at Birmingham, Heriot's Hospital of Edinburgh and the St. Luc schools at Belgium. All agree that industrial education can only be really given in a workshop, where teachers will be able to instruct pupils by means of practical demonstration and by sketches of designs. At Birmingham and Edinburgh pupils are admitted to technical schools, which are considered merely as a sort of primary industrial schools, where very fine chemical and physical laboratories are at their disposal, and in which they acquire a certain practice in preparation for industrial work. Belgium has founded thirty-six industrial schools, in which are given every evening, and on Sundays, the elements of scientific and artistic knowledge corresponding to the profession of those who frequent them. The number attending exceeds 25,000. In both England and Belgium the number of pupils in proportion to the population is about the same, that is, 42 to each 1,000. In Holland there are thirty-two industrial and twenty-five professional schools, attended by about 7,000 pupils. Switzerland has no less than eighty-seven schools, giving to apprentices and workmen professional instruction. The pupils number 8,000. In Denmark, a country of 2,000,467 inhabitants, there are seventy-seven schools for professional instruction of workmen, with more than 6,000 pupils. The technical school of Copenhagen alone numbers no less than 2,000. In Sweden there are twenty-eight industrial schools; that of Stockholm has 800 pupils, more than one half per cent. of the population of the town. Italy, which in 1885 had 136 industrial and art schools, with 16,274 pupils, has since then made great progress; but she is suffering, as England sometimes suffers, from an excess of manufactured articles, and these must be disposed of at any price in order to avoid a ruinous embarrassment. Hamburg, under the direction of Marius Vachou, has the best institution in Germany, both on account of the principles which inspired its creation and the methods of instruction. In entering there, if the pupil is neither an apprentice nor workman, he must choose a trade. A law of the Hamburg senate imposes on all industrial superintendents the duty of sending their apprentices to this school for six hours every week. The first part of the first year is exclusively devoted to the study of the primary elements of drawing. All drawings must be made from nature. After that comes instruction from professional designs. Each pupil receives instruction, personal, varied, and rapid, according to his temperament and taste. The discipline is very severe, so that the pupil becomes accustomed to conduct himself as a serious man, and to consider work as a social duty. The Hamburg school has served as a model to the schools of designs in various parts of Europe.—*Translated for Public Opinion, from the French of Edmond Planchut, in the Revue des Deux Mondes.*

MECHANICAL NOTES

Iron Buildings.

Notwithstanding the great value of iron as a material of construction for certain purposes, we think that in this country, where more iron buildings, perhaps, have been erected than in all other countries put together, there is a strong feeling among architects that they have had their day; and that a better, safer, and more durable structure can be made by combining masonry with iron than by using the metal as the only, or even the principal constructive material. In other countries, and especially in France, where iron construction is now applied to all sorts of new uses, it has the charm of novelty, and is often spoken of as the universal material of the future; but most experienced American architects have seen too many iron columns honeycombed with rust, and girders with half the thickness of the webs separating in flakes, to wish to entrust their reputation to such perishable material, while our fire engineers have thoroughly satisfied themselves that an iron building of the ordinary sort is less capable of resisting a severe fire than one of almost any other material. Among the engineers, a similar distrust of iron for construction exposed to the weather has become very general. Two serious accidents have shown that the life of a suspension bridge, with either wire or chain cables, is only about 40 years, and some recent examinations of plate-girder bridges have shown that, in about the same length of time, the web plates, notwithstanding careful and often-repeated painting, are eaten nearly or quite through, by corrosion, which works unobserved beneath the paint. The contrast between bridges which perish in a generation, and those which, like several of the masonry bridges built by the Romans, have been in use for nearly 2,000 years, and are still in excellent condition, is too striking not to attract the attention of intelligent engineers, and the next decade is likely to see brick and stone extensively used for railway bridges, to the great advantage of the landscape in the neighborhood. Already, it is said that the officials of the Pennsylvania Railroad, which has always led in scientific engineering, have given orders that no more iron bridges shall be built on the road, and the children of the present stockholders will probably have reason to rejoice at the decision.—*American Architect.*

Rolling Hollow Staybolts.

The rolling of hollow staybolts is an industry recently introduced, and claimed to possess special advantages. In this process, two pieces of iron rolled in U-shaped section, are laid together and wired in that position, these parts being then heated to a welding heat and run through rolls, and, as the welded tube comes from the rolls it passes over a mandrel, which fills the interior; before reaching the second pair of rolls it cools slightly and shrinks upon the mandrel, and in this pair of rolls it is drawn from the mandrel and the interior cleared. In this way, by five repeated operations, a hollow staybolt is obtained, which has a uniform interior diameter. The material must necessarily be the very best quality of charcoal iron; the bolts are made in lengths of six feet, and it is alleged that a considerable saving in expense is made by using hollow staybolt iron, instead of drilling the ends of the bolts after they are in position.

Action of Oils on Metals.

A series of tests, lasting some twelve months, on the action of various oils on metals in contact with them, recently carried out, gave the following results: In the case of iron, seal oil acted the least on it and tallow the most. Bronze was not attacked at all by colza oil, and but very slightly by olive oil. It was, on the other hand, vigorously eroded by linseed oil. In the case of lead, the most deleterious lubricant was whale oil, the best, olive oil. Whale, lard, and sperm oils were about equally erosive. Zinc seemed to be little attacked by mineral lubricant oils. The best oil was lard, and the worst, sperm. Copper was not attacked by any of the mineral oils. Sperm oil had the least and tallow the most action on it. Generally speaking, mineral oil attacked the metals under test, the least, and sperm oil attacked them the most. In conducting the experiments, the metals were first thoroughly cleaned in ether and then dried. They were next carefully weighed and placed in closed vessels filled with oil, which were kept for a year at a uniform temperature in summer, of 80° F. and in winter, of about 50° F.—*Metal and Iron Journal.*

Wolfram Mining.

Wolfram, or tungsten, belongs to a group of rare metals, and, until a comparatively recent time, was known only to the chemist, and its value was known only in the laboratory. With the invention of 100-ton guns the demand for tungsten soon made the previously obscure metal well known throughout the mining world. It was soon found that the steel tube lining the bore of these enormous guns could not resist the shock entailed by discharging many shots without becoming fractured. Experiment proved that the addition of a small quantity of tungsten to the fine steel employed in gun-making rendered the latter metal wonderfully elastic, so that the steel tube will expand under the tension of firing and contract again to its normal size a great many times before the quality of the metal is in any way impaired. The German gun factories absorb most of the tungsten found in the world, and from being a mere curiosity seen only in the laboratory of the chemist, this rare metal has acquired considerable value. Wolfram generally occurs in combination with iron in Europe, but it is also found in Scheelite, or tungstate of lime. It is in the latter form that it occurs in Otago. The metal itself is of a white color, extremely brittle and heavy, the specific gravity being 19·1, that of gold being 19·3. It will thus be seen than tungsten is a very heavy metal, being only very slightly lighter than gold.—*New York Ledger.*

Nuts.

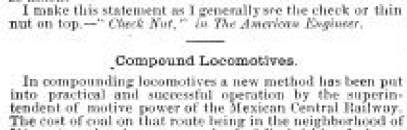
In looking over your correspondence column I am reminded of a problem that I think is generally misunderstood by mechanics. The problem is the use of double nuts on a bolt. One of the nuts is used as a check or jam nut and need be only ¼" or less in thickness except for convenience in not requiring a special wrench too thin for any other use. In theory the number of threads in the check or jam nut need only be sufficient to stand the strain that would usually be applied to the wrench in setting the nut as a check or jam.

The top nut is usually called the check nut whereas the bottom one is the check nut, and when set, prevents the top one from unscrewing. There is no weight or strain on the thread of the bottom nut due to the weight that is being held up, the thread of top nut holds the entire weight. The material in the bottom nut outside of the thread supports the top one and is of use only as a check or jam nut. When double nuts are used on large bolts it is more important to understand the problem as the cost is increased so much.

I make this statement as I generally see the check or thin nut on top.—"*Check Nut,*" *in The American Engineer.*

Compound Locomotives.

In compounding locomotives a new method has been put into practical and successful operation by the superintendent of motive power of the Mexican Central Railway. The cost of coal on that route being in the neighborhood of $11 per ton, the plan was conceived of diminishing fuel consumption by the introduction of a compound system, in which the high pressure cylinder is encircled by the low pressure cylinder. In this arrangement the high pressure cylinder is fourteen inches in diameter, and the low pressure a diameter of thirty and three-fourths inches, which is equal to a cylinder twenty-four and one-fourth inches in diameter. The stroke is twenty-four inches, and the two rods of the low-pressure piston are coupled with the single high-pressure rod to one crosshead. It appears that in a competitive test of twelve trips with a single engine the compound locomotive showed economy in fuel of about twenty-five per cent.—an important economy on a road where the fuel account is the largest item of operating expenses, being twenty-two per cent. of the total.—*New York Sun.*



Insomnia and Its Therapeutics.

Dr. Macfarlane, Fellow of the Royal College of Physicians, Edinburgh, has written a monograph upon the causes and remedies for insomnia. He outlines the hypotheses of many students who have made a specialty of investigating the phenomena of sleep, and a great part of the discussion is devoted to describing and differentiating the symptoms of sleeplessness. This he pronounces not a disease, but a symptom of many diseases differing widely in complexity and gravity. The paradoxical statement is made that women require more rest than men, and yet at the same time they "bear loss of sleep better—for a time—than do men." In reference to the habit of sleep, the writer quotes the example of the Iron Duke, who could induce sleep at will and preferred to rest in a narrow bed, believing that when it was time to turn over it was time to turn out.

Insomnia from over-cerebration is discussed in a chapter upon sleeplessness from disorders of the nervous system. Sea bathing, change of scene and of occupation, instantaneous stopping of work, are the remedies proposed, for in such cases medicine does little for the tired mind. Dr. Macfarlane does not lay claim to any new suggestion as a cure for sleeplessness, but he gives a careful resume of the therapeutics of the subject.

To Promote Sleep.

How to get to sleep is a matter of high importance to many persons besides yourself. Nervous persons who are troubled with wakefulness and excitablity usually have a strong tendency of blood to the brain, with cold extremities. The pressure of blood on the brain keeps it in a stimulated or wakeful state, and the pulsations in the head are often painful. Let such rise and chafe the body and extremities with a brush or towl, or rub smartly with the hands to promote a circulation and withdraw the excessive quantity of blood from the brain, and they will fall asleep in a short time. A cold bath, or a rapid walk in the open air, or going up and down stairs a few times, just before retiring, will aid in equalizing circulation and promote sleep. These rules are simple and easy of application in castle or cabin, and may minister to the comfort of thousands who would freely expend money for an anodyne to promote "Nature's sweet restorer, balmy sleep."

To Prevent Consumption.

At a time when so much is said about Koch's cure for tuberculosis, it may be worth while to call attention to the remarks of Mr. G. W. Hambleton, at the meeting of the British Association. He pointed out that consumption was a disease of civilization, produced by causes which reduced the standard breathing capacity below a certain level. To prevent this disease it is necessary to use the body to the extent its strength demanded, and to see that the work it had to perform was carried on under conditions favorable to the body. It was also desirable so to arrange habits and surroundings that their tendency as a whole should be to develop the lungs. Close and badly ventilated or heated rooms, occupations which involve stooping and cramped positions, corsets, tight-fitting clothes, should be avoided; "nipping" should also be prohibited; as much time as possible should be spent in active exercise in the open air; bedrooms should be well ventilated; wool should be worn next the skin; the body should be held erect; deep inspirations in breathing should be taken through the nose, and the cultivation of all kinds of athletic exercise should be encouraged. But above all, he considered a great deal depended on prompt and early treatment of the victims of consumption.—*New York Ledger.*

A Sea Trip for Health.

When exhaustion has gone so far as to produce a condition of positive breakdown without any special organic lesion a sea trip is in most cases to be preferred to any alternative. The patient has the advantage of perpetual carriage, exercise without the irksomeness of restrained posture and without its limitation to a few hours of sunshine. The chilling effects of night air and alternations of dryness and dampness of atmosphere are almost unknown at sea, and a recovery may in such cases usually be predicted as following almost certainly a few weeks on shipboard. But it is to the middle-aged man more than all others that a holiday at sea is recommended. In the great majority of cases a man who leads an active business or professional life selects his form of holiday as much for what he gets away from as for what he gets to. The desire to get out of harness and to escape from the weary treadmill of the recurring cares, from which few active men are free, is never better met than by a voyage. To such men exercise is a secondary consideration. Fresh air and the incidents that vary the monotony of sea life are sufficient to give all the benefits that any change can give, while the gentle exercise of walking the deck is sufficient to stimulate the appetite and promote digestion. The impossibility of doing anything more energetic than walking the deck is a safeguard to persons of this class; for, after the first flush of youth is over, the sudden transition from a sedentary life to severe exertion is more apt to be attended with risk than with benefit.

Prevalence of Diphtheria.

The Milroy lectures this year were on the natural history and prevalence of diphtheria. The lecturer gave it as his opinion that soil and geological formation have something to do with its prevalence; that it is especially common in damp valleys, and that in England it is most prevalent during the last three months of the year.

The greater number of persons attacked are between 2 and 12 years of age, and the liability is greatest between 2 and 5 years.

Many attacks of diphtheria are accompanied by simple sore throat and tonsilitis, and many apparently simple attacks of sore throat have really an infectious character. The same fact has been noted on this side of the Atlantic.

Some physicians look on diphtheria and scarlet fever as modifications of the same disease, and the occurrence of both at the same time in the same family seems at first sight to countenance this view. But the theory is disproved by the entire absence of diphtheria in several thousand cases of scarlet fever treated in the London Fever Hospital.

The probable explanation of the occurrence of both in the same family is that the condition of the throat in a family effected by scarlatina affords a soil favorable for the reception of the diphtheric poison.

When diphtheria does occur in connection with scarlatina, it is almost always as a sequel to it. So, too, the sore throats due to bad hygienic surroundings and imperfect drainage furnish excellent soil for diphtheritic microbes.

Many cases of diphtheria end unexpectedly in fatal heart failure, sometimes when the patient has seemed in a fair way to recovery. In such cases a postmortem examination reveals a fatty and granular degeneration of the muscular fibres of the heart.

This fact emphasizes the need of prompt treatment to secure the speediest possible recovery. It follows, too, that in all cases, until complete recovery, everything should be avoided which makes demands on the heart, a very slight effort often being fatal: and that the physician should always make a careful examination of the heart, and advise accordingly.—*From the Youth's Companion.*

The Use of Pillows.

A pillow is a necessity; but care and judgment should be exercised in its use. No mere matter of habit is the use of a pillow. It has a physiological basis. We sleep, for the most part, on the side, and without a pillow the head would be uncomfortably and harmfully lower than the body. It will be remembered that Jacob, when fleeing from Esau, took a stone for a pillow. He needed something for the purpose, and nothing better than a stone presented itself. Such practices are common in Africa at the present day.

Some people rest the neck instead of the head on hard pillows. In Africa extraordinary headgears make this practice necessary, and many a civilized women has been compelled by a somewhat similar coiffure to forego both the pillow and the recumbent posture. The consideration of the physiological reasons for pillows will suggest their proper thickness. They should merely bring the head to the natural level. Some pillows are much too thick. By bending the neck unduly they interfere with the outflow of the venous blood from the head. The pillow that just fills up the space above the shoulder best suits its end.

Again, pillows of feathers are objectionable. While they furnish the needed support for the head, they are too heating as they have a remarkable capacity for holding and accumulating heat.

It should be remembered that more blood, and hence more heat, goes to the head than to any other part of the body. Head heating pillows are against the wholesome maxim: "Keep the feet warm, but the head cool." There is nothing better than the hair pillows.

Further, the pillow is for the head, not for the shoulders. To rest the shoulders on the pillow defeats the very end for which it is used.

Finally, special care should be taken of infants in this matter. We have seen their heads sunken deep into the softest and thickest of pillows, and their faces, as a natural consequence, covered with great beads of perspiration. It is no wonder that children so treated die.

Ventilation of School Rooms.

In an article in the American *Engineering Magazine*, on ventilation, Mr. Laurence Allen contends that in very many schools the quantity of pure air admitted is not sufficient to expel the foul air. To maintain the air in a good sanitary condition in a properly constructed school room, his experience confirms the amount required as stated by Billings, to wit, 60 cubic feet of air for each occupant per minute. For 100 pupils this amounts to 360,000 cubic feet per hour. There are many schools that contain 100 pupils and do not introduce more than 25,000 feet of pure air per hour, and even that is rendered in a measure ineffective, because the air is not properly admitted. "The pupils," Mr. Allen says, "do not die in the poisoned atmosphere; many of them will appear reasonably healthy. So do many persons who visit and tarry in malarial districts. But though the effects are not immediate and striking, they are sure, permanent, and easy to be traced to their causes, in after years, by those who make a study of disease and its causes. It is scarcely less humane to kill a child than, by willfully ignoring sanitary requirements, to cripple it for life, physically, mentally and morally, as children are being crippled to-day in the vile atmosphere of many schools."

Electricity in Horticulture.

Because the entire animal creation gets tired and seeks periods of rest, it has been popularly supposed that the vegetable creation also gets tired in its efforts at growth, and would be overwrought were it not for the periodic torpidity which the darkness of night brings upon it; hence it has been believed for ages that the growing products of the vegetable kingdom require periodic exemption from the stimulus of sunlight. But experiments which have been made in Europe and in this country, notable at the Cornell Agricultural Station, show that this popular belief has no foundation in fact.

In these experiments a variety of plants has been kept under continuous light for long periods, by turning on electric lights from sundown to sunrise. The results of these experiments are remarkable. They show that periods of darkness are not necessary to the growth and development of plants; that plants do not need rest at night in the sense in which animals need rest; that there is no such thing as a plant becoming worn out or tired out in consequence of the stimulating influence of continuous light.

Plants have a faculty—which some writers call "the vegetable instinct"—of making the best of their situation. Within the temperate zones they have simply adapted themselves to the conditions of alternating light and darkness. During the day they assimilate or make their food, and during the night, when the process of assimilation is stopped, they use the food in growth. But in the Arctic regions, where, during the prolonged days of summer, plants are in almost continuous light, they grow without periods of rest.

By means of the varied and numerous experiments with electricity which scientists have already made, it has been discovered that if plants are kept under continuous light, although the process of assimilation is not stopped, the growth of the plant goes on even more rapidly than it goes on in the darkness of night, the electric light not only promoting assimilation, but often hastening growth and maturity. It has also been demonstrated that the electric light is capable of producing natural flavors and colors in fruit, and that it often intensifies the color and sometimes increases the production of flowers.

The scientific deduction from these facts is that there is good reason for supposing that the electric light can be profitable used in horticulture as soon as the details of its application shall be practically wrought out. It is alleged that the discoveries which have been made and the results already achieved strongly indicated that if the electric light enables vegetables to assimilate during the night and does not interfere with growth, it will ultimately produce plants of great size and marked precocity.—*New York Ledger.*

Edison's Exhibit at the World's Fair.

Thomas A. Edison's display of electrical apparatus at the world's fair is to be the greatest effort of that great inventor's life. He has been working on it for months, and a dozen or more of his ablest assistants have been helping him. The wizard of Menlo Park has just applied for space in the electricity building for his exhibit. He wants one-seventh of all the room in the big building. The electricity building is 345 by 700 feet, and contains exclusive of gallery space, 231,500 square feet of floor room. "I have it from Mr. Edison himself," said Chief Barrett recently, "that his display at the fair is to be the greatest achievement of his life. In talking of his application for space Mr. Edison admitted that he was asking for a large section of the building. 'But every inch will be put to good purpose,' he added, 'I shall not waste a foot of the area assigned to me, but will present a series of the most interesting electrical inventions ever produced.—*Chicago Journal of Commerce.*

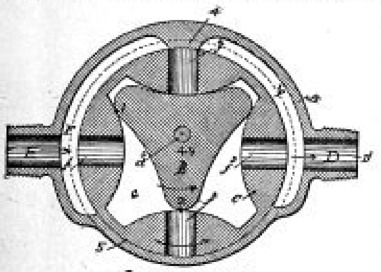
The Dynamo Made Harmless.

F. J. Crough, of Eugene, has invented a harmless dynamo which a child can handle without fear of danger, says the Portland *Oregonian*.

Mr. Crough says his machine is very simple, and adds that the secret of success is in the winding, induction, and proportion of metals. There is another secret which he will not divulge. He says the success of his invention is in one wire, but he does not desire to discuss the matter. Mr. Crough gave his invention a severe test in the presence of several people, including a reporter, recently. His principal purpose was to show that his machine was harmless and that it was impossible to get a shock from it. A feature of Mr. Crough's exhibit is a sixteen-candle power light burning in a jar of water, the naked wire being exposed to the water. Right above the jar is a light and an electric bell on the same circuit. A telegraph instrument has been worked a distance of three or four miles on the same line as an electric light without damage to either branch of the service. Again the incoming and outgoing wires of the dynamo have been run without insulation through mud, and then started lights without any loss of power. Mr. Crough says his dynamo has the power of ten volts. It will run fifty sixteen-candle power incandescents with four and one-half horse-power, including friction. In inventing it Mr. Crough says he cast aside all the theories of construction of electrical machines and started on a new track.

WATER MOTOR.

No. 457,294. James A. Tilden, Hyde Park, Mass. *Patented August 4, 1891.* The rotary piston B is made of triangular shape, as shown. It rotates within the four-sided chamber forming the interior of the ring C. The center of the piston is at d^2 and that of the ring C coincides with the center of the case A at the point 3. Water enters at E and passes through the port f^1 into the interior of the ring, where it presses against the lobes of the piston B. The piston is in contact with the ring at the points 1 and 2. It will be seen that point 1 is nearer the center d^2 of the piston than the point 2 is, consequently the greatest leverage is exerted on the lower lobe of the piston, and it revolves in the

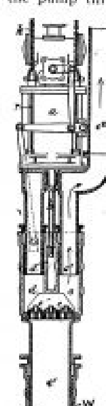


Cross section

direction of the arrow. The lobes of the piston successively enter the four recesses or corners of the chamber in the ring C and they revolve together, the piston making four revolutions while the ring makes three. They work together like a pinion into an internal gear. As the ring revolves the ports f^1 f^2 f^3 f^4 are closed when they reach the port 5 that fits against the ring, and they open into the exhaust D when they have passed it. They pass from the exhaust to the supply side as they go past the bearing 4. The supply and exhaust are thus controlled by the ring C, and no other valves are needed. The motion is reversed by shifting the pressure over to the exhaust side.

MINING PUMP.

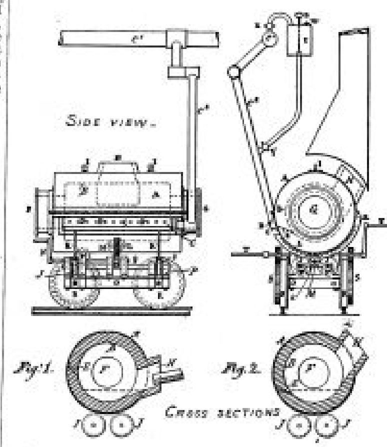
No. 457,023. William H. Bailey and Gustave Lindemann, Salford, England. *Patented Aug. 4, 1891.* One fixed water barrel W and two fixed plungers d^1, c^1, are connected to the steam cylinder a by rods r. The piston rod b, is attached to a pair of water barrels d and c, which are bolted to a large hollow plunger c^2. A set of valves e are attached to a plate bolted between them. The hollow interior of the plunger d^2 serves as an air chamber, and the water passes out of the pump through the plunger c^1.



When the steam piston moves the barrels c and d, and the plunger c^2 downward, the plunger displaces twice as much water as the plungers c^1 d^1 do on the up-stroke. Half of this water fills the space made by the withdrawal of the plungers c^1 d^1, and the remainder goes off up the column pipe c^2. On the up-stroke the plungers c^1 d^1 displace the water which on the down-stroke filled the space vacated by them, and the plunger c^2 sucks in enough water for the next double stroke. The discharge is thus double acting, and the suction single acting.

CONVERTER FOR COPPER MATTE.

No. 456,510. Pierre Manhes, Lyons, France. *Patented July 21, 1891.* This converter is designed for producing copper from matte of any composition. In construction and operation it resembles the converter employed in making Bessemer steel. The cylinder A is lined with refractory material, and has end openings F and G through which the flame from any convenient heating furnace is run for the purpose of properly heating it before receiving a charge of matte. These openings are covered when at work. The cylinder is provided with a vent or nozzle H and a blast box C having a number of tuyeres E which extend through the lining as shown. Blast is supplied through a jointed pipe C^2 C^2. The cylinder is supported on rollers J upon a car as shown. The apparatus can be propelled to any desired place by the handles T. The cylinder is turned over to receive a charge, or to bring the tuyeres beneath the metal, by means of the crank N. The charge is introduced through the nozzle H, when in the position shown in Fig. 1 the blast is turned on and the cylinder is then rotated to position shown in Fig. 2. The reaction commences immediately. The oxygen of the air combines with the sulphur and forms sulphurous acid, and with all the other bodies it forms oxides, which are carried away by the gaseous current. The greater part of the iron which passes to the state of oxide remains in the bath and would soon injure the lining of the converter and quickly render it useless. To prevent this, powdered silica contained in a reservoir U is fed into the blast-pipes, and is brought into contact with the oxide of iron and forms silicate of iron, which melts and floats in the bath of melted matte. The



volume of matte becomes less by the liberation of the sulphur and other bodies. Consequently the converter is turned slowly, in order that the air-blast may still penetrate the matte to the proper depth. The matte is thus concentrated and approximates metallic copper by the loss of the other elements—iron and sulphur—as well as the combustion and volatilization of the metalloids, and metals more easily oxidized. After a time there remains in the converter only sub-sulphide of copper, and this is shown clearly by the color of the flames. The sulphur continues to burn, and the copper is liberated, and descends by gravity below the remaining sub-sulphide. The cylinder is then turned backward slowly, so as to keep the tuyeres near the bottom of the layer of sub-sulphide, until crude copper alone remains. At the middle of the operation, when it is recognized by the color of the flames that all the iron has been burned, the converter is tipped to the postion Fig. 1, and the slag which floats, if sufficiently fluid, is run out, the air which strikes the surface at the rear of the bath being usually sufficient to force it out. If the slag is not fluid, it is raked out by the usual means. The apparatus is afterward turned back to reduce, as aforesaid, the sub-sulphide of copper by still further blowing. By this process poor and impure mattes can be treated at will for obtaining either a white matte absolutely free from iron and other bodies, or crude copper, or even refined copper in condition for rolling, and this is done in less than an hour after taking the matte from the blast-furnace and without consumption of fuel.

VALVE FOR HYDRAULIC MOTOR.

No. 459,736. Elijah B. Benham, Providence, R. I. *Patented Sept. 22d, 1891.* This valve is designed for that class of motors which has several cylinders, eight in the present instance, all of which radiate from one center. The piston rods all bear against one crank pin 63. A retaining ring Z hooks over the shoulder shown on the ends of the rods, and serves to keep them in place. A single port 27

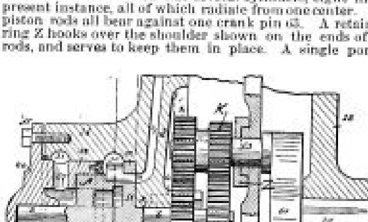


Fig. 1.

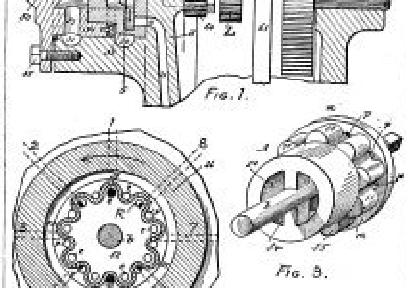
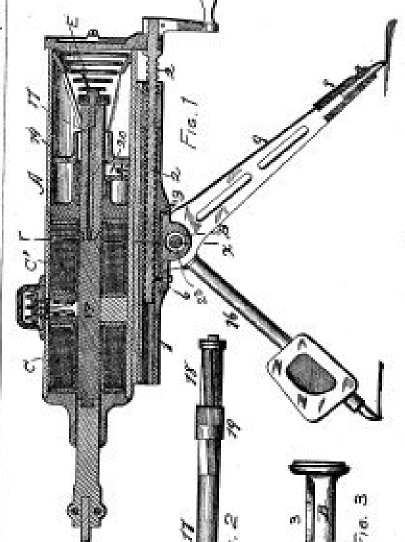


Fig. 2. Fig. 3.

runs from the outer end of each cylinder to the bottom of the steam chest. The eight ports are arranged in a circle at exactly equal distances apart. The valve which controls the admission and exhaust is shown in perspective in Fig. 3, and in cross section in Fig. 2. The face of the valve is a circular plate which fits the bottom of the steam chest. It contains eighteen equally spaced holes, on the same circle as the cylinder ports. The body of the valve is corrugated so as to have each alternate hole open into the inside of the valve, and the intermediate holes open to the outside. The former are the exhaust ports and the latter are the supply or inlet ports. In Fig. 2 it is seen that cylinder port 1 is fully open to the exhaust, and port 5 is fully open to the supply. Port 2 is opening and 8 is closing to the exhaust, 6 is opening and 4 is closing to the supply or pressure. 3 and 7 are closed, both those pistons being at the ends of their strokes. While the valve turns from the position shown, sufficiently to bring the exhaust hole R exactly over the cylinder port 1, or through one-ninth of a revolution, each cylinder port is opened and closed both to the pressure and to the exhaust, in the regular order necessary to secure one full stroke to each cylinder. Consequently the valve makes only one revolution for every nine of the crank, and the wear of the valve is correspondingly slow. The pressure chamber 30 is separated from the exhaust 31, by the cup leather packing shown in Fig. 1, which fits against the circular shell of the valve. The valve is turned by differential gears carried on the end of the crank pin 63. Wheel 60 is fixed, and L is fastened on the valve stem. K and h are keyed together, and turn on the crank pin. h and 60 are equal in size, but K and L are in diameter as 8 to 9. At every revolution L is turned forward one-ninth of a revolution thus giving the valve its proper motion.

ELECTRIC ROCK DRILL.

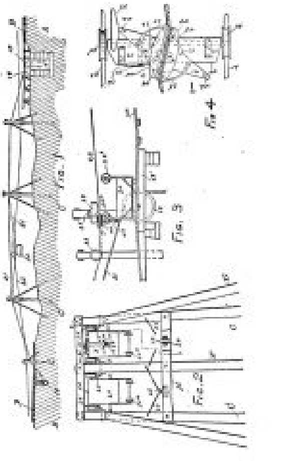
No. 460,089. Charles E. Life, Syracuse, N. Y. *Patented Sept. 22d, 1891.* The drill is attached to the bar 17 by a clamp in the ordinary way. The coils C C^1 of insulated copper wire are employed to operate the drill bar 17. When the electric current is sent through the coil C^1, the bar draws back into the casing until its center reaches the center of the coil, or so far as the coiled spring E will permit. Before it reaches the limit of its stroke in that direction, the current is switched out of the coil C^1, and into coil C. The rod now moves outward, tending to bring its middle to the middle of coil C. Before reaching that point, however, the current is again switched off, and into coil C^1. At or before that moment, the drill strikes the rock, and the pull from coil C^1 catches it on the rebound. The upper part of the drill rod 17 is made into a spiral 18, as shown on Fig. 2. This spiral slides through a ratchet sleeve 19, and pawls 20 serve to rotate the drill in the ordinary way. On the outward



stroke the sleeve turns, but on the inward stroke the pawls hold the sleeve and the drill rod turns. The tripod leg 9 is double, united at the foot, and each side is provided with a disc at the head, which engages the beveled ends of the center block B. The top ends of the legs 16 are also provided with large flanges which are clamped by a center bolt 23 tightly against the outside of the heads of the leg 9. The center block B has on its top side, a circular plate 3, with beveled edges, Fig. 3. The casing A slides in ways in the bar 1, and this bar has a socket and clamp block 6 which takes hold of the swivel plate 3. The drill can be swiveled horizontally on this joint, and can be swiveled vertically by easing off the center bolt 23 thus allowing the center block B to turn between the heads of the tripod legs. The feed screw 2 is operated by hand.

AERIAL RAILWAY.

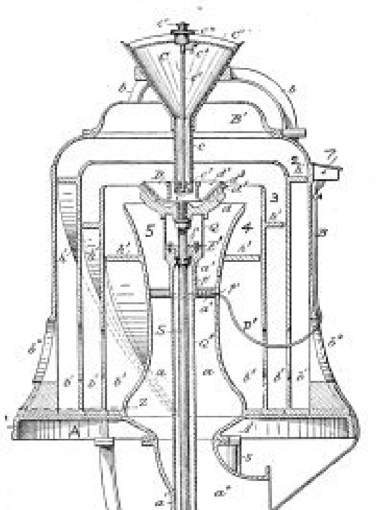
No. 460,587. Alfred H. DeCamp, Boonton, N. J. *Patented Oct. 6, 1891.* In this structure metallic flexible rails are used instead of ropes for the car wheels to travel on. These rails are made of flat iron bars which are arranged to slide through suitable ∩-shaped stirrups which are bolted to the knees 26 which support the track on the trestles C. Each stirrup is covered with a short piece of flat iron, tapered off at both ends and resting on top of the track, for the purpose of passing the wheels over the stirrups without shocks. The end of the rails at the anchorage A are attached to straining ropes and weights shown on the pit 19a. The cars are moved by an endless hauling rope 22. Surface tracks D extend to the ends of the aerial tracks and the cars are provided with two sets of wheels, the upper ones to run on the aerial tracks, and the lower ones for the surface tracks. The haulage rope draws the cars to any desired point on the surface line, where the rope grip is tripped automatically by a block 37, Figs. 3 and 4, fixed above the track on a suitable framework 38. The car is then switched by gravity over to the return track, and the grip is closed by a block overhead 37, similar to the one that opened it. The grip is composed of two jaws which are pivoted on pins 47 to a plate 41. They are connected by small links 49 on the under side. Each end of plate 41 has a lug 42 turned up high enough to be engaged by the blocks 37 which are fastened to overhead timbers at the engaging and disengaging stations. When the plate 41 is thrown around to the position shown in Fig. 4, the jaws are



forced toward each other sufficiently to grip the rope, and the rope is bent as shown. Both ends of the railway are provided with surface track switches and grip operating blocks 37, so the cars circulate continuously and automatically. Fig. 3 shows the end of the aerial track and of the surface track, with a car about to pass from one to the other.

CENTRIFUGAL ORE SEPARATOR.

No. 459,287. THOMAS CLARKSON, LONDON, ENGLAND. *Patented Sept. 8, 1891.* The crushed ore is fed into the hopper C. The feed is regulated by a conical valve at the lower end of the feed pipe, which is adjusted by a handwheel at the top of the hopper. The ore falls into a circular dish d, which is fastened on the top end of the spindle S. This dish is provided with a removable ring d^1, which is constructed with radial grooves d^2 on its top surface. These grooves range in size from $\frac{1}{32}$ to $\frac{1}{8}$ of an inch square, according to the material to be handled. A cover D rests by gravity on top of the ring d^1, and provides a top or cover for all the grooves in it. The pan and its cover are spun swiftly by a belt on the pulley P, and the ore is thrown from the pan, through the grooves d^2, outward and upward at an angle of 45 degrees. The distance that it is thrown

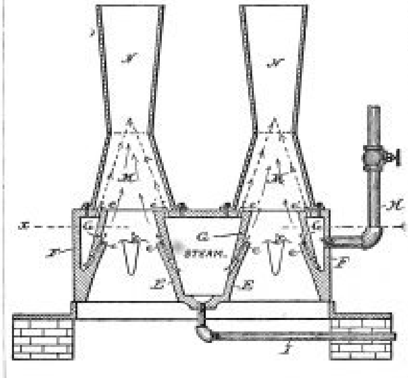


VERTICAL SECTION.

depends upon the weight of the piece. The pieces heavy with metal are thrown farthest into the outer chamber 2, smaller pieces into chamber 3 and the dust into chamber 4, while the finest dust falls into the central chamber 5, from which it is sucked out by an exhaust fan. These chambers are made of circular casings one inside the other, and they are provided with spiral flanges k^1, k^2, k^3, which form inclined bottoms to each chamber, by which the material is directed to suitable discharge holes in the base A. The spindle S runs in ball bearings in the upper sleeve E^1 and at the bottom hanger E. The dust is kept out of the upper bearing by a sleeve Q which slides on the pipe Q^1 and shoves up close under the bottom of the revolving dish d, without quite touching it. Oil is supplied to the bearing by a pipe p^1 which leads from an oil box 7.

STEAM BLOWER.

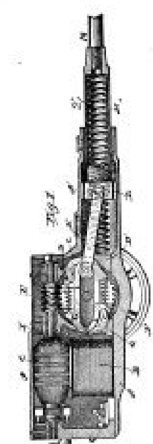
456,435. CHRISTIAN H. SCHARAR, SCRANTON, PA. *Patented July 21st, 1891.* This blower is designed for drawing the gases from the furnaces of steam boilers, etc., and thus create the necessary draft, without the smoke stack commonly employed for that purpose. It is usually set at the end of the flues where the chimney would otherwise be placed. A circular casing F is supplied with steam by the pipe shown. Several conical passages G are made through the casing for the passage of the smoke and gases. A pipe M N having



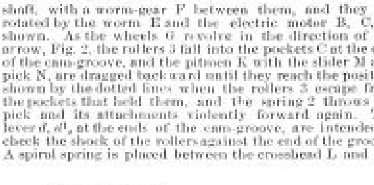
a contraction near the middle of its length, is placed over each passage G. A number of small jets e^1 are provided around the upper end of each passage and a second set e are made on the interior of the passage, as shown. All the jets are so inclined that the streams of steam which issue from them tend to converge at a point near the narrowest part of the tubes M N, as shown by dotted lines. A drain pipe I serves to keep the apparatus free from water when the fires are low, or the steam is shut off.

ELECTRIC MINING MACHINE.

No. 458,184. EDMUND C. MORGAN, CHICAGO, ILL. *Patented Aug. 25, 1891.* The pick N is attached to a tubular holder M which slides through a bearing in the front end of the machine frame and is guided by a crosshead L. A long spiral spring 2 is used to throw the pick forward. To draw it backward, two pitmen K are employed, which have rollers 3 running in the cam-grooves of the wheels G. There are two of these wheels, on the ends of a short transverse



shaft, with a worm-gear F between them, and they are rotated by the worm E and the electric motor B, C, as shown. As the wheels G revolve in the direction of the arrow, Fig. 2, the rollers 3 fall into the pockets C at the end of the cam-groove, and the pitmen K with the slider M and pick N, are dragged backward until they reach the position shown by the dotted lines when the rollers 3 escape from the pockets that held them, and the spring 2 throws the pick and its attachments violently forward again. The lever d, d^1, at the ends of the cam-groove, are intended to check the shock of the rollers against the end of the groove. A spiral spring is placed between the crosshead L and the



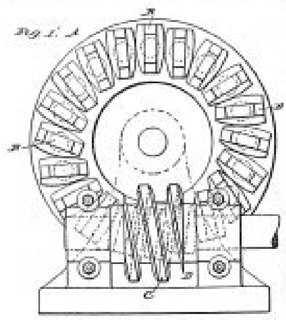
end of its slideway in the machine frame, also to cushion the stroke of the pick. The wheels upon which the machine is mounted, run on stout studs projecting from flat blocks which are arranged to slide in dovetail grooves running horizontally in the sides of the main frame so that they can be shifted forward or back to properly balance the machine.

WORM GEARING.

No. **456,796.** MATTHEW P. CAMPBELL, GLASGOW, SCOTLAND. *Patented July 28, 1891.* The object of this invention is to provide worm gearing suitable for transmitting great strains, and which will mesh properly with worms of different pitches of thread.

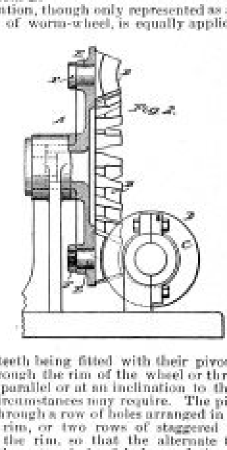
Figure 1 is a face view of the improvement; and Fig. 2 is a side elevation, the parts being in section.

The gear wheel A is provided on its face with teeth B, adapted to mesh into the thread C of the worm D. The teeth B are each provided with a pivot-pin E, fitted to turn in the wheel A, and retained in place by a collar or nut F. Each tooth B is free to oscillate on its pivot-pin E, so that while the pitch or actual distance from center to center of the teeth remains constant, the teeth adapt themselves by swiveling on their pivots to the inclination of the thread of



the screw or worm D with which they gear. The swiveling teeth B are, by preference, enlarged or formed with shoulders, near their roots, bearing against each other, as is shown, so as to distribute the strain throughout the series of cogs or teeth B.

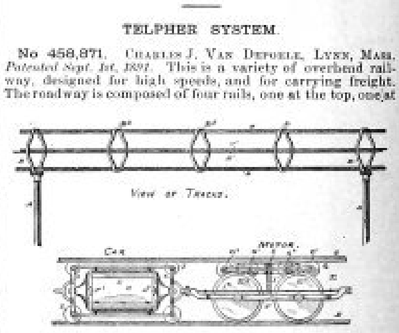
The invention, though only represented as applied to the bevel form of worm-wheel, is equally applicable to other



forms, the teeth being fitted with their pivot-pins passing radially through the rim of the wheel or through the side of the rim parallel or at an inclination to the axis of the wheel, as circumstances may require. The pivot-pins may be passed through a row of holes arranged in a circle round the wheel rim, or two rows of staggered holes may be formed in the rim, so that the alternate teeth may be pivoted in the outer circle of holes, and the others in the inner circle.

TELPHER SYSTEM.

No 458,871. CHARLES J. VAN DEPOELE, LYNN, MASS. *Patented Sept. 1st, 1891.* This is a variety of overhead railway, designed for high speeds, and for carrying freight. The roadway is composed of four rails, one at the top, one at



the bottom, and one at each side. The cars are thus enclosed so that they cannot leave the track at any speed. The rails are used to convey the driving current and also the return. The motors are constructed within the bodies of the driving wheels E^1 E^2 of the locomotive, and are of the kind which have no commutators. The car O is composed of a cylinder which is provided with suitable side doors, and is hung by spring connections to a frame R R. This frame has suitable wheels S which engage the top and bottom rails. Side rollers F^1 F^2 are provided to bear against the side rails and prevent oscillation. As the driving wheels of the locomotive cannot bear against both top and bottom rails at the same time, idler wheels G^1 G^2 are employed to make the contact with the top rail. It is desirable to make the locomotive as light as possible, and in order to get adhesion the wheels G^1 G^2 are drawn toward each other, thus forcing the driving wheels against the bottom rail. The force applied for this purpose is graduated in proportion to the drag or traction of the cars. The drawhead is attached to a rod I^2 which operates a lever I^1. This lever is connected to the axles of the wheels G^1 G^2 in such a manner that its movement draws them together and increases the pressure of the drivers on the rail. The train is stopped at stations by interrupting the circuit and so shutting off the power. As soon as the current is cut off—the brakes (not shown) which have been held off by suitable magnets, are thrown on by springs, and the train is quickly brought to a stop.

The Colliery Engineer.

AN ILLUSTRATED JOURNAL OF

Coal and Metal Mining and Kindred Interests.

VOL. XII.—NO. 6. SCRANTON, PA., JANUARY, 1892. WITH WHICH IS COMBINED THE MINING HERALD.

THE ECONOMIC GEOLOGY OF LEAD.

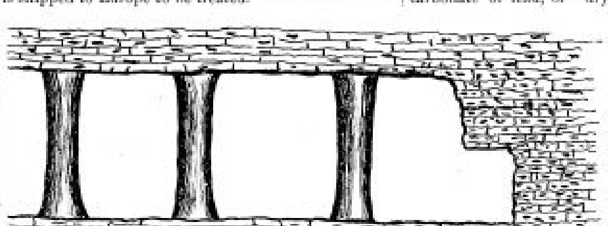
The Mineralogy, Mode of Occurrence, and Production of Lead.

BY H. A. WHEELER, E. M., OF ST. LOUIS.

The second, or South-Eastern Missouri group of lead mines, occur in limestone of lower Silurian age in South-Eastern and Central Missouri.

A series of nearly horizontal parallel beds of sandstone and limestone are found in that portion of the state which are all liable to carry at least small amounts of lead, but only two of the limestones have been found to carry it in paying amounts, and of these two, one produces nearly all of the large product from this district. The limestones are all dolomatized or have been more or less altered into magnesian limestone, which is especially true of the third limestone, which is the name applied to the richest ore, and in which the profitable mines are located. The lead occurs in the other or second magnesian limestone as "pipe veins," "gash veins," "floors," and caves, or similar to the Upper Mississippi region, though very often no zinc ore is found with the lead, while barite, or "heavy spar," is usually associated with the lead, and is sold for $1 to $3 a ton at the mine, according to its whiteness and freedom from iron-staining, to be used as an adulterant for white paint, paper, etc. The galena is often found in huge chunks and cubes of several hundred pounds weight in these gash-veins, and is seldom in small grains or in a fine condition, so that it is usually a very easy matter for the miner to dress his ore by the use of small picking hammers and hand dressing up to 80% lead. On account of the coarse condition of much of the galena, it gives rise to a peculiar local system of mining, known as "patch diggings," in which the miner hunts along the top of the decomposed lead-bearing limestone for the the loose chunks of mineral that have been set free by the weathering or decay of the encasing rock. For limestone is one of the least enduring rocks known, when exposed to atmospheric action, on account of its comparative easy solubility in surface waters; hence in the removal of the lime by atmospheric waters, the galena is left behind, together with the other insoluble impurities of the limestone, or a tough, sticky clay, known as "tallow" clay. In the winter season, when there is little to be done on a farm, it is a very common thing for the Missouri farmers to dig pits down through the clay, to the top of the solid, unweathered limestone, in search of the chunks of mineral, or galena, that may have thus been set free and hence in a condition almost clean enough for direct sale to the traveling ore-buyer. If lead is unusually high, the patch diggings are sometimes worked the entire year, while when low prices prevail, they are almost entirely neglected, though the total production from the patch diggings in a year is seldom large or important, as too frequently the farmers only make poor wages in carrying on this highly speculative hit or miss system of mining.

In the third magnesian limestone, the galena often occurs as finely disseminated granules and crystals in the limestone, which are usually more abundant along certain bedding or joint planes in the limestone. In this case the galena is never found in large masses, and is nearly always of quite low grade or the rock will assay, in paying ground, .5 to 20% in lead, though the usual average is between 6 and 10%. All the ore from this disseminated limestone requires concentration, before it can be smelted, and large mills have been erected in this district for crushing the ore by rolls and then concentrating it in jigs and on slime tables. Some iron pyrites occur with the galena, and at Mine la Matte a nickel cobalt bearing mineral called siegenite is found in sufficient quantities with the lead to annually furnish about $20,000 worth of cobalt nickel matte that is shipped to Europe to be treated.



SKETCH D.

SECTION OF THE ST. JOE MINE.—GALENA DISSEMINATED IN MAGNESIAN-LIMESTONE.

The largest producer in this region and in the Mississippi Valley is the St. Joseph Lead Co., at Bonne Terre, which produces about 12,000 tons annually, operating a narrow-gauge railroad over 50 miles long in carrying on its business, that has been built out of the profits, and which has been a dividend-paying mine for many years. At the St. Joe mine the lead-bearing limestone has been found to be over 400 feet thick, though the workings as yet do not exceed 200 feet in depth. The lead is found to follow certain quite and well-defined chutes or "runs" through the limestone, varying from 100 to 300 feet wide, and in working out a level or bench, 20 to 40 feet high, large round pillars of 15 to 25 feet in diameter are left to carry the overlying roof, which are spaced 30 to 60 feet apart, as shown in sketch D. These pillars are the only supports used in the mine, as the limestone is usually so solid as to give no trouble or require timbering.

Another mine in this district that produces about 3,500 tons annually, and which very much resembles the St. Joe is the Doe Run Mine, near Delassus. The lead-bearing limestone is here much thinner, and rests directly on the underlying archaean granite as shown by some of the workings of the mine, in which granite bosses have "come up and cut out the limestone," to use the miner's mode of expressing the trouble.

A famous historic mine in this South-Eastern district is Mine la Matte, which now produces about 3,000 tons of lead annually, and which has been more or less regularly worked since its discovery, in 1720, by la Matte in prospecting for silver.

The earlier workings were mostly superficial, and did not go below the water-level, and the curious blunder was made by the earlier miners of throwing away the carbonate of lead, or "dry bone," as they termed it, that was found at or near the surface. A shrewd miner, who subsequently observed this, quietly bought up the old dumps containing the "dry bone" before he announced that it was a valuable lead ore, and made a handsome profit with very little trouble, as the carbonate is the easiest ore of lead to smelt. The lead-bearing limestone is found to carry ore for a depth of 10′ to 150′ at this mine, and while the ore chutes are not so large or continuous as elsewhere in the district, they are usually richer or will run 10% to 20% in lead.

Recent explorations at Flat River in this South-Eastern district indicate that the output from the disseminated deposits is likely to continue to grow as it has done for the past 25 years, instead of diminishing, as has been the case of many of the other Mississippi districts, since the strong competition of the far Western lead has had to be contended with.

The South-Western Missouri lead region is much younger in age than the other Mississippi districts, as the lead is found in cherts and limestones of sub-carboniferous age or just under the true coal measures, and bitumen, as a product of the coals or bituminous shales that formerly overlaid (?) this region, is quite frequently found in association with the lead ores, while it is unknown in the others. The district includes not only the South-West corner of Missouri but also overlaps and extends into South-Eastern Kansas. The ore is found as irregular bodies in caverns in limestone and in highly brecciated or shattered chert filling the cracks and seams in the broken chert that occurs as "bars" or beds in the limestone, and the ore horizon has not yet been proved to be any deeper than 150 to 200 feet below the surface. The lead occurs as galena or the sulphide, though a little carbonate was found in the early workings, and is associated with large quantities of zinc blende and some iron pyrites. In the upper part of the ore formation the galena predominates, while the "jack" or zinc blende is in subordinate quantities, and was thrown away in the early history of the district, as was done elsewhere in the Mississippi Valley, under the impression that it was worthless; lower down the zinc decidedly predominates over the lead, and has given new life and greatly extended the area of production in this district, as now the miner finds that the zinc pays better than the lead, and only handles the lead as a by-product, while it has now become the heaviest zinc-producing region in this country, and hence a further description will be postponed until the occurrence of zinc is considered.

Other lead deposits occur throughout the Appalachian belt, as fissure veins, which have been worked in New England, Pennsylvania, New York, and elsewhere, but they have all failed to pay, as the veins are narrow and the ore chutes have thus far proved to be too small. The Wheatley Mine, in Pennsylvania, is well known for the beautiful specimens of quite a variety of the lead minerals that have been found in it, but as a lead producer it has not been a success.

In order to compare our production of lead with the large European producers, the following estimates are given from the *Engineering and Mining Journal* of January 3, 1891, for the year 1890:

United States	187,000 tons.
Spain	120,000 tons.
Germany	90,000 tons.
England	50,000 tons.
Belgium	30,000 tons.
Italy and Austria	20,000 tons.
France	12,000 tons.

Of the German output, 26,000 tons was the product from one concern, the Mechernich Co., which works the lowest grade lead ore, at a profit, of any concern in the world, or a heavy bed of galena-bearing sandstone, in Western Germany, that carries about 3 to 4% of lead. Mexico, South America, and Japan are small producers of lead that are not considered in the above figures, but, excepting the former country, their output is of little importance in the lead world. Mexico sent nearly 30,000 tons into this country, in 1888, as smelting ore, but our new tariff has nearly stopped this importation, and what is now produced there is smelted at home and the metal shipped to England for a market. But there is no doubt that under favorable conditions the Sierra Mohada and other lead-producing mining camps in Mexico could produce quite heavily, and what their maximum capacity amounts to has still to be determined.

A NEW COAL CUTTING MACHINE.

The undercutting of coal by machinery is an important problem for the mining fraternity. The undercut may be made by hand, but this method not only adds largely to the expense of mining coal, but also makes a large quantity of fine coal or slack, which is comparatively a waste product except in certain cases. A successful machine not only cheapens production, but also increases output, insures the mining company in a large measure from delays and shutdowns incident to strikes of ordinary miners, and simplifies mine management. There are several types of machines on the market and in actual operation, but the one herewith illustrated works in an entirely different line from other machines.

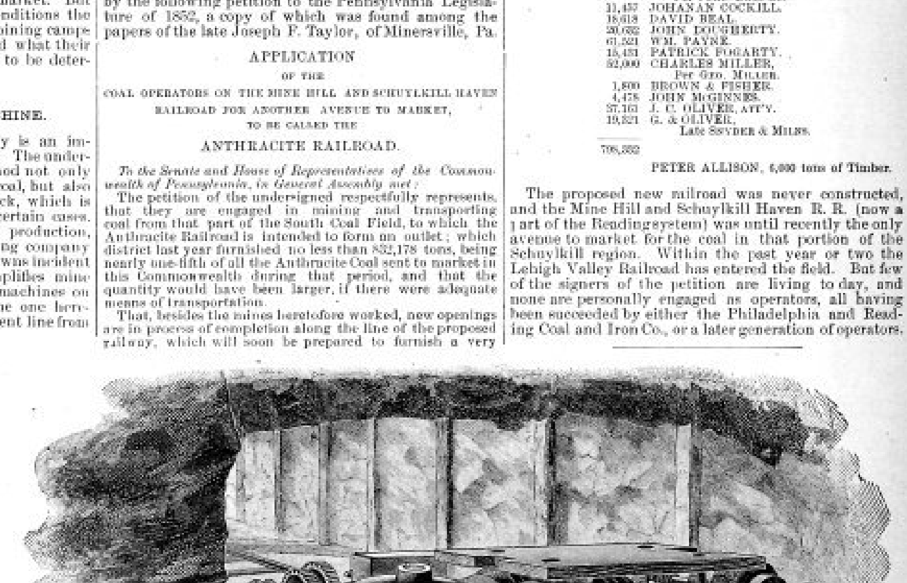
The new Arc Machine consists of the following parts: A heavy iron base cast in one piece, carrying two pairs of axles, one at right angles with the other, the parts serve as a foundation for all. The gauge of one pair of axles is fixed to suit the regular track gauge of the mine wherein the cutter is to work and these axles carry small flanged wheels upon which the cutter is easily moved about the mine and in and out of the rooms. The second pair of axles carry small wheels for supporting the cutter when in actual operation and carrying it along the face of the wall being cut. They are not flanged but are kept upon the track by two pairs of single and two pairs of double guides, as shown in the illustration. The support of the machine is easily changed from one pair of axles to the other by means of a cam worked by screws, the larger flanged wheels being raised out of the way when the cutter is in actual operation, as shown in the illustration.

The motive power is furnished by a 15 H. P. motor, which in the latest machines is somewhat changed from that shown, the motor being perfectly water tight and thoroughly protected from all danger of mechanical injury. The armature shaft carries a bevelled pinion at each end. That nearest the commutator is made to engage by means of a controlling lever, either one of the two bevelled gears shown in the illustration, thereby giving the shaft on the right a right-handed or left-handed rotation. By means of the chain of gears and an ingenious mechanical device, this shaft operates the feed chain at practically any desired speed. The feed chain is made fast to a post ahead of the machine, and in this way the cutter is drawn forward at a speed under control of the operator, and which can be varied with the hardness of the coal. The same gearing, by means of another controlling lever is made to move the arm from a position alongside the machine at the beginning of the cut to the position shown in the illustration, where it is held rigidly during the remainder of the cut. The second pinion on the armature shaft operates the endless chain carrying the cutting knives about the arm. The controlling devices are such that the cutter may be held stationary while the knives are in operation, an important point in cutting through particularly hard formations. The length of the arm carrying the endless chain is made to suit the requirements of the mine in which it is to operate, the undercut usually being made of a depth equal to the thickness of the vein.

The length of the arm is adjustable within certain limits in order to take up the stretching of the chain due to wear. The chain and knives are drop-forged and of a strength to withstand the hardest usage. The knives are easily detachable from the chain so that a new set of sharp knives may be substituted for the old set in a very short time. The track along the face of the work consists simply of two rails with an iron cross tie, and may be laid and removed in a very short time and with a small amount of labor. By the use of this track and this type of machine necessity for moving a heavy piece of apparatus by hand, oftentimes in a very low room, is avoided, a very important point as anyone who has had experience in these matters can testify. For its operation the cutter requires two men, one of whom is at the machine itself controlling the rheostat and operating devices, and the other keeps the track laid ahead and sets the posts for anchoring the feed chain. All trouble with the slack clogging up the cut is obviated as the knives themselves bring nearly all the slack outside the cut, leaving a clean space.

The machine is thus seen to possess very important advantages in all kinds of working, and for large rooms or a Longwall system these advantages become all the more prominent. It is operated on a 220 volt circuit, making it entirely harmless electrically.

The New Arc Cutter is handled by the Thomson-Van Depoele Electric Mining Co., 620 Atlantic Avenue, Boston, Mass., to whom should be addressed all inquiries regarding it.



ANTHRACITE OPERATORS VS. RAILROAD COMPANIES.

That transportation companies and individual operators of forty years ago had their disputes regarding rates of toll, etc., the same as they have to-day, is evidenced by the following petition to the Pennsylvania Legislature of 1852, a copy of which was found among the papers of the late Joseph F. Taylor, of Minersville, Pa.

APPLICATION

OF THE

COAL OPERATORS ON THE MINE HILL AND SCHUYLKILL HAVEN RAILROAD FOR ANOTHER AVENUE TO MARKET,

TO BE CALLED THE

ANTHRACITE RAILROAD.

To the Senate and House of Representatives of the Commonwealth of Pennsylvania, in General Assembly met:

The petition of the undersigned respectfully represents, that they are engaged in mining and transporting coal from that part of the South Coal Field, to which the Anthracite Railroad is intended to form an outlet; which district last year furnished no less than 832,178 tons, being nearly one-fifth of all the Anthracite Coal sent to market in this Commonwealth during that period, and that the quantity would have been larger, if there were adequate means of transportation.

That, besides the mines heretofore worked, new openings are in process of completion along the line of the proposed railway, which will soon be prepared to furnish a very large additional quantity towards meeting the greatly increasing public demands. Also, that owners of lands and others interested in the Second Coal Field, contemplate sending large quantities from that region over the extension of the Mine Hill and Schuylkill Haven Railroad, authorized to be constructed by a recent Act of the Legislature.

That the supply of coal from all of these sources finding its way to market by the valley of the West Branch of the Schuylkill, at the average rate of geometrically increasing consumption of this important fuel, must soon double the present quantity, and will render necessary all the facilities of transport which existing and projected lines of railways can furnish.

Your petitioners would further represent that the Anthracite Coal trade has now become so important an element of the prosperity of this great Commonwealth, that power to control, direct, or limit its extent, should not be granted to any corporation, nor should the fancied claims to "vested rights," set forth by existing lines of transit, be permitted to interfere with, or check its full development.

And that it is in accordance with the progressive spirit of the times, to extend similar legislative rights, to all parties desirous of making investments in improvements calculated to promote the public prosperity; as thereby oppressive monopolies are prevented, and the vast natural resources of the State called into greater activity.

Your petitioners allege, that their operations are now controlled by a corporation, which not only claims the exclusive and perpetual right to transport their products to market, but which has evaded, and continues to evade, the necessity of, and legislative right to, a reduction of charges imposed by its Act of incorporation, and by numerous supplements authorizing an increase of capital, which has now grown from the original $100,000 to $1,300,000; upon all of which your petitioners are liable to be taxed to the extent of 15 per cent. per annum; in consequence of which, they are at present compelled to pay about $80,000 more than would be charged them upon the new railroad applied for on the same quantity.

Your petitioners, (who of the total 832,178 tons, furnished in 1851, supplied 718,332 tons.) therefore ask your honorable bodies to extend to them the right to construct a road for the transport of their products to market, and pray for the passage of an Act to Incorporate the Anthracite Railroad.

And they will ever pray, etc.

117,973	M. G. & P. HEILNER.
31,822	RICHARD KEAR.
43,270	DAVID GLOVER.
33,785	F. MACDONALD.
72,989	RICHARD HECKSCHER.
21,825	DOLBIN & ROGERS.
18,097	WM. & CHAS. BRITTAIN.
	MORGAN & EDWARDS.
1,200	M. GOTTLEIB HEILNER.
1,000	JOHN R. DAVIS.
7,856	JONES & STROUB.
2,714	JOHN ODGERS.
28,745	JACOB SERRILL.
	R. BERRYMAN.
13,501	LEWIS C. DOUGHERTY.
9,478	J. F. TAYLOR, Per D. E. Nice.
2,818	R. HOLMAN & CO.
2,417	MORGAN BRACE, Per J. F. T.
70,329	G. BAST & CO.
40,500	ADAMS & MILLER.
24,078	JOHN R. McCREARY, Per John Hipple.
11,012	HENRY ECKLE & ECKLE & SON, Per John Barnet.
11,457	JOHANAN COCKILL.
18,618	DAVID BEAL.
20,032	JOHN DOUGHERTY.
61,521	WM. PAYNE.
15,431	PATRICK FOGARTY.
52,000	CHARLES MILLER, Per Geo. Miller.
1,800	BROWN & FISHER.
4,478	JOHN McGINNES.
37,161	J. C. OLIVER, Att'y.
19,821	G. & OLIVER, Late Snyder & Miles.
708,332	

PETER ALLISON, 6,000 tons of Timber.

The proposed new railroad was never constructed, and the Mine Hill and Schuylkill Haven R. R. (now a part of the Reading system) was until recently the only avenue to market for the coal in that portion of the Schuylkill region. Within the past year or two the Lehigh Valley Railroad has entered the field. But few of the signers of the petition are living to-day, and none are personally engaged as operators, all having been succeeded by either the Philadelphia and Reading Coal and Iron Co., or a later generation of operators.

Mr. H. A. Kingsbury, dealer in mine supplies, has in his window at 435 Spruce Street, in this city, a photograph of one of the longest wire ropes manufactured in this country. The length of the rope is 34,500 feet, or a little over six and a half miles, and the whole rope, which is 1¼ inch in diameter, weighs 93,845 lbs. As it stands on the car wound upon a reel, the diameter of the roll is over 14 feet. Mr. Kingsbury is agent for John A. Roebling's Sons & Co., of Trenton, who are the manufacturers, and is prepared to give estimates for any of their goods.

HISTORICAL SKETCH OF COAL MINES AND MINING OPERATIONS IN ALLEGHENY CO., PA.

BY SELWYN M. TAYLOR, M. E.

[In Reports of Inspectors of Mines of Pennsylvania for 1890].

That portion of Allegheny County lying south of the Ohio and Allegheny Rivers is practically one coal field of the Pittsburgh bed.

That part of the county lying north of the rivers is too low, or rather the rise of the measures to the north has carried the coal out of the hills.

That part of the county, however, as well as the southern part, is solidly underlaid by the "Freeport bed," which, on the failure of the gas supply, may become an important feature of the coal production of the county in the near future.

That part of Allegheny County between the Allegheny River on the north and the Monongahela and Youghiogheny Rivers on the South and East, originally had a coal area equal to about one-fourth of its entire extent, the larger part of which has been mined. This field, or portion of the field, consisted principally of small bodies of coal lying high in the hills with an overlying strata seldom more than one hundred feet in thickness and averaging perhaps sixty feet. A number of these detached bodies lay in what is now the city of Pittsburgh, those in the city limits, however, are nearly all exhausted.

The principal operations in the field north of the Pennsylvania Railroad have been those of the New York and Cleveland Gas Coal Company. The territory through which its operations extend has been quite a large one, and the systematic manner in which its coal has been mined has been remarkable as compared with other operations under similar conditions. That part of this field lying between the Pennsylvania Railroad on the north and the Monongahela River on the South, was quite a small one, and has been practically all mined out by two companies; W. H. Brown & Co., from the river front, and one mine on the Pennsylvania railroad, near Wilmerding station.

That part of Allegheny County south of the Ohio River and north of the Pittsburgh, Cincinnati, Chicago, and St. Louis Railroad has from one third to one-half of its area underlaid with the Pittsburgh coal bed.

The principal operations in this field are from the Montour's Run Railroad mines, and two or three mines on the Pittsburgh, Cincinnati, Chicago, and St. Louis Railroad. This coal also lies high in the hills with light overlying strata, this is practically yet a solid field, the coal that has heretofore been mined comprising but a small portion of the whole.

That part of the county lying between the Monongahela and Youghiogheny Rivers was almost entirely underlaid with coal, about one-third of which has been mined. This field generally lies from one hundred to two hundred feet above the river, but the hills rising abruptly back from the river has given it a thick overlying strata. This field is at present the seat of the principal operations of W. H. Brown's Sons, Horner & Roberts, and a number of small operators shipping their coal by river, and of W. L. Scott, who ships by rail.

This field has been, and will probably continue to be, one of the most valuable in the district owing to its natural advantages both for mining and shipping of coal.

The remaining part of the county lying south of the Monongahela River and P., C., C. & St. L. Railroad, which comprises one-half of the county, is underlaid with the Pittsburgh bed of coal, substantially throughout its entire area, with outcroppings on river and railroad of nearly one hundred miles. This field has its outcrop always at a sufficient height above the river and railroad to make it convenient for operating.

The mining and shipping of coal has always been divided into two methods—that of shipping by rail, and that by river, but the river operations are by far the elder, as they date back some sixty or seventy years.

The mines on the river are classed in what is known as "First," "Second," and "Third" pools—that is, all lying below Lock No. 2 on the Monongahela River are in the First pool, and those above, and on that part of the Youghiogheny that is navigable, as the Second pool, and all lying between Locks Nos. 3 and 4, the Third pool. The front hills, as they are usually termed, meaning those adjacent to the river, are very high and bluff; the coal outcropping near the tops of them. In these hills the first mining operations were conducted, and, indeed, it is only within the present decade that the operations have been extended into the second range of hills.

Mines in the first pool now in operation are those of Keeling, Walton, Castle Shannon, Hay's Estate, Rishers, and Munhall's. Nearly all of these mines are old ones, and their operations are being conducted at from two to four miles from the river front, the coal being hauled either by locomotive or wire rope. These mines still have large and almost unlimited field of coal back of them, and they will be enabled to continue in operation for many years to come.

The mines in the second pool on the west side of the Monongahela River have not nearly the quantity of coal back of them that those in the first pool have; many of them are already worked out, their field of coal being cut off by the "creek outcroppings," a short distance back from the river.

The mines which are known as railroad mines are mostly located on the P., C., C. & St. L. R. R., several are on the Wheeling division of the B. & O. R. R., the New York and Cleveland Coal Company's on the Allegheny Valley, Pennsylvania and Montour Run Railroads, and W. L. Scott's mines on the P., McK. & Y. and the P., C. & Y. R. R.'s. Nearly all of these mines, with the exception of those located on the P. R. R., and Allegheny Valley Railroads have an unlimited coal area to draw from.

Of the early mining operations in Allegheny County but little of good can be said as, the coal lies high in the hills with outcroppings on every side, natural drainage was almost always to be had, and the coal having to be hauled but a very short distance to the pit mouth, the need for scientific or economical mining was not felt. The sale of the coal always yielded a large profit, no matter how much it cost to mine it. During these early operations, disputes between the operator and miner in regard to the wages to be paid were constantly occurring, but there was seldom any effort made to economize in any other direction.

The mines were all worked on the single-entry system, and usually with only a single main entry, and air-courses were even driven as far apart as possible, three or four hundred yards sometimes intervening between them. No care was taken in the driving of rooms as to the width of the room or the thickness of the pillar.

Entries were seldom driven straight and the entry pillars were left as small as possible. No one ever dreamed of making a "cut-through" from one room to another, and ventilation in ninety per cent. of the mines was "natural" exclusively.

The supply of timber to the miner was limited, through a false notion of economy, in consequence of which, large bodies of coal were lost in almost every mine, for the loss of five or ten acres of coal that perhaps had cost the operator, when developed, from six to eight hundred dollars per acre, did not trouble the superintendent or pit boss at all, and rather than put in a pump or a limestone drain, ten or fifteen acres of coal would be abandoned forever, and the advice of a mining engineer was seldom asked, for the certainty that if the entries were driven far enough they would come to daylight was deemed sufficient.

Fire-damp was seldom met with and never in dangerous quantities, and if occasionally the mine boss would decide to drive an entry to hit a certain point or an air course sometimes he would do it by "sound," (mostly bad) guessing, and sometimes he would call in a surveyor.

Occasionally an operator, curious to know how much coal he had remaining unmined, would employ a surveyor and have a map made, and such a map! Often the entries only would be shown and sometimes the rooms would be indicated by a straight dotted line at right angles with the entry with the distances indicated in rods; and the mining out of other people's coal was the rule rather than the exception, for sometimes the coal from an entire tract would be taken without the owner's knowledge or consent.

Accidents were frequent, not from machinery or explosive gas, but from falls of coal, etc., and from narrow entries.

No business could have been more chaotic than that of mining coal in Allegheny County fifteen years ago. The average output of the mines of the district was probably about five thousand bushels a day for each mine, or about two hundred tons. There were required from thirty to fifty cents per ton for expenses, outside of that for mining, and yet the margin was large enough to make the business immensely profitable.

It would be difficult to trace each step that has been taken towards improvement, but the greatest of them probably dates from the taking effect of the Bituminous mine act of 1885, the operators being compelled by the provisions of that act to introduce some sort of ventilation into their mines, following this, the increased product consequent upon numbers of new mines being opened and the increased competition where before there had been none, tended to set the operators to thinking how their coal could be handled more economically outside of the cost of the actual mining, and wire rope haulage was rapidly introduced until now few mines that have been worked for many years are operated without it.

The "double-entry" system came next, and what a hard task it was to persuade the operators and mine bosses that it was not going to be twice as expensive as the old single-entry air course system was, without any advantages over it, but it was accomplished, and is now in almost universal use. Next came "fan ventilation," and the scrupulous mining of every ton of coal that was contained in an acre.

It was the prevailing idea among coal men, that the average quantity of merchantable lump coal to the acre was 80,000 bushels. The writer well remembers an occasion when a number of reputable operators and superintendents testified that not more than 90,000 bushels to the acre could be taken out, which was very probably true at that time, but now in our best mines the yield per acre is from 110,000 to 116,000 bushels, and in some cases as great as 120,000 bushels of lump coal over an inch and a half screen. In one year's work, in a large mine, the writer estimated that not more than one per cent. of coal remained unmined, a result hardly obtainable in any other vein of coal in the world.

The mining act of 1885 was certainly a great benefit to the operator as well as to the miner, as it started the weeding out of the old and ignorant class that had ruled the mines for so many years; how much the operator of this district left to the mine boss, for the operator seldom having any knowledge of practical mining himself, he felt that the mine boss who had been in his employ for so many years, and had never yet failed to get out the few thousands of bushels of coal that was expected to be produced, knew all about it and must be, of course, a first-class mining man, no matter how grossly ignorant he seemed to be, but the "certified mine boss system" has to a certain extent done away with this class and it has also led to reading, study, and inquiry by many of the miners who aspire to the position of mine boss or fire-boss and consequently to the general promulgation of mining information amongst the miners and others connected with the mining of coal.

The present condition of the mines and mining in Allegheny County may be summed up as follows:

First. As to their sanitary condition, fifteen years ago, perhaps 80 per cent of them were very poorly ventilated, now 80 per cent. are well ventilated and the drainage has also been greatly improved, and the Allegheny County mines, as regards the health and safety of the miners, are above the average.

The principal cause of accidents is from falls of roof, no marked decrease in such accidents is apparent; this is a matter which now lies almost entirely with the miner himself, for the operator furnishes him with an unlimited supply of timber, but he does not use it.

Second. As to the production of coal in large quantities by the mines, there are at present about eighty mines in the county shipping coal either by river or rail, of these about half have wire rope haulage plants in operation, and coal is being produced and hauled in some cases several miles underground at from five to twenty-five cents per ton, exclusive of the price of mining, and it is often produced the cheapest where the longest haul is necessary, and haulage has been reduced to a minimum in probably fifty per cent. of the mines, in many of the mines in the county, however, it is crude and expensive.

Third. Improvements in the mining of coal. While the system of entries has been exchanged from the single to the double, yet the old system of room and pillar which has always been in use in this district has undergone no change, nor has anyone attempted to make what might be called an improvement on it; the rooms are usually twenty-one feet wide and ribs twelve or thirteen feet thick, the coal is all taken out, but what a fortune in timber is buried each year in our mines! Occasionally some person who has a mine in leased coal and has no conscience as to the quantity of coal that is destroyed, tries driving rooms with the road in the center, "gobbing" both sides and burying the rib, this is not often done however.

No reliable experiment has ever been tried, to the writer's knowledge, to operate by any of the systems of Longwall, or to introduce any system which would economize in the timber supplies that are now wasted.

While the improvements noted have been the rule, yet there are quite a number of operators who are living and endeavoring to grow rich under the old order of things, and they will only reform when the heavy hand of the law compels them to use first-class appliances which will necessarily call for the employment of first-class men.

ENGINEERING ASSOCIATION OF THE SOUTH.

The regular December meeting of the Engineering Association of the South was held at the new headquarters of the Association in the Cumberland Publishing House, Nashville, Tenn., on the evening of December 10th. In the absence of the President and both Vice-Presidents, Mr. Hunter McDonald of Atlanta, Ga., engineer in charge of the Western and Atlantic R. R., presided with about thirty members and visitors present.

Applications for membership in the Association were received from Mr. William Hewitt, Engineer and Vice-President of the Trenton Iron Company, Trenton, N. J., and Mr. J. S. Walker, U. S. Assistant Engineer in charge of construction of locks on the Cumberland River Improvement. The Secretary presented the specifications governing the competition for the cash prize of $1,000 offered by the Board of Public Works of Duluth, Minn., for the best plans for a drawbridge across the ship canal at that place.

Mr. Olin H. Landreth brought before the Association for consideration, the question of instituting under the auspices of the Association a competitive trial of machinery used in highway building such as graders, ditchers, surfacers, rock crushers, steam and horse-rollers, etc. After an extended discussion by Messrs. E. C. Lewis Hunter McDonald and W. H. Lyle, which in the main was favorable to the enterprise, a committee was appointed by the Chair to investigate and report at the next regular meeting the feasibility of instituting the competitive trial proposed. Messrs. Olin H. Landreth, W. G. Kirkpatrick, and J. A. Fairleigh comprised the Committee.

The paper of the evening entitled "Refrigerating Systems" was then presented by Dr. Wm. L. Dudley, of Vanderbilt University, Nashville, Tenn. The paper comprised an historical account of the development of refrigerating methods, and after classifying the several processes under the head of "absorption" and "evaporating" systems, proceeded to develop a comparative exhibit of the chemical and mechanical results obtained by each process. The paper was illustrated by diagrams showing the working of the different systems as well as lithographs and photographs of modern machinery, as now built. In the discussion which followed Mr. W. G. Kirkpatrick suggested that the cooling effect of expansion of compressed air might be utilized both to cool and aerate the water of cisterns in summer by a portable air compressing apparatus with coils for cooling the compressed air. In many sections of the South roof water preserved in underground cisterns is the chief dependence for domestic supply, and the proposed method of cooling and aerating and thus rendering the conditions unfavorable for development of disagreeable taste and odor was referred to, the low thermal conductivity of the soil surrounding cisterns is a favorable circumstance to the permanence of the effect of such cooling.

The new headquarters of the Association occupied for the first time at this meeting, are in one of the most desirable portions of the business quarters of the city. The principal room is 43x23 ft., with excellent illumination, and has been neatly fitted up at the expense of the local members. Already a large list of exchanges have been received and an order is now out for a full list of all the leading technical journals. Non-resident members and other Engineers visiting Nashville are cordially invited to visit the rooms and make them their headquarters while in the city. Stationary and draughting accommodations will be found here for the benefit of the membership and guests.

THE PROGRESS IN MINING.

Reviews of Important Papers Relating to Mining in the Proceedings of the Mining and Scientific Societies, and in the Mining Journals of Europe, United States, and Canada.

Improvements in Drawing and Loading Coke. Mr. C. M. Percy, of Wigan, England, whose name is familiar to our readers as an authority on the mechanical engineering of collieries, has lately described an apparatus for drawing and loading coke which he considers of great importance. The patent, which is the property of Messrs. Chambers and Smith, is fitted up at the works of Newton Chambers & Co., Ltd., Thornecliffe, Sheffield.

It consists of a small vertical steam engine and boiler erected on wheels and capable of being run along the full length of a row of ovens. Connected with the engine by pinion gearing is a long rod running on rollers. At the end of this rod is a flat plate like a shovel with which to extract the coke. The rollers on which the rod runs are alterable by hand gearing, so that the shovel may be directed at any horizontal angle to reach all parts of the oven without the use of rakes. The apparatus can be adapted to any class of oven. Along the mouths of the ovens is a traveling belt to receive the coke, whence it is conveyed to an elevator which raises it to a suitable height where the coke is put down by the elevator buckets on to a vibrating screen.

By this patent a Beehive oven containing three tons of coke can be drawn in eight minutes, and in the erection described by Mr. Percy one machine is now actually drawing twenty-five ovens per day. In consequence of this saving of time 20 per cent. more coke can be produced by each oven, and, owing to the small time occupied in the drawing, the cost of repair from excessive expansion and contraction of the ovens is reduced.

In a block of fifty Beehive ovens, thus fitted up, the entire cost of coking, including charging, drawing, and loading, and repairs to ovens and machinery, does not exceed twelve cents per ton.

Accidents from Blasting in Collieries. Mr. James Ashworth, M. E., in a paper recently read before the Manchester (Eng.) Geological Society, points out that where a two-inch diameter hole had been used while blasting with powder the same size of hole was still continued for high explosives, and hence instead of occupying eight or more inches of the length of the hole the high explosive occupied only from one to two inches, and the pressure exerted was as great or even greater on the tamping as on the sides of the hole where the power was required and he suggested that high explosives should be put in a hole with a diameter proportionate to their strength as compared with blasting powder, because seven inches of tamping in a one inch diameter hole is as effective as eighteen inches in a two inch hole.

Mr. Ashworth also stated that the worst disasters from blasting had occurred where the shots faced the ventilating current, a detonating vibration apparently ensuing, whereas, if the force of the shot went with the air no such effect was produced.

Greenwell's Patent Screen for Sorting Coal. This consists of a series of parallel short-linked endless chains, driven by engine power, and working between fixed bars of a particular section and of various widths. The coal is tipped on to the screen, and is carried forward by the chains, which travel at a slow speed, and as it passes forward, the dirt and stones are picked out by boys stationed at intervals on each side receive it. It will be at once seen that the screen may be erected of any length and with any num-

FIG. 2.—Section on B B Nuts.

ber of sections, and that by putting a sufficient number of small guiding pulleys to keep the chains steady, the coal may be very accurately sorted into as

FIG. 3.—Section on C C Cobbles.

many different sizes as required. The accompanying plan, elevation, and sections will explain the method. The chains travel at a speed of seventy-three feet an hour, they pass 100 tons of coal per hour at a cost of half a cent per ton, and the cost of erection for each screen is $500.00.

Centrifugal Ventilators. Mr. E. Van A. Norris, of Wilkes-Barre, Pa., read an interesting paper on the above subject at the Glen Summit meeting of the American Institute of Mining Engineers. Mr. Norris treated the subject in a very exhaustive manner, and while the mathematical details of the paper may not be of great interest to the majority of our readers his deductions are interesting as showing how little attention is paid here to obtain reliable data of the work done by fans. There were twenty-five fans in all with which tests were made, and unfortunately, as the author states, "the detailed results of each test show a mass of contradictions from which it is exceedingly difficult to draw any satisfactory conclusions."

The influence of the mine on the fan is so varied in the various tests as to indicate that to obtain any practical comparative results on this point would require that each type of fan should be tried under the same conditions.

The influence of the diameter of the fan on its capacity seems to be *nil*; a large fan having the advantage of requiring a lower speed. The increase of width of a fan seems to increase the quantity exhausted.

The curve and shape of the blades of a fan does not seem to have any influence on the efficiency of the fan. The shape of the spiral casing is important, and results of tests indicate that the best shape of spiral casing would be one so constructed that the air between each pair of blades could discharge freely into the space between the fan and casing the whole being swept along into the *evasee* chimney in a gradually decreasing proportional speed.

The regulating shutter has advantages in that it can be made to suit the varying speed of the fan. Pieces of paper dropped into the *evasee* chimney of a fan have been known to be sucked down and after having made a revolution with the blades to be expelled. Such is not the case when the regulating shutter is applied.

In concluding what is undoubtedly an interesting and instructive paper, Mr. Norris suggests that variations in the methods of taking the observations of the water-gauge and the measurements of air prevent the possibility of obtaining unvarying results, and he trusts that his paper may awaken interest in a somewhat neglected subject. The efficiency obtained in his series of tests varies from 23 to 91·5 per cent., and it would be interesting to compare this percentage with some well conducted experiments upon such a fan as the Waddle, which is so commonly used in England.

Method of Mining the Iron Ores of Danville, Pennsylvania. The ores of this district are of two distinct sorts. (1). The fossil ore, which is simply a fossil limestone impregnated with iron. (2). The sandstone, or block ore, which is a sandstone impregnated with iron. The first named is divided into three splits by partings of sand-slate.

The section is as follows:

SLATE TOP.

Upper Split	5 to 6 inches.
Sandstone Parting	6 to 8 inches.
Buncombe Split	15 to 20 inches.
Sand Slate	10 to 12 inches.
Bottom Split	5 inches.

SLATE BOTTOM.

The block ore ranges from eighteen to twenty-four inches thick with a roof and bottom of sandstone.

The system of mining is the Longwall method. Gangways are driven level, 90 feet apart, each gangway being always a little ahead of that above, or to the rise of it.

These gangways are 7 to 10 feet wide and 5½ to 7 feet high. The working face is generally at an angle of 45° from the line of gangway, and to obtain height in the gangway and to facilitate loading from the chutes the bottom rock is blown up so that the chute enters the gangway next the roof. The chutes are about twenty feet apart, and as all the ore is taken out by the working, as it proceeds, the chutes are maintained by a rock pack on each side.

When first driven, the gangway is timbered on the upper side, but, as settling takes place, this timber requires to be withdrawn and the roof ripped down to maintain height. The props in the gangway are placed two to six feet apart, dependent on the nature of the roof. The length of each working face is twenty-four feet, and is worked by one miner and one laborer, or two miners will combine and work two breasts.

The cost of mining including all expenses to the delivery of the ore at the stock house is $1.37 per ton.

An Improved Mechanical Coal-Getter. Mr. E. Mould, of Whitebarn Colliery, England, recently read a paper descriptive of this machine, (Fig. 4), of which he is the inventor, before the Colliery Managers' Association. It is composed of four distinct parts.

(1). The head.
(2). The cylinder.
(3). The mandrel.
(4). The piston rod, side pieces, and pump handle.

The last named are the only loose parts there are. The "head" contains the pump, and in part, answers the purpose of a reservoir. The cylinder is simply a round parallel barrel, screw-threaded at each end, and is connected to the head at the top end and to the mandrel at the bottom end. This cylinder is covered by a shell cylinder, leaving a cavity between the two. The inner cylinder is perforated on the sides at the bottom end, to allow the water to pass from the under side of the piston, while it is being forced into the cylinder on the top side of the piston by means of the pump, thus supplying the pump during the operation of breaking loose the material in which it has been placed. It has been already said that the inner cylinder was screw-threaded at each end. While it is being screwed together, the outer shell is drawn on to faced joints at both top and bottom ends, and is so made water-tight, and becomes a portion of the reservoir for water.

There is, therefore, ample provision in the head, the cylinder, and the cavity to avoid the necessity of continually refilling with water, which may be more or less unclean.

The mandrel is screwed into the bottom end of the cylinder, and so becomes a permanent joint. The mandrel is also provided with recesses, constituting incline planes. In these incline planes are placed side pieces or wedges, thus making the mandrel cylindrical in form, in which condition it is placed in the hole prepared for it.

There is also a piston-rod. This rod passes from the piston in the cylinder through the mandrel, and on the bottom end there is placed a collaring, so as to enlarge the bearing, because this becomes the base of pressure.

It is very important that the machine should go quite to the far end of the hole (and to ensure this the drill should always be one-eighth of an inch larger in diameter than the machine). Now, supposing the machine is in the hole, and quite at the far end, the moment pumping is commenced, the piston-rod, being at the end of the hole, cannot go forward; therefore the machine moves outward, and the friction on the sides of the hole being greater than that of the incline planes, the side pieces become fixed, and the machine moving outward produces lateral pressure by means of the incline planes, thus forcing asunder the material in much larger blocks than when exposed to the shattering influence

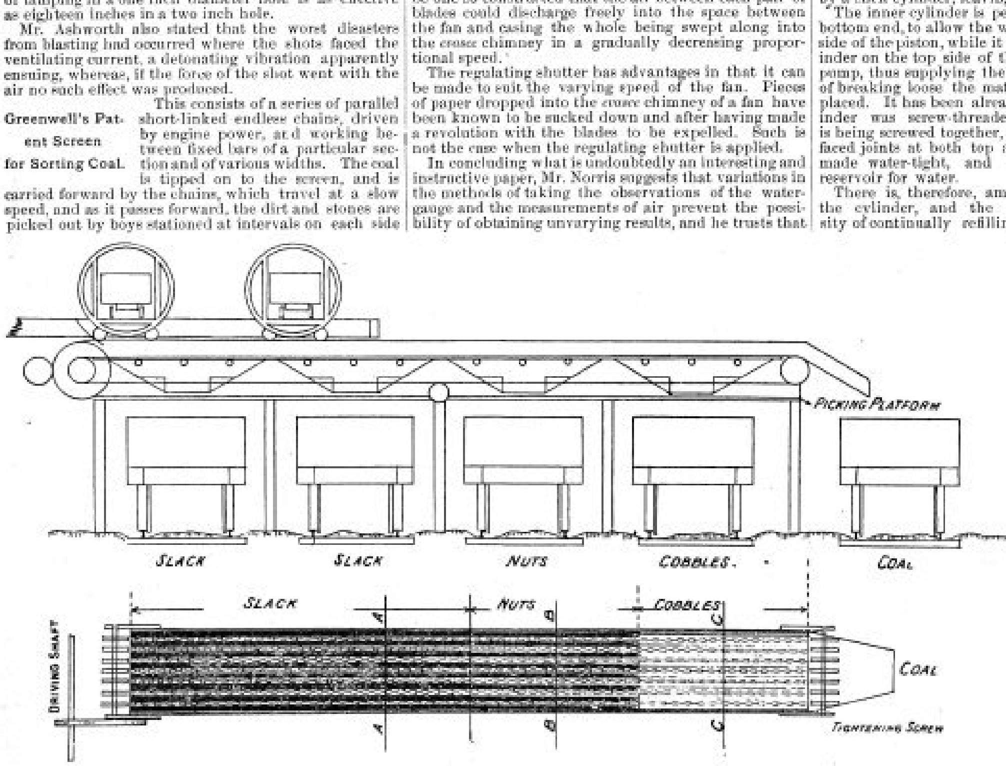


FIG. 1.—PLAN AND ELEVATION OF GREENWELL'S PATENT SCREEN.

and the various sizes of small coal drop through between the chains and bars into wagons placed below; the smallest size passing through in the first length, and the larger sizes in the succeeding lengths, until at the end of the screen the large coal is delivered, free from small and dirt, into the wagons placed ready to of an explosive, securing better results, and at the same time avoiding all the evils contingent on the use of explosives.

This machine has been severely tested and the following merits are claimed for it:

(1). Efficiency.
(2). Portability.
(3). Economy.
(4). Simplicity.

It weighs only 60 lbs. when charged with water, the same water may be used over and over again so that the whole pump is very intact. This is accomplished by means of a screw. When the operation of wedging down a body of coal is completed, by turning this screw

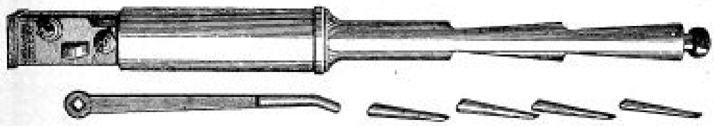


FIG. 4.

the water returns to the under side of the piston, and by tightening the screw again the operation may be repeated indefinitely. The first cost of the machine is low and as the parts are few it is not liable to get out of order. If the pressure requires to be exerted in an upward or downward direction the wedge pieces are placed in the top and bottom, but if the pressure is to be exerted sideways the wedges are placed along the sides of the hole.

The wedges are placed in the recesses of the mandrel and then the machine is put into the hole, and pumping commenced, and in less time than a hole can be rammed for an explosive the body of coal is burst down on to the sprngs.

The machine may also be effectively used as a hydraulic jack.

Hand Power Diamond-Boring Machines. Mr. G. Nordenstrom recently read a paper before the English Institution of Civil Engineers on this subject. It seems that the use of bore-holes underground in Sweden for the discovery of fresh ore deposits has been in vogue for a long time. In 1872 diamond boring was tried by machine at a cost of $10 per foot for which price shafts could have been sunk in the same ground. After that an American prospecting machine, driven by compressed air, was tried in a bore passing through granite, felstone, and limestone.

This machine did 8 ft. 8 in. a shift and a maximum of 16 feet in one shift was attained in the limestone, but the cost was about the same as levels could be driven through the strata, so that the only saving was in point of time.

Four years ago a light portable hand-boring machine was adopted. The rods are hollow tubes 1·29 inches outside and ·98 inches inside diameter. They are screwed together in 5 foot lengths. The boring bit is fitted with 8 diamonds, 4 inside and 4 outside, at a total cost of about $100. The entire boring apparatus including the force pump and gear for flushing the bore, and 55 yards of boring rods weighs only 400 lbs. The largest bore made by these manual machines was 200 feet. The borings were mostly underground; 25 per cent. was vertically downwards, 37 per cent. horizontal, and 38 per cent. varied between 58° upwards and 78° downwards. Four to six men were required to work the machine and about 1½ gallons of water were required per minute for flushing the hole. The rate of advance was from 2½ to 5 feet per shift, and the total cost from $2.12 to $2.28 per foot.

The Use of the McClave Grate and Argand Steam Blower in Utilizing Small Sizes of Anthracite, or Bituminous Slack in Boiler and Similar Furnaces. This is the subject of an illustrated paper contributed to the American Institute of Mining Engineers by Mr. Rufus J. Foster, M. E., of THE COLLIERY ENGINEER.

This grate presents no long lines of metal in contact with the fire. It is constructed of two or more rows of bars, which run across the fire; these bars are each connected with rod and lever by which a shaking movement may be simultaneously applied to the entire grate surface. The advantage in the McClave over other oscillating grates is that at no point of the movement is there any increase in the size of the openings between the bars.

The Argand Steam and Air Blower opens into the ash pit, just under the bars, and gives a thorough supply of air with a small amount of steam to the furnace. In the Argand blower the percentage of steam is very small because it has been proved in practice that an excess of steam generates carbonic oxide, while a moderate supply furnishes oxygen by dissociation at the proper point or stratum in the fire and helps to consume the carbonic oxide, which would otherwise be formed and passed off unconsumed.

The steam also keeps the clinkers soft and porous, and moistens the fine ashes from the grate upwards as fast as they are made.

British Society of Mining Students. The annual meeting of this society was held recently. In the absence of the President the address from the chair was delivered by Vice-President Mr. H. W. Hughes. This address touched first on the subject of coal-dust, and reference was made to the recent experiments of Mr. Hall, one of Her Majesty's Inspectors of Mines, and Mr. Hughes failed to see that in all cases coal-dust was of itself explosive when unmixed with gas, but he would not assert that some varieties of coal-dust were not so. One argument against the explosive properties of pure coal-dust was that no explosions had ever occurred in non-fiery districts.

Touching upon the subject of haulage, Mr. Hughes pointed out the advisability of members bringing forward papers dealing with details of haulage. In general the system of haulage at each colliery is practically the same, but the details to suit particular circumstances at each are different, and may assist other managers in getting out new works.

Mr. C. H. Cobbold, the new President, in his address drew up an advisable course to be undertaken by a young man starting out as a mining engineer. First, he said, "let him take fixed residence for six months at a colliery, which would enable him to test his liking for the work, and ground him in the rudimentary working of the mine; then nine months actual work in a general engineering shop and foundry, where colliery break-downs were the principal work, but where engines are built; twelve months fixed at the colliery where he commenced, during which time he should have leisure to attend mining classes at one of the technical schools, rather than in making himself useful in doing clerk's work at the colliery; then six months apart at say six collieries in different mining districts. This could be carried out by those engineers who take pupils arranging a system of interchange; the result of the six months to be put down in six written papers; lastly, three months at a large sinking where he would learn sinking, tubbing, walling, pumping, and the laying out of a large colliery. The embryo mining engineer would thus, at the end of three years, be fit to come back to his original master, and take charge of a district of the mine, his sphere being gradually increased with his capacity for it."

The British Society of Mining Students is not a society which holds periodical meetings, but all the papers are printed and circulated amongst its members who reside all over the country. It is another feature in education by correspondence.

Automatic Tipping Apparatus. We give, in the accompanying illustrations Figs. 5 and 6, two views of a new automatic tipping apparatus for use on inclined railways, recently illustrated in the *Colliery Guardian*, and which has been in successful use for some time past at the Homeward Bound Gold Mine, Yalwal, New South Wales. As will be seen by reference to the illustrations, a spring is bolted to the bottom of the truck, which presses on a lever working on the axle of the front wheels. In its

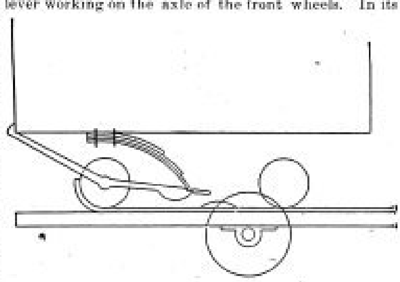


FIG. 5.

normal position, Fig. 5, a catch keeps the door of the truck closed, but should anything lift up the spring, the

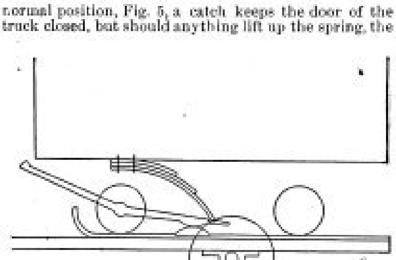


FIG. 6.

door is then released, Fig. 6. At the bottom of the inclined line what is termed a "kick-up" is fixed, the axle on which it turns being a little out of center so that when a truck runs on it, it will overbalance. In order to keep the "kick-up" table in its place ready for a truck to run on it, a weight attached to a rope passing over a pulley connected with the axle of the apparatus counterbalances the greater half of it. Between the lines of the "kick-up" is placed a chock of wood, so that when a cam on the lever passes over this, the spring is pressed back, and the catch of the door is released just at the moment the "kick-up" is tilted. In returning, the cam passes over the chock of wood just as the kick-up rights itself, and the door of the truck swings to so that everything is ready for the truck to be refilled, when it reaches the top of the incline.

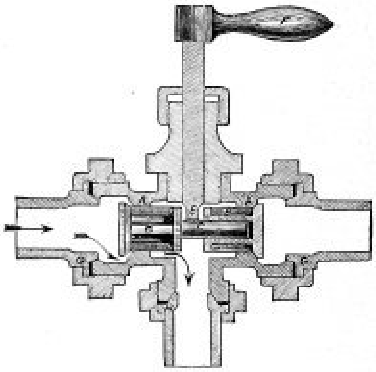
Automatic Cylinder Cocks, for Slide-Valve Engines and Pumps.

The Lunkenheimer Automatic Cylinder Cock is a simple valve contrivance, which, when applied to slide-valve steam engines or pumps, will in every instance result in the saving of steam, amounting in value per annum to many times the cost of the device. It is perfectly automatic, requiring no attention whatever.

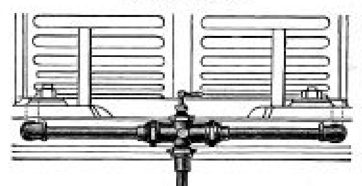
DESCRIPTION.

In consists of two simple, winged check-valves B B, which close alternately against seats A A with a lever E F which can be turned to hold both valves open; union joints G to connect with the drip-pipe from both ends of cylinder, and H with pipe leading the drip away, all arranged in a compact, convenient form.

When steam is admitted to one end of the cylinder, the valve B for that end closes under pressure, and forces open, by means of stem C, the valve for the other



SECTIONAL VIEW.



AS APPLIED TO A CYLINDER.

end, holding it open for the whole stroke of piston, and allowing the water of condensation to flow out into the drain-pipe. This action is reversed when steam enters the other end of cylinder, and so on, alternately, always leaving the exhaust end of cylinder open for the escape of water.

If desired, both valves can be held open by turning lever F down.

Mr. J. Parke Channing, of the East New York Iron Co., writes the manufacturers (The Lunkenheimer Brass Mfg. Co., of Cincinnati, Ohio) as follows:

"Please ship us by express two more ½" automatic cylinder cocks for my hoisting engine.

"The two that I bought from you have been in constant use on a Worthington mine pump since last May and have done their duty admirably. Without them we were obliged to keep steam leaking all the time and in addition to the loss, the level was more or less filled with steam, much to our inconvenience.

"We have ordered them for the hoisting engine and feel convinced we will soon save their cost in steam and packing."

As a guide to the size required for different size cylinders, we append the following table:

Size	⅛ in.	¼ in.	⅜ in.	½ in.	¾ in.	1 in.	1¼ in.
Adapted to Cylinder.	Up to 6 in. in Diam.	From 6 to 10 in. in Diam.	From 10 in. to 14 in.	From 14 in. to 20 in.	From 20 in. to 30 in.	From 30 in. Upwards.	

These cocks are manufactured only by the Lunkenheimer Brass Mfg. Co., who will cheerfully furnish any further information desired.

Tin Plate Manufacture at Piqua, Ohio.

On October 16th the Cincinnati Corrugating Co. started an extension to the works at Piqua, so as to more extensively engage in the manufacture of tin plate. The additional machinery consists of one pair of cold rolls, six annealing, boxes, four Morewood tinning pots, one five-roll Morewood tinning machine, one pump for liquid tin, etc., etc.

The extension to the works is necessary to contain part of the new machinery, etc., for the tin plant, as there was not room for all in the original buildings. As soon as completed the Corrugating Co. will have increased facilties for making either bright or terne tin plates of highest grade. The steel sheets will be rolled as heretofore by the Piqua Rolling Mill Co.

If the Corrugating Co. finds the operation of the plant above referred to as profitable as they have reason to expect they propose to double or treble it as fast as good business policy dictates.

RECORDS FOR GEOLOGICAL PURPOSES.

The Importance of Systematically Preserving Records of Bore-Holes.

We referred recently to the great importance of the Geological Survey as a means of establishing the value of land and making known the resources of the country generally.

We are indebted to a valued English correspondent for the following article showing the important office in obtaining reliable geological knowledge, bore-holes are made to perform in England and suggesting that the law compel the preservation of the records of all bore-holes made in the United States. Our correspondent also describes a box which is much used for preserving such records in England.

"England has for years been pretty well mapped out in a very detailed manner. All fences, foot-paths, cattle ponds, wells, springs, and even erratic boulders appearing on the Ordnance Survey maps, which may be obtained either to the scale of one inch to the mile or six inches to the mile, as well as to a still larger scale of twenty-five inches to the mile, and in towns five feet or ten feet maps can often be obtained. With a six inch map in hand the labors of the geological surveyor are much reduced, and where any particular stratum extends over large areas the work is practically confined to coloring the whole sheet one uniform color indicative of the surface rock.

In other cases, of course, where the dip is quick, and faults come in to destroy the uniformity, there is much more work involved.

An example of this is seen in the country south of London where the district known as the Weald is bounded on both sides by the cretaceous rocks which have in places very acute dip, and their outcrop on the map is confined to a mere streak of color only $\frac{1}{16}$ inch wide on the one inch map. It has been remarked that in a journey from East to West of England, a matter of 200 miles or so, the traveler may start on the latest drift and travel over the outcrops of every geological period until he reaches the outcrop of the lowest known granitic and trappean rocks. This result of quick dip necessarily adds much to the amount of work to be given by the geologist, but still this must be less than what is necessary over the Continent of North America.

Compared with the mapping of the solid rocks, the proper delineation of the drift presents, if not more difficulty, at least more labor, of a sort, though the drift being a superficial sheet is readily determined itself whilst adding to the difficulty of properly defining the boundaries of the solid rocks beneath, and the English "solid" maps frequently bear the words "obscured by drift."

The geologist receives an immense amount of assistance from the work of practical men in England. For example, the English railways have very much more largely than American railroads been constructed with heavy works in the shape of tunnels, cuttings, and embankments. Many such works were constructed in the early days of railway engineering entirely with the idea that easy gradients were a prime necessity, for the locomotive of that period was a small affair compared with that of to-day. From the sections thus presented precise and valuable information became open to view and enabled points to be fixed with accuracy from which boundaries could at least be often closely inferred. For deep work, however, a very useful source of information has been the boring of artesian wells.

These have proved of immense value to the English Geological Survey, and we cannot too strongly emphasize the importance of preserving a truthful record of every boring into the earth's surface, which may be made.

Unfortunately well-borers are in many instances men of little education, and large numbers of bore-holes have been made of which no record whatever exists. Often, too, such record as does exist is due not to the workmen but to the scientific knowledge and interest of some resident in the locality who has made it his special care to watch the progress and note the strata passed through.

The better class of artesian well engineers have, however, kept sample bores of every boring they have made, not merely as a matter of scientific interest, but as a useful record for possible future operations in the same locality, and these, of course, are most serviceable to the geologist. The English Geological Survey, whose headquarters are at Jermyn Street, are always glad to afford information relative to the probabilities of a boring for water in return for the information given them by the engineers. The evidence thus gradually accumulating is daily rendering the geological knowledge of the country more complete. But, even in a small country like England, there is still an immense amount of information lacking to complete the mapping of the deeper rocks.

It has long been held that beneath the Southeast of England there is a ridge of older rocks rising up to the base of the cretaceous rocks which form the surface, or are but little sunk below it.

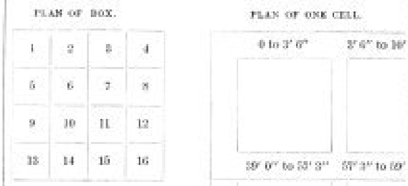
The truth of this theory seems to have received confirmation by the penetration at 1,200 feet below surface of what appear to be Devonian rocks immediately underlying the chalk at a brewery in London, the whole of the strata properly interposed and superficially, indeed, forming the whole breadth of England being absent. It is now reported that a boring in the country about seventy miles north of London, has, at a depth of less than 700 feet below the surface, reached the base of the chalk and passed directly to a bed of Palæozoic rocks as in the above named London boring, thus supplying another link of evidence confirmatory of the opinion that a ridge of older rocks thus exists.

In the London boring there was but little doubt that the rock reached was Devonian, of course completely below the coal measures. In the recent boring there appeared, at first, a doubt whether the rock was not a portion of the coal measures *above* the coal, but the latest opinion seems convincing to the effect that though the coal measures were the rocks reached, it was only one of the series below the coal seams which had been denuded, if ever they existed. A discovery like this, however, is as interesting to the pure and simple geologist as though a valuable coal field had been discovered, and indicates how very unexpected results may prove without the slightest surface indication. Indeed the surface of England above this ridge comprises a portion of the most level tract in the country. The fact of there being no coal at this particular spot is, of course, no evidence that on the slopes of the ridge and at somewhat greater depths coal will not eventually be discovered. Had it been proved in this instance it might have changed what is now the most rural portion of the country into a hive of manufacturing industry.

Every fresh boring may add something to the existing knowledge of the earth's crust, fixing the slope of the hidden rocks and giving data from which to estimate probable depths at a distance.

In much-faulted districts, too, borings are invaluable as a means of measuring the vertical displacement, and too much stress cannot be laid on the importance of keeping a record of what is passed through.

Such a record, to be most valuable, should not be merely in writing but should consist of actual samples of the *debris* from the boring preserved in a properly partitioned box and marked for depth as per sketch.



Each cell may be 3" × 3" × 3" and above each its extension should be marked, whilst a paper pasted in the cover may contain a written description, if desired. Such boxes, when carefully filled, are of abiding value as *known facts*.

America, as compared with England, is as yet barely touched. Her railroads form a far less proportion to her area than do the railroads of England, and bear less evidence in the shape of cuttings. Heavy works, indeed, have formed so serious an item in English railways that a story is told of one engineer who was sent to a foreign land to survey a line. Said foreign land was level and flat and the engineer pronounced it quite unsuitable for a railroad. "Where," he exclaimed, "will you run your tunnels?" He could not understand a railroad without tunnels. In borings too, except over a limited area, America has relative to area a small number and hence the wisdom (before spending money on boring the large numbers which will some day exist) of making provision—advisably by law—for preserving records of every boring made. Without their confirmatory evidence the horizontal section maps cannot be more than inferentially correct. With their evidence they become positive statements of fact, and in this way they may frequently prevent the useless expenditure of money on works of engineering and mining, which has so often been incurred.

The search for coal in Eastern England has so far had as one cause for its being not undertaken the extreme depth at which it must exist. Now, a single boring to a small depth upsets this objection and introduces the opposite one of possible denudation, following upheaval, previous to the deposition of the later post carboniferous rocks, though it opens at the same time a book of study and research which contains many blank leaves to be written up.

With such possibilities in a narrow field, how wide an area remains to be filled out in the blank book of the United States."

METHOD IN OUR WINTER TEMPERATURES.

BY H. GAWTHROP, PHILA., PA.

The weather reports of the cities of Boston, New York, Philadelphia, Buffalo, and Chicago show a striking resemblance in their Winter temperatures, when comparing one with the other as to the variation in the mean temperature for each month. Changes to cold or warm are uniform throughout the territory covered by these stations, so that any one of them may be taken as representative of all, in this respect.

Taking the mean temperature at Philadelphia for the six coldest months of the year, November to April inclusive, since the first observations in 1871, the average for the twenty years is found to be 38·87 degrees. It is found also that nine of these periods average above and eleven of them below that of the twenty years. In the table below, the averages and extremes of the mean temperature for the months of each period are given. For sake of brevity, they will be called Warm Winters and Cold Winters respectively.

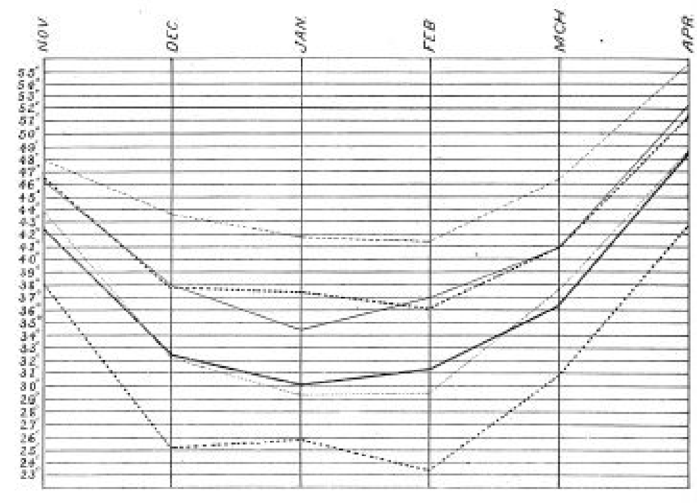
MONTHLY MEAN TEMPERATURE.

For Nine Warm Winters.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Av.
Highest	48·0°	42·6	41·8	41·4	46·4	55·6	44·1
Average	46·2	38·9	34·5	37·0	40·9	52·2	41·5
Lowest	43·8	33·2	29·4	29·5	37·6	48·7	39·9
For Eleven Cold Winters.							
Highest	46·5°	37·8	37·4	36·1	40·9	51·3	38·6
Average	42·3	32·4	30·1	31·2	36·4	48·5	36·8
Lowest	38·0	25·1	25·8	23·4	30·8	42·6	36·8

The chart gives a graphic view of these figures, the dark line for the averages, and the heavy dotted lines for the extremes, of the cold winters; and the faint line for the average, and the light dotted lines for the extremes, of the warm winters.

It will be seen that, with the exception of the broadening, from the greater range of temperatures, in mid-winter, the lines are nearly parallel throughout the six months, and the winters continue and end as they commence. It may be said that, as goes November, so goes the winter. The only variation from the symmetry of the hole, and that but slight, is the close approach of December and February temperatures to that of January in the cold winters, the extreme cold seeming to cover a greater period than in the warm winters.

The limitation in the extremes for each period is noticeable. In the warm winters, the extremes go but



slightly below the average of the cold winters; and, except in January, the line of extremes in the cold winters follow closely the average of the warm winters. Each group has its well defined course and limit.

For the next twenty years, there will probably be a similar result, and this uniformity in the winter temperatures may be accepted as a rule; but when weather observers turn prophets, they take much risk, because of the striking exceptions. Nature in her various forms, insists on exceptions to all rules, but the geologist or botanist does not hesitate to formulate the rule and gives slight heed to many exceptions. In the weather department of Natural Sciences, however, phenomenal temperatures, blizzards, and floods are so prominent that advocates of rule are without honor.

For this present season, the mean temperature of November (44·2), has been close to the average of twenty years (44·1), so that the winter may be considered as commencing with an average temperature. During the twenty years under consideration, but one winter, classed as warm, has begun with less temperature in November than this year, and it turned out to be close to an average winter. In the same period, five Novembers with a higher average, preceded cold winters.

It will be left to the readers to draw their own conclusions and to prophecy as to remainder of the winter

THE FUEL SUPPLY OF THE UNITED STATES.

A Sketch of the Progress of Twenty years in the Economy of Production and Consumption.

BY JOHN BIRKINBINE, PHILADELPHIA, PA.

[Presidential Address at the Glen Summit Meeting of the American Institute of Mining Engineers, October, 1891.]

Four meetings of the Institute have been held in the Anthracite coal fields of Pennsylvania, and excursions into the district, in connection with meetings elsewhere, have familiarized our members with the development of this unique region. But the progress of that development has been so marked that, in view of our assembling within a few miles of where, two decades ago, the Institute was organized, a brief *resume* of the history of the Anthracite coal mining industry, and some thoughts upon the fuel problems of 1871 and 1891 seem to be specially appropriate on this occasion.

Seventy years ago, the "burning stones" which we recognize as Anthracite coal, were first mined, but what has now become a magnificent industry grew with comparative slowness for two decades; and it was not until 1842 that 1,000,000 tons of Anthracite coal per annum were produced.

The opening of this fuel-field, however, soon exerted a stimulus upon railway and canal construction, some of the earlier enterprises and numerous later additions having been projected and maintained to carry Anthracite coal to points of consumption or to navigable waters. And this stimulus reacted upon the industry itself. Larger shipments were demanded to meet the requirements of the market developed by these improvements.

From 1842 to 1864 the annual production of this form of fuel increased tenfold, from 1,000,000 to 10,000,000 tons, and this amount was again doubled (to 20,000,000, tons) in 1873. The shipments of Anthracite coal for 1890, show another step in geometrical progression: for, if to the 36,000,000 tons of Anthracite shipped, we add the coal used at the mines, a production exceeding 40,000,000 tons is accounted for.

The astonishing record of the mining industry within this limited area can be best appreciated by comparing the output with that of another mining industry. Thus, the weight of Anthracite coal mined in Pennsylvania in 1890 was nearly three times as great as the total iron-ore product of the United States; and this coal was obtained at greater average depth, and under conditions generally less favorable, then are found at the iron-ore mines.

The total output of the Anthracite regions of Pennsylvania for the past seventy years, approximates 750,000,000 tons. Of this, over 12 per cent. was obtained in the forty years between 1820 and 1860; 15 per cent. in the decade following; nearly 25 per cent. between 1870 and 1880; and for the past ten years the output has averaged about 35,000,000 tons annually, aggregating nearly 48 per cent. of the whole.

Of the total output of the Anthracite coal region as recorded, one-half has been mined since 1879, and the period of twenty years which marks the existence of the American Institute of Mining Engineers, covers a reported production of Anthracite coal of nearly 540,000,000 tons, or 72 per cent. of the total output of the region.

Mr. J. H. Jones, special census agent, places the value at the mines of the Anthracite coal product of Pennsylvania in 1889 at $65,721,578, demanding, at 362 regular establishments, the services of over 124,000 employes, who received in that year nearly $40,000,000 as wages. The capital invested in the coal lands amounts to almost $162,000,000; and this valuation does not include undeveloped properties nor any surface improvements, except such as are necessary for mining and preparing the coal. If to the above amount were added the coal lands held in reserve, the numerous dwellings, and the enormous railroad facilities specially built and maintained to convey the product of the mines and breakers to trunk lines, the valuation would be greatly augmented; for no part of Pennsylvania is so well supplied with railroads as the Anthracite coal fields, and few points in the United States are connected with as many competitive systems of transportation as the section which the Institute visits during this meeting.

Our *Transactions* demonstrate that much of the progress in mining methods and appliances by which the above results were accomplished is traceable to members of the Institute; and of those we can truly say, "the half has not been told" in the printed papers forming part of our publications.

An approximate review of the consumption of all kinds of fuel, for the past twenty years may be obtained from the following census data:

	1870.	1880.	1890.
Gross tons of Anthracite coal,	13,925,229	25,580,189	40,714,721
Gross tons of Bituminous coal,	15,356,619	38,242,641	85,383,059
Bushels of charcoal,	....	74,008,972	90,000,000*
Cords of wood,	....	145,778,137	180,000,000*
Barrels of petroleum,	5,260,745	26,286,123	34,820,306
Natural gas, value in coal displaced,	No report.	No report.	$20,000,000*

*Estimated.

The fuel consumed in the United States, exclusive of natural gas, but including the coal and wood converted into gas, requires the conveyance, by various methods, of nearly one and a half million gross tons each day of the year (no unimportant factor in the national problem of transportation), and demands the energies of over one million wage-earners to mine, cut, handle, and convey it to points of consumption. The fuel-consumption, *per capita*, in the United States, is in calorific value equivalent to 3½ tons of coal per annum. Possible economies may reduce this to 2½ tons for the same amount of work performed.

By reason of the extended area of the Bituminous coal-fields, their development has greatly benefited the entire country. This fuel has supplied most of the illuminating and fuel-gas, and in addition to its liberal use for domestic and steam-producing purposes, the coke resulting from its distillation has influenced the iron industry to a wonderful extent, as is shown by the following figures, taken from the reports of the ninth, tenth, and eleventh censuses:

	Gross tons. 1870.	1880.	1890.
Pig-iron, ...	1,832,876	3,375,912	8,553,374
Manufactured iron, ...	1,287,347	2,101,183	2,518,193†
Steel, or, finished product; & ingots	41,426e	1,022,060	3,988,227†

†As the census statistics have not been issued, the above figures are taken from the report of the American Iron and Steel Association for 1890.

The output of Bituminous coal, added to the production of Anthracite in 1890, brings the total of coal mined in the United States to 75 per cent. of that mined in Great Britain, the country which supplies nearly as much coal as all others in the world combined, exclusive of our own. In other words, the United States now produces about 30 per cent. of the world's output of coal, while it consumes, in addition, great quantities of wood, charcoal, oil, and natural gas. The United States is the great fuel-consumer of the world.

Over 2,000,000 cords of wood are annually cut to produce the 90,000,000 bushels of charcoal which I estimate were used in smelting ores of iron and of the precious metals, and for other specialties. The cordwood used as fuel for various purposes largely exceeds that cut for charcoal, but the amount can only be roughly approximated. The total wood of all kinds used for fuel is estimated by Mr. B. E. Fernow, chief of the Forestry Division of the United States Department of Agriculture, at 180,000,000 cords per annum.

Peat is used to a moderate extent only; but various methods of drying or preparing it are passing through experimental stages.

In thirty-two years the product of petroleum has grown from 2,000 barrels to 35,000,000 barrels annually, reaching a total for the whole period of 450,000,000 barrels. Of the present output, approximately 40 per cent. is used for fuel; and this has a calorific value, three barrels of petroleum being taken as equivalent to one ton of coal, of over 4,500,000 tons of coal annually. The convenience of application favors the use of petroleum in localities where coal commands relatively high prices, and in cases where intermittent firing is employed; and we may anticipate a growing demand for this form of fuel.

It is perhaps impossible to determine the quantity of natural gas used in this country, but a measure of its importance may be found in the equivalent money-value of coal it has displaced, which is calculated to approximate $20,000,000 annually. Moreover, the extensive introduction of natural gas for industrial and domestic uses has stimulated the employment of producer-gas, and in many instances the manufactured gaseous has supplanted the natural solid fuel.

The magnitude of the quantities represented by our fuel-supply emphasizes the importance of economies in its use. A saving of one per cent. of the fuel of all kinds consumed in the United States would be equivalent to 2,300,000 tons of coal per annum. Each of our members will aver that, in almost every case of which he is cognizant, one per cent. of the fuel used could be readily saved, and in numerous instances the possible economies appear to be much greater. If all the fuels produced in the United States were used for one year for the generation of steam, they would furnish continually, through boilers and engines of ordinary efficiency, nearly 12,000,000 horse-power; but if applied to boilers and engines of high economy, the resulting energy would be augmented to 25,000,000 or even 30,000,000 horse-power. An average reduction in American blast-furnaces of one hundred weight of fuel per ton of pig-iron made would amount to an annual saving of nearly a half million tons of coal, and proportionate economies in iron and steel manufacturing processes would more than double this saving.

The crowds of coal-pickers covering a city's ash-heaps attest the waste of fuel imperfectly consumed for domestic and manufacturing purposes, and the "smoke nuisance" (the abatement of which is always in the future) is constantly before us as an indication of improvidence. The evil is to be overcome, if we believe the announcements of trade-circulars, by patented boiler-settings, which facilitate the evaporation of water at a rate in excess of theoretical perfection; by smoke consuming devices, which effect such economies that it will pay to burn coal merely to utilize the smoke; or by stoves or furnaces which, through some secret of nature confided to the inventor only, utilize upward and downward draughts in the same chimney, the downward draught bringing the combustible myth to intensify immensely the heat of the normal fire. Economies are also claimed for special details in blast-furnaces, heating-furnaces, puddling furnaces, or other metallurgical constructions, some promising a return of more heat units than are accepted as theoretically attainable.

While many of the so-called fuel saving inventions are farcical, because they are based upon unsound theory, we are indebted to others for marked economies in fuel-consumption, which have made it possible to advance metallurgy and manufactures to the position they now occupy. It requires but a brief retrospect to recognize the true economies, and for this we need note only improvements made during the existence of the American Institute of Mining Engineers.

Suppose for a moment that the quantity of pig-iron and manufactured iron and steel now demanded by the United States had to be produced, manufactured, manipulated, and transported by methods in use two decades ago—how many tons of fuel would be wasted in producing the 8,553,374 tons of pig-iron we made in 1890, if the blast-furnaces were equipped with open fronts and fore-hearths, following the custom of charging more fuel than the furnace could consume, so as to shovel it out at the bottom? What additional fuel would be required if gas-producers were not connected with the furnaces in our mills and steel-works, or if the direct methods of conveying molten metal from blast-furnace to converter, and hot ingots or billets from converter to mill, or from one mill to another, were abandoned, and if our mills returned to the former practice of allowing the metal to cool between each two stages of treatment.

The developed coal mines of the United States could not possibly supply the present demands of the country if our industries, our locomotives, and steam-vessels consumed fuel at the rate per ton of product or per horse-power that they did in 1871. Neither could the coal mines, as opened and equipped in 1871, produce the fuel now demanded.

Among the economies already achieved, none are more notable than those adopted in and about the mines, by which the coal is removed with less loss in mining, and prepared so that, of that which formerly went to the dump piles, nearly all that is combustible is reclaimed. The application of finer sizes, and even of the slack coal and dust to useful purposes, is entitled to a prominent position among the fuel economies.

A critical review of the advances made in the methods and processes of mining, preparing, handling, and transporting coal, of producing and using steam, of smelting, refining, and manufacturing metals, would probably show that we are now able to accomplish with one ton of combustible mined, results which, twenty years ago, would have required the mining of two tons or more. If then he is entitled to credit as a benefactor who causes two blades of grass to grow where one grew before, we have cause for congratulation and for just praise, that in 1891, one ton of combustible taken from the mines benefits the country as much as, or possibly more than, two tons as removed, prepared, and used in 1871.

Such results, however, are not due to one man; to accomplish them, thousands of active minds have worked in one general direction, against difficulties and discouragements. The geologist, the mineralogist, and the explorer have done their part in locating and developing additional sources of fuel supply. The mining engineer, with the aid of the constructor and the mechanic, has brought to the surface, prepared, and delivered to consumers the solid, liquid, or gaseous fuels at low cost, while the laboratories of the chemists and physicists have contributed valuable data as to the composition and utilization of various fuels to assist the metallurgist and engineer in applying them. All of the classes mentioned are represented in the list of members of the American Institute of Mining Engineers. Our roll of 2,300 embraces in each department distinguished specialists, whose contributions to the *Transactions*, or work in practice, have aided in no small degree to accomplish what has been achieved. Yet, as indicated, there remains much to be accomplished, and the purpose of these remarks has been to invite attention, in a general way, to the magnitude of the fuel problem, and, while recognizing the advances made in the past twenty years to encourage the endeavor after further economies in the utilization of fuel.

A Growing Business.

The Webster, Camp & Lane Machine Company, of Akron, Ohio, manufacturers of Mining Machinery and Corliss Engines, has completed arrangements by which a part of its business will be removed to Kent, Ohio, ten miles east of Akron, where buildings will be erected for the manufacture of heavy machinery.

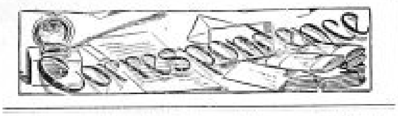
While the Company will continue its offices in Akron, and the use of its present shops for local work, it will erect at Kent complete shops, consisting of machine shop and main erecting shop 100 ft. wide x 400 ft. long, built with 25 ft. galleries on either side of a 50 ft. crane span; foundry building 100 ft. wide x 300 ft. long, with wing 75 ft. x 100 ft.; smith shop 60 ft. x 80 ft., besides pattern shop and pattern storage building. Both machine shop and foundry will be equipped with thirty-ton electric cranes of most approved pattern.

All buildings are to be of brick, and erected on a twelve-acre tract of land situated between N. Y., P. & O. Division of the Erie Railway, and the Pittsburgh & Western Division of the B. & O. Railway. The Cleveland, Canton & Southern Railway runs across the south end of the property, so that the Company will have unsurpassed shipping facilities.

The Company has been very much cramped for room in its old works, and so hemmed in on all sides that additions there were out of the question. It expects to start the new works with three hundred men in addition to the force employed in Akron, and this number will be increased as fast as required.

The Webster, Camp & Lane Co., has won a trade through the superiority of its machinery, that will, we have no doubt, require still further enlargements in the near future. This new move gives it a chance to make these enlargements as fast as business demands them. It is a live Company, and the officials are energetic, enterprising men.

We have recieved from the Lidgerwood Manufacturing Co., of 96 Liberty St., New York, a copy of a very handsome and interesting illustrated pamphlet, entitled "Phosphate Mining." The book is issued to illustrate the use of the Improved Suspension Cableways in phosphate mines. All the sketches are made from photographs, and are therefore true to actual existing circumstances. These cableways have been used for years in handling materials of all kinds, and have proven their superiority over other methods. Readers of this journal should send for a copy of this book, which is mailed free on application to the Lidgerwood Mfg. Co., 96 Liberty St., New York.



This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.

Mensuration.

Editor Colliery Engineer:

SIR:—In answer to "Trackman," in your October issue, I submit the following which I think is right, if I understand the question:

A tree 80′ long, 6′ diameter at butt end, tapers to 1′ diameter, how long a rope will it take to coil around it, the coils to be close together, also how long will the rope have to be, allowing 12″ between coils?

From the two end diameters we find the mean diameter to be $3\frac{1}{2}'$. The proof of which is

$$1 + 3\tfrac{1}{2} + 6 = 10\tfrac{1}{2} \div 3 = 3\tfrac{1}{2}'.$$

Then,

$3\frac{1}{2} \times 3{\cdot}1416 = 10{\cdot}9956$, the circumference, which multiplied by the number of times the rope goes around the log will give the number of feet required to cover the log, thus

$$10{\cdot}9956 \times 960 = 10555{\cdot}7760'.$$

Now, for the rope to go around every 12 inches it will take 80 times, then

$10{\cdot}9956 \times 80 = 879{\cdot}6480'$. Therefore, allowing 12″ between coils, it will require 879·6480′; and if the coils are close together 10555·7760′.

Yours, etc.,
JAMES PAYNE.

Adger, Jeff. Co., Ala., Nov. 21st.

Mechanics.

Editor Colliery Engineer:

SIR:—As I have not noticed any answer to "J. T. G.'s" question which appeared in the September issue, I offer the following:

On an incline rising 1 in 10, the loads weighing 12,000 pounds, and the empties 3,000 pounds, the drums, ropes, and sheaves 5,000 pounds; the friction of the cars equal 1% of their weight, and the friction for drums, ropes and sheaves $\frac{1}{40}$ of their weight. When they are being let down by a brake, it takes 4 minutes to run 300′ now what is the amount of friction applied by the brake?

$$12{,}000 \text{ lbs.} - 1\%, \text{ or } 120 \text{ lbs.} = 11880 \text{ lbs.}$$
$$3{,}000 \text{ lbs.} + 1\%, \text{ or } 30 \text{ lbs.} = 3030 \text{ lbs.}$$
$$8850 \text{ lbs.}$$

Then

$$8850 \text{ lbs.} \div 10 = 885 \text{ lbs.}$$
$$5000 \text{ lbs.} \div 40 = 125 \text{ lbs.}$$

760 lbs. actual load tending down plane without any resistance, whatsoever. This load turned loose at head of incline 300′ long rising 1 in 10 would travel the distance in 13·7 seconds out; our load must only travel 300′ in 4 minutes or 240 seconds.

The vertical height of a plane 300′ long that will give a body a velocity of 300′ in 240 seconds by the following formula is ·096 feet.

$$\frac{300^2}{240^2 \times 16{\cdot}08} = {\cdot}096'.$$

This deducted from total height of plane which is 30′ will leave 29·9′; and $29{\cdot}9' \div 30 = {\cdot}9966$ co-efficient of friction, therefore

$760 \times {\cdot}9966 = 757{\cdot}4$ lbs. of friction which will have to be applied.

Yours, etc.,
H. L. D. W.

Cincinnati, Ohio, November 24th.

Answers to Miscellaneous Questions.

Editor Colliery Engineer:

SIR:—I submit the following in reply to "S. W.," of Irondale, Ohio:

(1.) *a.*—Suppose the ventilation to be produced by a *force* fan; a fall occurs partially closing or contracting the inlet, the fan still making the same number of revolutions, the result is the water rises in the opposite leg of the w. g.

b.—Suppose the same fan with two parallel headings. Suddenly, by some means, the stoppings are removed making the air course larger, the w. g. will fall.

(2.) Density so far as air in mines is concerned may be diminished by applying heat, say at the upcast and rarifying it. Also, density can be increased by using a powerful force fan with small return airways and heavy drag.

(3.) The depth of shaft must be according to the square root of the quantity:

$$60{,}000^2 : 70{,}000^2 :: 400' : x,$$

$$\frac{49 \times 400}{36} = 544{\cdot}44'; \text{ subtracting}$$

the 400 we have 144·44′ as height of stack.

(4.) *a*—First

$20' \times 20' \times 10' = 4000$ cu. ft. of water to be raised 60 ft. in 30 minutes. Then, $4000 \div 30 = 134$ — cubic feet in one minute = 8375 lbs.

$$8375 \times 60 = 502{,}500 \text{ units of work.}$$

Allowing $\frac{1}{4}$ for slip of pump, we have 628,125, and one-half of this last sum for friction of machinery, etc., we have 942,158 units of work to be performed which divided by 33,000 equals 28·55 H. P.

b.—From THE COLLIERY ENGINEER POCKET-BOOK we get the formula

$$D = \sqrt{\frac{F}{L \ N \ {\cdot}00545}}$$

Where

F = cu. ft. per minute.
L = length of strokes.
N = No. of strokes.
$\cdot00545$ = constant.

I would use a double action pump making 67 cu. ft. per minute for each pump, then

$$D = \sqrt{\frac{76}{40 \times 2 \times {\cdot}00545}} = 12{\cdot}4, \text{ allowing}$$

$\frac{1}{4}$ of the area of plunger for slip of pump, or what is the same multiply the diameter by $\frac{1}{8}$, we have

$12{\cdot}4 \times 1{\cdot}125 = 13{\cdot}95$, or say 14″ as diameter of pump.

Now

$$A = D^2 \times {\cdot}7854 = 153{\cdot}93.$$
$$60 \times {\cdot}434 = 26{\cdot}04 \text{ lbs. per inch of plunger,}$$

and

$$153{\cdot}9 \times 26{\cdot}04 = 4000 + \text{ lbs. total weight.}$$

Add 50% to this for friction, etc., and we have

$$4000 + 2000 = 6000 \text{ lbs.}$$

Say the steam pressure is 40 lbs. per inch, then

$$\frac{6000}{40} = 150'' \text{ as area of steam cylinder.}$$

Then diameter equals

$$\sqrt{\frac{a}{{\cdot}7854}} \text{ or } 13{\cdot}8'' \text{ as diameter of steam}$$

cylinder.

$$\frac{2 \ A \ P \ R \ S}{33{,}000} = 29 \text{ H. P. practically the}$$

same as before if the decimals had been carried out. Therefore 14″ pump with 14″ steam cylinder would do the work.

Yours, etc.,
J. V.

Punxsutawney, Pa., Nov. 26th.

Ventilation.

Editor Colliery Engineer:

SIR:—The following question was asked at an examination in Nova Scotia:

It seems there are several different opinions regarding the proper solution, some solve it by Mauchline's rule, given on page 53 of his book, while others work it out differently. I hope it will be freely discussed until we can all see it in the one true light.

"What *pressure* and *power* will it take to get 10,000 cubic feet per minute through an airway 6,300 feet long, of which 6,000 feet is 5′ × 8′ and 300 feet 2′ × 5′; also, what quantity would you get with the above pressure, if the airway was 6,300 feet long and 5′ × 8′ area?"

I wish your correspondents would discuss the question from three standpoints, viz., (1.) The 300′ × 2′ × 5′ being at inlet; (2.) The 300′ × 2′ × 5′ being in the center of airway, and (3.) The 300′ × 2′ × 5′ being at the outlet.

Yours, etc.,
H. L. D. W.

Cincinnati, Ohio, Dec. 4th.

Pumping.

Editor Colliery Engineer:

SIR:—The question of "Beginner," of Mt. Pleasant, Pa., in your August issue, has become interesting, and the four solutions which have appeared in your journal showed that "Beginner" has hit upon a question that needs to be discussed and properly solved. Please allow me to contribute a mite to this end.

The question is: "In a shaft 100′ deep a pump is placed with 5′ suction and 95′ discharge. Will it require more or less power if the pump is placed up the shaft, with 20′ suction and 80′ discharge?"

In your October issue "J. V.," of Punxsutawney, Pa., and "T. S. A.," of Anita, Pa., state that with 5′ suction it requires 6·51 lbs. per square inch more power. Having discussed this question with a great number of pumpmen, engineers, and surveyors, I find about nine-tenths of them of the same opinion. But I am much pleased to note that in your December issue "F. B.," of Macean, N. S., and "J. N. K.," of Mansfield, Pa., have given us a much more satisfactory solution, by stating that the power required in both positions of the pump is one and the same. No doubt this is correct, and they have made a noble attempt to explain the *modus operandi* of a pump. In his attempt to do so "F. B." states that if we raise water in the suction 5′ we must create a vacuum of 2·17 lbs., to raise 10′ we must create a vacuum of 4·34 lbs., and 20′ the vacuum must be 8·68, and 30′, 13·02, and so on until we reach perfect vacuum. Again, we get the same principle with "J. N. K.," as follows: "The suction is only an indirect way of lifting water: in the suction pipe there is a pressure of 14·7 pounds of air to the square inch. Now without computing anything for friction, in order to get water up to the piston of the pump we must exhaust the air until only a pressure of 6·02 lbs. remains. 20′ of water will weigh 8·68 lbs. per square inch of area, and in order for the atmospheric pressure to force the water up the pipe we must exhaust a pressure of air from the pipe of 8·68 lbs., which is the same as if the water was lifted."

After reviewing the above I am compelled to disagree with the mode of operation described. That we create a vacuum equal to the height of the suction when a pump first takes its water is true. After that to me it is an impossibility for that operation to continue, but as soon as the working barrel is filled with water, the plunger is withdrawn against the pressure of the atmosphere of nearly 14·7 lbs. to the square inch of this area. But we also find the water forced into the working barrel and against the bottom of the plunger with the same pressure to the square inch—14·7 lbs., and in a 5′ lift 2·17 lbs. of this is utilized to raise the weight of the water to the plunger, while the balance of 12·53 lbs. per square inch is forcing the water against the plunger to that extent (no allowance made for friction or weight of valves), and compensating for that amount of work done by the plunger, or in other words, assisting the plunger to that extent; so that actually the power attached to the plunger is only to lift actually the weight of the water, as stated by "F. B." and "J. N. K." But to use the term creating a vacuum of so many lbs. when a pump is in operation, is out of place, as we here find a continuous solid body of water and plunger obstructing a broken body of air from coming together, which is with all its power seeking its equilibrium. The above conclusion is true of all pumps except the pulsometer and kindred pumps, where expanded or exhaust steam is condensed to continuously create vacuum. In these kinds of pumps with every inch we lift the water is a clear gain in power. In harmony with the above, solution to "Beginner's" question is as follows:

The constant ·434 used in these formulæ is the weight of water 1″ square and 1′ high. With the pump 5′ above water the discharge is $95' \times {\cdot}434 = 41{\cdot}23$ lbs.; suction 5′ = 14·7 lbs. minus 12·53 lbs. compensated or returned power = 2·17 lbs, then 41·23 and 2·17 = 43·4 lbs. per square inch required. With pump 20′ above water, the discharge is $80' \times {\cdot}434 = 34{\cdot}72$; suction 20′ = 14·7 lbs. to be deducted for compensated power 6·02 = 8·68 lbs., then 34·72 and 8·68 = 43·4 lbs., the power required per square inch of plunger, friction and weight of valves not considered.

Yours, etc.,
D. W. E.

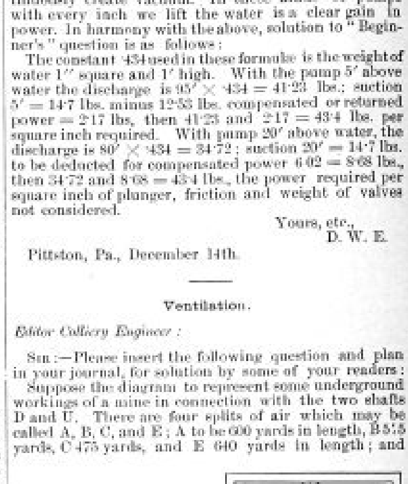
Pittston, Pa., December 14th.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following question and plan in your journal, for solution by some of your readers:

Suppose the diagram to represent some underground workings of a mine in connection with the two shafts D and U. There are four splits of air which may be called A, B, C, and E; A to be 600 yards in length, B 535 yards, C 475 yards, and E 640 yards in length; and



from bottom of downcast to split C E to be 150 yards. Air crossings are supposed to be built at points marked H; now, what quantity of air will circulate through each split, their areas being all 8′ × 8′ and subject to the same pressure at downcast, say, ·25 inch w. g.? In the diagram let H represent two overcasts over A and B; D the downcast, and U the upcast shaft.

Yours, etc.,
E. R.

Hopwood, Pa., Nov. 30th.

Mensuration.

Editor Colliery Engineer:

SIR:—I would like to venture a brief solution to "T. W. Hale's" question in your May issue, as worked out by simple mensuration. "A horse is tied to the corner of a barn 25 feet square by a rope 100′ long. How many square feet of surface can the horse feed over?

$$200^2 \times {\cdot}7854 \times \tfrac{3}{4} = 23{,}562 \text{ sq. ft.}$$

And

$$75^2 \times 3{\cdot}1416 \times \tfrac{1}{2} = 8835{\cdot}75 \text{ area of half}$$

circle with a radius of 75′,

$$(55{\cdot}22 \times 2) \times (50 \times 2) \times \frac{{\cdot}7854}{4} = 2168{\cdot}4894'$$

area of quarter circle.

Then,

$$23{,}562 + (8835{\cdot}75 - 2168{\cdot}4894) = 30{,}229{\cdot}2606'$$

the required area.

Yours, etc.,
Inquirer.

Nanaimo, B. C., Dec. 3d.

Discussion Upon Questions 14, 18, 20, and 21, Given at the Iowa Examination of Candidates for Mine Inspectors April 9th, 1890.

Editor Colliery Engineer :

SIR :—In the October issue of THE COLLIERY ENGINEER you publish by request some answers to the above mentioned questions.

Question 14 is not stated correctly, and there being also an error of multiplication, the answer arrived at is very different from the correct answer.

Question 14, stated correctly, is as follows: "If a water-gauge shows a difference of reading of 1·2 inches between the intake and the return of a certain portion of a mine; and the anemometer indicates a velocity of 10 ft. per second, size of entries 6 × 8 ft.; what effective horse power has been expended in the ventilation of that part of the mine?"

We find the pressure per sq. ft. to be 5·2 lbs. × 1·2 inches = 6·24 lbs., and volume of air = 6 × 8 × 10 × 60 = 28,800 cu. ft. per minute.

$$\text{H. P.} = \frac{6{\cdot}24 \times 28{,}800}{33{,}000} = 5{\cdot}45$$

instead of 50·7 as given.

The answer given to Question 18, which is, "In what part of a mine should observations with the anemometer be taken, and why?" is correct as far as it goes but it does not say why; nor does it cover the point aimed at in the question.

The point desired to be brought out by asking Question 18 is, that the return air or "the last of the air," as it is called, is always traveling at a different velocity from the intake current, its velocity being affected by the rarefication or otherwise of the return air, due to the relative temperatures of the pit and the outside air; also by the presence in the return current of the mine gases which often largely increase the volume of the air; and last, but by no means least, the return current has been relieved of the pressure of the pit, which is often two or three atmospheres and sometimes much greater, and its volume and consequently its velocity is proportionately increased.

From the above considerations it is very evident that readings taken with the anemometer upon the return, may show a large amount of air passing, while the face of the workings and the entire pit are deficient of the required amount. It is always most important and absolutely necessary to take readings at the face of the workings or the inside headings, to be assured the entire amount of air in the split is passing around the face and does not leak through imperfect stoppings; but to obtain correctly the amount of pure air passing in a pit, the calculations must be based upon observations taken upon the intake and not the return.

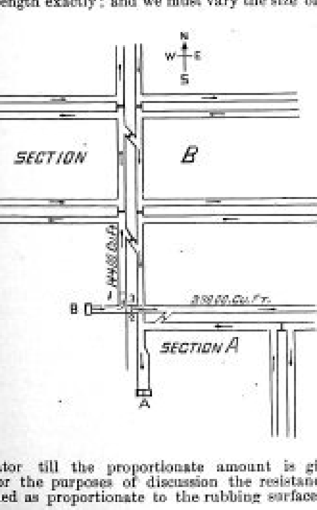
It is interesting to note in passing that the observer should stand a little to one side and as far from the instrument as possible, while taking the reading, in order that his body shall not obstruct the area of the entry and thus create a higher velocity than actual.

Question 20 is: "In the section of the mine mentioned in Question 14, which we will designate as Section 'A,' the air travels 6,000 ft. of entry, including the return. In Section 'B' of the same mine there is required 14,400 cu. ft. of air per minute, but it must travel 12,000 ft. of entry, including the return, how would you arrange the regulator, or in what proportion would you split the air for these two sections to equalize the ventilating currents in them? Size of entries in both sections is the same."

This question might have been better stated by asking. "How would you arrange the regulator or in what proportion would you split the air for these two sections to give to each its required proportion of air."

This is the meaning of the question and not that each section should receive an equal current, as explained in THE COLLIERY ENGINEER; as the question states explicitly the amount of air required in each section.

The discussion in regard to regulators, which follows in THE COLLIERY ENGINEER, is partly right and partly wrong. It is right in saying we determine the size of the regulator by experiment; for the reason that no two airways in a mine of the same sectional area, will offer a resistance to the air current proportionate to their length exactly; and we must vary the size of our



regulator till the proportionate amount is given. But for the purposes of discussion the resistance is assumed as proportionate to the rubbing surface.

But, on the other hand, it is by no means clear that the only way to divide the air current proportionately, is by increasing the resistance in one of the airways till it becomes equal to the resistance offered by the other airway. This a wrong basis to start from; and, as stated, entails a large amount of dead work. Every regulator that is placed in an airway on this principle is an obstruction to the free passage of the ventilating current; it increases the drag of the mine and consequently the power necessary to ventilate. It will accomplish the dividing of the air in any proportion provided the power is present to drive the air; but it is based on no scientific principle and is expensive.

To fully explain the principles of "splitting" the air in mines, would require more space than allowed to us; but we may in a simple manner, and by reference to the accompanying diagram, make plain some points.

Let B be the air-shaft (downcast); A the hoisting shaft and upcast; the ventilating motor a force-fan; S denotes a split, and X an overcast. There is 43,200 cu. ft. of air coming down the air-shaft per minute. Of this 28,800 cu. ft. is required to pass over the overcast and travel East to ventilate Section "A." The length of this split is say 6,000 ft. The remaining 14,400 cu. ft. travels north and ventilates Section "B." The length of this split is say 12,000 ft. to where it escapes up the upcast. We note that the velocity of the current in Section "A" is twice the velocity of the current in Section "B" since the size of the entries is the same in each.

Suppose we stop the air course leading to the north by a door at (1), and also the air course leading to the east by a door at (2), thus shutting of all entrance of air to the mine from the air shaft. Now if the fan be kept running at a uniform velocity the pressure in front of these doors will continue to rise until a fixed point is reached, and the pressure at that point will indicate the ventilating power of the motor at that velocity. And further, until this working pressure is reached in the mine, the full capacity of the ventilating motor is not used.

Again, behind these imaginary doors at (1) and (2) lurks the resistance or "drag" of the mine. This resistance exists in the mine as a force directly opposed to the movement of the ventilating current; and until this force can be overcome by the pressure of the air current, no movement can take place. What is called the "static" resistance or force necessary to create a circulating current is much larger than the dynamic resistance or the force necessary to maintain such a circulation after it is established. The dynamic resistance is what interests us most, and is what is known as the resistance of the mine. It varies as the amount of the rubbing surface varies; and as the square of the velocity of the current. We are dependent upon the working pressure of the air current to overcome the resistance.

Again, if we open the imaginary door at (2) leading to Section "A" the "static" pressure is at once relieved and a working pressure soon established, which is equal to the dynamic resistance of Section "A." All the air is now passing through Section "A." Did Section "A" offer no resistance to the air current the working pressure would be *nil*. The working pressure at the intake of any section or split can never be greater than the dynamic resistance of that split but is always equal to it. We must remember here that the dynamic resistance and consequently the working pressure varies with the square of the velocity of the current; and as all the air is now passing through Section "A" the velocity will be greater and the working pressure, at the point where the split is to be made, higher than when Section "B" is open also. This is as it should be, because the greater the egress of the air, the less the pressure behind it; although some would say more work was being done and the working pressure should be higher. But one of the chief advantages of splitting the air is that with the same expenditure of power a larger volume of air can be moved. Now, if we open the imaginary door at (1) leading to Section "B," just a little, some of the air will escape and pass down through Section "B." We can open this door enough to allow the proportionate amount of air to pass. But now let us abandon the imaginary doors at (1) and (2), which were only supposed for the purposes of discussion and in their stead build a brattice, from the corner where the two air courses meet, out into the entry so as to cut the air coming from the air shaft, and make the last five or six feet of this brattice to swing as a door. This can be set to the right or left so as to regulate the proportionate flow of air to Section "A" or Section "B."

Thus far in this discussion the term "working pressure" has been used relatively and denoted the *unit* of working pressure or the pressure per sq. ft. of area. We will now multiply this unit of working pressure by the area of the entry coming from the air shaft before it is cut by the edge of the brattice. The product will give the moving power of the current or the motive force of the current, opposed to the total dynamic resistance of the mine. Now this motive power must be divided between the two sections of the mine in proportion to the resistances of those sections. And consequently the brattice must be swung so as to divide the area of the entry in the same proportion. It is well to note that the unit of working pressure changes as it passes the brattice or regulator and adapts itself to the enlarged sectional area of entry. The velocity of the current is also changed at this point.

This form of regulator splits the air current proportionate to its work and introduces no obstruction or increased resistance. In the present instance the regulator should be swung so as to divide the air in the ratio of 1 : 2 in favor of Section "A."

Yours, etc.,

J. T. BEARD,

Secy. State Board of Examiners.

Ottumwa, Iowa, Dec. 21st.

Correction.

Editor Colliery Engineer :

SIR :—I wish to thank "S. U. P." for pointing out my error in the December issue in my answer to his question. But if he will go over his solution again he will find that he has made a mistake also in the volume. The volume I obtained was 53,168′, if "S. U. P." were to carry his figures out to three decimal places the result would be 53,410′.

Yours, etc.,

L. P. H.

Avoca, Pa., Dec. 14th.

Ventilation.

Editor Colliery Engineer :

SIR :—Please publish the following question in your next issue so that some of your able correspondents may answer: If we have 6,250 cubic feet of air traveling in a mine through an area of 25 sq. ft., and wishing to have 22,500 cubic feet per minute in the mine with the same power, how large should the area be?

Yours, etc.,

CARBON.

Lemont Furnace, Pa., Dec. 14th.

Speed of Fans.

Editor Colliery Engineer :

SIR :—In Inspector G. M. Williams' report of the disaster at the No. 3 shaft, South Wilkes-Barre, he says. "In order to accomplish what was desired it was necessary to change and reverse the direction of the air current leading to the 'Stanton,' so that the smoke would be driven back towards the South Wilkes-Barre fan, therefore the South Wilkes-Barre fan was run up to a speed of 200 revolutions per minute."

Would Inspector Williams be kind enough to tell us what kind of a fan it was? I would also like to know what is the maximum speed of a 20 foot Guibal fan connected directly to the crank of a engine.

Yours, etc.,

WM. WEST.

United, Westmoreland Co., Pa., Dec. 14th.

Pumping.

Editor Colliery Engineer :

SIR :—In the August number of THE COLLIERY ENGINEER the following question was asked: "In a shaft 100 ft. deep, a pump is placed with 5 feet suction and 95 feet discharge. Will it require more or less power, if the pump is placed up the shaft with 20 feet suction and 80 feet discharge?"

Theory and practice support the fact that the power will be the same in either case, but the short suction will give the best results. Calculations on power to lift water must always be based on the vertical height from the point of lift to the point of delivery, no matter whether it is to be a long or short suction.

Yours, etc.,

ROBT. RAMSAY.

Mt. Pleasant, Pa., Dec. 14th.

Arithmetic.

Editor Colliery Engineer :

SIR :—Please insert the following in answer to question asked by "A. A.," of Buena Vista, Pa., in your last issue:

If we obtain 25,000 cubic ft. of air from a furnace and 22,000 cu. ft. from a steam jet, or other means, what will be the quantity of air if the two are acting together? The combined effect will be according to the square of the one quantity added to the square of the other, and extracting the square root of the product gives the result, or

$$\sqrt{25{,}000^2 + 22{,}000^2} = \text{answer.}$$

Then $25{,}000^2 = 625{,}000{,}000$, and $22{,}000^2 = 484{,}000{,}000$, and $625{,}000{,}000 + 484{,}000{,}000 = 1{,}109{,}000{,}000$, then

$$\sqrt{1{,}109{,}000{,}000} = 33{,}301 +.$$

Yours, etc.,

CARBON.

Lemont Furnace, Pa., Dec. 14th.

Haulage.

Editor Colliery Engineer:

SIR :—I would be pleased to have some of your correspondents give me their ideas as to the best way to work incline and kind of brake to use in the following question:

I desire to bring coal from an upper to a lower level by means of inclined plane and have the loaded cars pull back the empties; the distance is 3200′ and incline 5°. The distance being considerable, I want to let down as many cars as possible each trip.

Yours, etc.,

X. Y. Z.

Rock Springs, Wyo., Dec. 16th.

A Peculiar Mine Gas.

Editor Colliery Engineer :

SIR :—I beg leave to submit the following reply to John A. Carroll's question, page 106, of December issue:

From the odor of the gas and the fact of its being heavier than air, I judge it to be sulphureted hydrogen, a gas evolved from the decomposition of pyrites or mundic. In a mixture with air, a candle will burn, but, of course, not if plunged into the gas, for it has nothing on which to support combustion. A breath of it is debilitating, if not poisonous.

Inherently it is not dangerous, it forms no explosive mixture with air, but is indicative of heat, and is a symptom of spontaneous combustion. For in the decomposition heat is developed which threatens danger to coal and waste in isolated spots and goaves. A mine having this gas should be carefully watched for a local rise in temperature, and a correspondingly cooling. This gas weighs 96 lbs. per 1,000 cu. ft. (air 81 lbs.)

Yours, etc.,
M.

Golden, Colo., Dec. 13th.

Miscellaneous Questions.

Editor Colliery Engineer:

SIR:—Will some of your able correspondents favor me by solving and giving formulæ for the following questions:

(1). An airway 10′ × 10′ and 2,000′ long is passing 60,000 cu. ft. of air per minute, what would be the required area of an airway to pass 15,000 cu. ft. per minute its length being 1,800′, the pressure remaining the same?

(2). What is the least inclination of a self-acting incline 600′ long to run a set of cars in two minutes, the total weight of full set over empty set being 6,000 lbs., and the total friction on wheels, rope, etc., being $\frac{1}{10}$?

(3). What weight would an ordinary mine prop sustain, its length being 8′ and diameter 6″? Give formula and work out.

Yours, etc.,
J. W. S.

Westville, N. S., Dec. 14th.

The Practical Work of Engines.

Editor Colliery Engineer:

SIR:—The practical work of engines has been discussed by several correspondents during the past year in your columns but it does not seem to me that any very satisfactory conclusion has been reached. With your permission I will reopen the discussion.

It is important to have reliable rules by which to calculate the starting power and the hoisting or pulling power, and in my opinion the most useful rule is one to find the starting power. Whatever an engine will start it will surely pull.

"Theorist," in your August, 1891, number, correctly states the distinction between the static and dynamic aspects of the case, but it seems to me he is in error in other points.

In an engine about to start, or just starting, we may make an allowance for inertia and friction overcome which we call f or co-efficient friction of engine. In "Theorist's" first formula for "static equilibrium," I question the correctness of the first half, viz., 2 A a P C f.

This cannot in my view be true unless the cranks of engines are set at 180° or opposite each other. With engines at 90° apart as is the usual custom the position at starting will be one crank at top of stroke, the other on dead point, in which case we have only the action of one cylinder to consider.

In such case also we can use full boiler pressure since the throttle is wide open and the engine about to start. The internal resistances of engines is usually reckoned at 10% of power in locomotives and is probably not more in a good hoister. I would, therefore, call f = coef. friction of engine $\frac{1}{10}$. For resistances we have (1) the strain in rope produced by load (2) strain in rope, produced by resistance of sheave pulleys to turning on their axles and by the resistance of ropes to bending around pulleys and drum. These all act at circumference of drum and hence have leverage. "Theorist's" formula would therefore read:

$$A\ P\ C\ f = L\ R + R \text{ (strain in rope due to friction).}$$

If we assume (strain in rope due to friction) = $\frac{1}{28}$ load and solve with the dimensions given by "Equity" we have load = 6552 lbs., which is *not load*. For the dynamic case the simplest rule in words "total available pressure on cylinders × space traversed = resistances × space traversed." In this since one revolution of drum is produced by two complete strokes of each piston we can deduce from the formula expressed in terms of piston strokes and drum circumferences (or space traversed by resistance) the strain or load on the rope. If we call $f = \frac{1}{10}$ and rope friction $\frac{1}{28}$ load as before the formula should read

$$\left(L + \frac{L}{28}\right) D = 2\ A\ a\ P\ 2\ s\ \frac{9}{10},$$

which being solved with dimensions as above gives load = 8273 lbs. which is *not load*.

In such cases we have the action of both cylinders throughout full strokes and hence must use "average" or mean effective pressure.

For a geared engine the same rules apply, making proper provision for the gearing and correspondingly increased allowance for friction of gearing—say $\frac{1}{15}$ the pressure between teeth.

If an engine is geared 1 to 5 for example, then one revolution of drum means 5 revolutions of cranks or 10 strokes of pistons.

In determining size of engines for use under given conditions it would be wise to make a liberal allowance to insure ample power for all contingencies and emergencies.

If I understand "Equity's" case correctly it does not appear a fair test of his engine's starting power. His water box appears to be submerged in the sump at starting. If so, he has at the instant of starting only the weight of rope or 2956 lbs. by his figures (since the box will displace the bulk of water it contains) and if there is any buoyancy in the wood he may have even less. This case is analagous to starting a train of cars with slack couplings and is more a dynamical than a statical question. The load being added to the engine by successive increments.

If my reasoning herein is incorrect I would like to see others discuss the question that we may arrive at a definite and satisfactory conclusion.

Yours, etc.,
R. M. H.

Denver, Colo., Dec. 30th.

Thanks the Correspondents.

Editor Colliery Engineer:

SIR:—I feel that I must thank the many correspondents who took part in the discussion of "Examination Question"; that the temperature of the upcast shaft is 137° there is no doubt in my mind. My reason for expressing any dissatisfaction was only to draw out as full a discussion as possible as one of *the then* Board of Examiners contended that 119.9° was correct, as per Mauchline's rule on page 104, question 4, of his book. This did not agree with the teaching in our mining class, as we found temperature from weight of air. This difference of opinion tended to cause a division which was not wished for, hence the desire for a full discussion.

In reply to "F. B.," would say that I am not one of the unappreciable kind, I appreciate very much the information given in THE COLLIERY ENGINEER and esteem its usefulness and many of its correspondents.

Yours, etc.,
J. W. S.

Westville, N. S., Dec. 14th.

Arithmetic.

Editor Colliery Engineer:

SIR:—"A. A.," of Buena Vista, Pa., asks if some one will solve the following problem as found in Fairley's book:

$$\sqrt{25{,}000^2 + 22{,}000^2} = 33{,}301.$$

The square of 25,000 = 625,000,000, and
the square of 22,000 = 484,000,000,
adding, we have 1,109,000,000.

Now, the square root of 1,109,000,000 is found to be 33,301 as follows:

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          11'09'00'00'00 (33,301
           9
     63    209
           189
     663    2000
            1989
     66601    110000
               66601
               43399.
```

Yours, etc.,
J. S. K.

Canon City, Colo., Dec. 16th.

Ventilation and Mechanics.

Editor Colliery Engineer:

SIR:—Please insert the following answers to questions by "J. M.," of Morrisdale Mines, Pa., in your December issue:

(1). Assuming that a fan making 80 revolutions per minute produces 40,000 cubic feet of air, how much more would it produce if the revolutions were doubled?

It would produce 56,445½ cu. ft. per minute, which is found by proportion thus, as the square root of 80 is to the square root of 160 so is 40,000 to x, the required quantity, or

$$\sqrt{80} : \sqrt{160} :: 40{,}000 : x, \text{ or } 56{,}445\tfrac{1}{2}.$$

(2). How would you practically test the safety-catches of a cage in a shaft?

I would raise the cage, say, two or three feet above the top of the shaft, covering the mouth of the shafts with timber sufficiently strong to catch and hold the cage in case the safety-catches failed to hold the cage when the main bolt was drawn. Then knocking out the bolt, I suppose, would be the only true test that could be made.

Yours, etc.,
J. S. K.

Canon City, Col., December 16th.

The Necessity for Greater Technical Knowledge for Miners.

A subscriber in Allegheny County writing from the standpoint of an intelligent miner, says:

"There is considerable talk of reform in mining to be brought about by legislative enactments, which, while it may be right as far as it goes, is not the only way by which effective reforms can be accomplished. If all persons desirous of reform would begin at once by raising the standard of mining intelligence among the mining population, reforms would come much sooner, and they would be more effective.

"For instance, if every colliery official who has, by study, qualified himself for his position, would use his influence to get his miners to read such journals as THE COLLIERY ENGINEER, and to read carefully the annual reports of the Inspectors of Mines a vast amount of good work would be done. The Mine Inspectors' reports, which ought to be supplied to the miners, whom they would benefit, instead of to merchants and farmers, show in many different ways what causes led up to the accidents, and how they might have been prevented.

"Again, if the operators would make it a point not to employ as officials, men whose sole qualifications did not lie in the fact that they held certificates of competency; but to employ men who also had the faculty of governing workmen in such a way as to win their respect by taking an interest in them and by treating them as men, instead of men who seem to be the incarnation of petty meannesses, as are sometimes met with in official positions.

"If all colliery officials were men that would endeavor to increase the standard of intelligence among the miners, and would encourage them by example and kind words to lift themselves up to a higher plane, we would find in a short time such reforms brought about as legislative enactments would not accomplish in a generation, if at all. I think it is evident to all thoughtful men, that if we are to advance the most potent factor must be the better technical education of the miners.

"Before concluding, I cannot help commending your journal. I have taken it for several years, and it has been a great help to me.

"Your editorial articles have always convinced by their aggressive and comprehensive character, that the editors are fully informed in the science of mining, and they are continually laying before their readers descriptions of the improved methods of mining, and of modern research in connection with the working of collieries.

"As a miner, I must say, that if miners remain ignorant on the subjects relating to their calling while having such opportunities as your journal presents, the fault is their own.

"Hoping that all colliery officials may take more interest in recommending it to their workmen, I conclude with an earnest wish for a long and successful life for THE COLLIERY ENGINEER."

Important Change of Colliery Officials.

Mr. J. I. Hollenback, of Audenreid, Pa., who, for a number of years has been superintendent of the Lehigh and Wilkes-Barre Coal Co.'s collieries in the Lehigh region, resigned his position on the 30th ult. By order of President J. R. Maxwell, Mr. E. H. Lawall, Superintendent of the Wyoming division has been appointed General Superintendent of all the company's collieries. Mr. Lawall has appointed Mr. David R. Roberts, of Audenreid, Assistant Superintendent. He will have charge of the company's operations in the Lehigh region, and will report to and receive instructions from Mr. Lawall.

This widening of the authority of Mr. Lawall, and increase of responsibilities thrown on him by his superior officers is evidence that his efforts to advance the interests of the company and his efficient management of the Wyoming region collieries, have been highly appreciated.

A recent letter from the Jeffrey Mfg. Co., of Columbus, Ohio, states that they are having wonderful success in introducing their coal mining machines and drills, and their coal handling machinery. Their recent customers have been as follows:

MINING MACHINES, DRILLS, PUMPS, ETC.

Robbin's Coal Mining Company, Pittsburgh, 1 Mining Machine, 1 Power Drill; Sunday Creek Coal Co., Columbus, O., 3 Mining Machines, 2 Power Drills (second order); Gaslee & Lockwood, Evansville, Ind., 1 Power Drill; Hocking Valley Coal Co., Nelsonville, O. (Wm. Job, President, formerly General Manager of The Morris Coal Co.), 5 Mining Machines, 3 Power Drills; Union Colliery Co., Victoria, B. C., 1 Electric Mine Pump; Egyptian Mining Co., Du Quoin, Ill., 2 Power Drills; Harris Coal Co., Jobs, O., Additional Order 1 Mining Machine; Cambria Mining Co., Cambria, Wy., 5 Power Drills; Monongah Coal Coke Co. Monongah, W. Va., Additional Order, 1 Mining Machine; New Pittsburgh Coal Co.; Nelsonville, O., Additional Order 1 Power Drill; Glen Mary Coal Co., Glen Mary, Tenn., 3 Power Drills; Upson Coal Co., Shawnee, O., Additional Order 1 Mining Machine; H. D. Turney & Co., Columbus, O., Complete Electric Plant, consisting of Engines, Boilers, Electric Machinery, including the Jeffrey Mining Machines.

COAL HANDLING MACHINERY, ELEVATORS AND CONVEYORS.

Mt. Carbon Co., Mt. Carbon, W. Va.; Luhrig Coal Washing Co., Mt. Carbon, Ill.; North Bend Coal & Coke Co., North Bend, O.; Mud River Coal and Coke Co., Mud River, Ky.; Union Pacific Ry. Co., Rock Springs, Wyo.; Texas & Pacific Coal Co., Thurber, Tex.; St. Louis & Big Muddy Coal Co., Carterville, Ill.; New Pittsburgh Coal Co., Farmersburgh, Ind.; Louder Wooley Coal Co., Evansville, Ind.; Crystal Plate Glass Co., St. Louis, Mo.; St. Louis Ore and Steel Co., Murphysboro, Ill.

Aerated Crude Petroleum.

The use of aerated crude petroleum as fuel in place of coal is rapidly extending, and very many of the largest concerns in this country whose work requires the employment of an intense heat have adopted this system. The chief lines of work for which it has been introduced are iron and steel forging, tempering, welding, annealing, etc., in glass works, for furnaces, glory holes, lears and ovens; for generating steam, burning lime, burning sewer pipe, heating asphalt, tinning and japanning, oxydizing lead, heating retorts in gas works, etc.

An efficient and economical air compressor is a most important factor in the successful operation of these plants, and after a careful examination of the various types of these machines now on the market, the majority of the licensees who were intrusted with the introduction of this new fuel in their several districts, decided to adopt a special design submitted by the Clayton Air Compressor Works, of 43 Dey Street, New York; thus scoring another triumph to the already long list achieved by the makers of these unrivaled machines.

They are now in use in over two-thirds of the oil burning fuel plants in the country, everywhere performing their duty in a manner to merit the highest praise.

MODEL SHAFTS.

Lehigh and Wilkes-Barre Coal Company Officials, visit the Philadelphia & Reading Coal & Iron Co.'s Model Shafts in the Schuylkill Region.

As the Lehigh and Wilkes-Barre Coal Co. will shortly begin to sink a large and deep shaft at Ashley, Pa., and as two new breakers are also in contemplation by the same company, Mr. E. H. Lawall, Genl. Supt., decided that it would be to the interest of his company for himself and subordinate officials to visit the most recent improvements of the Philadelphia and Reading Coal and Iron Co., in the Mahanoy Valley. By such a visit improved ideas in shaft sinking and timbering, arrangement of tracks, and in breaker construction could be inspected and the knowledge gained could be utilized for the benefit of the L. & W.-B. Coal Co. An additional incentive was, that the two shafts to be visited were sunk by contractor John Evans, of Shenandoah, who has secured the contract to sink the Ashley Shaft, and an opportunity was offered to inspect the character of his work.

Accordingly on the morning of the 19th ult., a party consisting of the following persons boarded the Lehigh and Wilkes-Barre Coal Co's. special car at the Jersey Central station at Wilkes-Barre:

E. H. Lawall, Gen. Supt., Lehigh & Wilkes-Barre Coal Co.

W. J. Richards, Chief Engr., Lehigh & Wilkes-Barre Coal Co.

Morgan Morgan, Inside Supt., Lehigh & Wilkes-Barre Coal Co.

W. H. Herring, Outside Supt., Lehigh & Wilkes-Barre Coal Co.

Gib Stewart, Master Mech., Lehigh & Wilkes-Barre Coal Co.

H. W. Saums, Asst. Outside Supt., Lehigh & Wilkes-Barre Coal Co.

E. W. Marple, Auditor, Lehigh & Wilkes-Barre Coal Co.

C. H. Gardner, Shipper, Lehigh & Wilkes-Barre Coal Co.

D. Cottle, Chief Clerk, Lehigh & Wilkes-Barre Coal Co.

J. Davenport, Dispatcher, Lehigh & Wilkes-Barre Coal Co.

W. F. Dodge, Ex-Chief Engr., Lehigh & Wilkes-Barre Coal Co.

C. L. Lippincott Asst. Supt., L. & S. R. R.

J. C. Brastow, Master Mech., Ashley Shops.

G. M. Williams, Inspector of Mines, Fourth Anth. Dist.

James Pollock, Mechanical Engr., and Rufus J. Foster, of The Colliery Engineer.

The car was attached to engine No. 49, and was run via Mauch Chunk and Tamanend to Mahanoy City, where a brief stop was made, and the following gentlemen joined the party:

Geo. S. Clemens, Div. Engr., P. & R. C. & I. Co.

H. M. Luther, Asst. Engr., P. & R. C. & I. Co.

F. P. Weiser, Asst. Engr., P. & R. C. & I. Co.

Christ Muelhof, Master Breaker Builder, P. & R. C. & I. Co.

Noah Owens, Outside Foreman, Indian Ridge Colliery, P. & R. C. & I. Co.

Wm. Stein Inspector of Mines of the Seventh Anth. Dist., and David R. Roberts, of Audenried, the newly appointed Asst. Supt. of the L. & W.-B. Coal Co.

The run to Maple Hill Shaft was made in a few minutes, and here the party was joined by Genl. Inside Supt. John Veith. Asst. Engineer J. H. Pollard, Div. Supt. Jno. L. Williams, Dist. Supt. Jno. G. Davis, and Master Mechanic George Simmons, of the P. & R. C. & I. Co.

The Maple Hill Shaft is situated near St. Nicholas, two miles west of Mahanoy City. It is 719 ft. deep to the Top Split of the Mammoth seam. It is rectangular in shape and has two hoistways and a pumpway. It is one of the most substantial colliery openings in America. The timbering throughout the whole length of the shaft is massive and regular, and its alignment is perfect. The turnouts at the foot are roomy and are timbered with massive squared timbers coated with whitewash. The timbering of these turnouts was done in a particularly careful manner, every set being carefully lined up so that the faces of the legs are exactly parallel with the center lines of the tracks, and the bottoms of the collars are parallel with the gradients of the tracks. The tracks were laid out by the company's engineers, who were careful to arrange easy and regular curves, and such gradients as would conduce to the easy handling of the large output to be annually produced.

All the loaded cars are delivered to the east turnout, and are run by gravity on to the cages, automatic safety catches preventing them from running into the cage pit after the cage has left the bottom. The empties are run off the cages on to the West turnout by gravity, and run by gravity to an inside chain hoist in the rock which elevates them to a point from which they run by gravity to a sort of underground yard, where trips are made up for the various main gangways. The shaft, as was stated before, is sunk to the Top Split of the Mammoth seam, which is 14 ft. thick. Tunnels through the rock cut the Holmes seam, 8 ft. thick; the Middle Split of the Mammoth, 10 ft. thick; the Bottom Split of the Mammoth 16 ft. thick; the Skidmore, 7 ft. thick; the Seven Foot, 7 ft. thick; and the Buck Mt., 16 ft. thick. The tunnels cut all these seams on both the North and South dips, and all seams are in excellent condition.

The breaker, which has just been completed, is an exceptionally fine structure with sides and roof of corrugated iron. It is roomy and light, and is fitted out with the most improved appliances for perfect and rapid cleaning and sizing of coal. It has a capacity of 2,500 tons per day, and was designed and built under the supervision of Master Breaker Builder Christ Muelhof, who is justly proud of his work.

The coal is hoisted out of the shaft by a pair of direct-acting engines with 30-inch cylinders, 60-inch stroke, and 12 feet diameter drum. The mine cars will run from the shaft to the breaker tip by gravity, and, after dumping, they will be hauled up a short incline, by an endless chain, and from the summit of the incline they will run by gravity back to the west side of the shaft, from whence they run by gravity on to the cages. The officials of the Philadelphia and Reading Co. are to be congratulated on the convenient arrangement and substantial construction of this colliery, and Inspector Stein claims that it is the best arranged colliery in the Anthracite regions.

This colliery will be one of the largest shippers in America. It is one of a group of three belonging to the P. & R. C. & I. Co., viz.: the Ellangowan, the Maple Hill, and St. Nicholas, all located within a short distance of each other, which have a combined capacity of about 1,250,000 tons per year, and all three will have an average life of twenty-five years.

After viewing the colliery in all its parts, the party boarded the car, and enjoyed a splendid lunch provided by Mr. Lawall. While disposing of it, the car was run to Shenandoah, via Mahanoy Plane, and the Shenandoah City Shaft, which is modeled on the same lines as the Maple Hill Shaft, was visited, as were also the Shenandoah City strippings. An instructive and pleasant hour was spent here, and a large party went down the shaft under the guidance of District Superintendent John Bradigan. From Shenandoah the car was run to the Patterson Anthracite Mining Co.'s new colliery at Natalie, near Mount Carmel, but as so much time had been spent at Maple Hill and Shenandoah, the schedule arranged by the railroad officials compelled the visit here to be limited to ten minutes, and but a hasty view of the outside improvements was possible. The return journey was commenced then, and after dropping off the P. & R. officials at different points along the Mahanoy Valley, the train arrived at Wilkes-Barre at 9.45 P. M., all on board having enjoyed both a delightful and instructive trip. The Lehigh and Wilkes-Barre Coal Co. are, as was stated before, about to start sinking a shaft at Ashley, which will be 960 ft. deep to the Red Ash Vein. It will have an area for 420 ft. of its length, to the Baltimore seam, of 54′ x 13′ and from the Baltimore to the Red Ash of 27′ x 13′ ft. There will be two hoistways and a pump way to each seam. Two new breakers are also in contemplation by this company, and Messrs. Lawall and Richards feel amply repaid for the trip in the ideas they gathered by the visit to Maple Hill and Shenandoah, and it is safe to say that they will not only adopt some of them, but will be able to add to them in the new work about to be started under their direction.

Such visits are, beyond doubt, of great value to colliery officials and the company they represent, as new ideas are secured and improvements seen, invariably suggest others to them, which can be utilized to advantage in proposed new work.

Daniel Bertsch.

Daniel Bertsch, the president of the Upper Lehigh Coal Co., died on the 17th ult. at the residence of his sister, Mrs. E. Polk, at Mauch Chunk, Pa. He was in the 65th year of his age, and was a native of Mauch Chunk. Death was caused by an affection of the heart, after a sickness since early in October.

The deceased was the eldest son of the late Daniel Bertsch, who during his lifetime was closely identified with the building of the works of the Lehigh Coal & Navigation Company. Mr. Bertsch was a thorough mathematician, and at an early age entered the service of the Navigation Company, in the engineering department, under the late E. A. Douglass. He became identified with the Upper Lehigh Company in 1865, and was its first president. Later he was chosen its superintendent, and this position he held at the time of death.

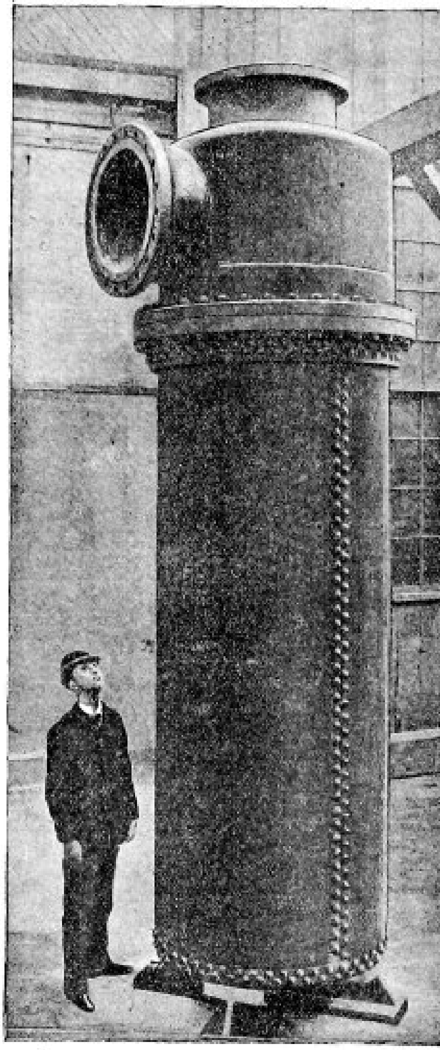
He was also a director of the First National Bank of Mauch Chunk, the Nescopec Coal Company, the Pioneer Mining and Manufacturing Company, of Alabama, and the Mauch Chunk Electric Light Company. He died possessed of large means, with which during life he contributed largely toward all enterprises that benefited his fellows. He was one of the main supports of the Young Men's Christian Association of Mauch Chunk. He was unmarried and is survived by only two sisters; Mrs. E. Polk, and the wife of Associate Judge Samuel B. Price, of Carbon County, Pa.

Sale of a Curious Letter.

A curious letter of Sir Humphrey Davy's has been knocked down at a sale of autographs in Paris. It is dated February 8, 1817, and in it the writer accuses George Stephenson of having appropriated his idea of the safety-lamp. Speaking of the allegations contained in Stephenson's pamphlet on the subject, Davy says that it was in October, 1815, that he was working in his laboratory in London when he hit upon the idea of the tubes with which the lamp was constructed. He protests that he never intended, as Stephenson alleged, to make use of capillary tubes. "To make a lamp that will burn with three capillary tubes," he adds, "is as impossible as to make it burn in a close decanter." The letter was bought by some scientific enthusiast for 105 francs. At the same sale a letter of Madame Sarah Bernhardt fetched only 12 francs, but Alfred de Musset was valued at 128 francs, and David, the painter, at 205 francs.

AN IMMENSE STRATTON SEPARATOR.

The illustration shows what is believed to be the largest separator ever built for separating water from dry steam. It was built by the Stratton Separator Company, of New York City, for the Calumet and Hecla Mining Company, miners of copper ore on Lake Superior, Mich. It was constructed under the strictest requirements, and according to the specifications of Mr. E. D. Levitt, consulting engineer of the Calumet and Hecla Mining Company. It is doubtful if a more perfect piece of work could be constructed.



This immense separator is 3 feet 8 inches in diameter, 14 feet 5 inches in length over all, for a steam pipe of 21 inches diameter, and designed for a working pressure of 185 pounds.

The shell is made from a single sheet of steel, and the top of cast gun metal.

The Stratton Separator Company have furnished the Calumet and Hecla Mining company several separators for high pressure, that seen in our illustration being the most notable.

Steam separators are now being recognized as a necessary adjunct of a perfect steam plant; the absolute certainty that none but dry steam will reach the engine being duly appreciated by every engineer, and we take pleasure in illustrating a remarkable example of one of the best known forms of separators in the market.

Increased Coal Shipments.

The Pennsylvania Coal Co., under the efficient management of the veteran Jno. B. Smith, Esq., has during the year 1891 shipped to market 1,421,581·05 tons of coal, an increase of 267,485·05 tons over the shipments of 1890. This handsome increase of nearly 16% over the shipments of 1890 is abundant evidence of the managerial capacity of Mr. Smith, and the efficiency of his subordinate officials.

The Colliery Engineer.

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ALEX. DICK, MINING ENGINEER, ASSISTANT EDITOR.
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THE COLLIERY ENGINEER COMPANY,
Coal Exchange,
Scranton, Pa.

Cable Address—"Retsof, Scranton."

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SOME POINTS OF DIFFERENCE BETWEEN THE ENGLISH AND ANTHRACITE MINE LAWS.

THESE two mine laws are constructed to suit the requirements of two different sets of conditions, and for this reason there are many points in each which could not well be common to both. There are, however, a number of differences which relate to the principles of mining, and directly affect the safety of the workmen, a consideration of which is interesting.

In the matter of ventilation, for instance, the quantity of air required per man is differently treated.

The Anthracite Mine Law of Pennsylvania says:

"The minimum quantity of air produced shall not be less than 200 cubic feet per minute for each and every person employed in any mine, and as much more as the circumstances may require.

The ventilating current shall be conducted and circulated to and along the face of each and every working place throughout the entire mine in sufficient quantities to dilute, render harmless, and sweep away smoke and noxious or dangerous gases to such an extent that all working places and traveling roads shall be in a safe and fit state to work and travel therein."

In the English Mine Law it says:

"An adequate amount of ventilation shall be constantly produced in every mine to dilute and render harmless noxious gases to such an extent that the working places of the shafts, levels, stables, and workings of the mines, and the traveling roads to and from these working places shall be in a fit state for working and passing therein."

There does not seem, at first glance, to be any material difference in these two enactments with the one exception, that the Anthracite Mine Law requires 200 cubic feet per man per minute as a minimum, whereas the English Law requires "an adequate amount * * * to dilute and render harmless." This definite minimum is a mistake in principle. Any one connected with mining knows that where in one mine 200 cubic feet per man per minute is ample, in another it is far from sufficient. It is very difficult to compel some operators and mine superintendents to supply a quantity greater than the minimum demanded by the law, whereas if an *adequate amount* is required by the law the inspector has the power in his own hands to fix the amount. It may be contended that the Anthracite Mine Law also requires "sufficient quantities to dilute, render harmless, and sweep away smoke or dangerous gases." If this be the intention of the law why not say so and be done with it without putting in a clause providing for 200 cubic feet per minute and thus affording an opportunity for any one to violate the spirit of the law while obeying the letter of it.

It is, however, in the regulations relating to the storage and use of powder in mines that the greatest differences are noticeable between the two laws.

The Anthracite Mine Law says:

RULE 26. Gunpowder or any other explosive shall not be stored in a mine, and a workman shall not have at any one time, in any one place, more than one keg or box, containing twenty-five (25) pounds unless more is necessary for a person to accomplish one day's work.

RULE 27. Every person who has gunpowder, or other explosive in a mine shall keep it in a wooden or metallic box, securely locked, and such box shall be kept at least ten (10) feet from the tracks in all cases where room at such a distance is available.

RULE 28. Whenever a workman shall open a box containing explosive, or while in any manner handling the same, he shall first place his lamp not less than five (5) feet from such explosive and in such a position that the air-current cannot convey sparks to it, and a workman shall not approach nearer than five (5) feet to an open box containing powder with a lamp lighted, pipe, or any other thing containing fire.

RULE 29. When high explosives other than gunpowder are used in any mine, the manner of storing, keeping, moving, charging, and firing, or in any manner using such explosives shall be in accordance with special rules as furnished by the manufacturers of the same. The said rules shall be endorsed with his or their official signature and shall be approved by the owner, operator, or superintendent of the mine, in which such explosives are used.

RULE 30. In charging holes for blasting in slate or rock in any mine, no iron or steel-pointed needle shall be used and a tight cartridge shall not be rammed into a hole in coal, slate, or rock, with an iron or steel tamping bar, unless the end of the tamping bar is tipped with at least six (6) inches of copper, or other soft metal.

RULE 31. A charge of powder or any other explosive in slate, or rock, which has missed fire, shall not be withdrawn or the hole reopened.

English Law says:

Any explosive substance shall only be used in the mine below ground as follows:

(*a*). It shall not be stored in the mine.

(*b*). It shall not be taken into the mine, *except in cartridges in a secure case or canister containing not more than five pounds.*

(*c*). A workman shall not have in use at any time in any one place more than one such case or canister.

(*d*). In the process of charging or stemming for blasting, a person shall not use *or have in his possession* any iron or steel pricker, scraper, charger, tamping rod, or stemmer, nor shall coal or coal-dust be used for tamping.

(*e*). No explosive shall be forcibly pressed into a hole of insufficient size, and, when a hole has been charged, the explosive shall not be unrammed, and *no hole shall be bored for a charge at a distance of less than six inches from any hole where the charge has missed fire.*

We have italicized those parts of the English Law to which we wish to draw special attention. From these it will be seen that the conveyance of loose powder and consequent making of cartridges underground is forbidden.

When a miner is making a cartridge he requires a good light. It is a delicate operation and requires careful performance. A defective cartridge is dangerous, and considerable time is lost to the workman if the shot is not effective. There is therefore every temptation to a man to have his lamp close to him when making a cartridge and although the Anthracite Mine Law provides that he place his lamp at least five feet from him when doing this work, the accidents from this cause as given in the Mine Inspectors' Reports show that this provision of the law is not observed. This could all be obviated if the making of cartridges underground were forbidden. We have not the exact figures to go on but we can confidently state that the number of accidents from explosions of powder underground in England is very much below that in the Anthracite regions of Pennsylvania even when allowance is made for the proportionately greater amount of powder used in the latter.

In Great Britain a compressed powder is coming much into use. It is made up in bobbins about 3 inches long and slightly less in diameter than the drill. There is a hole through the center of the bobbin of sufficient size to admit the fuse, and the miner can put in any number of bobbins according to the power of charge required.

Regarding the difference in the quantity of powder allowed to each man there is this to be said, that the amount which would be sufficient in working Bituminous coal, would be quite inadequate in working Anthracite.

The English Law forbids any man to have iron or steel tools used in blasting *in his possession*. The Anthracite Mine Law says: "*In charging holes for blasting in slate or rock* no such tool shall be used." Both laws forbid the practice of forcing a tight cartridge into a hole, and they also prohibit unramming. A perusal of the summary of the accidents from blasting in Pennsylvania Anthracite Mines in 1889 and 1890 given below will show the necessity of removing temptations by forbidding such tools as steel tampers, etc. The English Law prohibits the use of coal dust in tamping. This is a wise precaution in the light of recent investigations which prove that such tamping elongates the flame of the blast and increases the possibility of an explosion. The clause in the English law to prohibit boring a new hole within a certain distance of a missed shot is also of importance. In the Seventh Anthracite District in 1889 by misdirection a hole was drilled into a shot which had missed fire with the result that five men were injured, one fatally. The Inspectors' report does not say how far the two holes were apart at the commencement but too much caution in such matters cannot be exercised.

The following table gives the number of accidents due to blasting operations in the Anthracite districts of Pennsylvania in 1889 and 1890:

Year.	Total accidents during year.	Total accidents due to blasting.	
		Number.	Percentage.
1889	1382	118	8·53
1890	1391	105	7·54
Total	2773	223	8·06

It will be seen that during the two years 8 per cent. of all the accidents was due to blasting operations. After eliminating a majority which were due to premature explosions, 50 remain which have been caused as follows:

Filling cartridges, or using powder with a lamp on head 23
Penetrating cartridge with needle, to put in a new squib or attempting to drill out tamping 17
Forcing in cartridge 10

These 50 accidents are the result of direct violation of the law. It is painful to read time after time in the Inspectors reports that these men attempted to fill a cartridge or handle powder with a naked light on their heads. Such an action in any other walk of life would be called suicidal and it is the duty of the law to put out of the reach all temptations to a practice which is so very dangerous.

THE MECHANICAL EDUCATION OF STATIONARY ENGINEERS EMPLOYED AT COLLIERIES.

IT requires special training before a man can construct a piece of machinery, and yet many people have an idea that after the engine has been built any one can run it. That is why so many of the overwinding accidents at mines occur, and the whole pit is liable to be thrown idle for some one's want of knowledge of the principles of mechanics. The stoker who fires the boilers, the greaser who lubricates the machinery, the mechanic who looks after the shaft fittings and ropes, and the engineer who stands at the throttle valve, are all responsible for the lives of every man at work underground. A hitch in the steam supply, a nut or a pin loose somewhere, a section of machinery unlubricated, even if of no apparent importance to an uneducated mind, may cause a sudden and prolonged stoppage of the ventilating fan and it does not require that state of matters to exist for any length of time to cause a general blow up.

It is necessary, therefore, that every engineer and pumpman should know the principles of mechanics to enable him to attend to his work intelligently, and we predict that the day is not far distant when every man who is in charge of machinery at a mine will be required to obtain a certificate just as those who are in charge underground do at present. And this will be only right. Of what benefit is a certificated man underground as a guardian of life and property if an incompetent person is allowed to play ducks and drakes with the machinery on the surface? This argument is well known and appreciated by many stationary engineers and pumpmen, and it is for the purpose of affording these men a cheap and complete system of education in their special line of business that we have founded The Colliery Engineer School of Mines Complete Mechanical Scholarship.

Each student who goes through the Mechanical Course, which includes Arithmetic, Mechanics, Mechanical Drawing, Ambulance, Mining Legislation, and Mine Accounts, and passes a successful final examination in these subjects, will be awarded The Colliery Engineer School of Mines Mechanical Diploma.

This diploma is of great value to the holder, as it is a guarantee of his knowledge of the laws of mechanics and machine construction, and of his ability to make a mechanical drawing from notes and dimensions taken.

In the State of New York stationary engineers are required to pass an examination as to their competency, and this course of study will give them the required knowledge. As we have already said, the time will soon come when every engineer at a colliery will have to pass such an examination.

All the instruction in the mechanical course is conducted by correspondence and the student is not required to leave his home to study. Each student is a class by himself, and he can proceed with the course as rapidly or as slowly as he may desire, he will have no text-books to purchase, as the Instruction and Question Papers are all the text-books required. All engineers, pumpmen, firemen, or others desirous of advancing their knowledge of mechanics should send a postal card for a Prospectus of The School of Mines, now in operation with over one hundred students from almost every State in the Union and the British Provinces.

EDITORIAL NOTES.

PROF. C. Le Neve Foster, in his inaugural address to the students at the "Royal College of Science," London, which is the new title of the "Royal School of Mines" deplored the absence of a sort of mining *Review of Reviews* as it was impossible for all but those having abundant leisure to pursue the mass of valuable literature which is now placed before the professional mining men. Prof. Foster thinks that even a catalogue of the articles which appear will be of great value.

It is to meet this requirement that we have introduced the department called the Progress in Mining, and we feel sure that the aid it gives busy men in keeping acquainted with the latest improvements and discover ies related to mining is already thoroughly appreciated.

WE congratulate our enterprising contemporary, *The Black Diamond*, of Chicago, on its change from a semi-monthly to a weekly. The editors and publishers have recognized the fact that the coal market is in such a condition that trade news, to be of most value, must be published at least once a week, hence the change.

The first weekly issue presents a handsome appearance, and is brimful of interesting and well selected news for the trade. It is a credit to the editorial force, and we wish them abundant success in their new departure.

The Anthracite Trade.

The Anthracite trade during the past month has been very dull, and this was due to the remarkably mild weather. Had the weather been seasonable there is no doubt but that there would have been a very heavy December business done. Now, however, it is considered between seasons by the trade, and the demand will depend almost entirely on the weather until the spring trade opens. Stocks as a rule are low, and in case this month gives us a continued spell of cold weather many dealers will be caught short and there will be a temporary brisk demand for coal.

The production for the year 1891 will approximate 45,000,000 tons, of which about 40,000,000 was shipped to market. This shows an increase of about 6,000,000 tons over the production of 1890.

As the stocks on hand at tide water shipping points are within 100,000 tons, the same as they were at the beginning of last year, it is evident that the coal shipped has all gone into consumption.

At the beginning of last year there was a surplus of coal at all the prominent markets, and retail dealers were carrying large stocks. This year there is not so large an amount at the markets, but there are large amounts stocked along the lines of the different roads.

The production for January has been placed by the sales-agents at 2,500,000 tons.

The Bituminous Trade.

The Bituminous coal trade, like the Anthracite, has been dull during the past month, owing to the continued mild weather. Stocks on hand are sufficiently large to meet all demands, and from now on till the Spring trade opens, the amount of business done will depend on the weather.

The tonnage produced during the past year, like the Anthracite, will be largely in excess of the tonnage of 1890.

The Coke Trade.

The Connellsville coke trade remains in about the same condition as last month, but it is impossible for anyone to say how much longer it will continue so. Prices remain as follows:

Furnace coke, $1.90; foundry, $2.30; crushed, $2.65; all f.o.b. cars at ovens, per ton of 2000 lbs.

NEW MINING COMPANIES.

Names and Post-Office Addresses of the New Mining Companies Incorporated in the United States Since our Last Issue.

Madison Coal Co.,	Glen Carbon, Ill.
Ozark Lead & Zinc Co.,	East St. Louis, Ill.
Hayden Hill Consolidated Mining Co.,	Bieber, Lassen Co., Cal.
The Miamisburg Mining & Manufacturing Co.,	Miami-burg, Ohio.
The Buckhorn Syndicate Mining Co.,	St. Paul, Minn.
The Azure Mining Co.,	Silver City, N. Mex.
Little Tycoon Mining Co.,	Burlington, Iowa.
Graham Nickel Mining Co., of Chicago,	Chicago, Ill.
Royal Purple Mining Co.,	Joseph, Oregon.
Lithomar Milling Co.,	Alexandria, Va.
Morning Milling Co.,	Milwaukee, Wis.
The Maravillas Mining Co.,	Philadelphia, Pa.
The Jade Mining Co.,	Denver, Colo.
The Colorado City and Manitou Prospecting & Mining Co.,	Colorado, Colo.
The Mount Powell Mining Co.,	Cleveland, Ohio.
Lo Lo Chickmaim Mining Co.,	Lo Lo, Missoula Co., Mon.
Galvin Milling Co.,	Helena, Mon.
The Peralta Consolidated Mining Co.,	Denver, Colo.
The Union Pacific Coal Co.,	Denver, Colo.
Kaministigue Iron Co.,	Minneapolis, Minn.
The Chicago Floated Silica Co.,	Chicago, Ill.
Royal Mining & Milling Co.,	Chicago, Ill.
The Humbolt Mining & Milling Co.,	St. Louis, Mo.
The Gold & Globe Hill Mining Co.,	Colorado Springs, Colo.
Kenova Coal Co.,	Kenova, W. Va.
La Plata Mountain Mining & Milling Co.,	New York, N. Y.
Byron Gold Mining Co.,	Deering Me.
The Illinois Phosphate Co.,	Chicago, Ill.
National Mining and Development Co.,	Spokane, Wash.
Mexican Hidalgo Zaragoza Gold and Silver Mining Co.,	San Francisco, Cal.
Standard Quicksilver Co.,	San Francisco, Cal.
The Homer Coal & Mining Co.,	Jersey City, N. J.
Ka-Ki-na Iron Co.,	Duluth, Minn.
Bitter Root Canal & Mining Co.,	Butte, Mon.
The Lillian Mining Co.,	St. Louis, Mo.
Jupeter Mining Co.,	Ashland, Wis.
Montfort Mining Co.,	Montfort, Wis.
Heckle Mining Co.,	Wallace, Idaho.
Standard Mining Co.,	Wallace, Idaho.
Kentucky Mineral and Timber Co.,	Jersey City, N. J.
The Cripple Creek Consolidated Mining Co.,	Colorado Springs, Colo.
The Mowenqua Coal Mining & Manufacturing Co.,	Moweaqua, Ill.
S. B. Mining Co.,	Santa Fe, N. Mex.
Pacific Mining Exchange,	San Francisco, Cal.
Sheridan Iron Co.,	Duluth, Minn.
The Coshocton Coal Co.,	Cleveland, Ohio.
The Sadler Lead & Zinc Co.,	Bethlehem, Pa.
The West Fork Coal & Coke Co.,	Fairmount, W. Va.
The Slumbering Bonanza Mining Co.,	Deadwood, S. D.
Wilmams' Mining Co.,	Seattle, Wash.
The Twin Metals Mining & Milling Co.,	Pueblo, Colo.
The Fasset Mining & Milling Co.,	Denver, Colo.
The 4-One Mining Co.,	Chicago, Ill.
National Coal & Mining Co.,	Dallas, Texas.
The Waverly Mining Co.,	East St. Louis, Ill.
The Gurney Mining & Milling Co.,	Denver, Colo.
The Pueblo Cement Plaster Co.,	Pueblo, Pueblo Co., Colo.
The Idaho Development Co.,	Bonner's Ferry, Idaho.
The Antelope Valley Marble Co.,	Fairmount, Cal.
Meramec Onyx & Metal Co.,	Boston, Mass.
National Lead Co.,	Jersey City, N. J.
The Bilharz Ore Process Co.,	Jersey City, N. J.
The Bryn Mawr Land & Improvement Co.,	Seattle, Wash.
The Pawnee Mining & Milling Co.,	St. Elmo, Colo.
Limbark Natural Gas & Oil Co.,	Dunkirk, Ind.
The Sterling Coal & Coking Co.,	Columbus, Ohio.
Alpha Slate Co.,	Bangor, Pa.
North American Oil Co.,	Bradford, Pa.
Muskogee Coal & Mineral Co.,	Fort Smith, Ark.
Empire Mining Co.,	Tacoma, Wash.
Pearsall Mining Co.,	Seattle, Wash.
The Forge Hill Mining Co.,	Plainfield, N. J.
Rutland County Marble Co.,	West Rutland, Vt.
Gordon City Mining, Milling & Improvement Co.,	New York, N. Y.
The Pittsburgh Iron Co.,	Duluth, Minn.
The Bachelor Mining Co.,	Denver, Colo.
The Gold Cup Mining Co.,	Denver, Colo.
The Armdue Mining Co.,	Denver, Colo.
The B. V. Mining Co.,	Colorado Springs, Colo.
The Commercial Gold & Silver Mining Co.,	Leadville, Colo.
Capitol Phosphate Co.,	Ocala, Fla.
The Central Florida Phosphate Co.,	New York, N. Y.
American Oil Co.,	Los Angeles, Cal.
Eclipse Mining Co.,	San Francisco, Cal.
Electric Reduction Co.,	Albuquerque, N. Mex.
Dunlow Coal Co.,	Dunlow, W. Va.
The Bullion Queen Mining Co.,	Denver, Colo.
The Western Pipe & Brick Co.,	Golden, Colo.
The Broken Hill Mining Co.,	Denver, Colo.
Excelsior Phosphate Co.,	Jacksonville, Fla.
Saddle Creek Phosphate Co.,	Vicksburg, Miss.
Pharr Phosphate Co.,	Bartow, Fla.
Fresno Oil Co.,	Los Angeles, Cal.
Mabel Consolidated Mining Co.,	Downieville, Cal.
The Mutual Mining & Milling Co.,	Colorado Springs, Colo.
The Alderson Land & Development Co.,	Charleston, W. Va.
The Welcome Mining Co.,	Anaconda, Mon.
Siloam Springs Mining & Prospecting Association,	Siloam Springs, Ark.
Terre Haute Mineral Paint Co.,	Terre Haute, Ind.
Bald Mountain Consolidated Mining Co.,	Oakland, Cal.
The Little Tycoon Mining Co.,	Burlington, Iowa.
The Ore Fine Mining & Milling Co.,	Louisville, Ky.
The Barker Mining & Milling Co.,	Denver, Colo.
The Roderick Dhu Mining & Milling Co.,	Denver, Colo.
Carlisle Mining & Paint Mfg. Co.,	Carlisle, Pa.
Garnet Gold Mining Co.,	East St. Louis, Ill.
Ashland Mining Co.,	Portland, Oregon.
Hidden Treasure Silver Mining Co.,	Minneapolis, Minn.
Shaw Iron Co.,	Duluth, Minn.
The Colorado Copper Co.,	Chicago, Ill.
The International Mica & Phosphate Co.,	New York, N. Y.
The Ulster Granite Co.,	New York, N. Y.
Georgia Pyrites Co.,	Kittery, Me.
The Penasco Reservoir & Irrigation Co.,	Eddy, N. Mex.
The Western Indiana Coal Co.,	Terre Haute, Ind.
Valencia Mining Co.,	Norway, Mich.
The Phoenix Gold Mining Co.,	East St. Louis, Ill.
White Ash Coal & Mining Co.,	Dallas, Texas.
Green River Coal & Coke Co.,	Seattle, Wash.
The Washington Decorative Marble Co.,	Spokane, Wash.
The Quartz Hill Gold & Silver Mining Co.,	Denver, Colo.
Vista Coal Co.,	Pittsburgh, Pa.
Missoula and Victor Mining Co.,	Missoula, Mon.
The Somerset Mining & Milling Co.,	Denver, Colo.
Maine Asbestos Land, Mining, & Smelting Co.,	Portland, Me.
The Indiana Cement Co.,	Jeffersonville, Ind.
Baker City Gold & Silver Mining Co.,	Baker City, Oregon.
Washington Gulch Mining Co.,	Portland, Oregon.
Irvin Mining Co.,	San Francisco, Cal.
The New York Underwriters & Indemnity Association,	Jersey City, N. J.
Moonshine Mining Co.,	Joplin, Mo.
Bainbridge Placer & Quartz Mining Co.,	San Francisco, Cal.
Big Creek Iron Co.,	Mauston, Wis.
Claire Mining Co.,	Milwaukee, Wis.
Briar Hill Coal & Coke Co.,	Fairmount, W. Va.
Brooklyn Coal Co.,	Rush Run, W. Va.
The Minneapolis Mining & Milling Co.,	Minneapolis, Minn.
Continental Phosphate Co.,	Ocala, Fla.
Montana Gold & Gem Exploration Co.,	Helena, Mont.
The Monarch Coal Mining Co.,	New Whatcom, Wash.
Rich Hill Coal & Coke Co.,	Tacoma, Wash.
Osceola Phosphate Co.,	Albion, Fla.
Long Shot Mining Co.,	Chicago, Ill.
Alcazar Mining Co.,	Chicago, Ill.
Gate City Smelting Co.,	Jersey City, N. J.
Commercial Coal & Coking Co.,	Clarksburg, W. Va.
The North Carolina Smelting Co.,	Newark, N. J.
Freeport Gas Co.,	Freeport, Shelby Co., Ind.
The Little Howard Mining Co.,	Denver, Colo.
The Mexico Onyx Quarry Co.,	Denver, Colo.
The Colorado Bonanza and Union Tunnel & Mining Co.,	Central City, Gilpin Co., Colo.
The Andirondack Garnet Co.,	North Creek, N. Y.

"The Jeffrey Manufacturing Company who are known largely throughout the country as manufacturers of malleable and Steel Roller Chains, Hey-Oborn and Special Chains, have added a line of Link Belting, made from their own patterns, which they insure uniform pitch. These are made to work on standard sprocket-wheels and are interchangeable with other makes of corresponding numbers. This company has the largest line of chains to select from in the world and it would be to the interest of all users of chain to have their reduced price-list which can be had by addressing the company at Columbus, Chicago, or New York."

ANTHRACITE COAL STATISTICS.

Statement of shipments of Anthracite coal for month of Nov., 1891, compared with the corresponding period last year Compiled from the returns furnished by the Mine Operators.

	November, 1891.	November, 1890.	Difference.		For Year 1891.	For Year 1890.	Difference.	
From Wyoming Region,	2,099,572·06	1,819,280·00	Inc.	280,292·06	19,440,196·13	16,984,946·02	Inc.	2,455,252·11
From Lehigh Region,	585,966·02	557,572·02	Inc.	28,364·00	5,800,448·16	5,842,448·12	Dec.	41,999·16
From Schuylkill Region,	1,442,048·15	1,124,634·19	Inc.	317,413·16	11,619,717·09	9,962,571·19	Inc.	1,657,145·10
Total	4,127,557·03	3,501,487·01	Inc.	626,070·02	36,860,364·13	32,789,966·13	Inc.	4,070,398·03

The stock of coal on hand at tide-water shipping points, November 30, 1891, was 637,846 tons; on October 31, 1891, 598,833 tons; increase, 39,013 tons.

MINE INSPECTION IN PENNSYLVANIA.

A Review of the Most Important Facts and Suggestions Contained in the Reports of the Pennsylvania Inspectors for 1890.

FIRST ANTHRACITE DISTRICT, *P. Blewitt, Inspector.*

In his report for 1890, Mr. Blewitt refers to his recommendations of the previous year as to the necessity for examining boilers periodically, and as to the qualifications necessary in those who make the examinations. He draws attention to the need of all connected with mining to adhere strictly to the letter of the mine law, and thus reduce the number of accidents.

The President of the Pancoast Coal Co., at Throop, writes to Mr. Blewitt to say that at their colliery they struck a dip, which made more water than twenty men could bail, and that they were drowned out.

They fitted up a Thomson-Van Depoele Electric Pump in thirty hours, which cleared the mine and kept out the water with ease. The entire cost of the pump was less than that of putting in steam pipes for even a much shorter distance than would have been necessary in this case, had a steam pump been fitted.

SECOND ANTHRACITE DISTRICT, *H. McDonald, Inspector.*

Mr. McDonald draws attention to the want of care in setting props to support the roof. These are, he states, placed in every conceivable position but the right one, and the excuse generally made is that they are displaced by shot-firing. The Inspector does not think this is the cause so much as carelessness in setting and want of enforcement of discipline by the mine bosses. As one-half of the accidents in the district were caused by falls of roof and coal he emphasizes the necessity of more care in setting timber by the miners, and of the maintenance by the bosses of more strict discipline in this regard.

THIRD ANTHRACITE DISTRICT, *G. M. Williams, Inspector.*

In this district there were 100 lives lost during the year. Of this number 51 were lost in five disasters, all of which Mr. Williams says occurred "from conditions which arose within a few hours of the time in which they happened, and not from conditions permitted to exist in violation of the law."

Mr. Williams makes the following general remarks prefacing his description of the most destructive accidents which occurred in the district during the year:

"Before entering upon a detailed description of the disasters which occurred in this district during the year 1890, it is necessary to explain the relation of mine foremen and superintendents to the mines, and the part they take in causing or preventing accidents. Whenever a disaster occurs in a coal mine, the public is inclined to believe that the mines, in general, are badly managed, and that the officers have no regard for the safety of the workmen, and that the causes which result in disaster have always existed, needing only a slight mistake, or a heedless act, on the part of one of the employes to cause it. This is wrong and unjust. The conditions which make a disaster even possible are seldom known to exist before the moment it takes place, and, in most cases, the existence of danger has not even been suspected. Five disasters occurred in mines of this district in 1890, and in only one was it known that danger existed before the occurrence of the disaster, and it occurred in that one while efforts were being made to remove the cause of danger. It was the one at No. 4 Slope, Nanticoke. With the exception of the case at the Hollenback and Jersey Collieries, it is not probable that any unusual danger existed which could have been discovered twenty-four hours before the time at which the disasters occurred.

"Superintendents and mine foremen are generally exceedingly careful, but they have hundreds of points to watch, and must trust a large share of that work to assistants. With the exercise of the greatest precautionary care, conditions which make disasters possible arise suddenly and unexpectedly in gaseous mines, now and then, but happily in most cases the dangers are removed without accidents. No man, who has never had any experience in a gaseous mine, should be placed in charge, nor be placed as an assistant, in charge, of such a mine. I regret to state that I believe that if the mine foremen and assistant mine foremen in positions in this district in 1890 all had the experience required to enable them to foresee what every experienced man ought to see, some of the disasters mentioned could have been easily averted. The operator or superintendent who engages a mine foreman or an assistant mine foreman, who has not had the necessary experience, is guilty of gross indifference as to the effect on the safety of the workmen; he places no value on their lives and jeopardizes the safety of his or his employer's property."

While the ventilating capacity is ample at all the collieries there are in some of them certain districts which do not receive a sufficient quantity of air, partly, says Mr. Williams, from lack of ingenuity on the part of the mine foreman.

FOURTH ANTHRACITE DISTRICT, *John M. Lewis, Inspector.*

Mr. Lewis, in speaking of the improvements in his district during the year, refers to the new breaker erected by Coxe Bros. & Co., at Drifton, as described in detail in THE COLLIERY ENGINEER of January and February, 1891, and he recommends all who are interested in improvements in the sorting and cleaning of coal, to give the description a careful perusal.

Mr. Lewis gives a description of the State Hospital at Hazleton, and points out the advantages of such institutions. In the December issue of THE COLLIERY ENGINEER we drew attention to the crying necessity for ambulance knowledge. Here we have a description of the provision of a haven for the reception and care of disabled miners, and we trust that at an early date we may hear of the establishment of the connecting link between the scene of disaster and these hospitals in the existence of a body of men who are able to attend to the immediate wants of the injured.

FIFTH ANTHRACITE DISTRICT, *Wm. Stein, Inspector.*

Mr. Stein tells a tale of depravity amongst coal miners which we feel bound to reproduce. He says:

"I will here give one experience of the law being violated, which was brought to my notice a short time ago. I learned that some of the miners working in a colliery where safety-lamps were absolutely used, lit their squibs with matches. I investigated the matter and found it to be true; in talking with the miner he said, he did not do it any more. 'What do you do now?' I asked; his reply was, 'I suck the flame through the gauze with my pipe, then put the squib in my pipe when I am going to fire a shot.' I threatened to have him arrested when his 'Butty' appealed, saying at the same time 'there is worse than that done in this colliery,' and with some persuasion he very reluctantly told me that some of the men unscrewed the gauze with a nail and worked with the naked flame. This was a very alarming statement, because it endangered the lives of all in the colliery, and the practice may have caused the loss of many lives elsewhere from explosion of gas."

Comment is superfluous. Mr. Stein expresses the same opinion as others of the Inspectors, namely, that if the men would act up to the law, at least 66 per cent. of the death rate from accident would be averted.

SIXTH ANTHRACITE DISTRICT, *Wm. McMurtrie, Inspector.*

Fifty per cent. of the accidents were due to falls of roof and sides and the inspector calls for better care and judgment on the part of the men. Mr. McMurtrie describes a way of tapping old wastes at Mount Carmel Colliery, which is almost identical with the system described in "The Progress in Mining" in THE COLLIERY ENGINEER for December, 1891.

He also mentions some new air-compressing plant and rope haulages, which have been introduced during the year.

SEVENTH ANTHRACITE DISTRICT, *Samuel Gay, Inspector.*

"Notwithstanding the depressed condition of the Anthracite coal trade during the two preceding years, the sanitary condition, as well as the producing capacity of the collieries, has been kept up to even a higher standard than in any preceding year. The output of coal has been largely increased in proportion to the number of fatal and non-fatal casualties.

"In that respect the Philadelphia and Reading Coal and Iron Company has made a rather remarkable showing; having produced over 265,000 tons of coal per each life lost. This company operates thirteen collieries in this district, giving employment to 5,820 persons, under and above ground, the death rate being 1 in every 1,164. These facts, when it is taken into consideration, that a number of these collieries are very gaseous, much more so than in any other part of the district, would indicate that the management and discipline in and about these collieries had been more than usually rigid.

"The individual concerns have also made a showing that is worthy of notice in point of production, having an output of over 300,000 tons to each fatal accident. However, the death rate is much above that shown in the foregoing. The difference being 1 death in 890, as against 1 in 1,164."

Mr. Gay has the following to say with regard to advantages of better discipline in the working of the collieries:

"Notwithstanding that the mechanical appliances for the prevention of accidents in and about these collieries are equal to any in the district, and we may venture to say any in the state, yet accidents of the character we have given a brief synopsis of, have been more frequent at some of these collieries than at others. We have stated elsewhere that according to the evidence of the foreman in charge of these collieries that several of the accidents are attributed to disobedience of orders given. However, it is a well-established fact that, as a general rule, that insubordination is the result of lax discipline. It should be understood by those in charge of mines, that as long as it exists, just so long must they expect the same results."

FIRST BITUMINOUS DISTRICT. *Henry Louttit, Inspector.*

Mr. Louttit touches on the dangers attending the presence of natural gas-pipe lines passing over lands on which the coal is being worked. He says: "The attention of the Legislature is again called to the dangers arising from natural gas mains being laid over coal mines, and the necessity of a law being enacted, compelling the companies owning them to put their pipes on the surface, and I would further suggest that they be placed on trestles or blocks of sufficient height to allow a current of air to circulate under them. This method would allow the air to sweep away any leakage from the pipes, and when it is necessary for pipes to be laid on tillable ground, bridges or crossings could be made in each field for the passage of teams, etc. During the year I have had considerable trouble with this subject, owing to these mains passing over some three mines in this district, their presence being a standing menace of danger to the men and the mine. The natural gas companies' attention being called to the matter, they invariably did not (I will except the Carnegie Company), or pretended at least, to see no danger by the presence of their pipes over the mine, and ridiculed the idea of even a possibility of gas from their pipes entering the mine, as the gas was specifically lighter than air, and would as a consequence go upward even if the pipes would become broken or displaced by a subsidence of the surface caused by the excavation of the coal beneath them. This belief and the silence of the act of June 30, 1885, in regard to this subject, made it a difficult matter to handle, and the only thing we could do for the safety of the mine and those employed therein, was to stop the mine or part of it. I had occasion to stop part of two mines in the district on account of those lines, and when the gas companies who owned the lines were informed of it they adjusted their pipes somewhat as will be seen by noticing in the body of the report on the Globe and Snowden mines. It is erroneous to think because the specific gravity of natural gas shows it to be a little over half as heavy as air that there is no danger of it descending. There are conditions under which it is placed that must not be overlooked in dealing with it; for under some circumstances its specific gravity is a very small factor in the case, as the following will I think prove. A cubic foot of air weighs ·080977 pounds when the temperature is 32° and the barometric pressure 30 inches, which is equal to 14·72 pounds pressure to the square inch; a cubic foot of natural gas will, under the same conditions, weigh ·04421 pounds; this weight of the gas is only under one atmosphere. Now it is evident that the weight per cubic root will increase as the pressure gets higher. We find that when the pressure is 60 pounds per square inch in the pipes, that it has increased from ·04421 to ·1768 pounds per cubic foot; this weight is for the gas at the moment of exit from the pipes, and this will be maintained for quite a distance after leaving them, owing to the great velocity with which the gas travels."

Mr. A. N. Humphries, of Irwin, Pa., furnishes Mr. Louttit with the following report of experiments tried on June 12th, 1890, at the South Side Colliery of the Westmoreland Coal Co., to ascertain whether natural gas will or will not enter a mine.

When the gas mains are laid as the law provides and court instructs, *i. e.*, "in broken stone from which escape pipes, placed one hundred feet apart, lead to the surface of the ground, the broken stone to be covered with tarred paper, and the paper to be covered with clay.

"Experiments were tried under conditions essentially similar to those caused by such breaks in gas mains as must invariably result from subsidence of the surface if the strata be broken by the removal of the coal from underneath. In the first experiment tried two 3″ gas pipes were placed end to end in broken stone in a trench, the top sides of the pipes touching, but the under sides being apart a little over one-sixteenth of an inch (this opening being equivalent to a crack extending partly around a pipe of that size), and each pipe being gently inclined toward the opening; or, as they would be if the ground had sunk slightly after the pipes were laid. These pipes were placed by the side of an inlet to an exhaust fan over a ventilating shaft.

"Immediately beneath the opening between the pipes and three inches distant from it (the space between being filled with broken stone) was placed at the end of a 3″ gas pipe that lead into the fan inlet and on down vertically through the shaft into the mine, and having a valve on the end. A layer of broken stone ten inches thick was placed over the pipes and was covered with tarred paper. Escape pipes extended from the broken stone to the surface of the ground were placed on each side of the opening between the pipes and three feet distant from it, thus affording the gas the best possible conduit to the surface. Finally, the trench was filled above the tarred paper with well-stamped clay.

"After one end of the horizontal pipe was closed with a cap, gas, under a pressure of one and four-tenths pounds per square inch, was admitted to them at the other end, through a half-inch gas pipe. The fan was started and speeded so as to maintain a ventilating pressure equal to a half-inch of water.

"To discover whether the gas would pass through the pipe when the valve would be opened in the mine, was an undertaking attended with not a little danger, as the gas might be highly explosive because of an admixture of air from the escape pipes. A safety-lamp was used to make the test, and we found but little gas coming through the pipes.

"The fan speed was then increased until the water-gauge indicated a depression of one inch, the regular ventilating pressure at this mine. Gas was now found coming through the pipe and in a very explosive form. It would explode within the lamp gauze and put the light out. A miners' lamp of the ordinary kind was fastened on the end of a long stick, and, from a distance, the flame of the lamp brought in contact with the gas issuing from the pipe. The result was an explosion of such violence in the pipe, and about the end of it, that the detonation could be heard through the escape pipes on the surface. This was tried several times. Once the lamp was knocked off the stick by the concussion. During this trial we found that the air continually entered the escape pipes and no gas passed out through them into the atmosphere.

"An experiment was then tried to determine whether or not gas would enter the mine from a break in uncovered pipes. The covering was removed from around the pipes at the opening where the gas was to leak, the size of the opening was increased to three inches, and the cap was taken off the end of the pipe to permit the gas to pass off that way if it would. The top end of the vertical pipe was lowered to a position about five inches from the opening between the other two pipes.

"The gas was then turned on, the fan being in operation, and, curiously enough, a small quantity of it passed off up through the escape pipes, none went out where the cap was taken off, while in the mine the burning gas flamed up fully four feet above the end of the pipes and would have soon ignited the roof coal had the valve not been closed."

The writer has always contended that gas from a broken main would descend through cracks or breaks in the strata and enter any mine ventilated by furnace or exhaust fan. This has now been conclusively proven.

Not a few engineers insist that because natural gas, or say $C\,H^4$ is lighter than the atmosphere it must necessarily rise in the air, like a cork from beneath water, forgetting altogether that the gas in the mains is often under two or three hundred pounds pressure to the square inch, and, therefore, is much more weighty than atmospheric air.

However, the gas used in trying these experiments was much lighter than air; yet escaping under pressure as it did, a very trifling quantity was diffused into the atmosphere; and this, through the action of the fan, seemed to be retarded by the air which was drawn or held nearly stationary in place in the openings through the broken stone.

If the buoyancy of the gas used on this occassion did not cause it to rise, how then would gas under several hundred pounds pressure, act when escaping from a broken main into a crack or rent leading through broken strata into a mine with a ventilating current produced by a fan or furnace reducing pressure? I fear this query will only be answered by the total destruction of some large extensive mine, and the loss of very, very many valuable lives."

SECOND BITUMINOUS DISTRICT, *Wm. Jenkins, Inspector.*

Mr. Jenkins notes improvements in machinery for hoisting and haulage and larger ventilation power, and he reports that the mines are generally in an efficient state. With regard to the prevention of accidents Mr. Jenkins says: "I again urge upon the mine bosses and fire bosses the necessity and importance of a strict observance of the provisions of the mining laws, and rules at the mines, and require that they be strictly carried out, and in no case permit any one to work in an unsafe place. The security of the mines, and the safety and health of the miners are committed to their care, and in view of this, it is their duty to demand that their orders are faithfully and strictly carried out. Thereby not only doing their duty, but at the same time are doing what is required of them. Although many of the lives lost during the past year were carelessness of the victims themselves, yet this must not deter them from enforcing the laws and the rules of the mines, and require strict obedience to them. I desire to call attention to the fact that last year nearly all the fatal accidents happened to old miners, but this has changed, as sixty-five per cent. of the fatal accidents this year were "greenhorns" or men who had little or no experience in the mines, and from present indications, this class of men will be our future miners, as many of our old miners are seeking other employment, therefore great care will be required with the new men until they become thoroughly acquainted with the dangers encountered in mining."

THIRD BITUMINOUS DISTRICT, *Thos. K. Adams, Inspector.*

Mr. Adams, reports favorably of the condition of the mines generally, but points out that many accidents are still attributable to carelessness on the part of the victims. Considerable improvement has been effected in ventilating appliances, and several new air compressors have been introduced.

FOURTH BITUMINOUS DISTRICT, *Jas. N. Patterson, Inspector.*

Mr. Patterson reports marked improvement of a general character in the working and fitting up of the mines.

FIFTH BITUMINOUS DISTRICT, *Wm. Duncan, Inspector.*

Mr. Duncan, gives a detailed report of the Hill Farm disaster. He also reports numerous improvements in fitting, and states that the mines are generally in a good state.

SIXTH BITUMINOUS DISTRICT, *I. T. Evans, Inspector.*

Of the forty-two accidents in this district, Mr. Evans reports that one-half of the injured were unskilled men. Falls of roof are the chief causes of accident. In former years the accidents were greatly due to falls of coal, but a rule which was enforced compelling all miners to put sprags under the coal when undermined, at least every five feet, has reduced this class of accidents.

The miner is greatly to blame himself for not safely propping his working place.

Mr. Evans advocates increased ventilating power in the district, and more effective distribution of the air. Amongst improvements which have been made Mr. Evans describes a double tail-rope system at Webster Colliery, Pa.

With regard to better discipline as means of securing greater safety, Mr. Evans says: "Another great preventive of accidents in our mines would be to have better discipline enforced in them. I can scarcely imagine where it is required to a greater extent than there where, possibly, each man in it holds the life of the rest in his hands. But I am sorry to say that there is a great lack of it in our mines. I therefore hope that in the revision of our mining laws a proper code of rules, governing all employes, will be inserted in it, and penalties attached for the non-compliance with them, so as to bring our mines all down to a good system of discipline. This would be of incalculable benefit to both employer and employe."

SEVENTH BITUMINOUS DISTRICT, *James Blick, Inspector.*

Mr. Blick advocates the stringent application of the law in mines. He reports that the mines are in a good state. Haulage by rope is now in vogue in twenty-two mines in this district. On this important subject Mr. Blick says: "Many of the mines in this section are extended a long way from the tipples, and the cost of underground haulage, where done by horses or mules, is quite an item in the cost of production. The wire rope system of haulage is in use in about twenty-two mines in this district, and it could be adopted in many others to good advantage. The total length of wire line in use in the above mines is about 100,000 yards, or 57 miles, and varies in size from seven-eighths to one-half inch in diameter. The life of a rope depends more upon the care taken of it than upon the aggregate tonnage hauled. On a favorable even grade, with dry roads, a good road bed, and the rope properly tarred at regular intervals, a good rope will probably last in constant use about five and a half or six years. The number of mules required to do the work now being done by the ropes would be about 510. This system of haulage in general admits of a saving to the operators and is of great benefit to the mines from a sanitary point of view. As a rule, the main hauling roads are also used as the main intake for the ventilation, and if a large number of mules are employed thereon the air currents are more or less vitiated before reaching the working places of the miners, which source of pollution is obviated by the use of the wire-rope system."

EIGHTH BITUMINOUS DISTRICT, *Austin King, Inspector.*

In this district the accidents were doubled over the previous year. Many of these were due to carelessness on the part of the workmen. Falls of roof and coal were the causes of 79·1% of the fatal, and of 60% of the non-fatal accidents. Mr. King writes as follows regarding the difficulty in securing good ventilation of the district:

"There is no fire-damp in this district that is discernible or that has ever been detected. This is the chief reason why the means of producing ventilation are usually too small and weak to accomplish the work they are expected to do. Some very good authorities have stated that in their opinion 'fire-damp in mines was a blessing in disguise.' This will almost be admitted to be true if a little thought is given to the great attention and study that has been given the subject of ventilation of mines by many eminent mining engineers in the past century, and especially in the last fifty years, which would not have been given but for the occurrence of explosions so frequently as to compel such attention both from a humane and business standpoint—a large number of the mines taking fire from the explosions.

"It is generally found much harder work to convince managers of the bad or unhealthy condition of the ventilation in their mines, where fire-damp is not given off, than where it is as its presence usually creates a wholesome fear of possible results if ventilation is not ample in quantity and properly conducted to working places. Mines should be well ventilated because, to be healthy, we must have pure air to breathe.

"Operators of mines are not men who care to be classed as altogether void of the milk of human kindness, many of them would give liberally to a workman or his family in necessity, but at the same time would not think it a violation of the decalogue to have his mine so poorly ventilated that men could not be seen by each other six feet apart and would raise quite a storm about the ears of the mine boss, if the cost of lumber, erection of brattices or doors, or yardage of air-courses was greater than perhaps during some short period, when little or none of that work had been done, because some mining boss probably made an effort to build a reputation for cheap coal, at the expense and comfort of the miners in the advance workings of the mine, and, having a certificate to that effect in the form of a letter of recommendation from the operators, would leave for other fields to wear his laurels as a cheap coal producer, while the new incumbent was being soundly drubbed because of his extravagance (compared with his predecessor), while he is endeavoring to set things right. Conditions such as these have been observed in this district and the reasons given are nearly correct in the majority of cases. A more humane spirit should be developed and encouraged, with a standing order to mining bosses something like this, 'take no *risks* where life and limb are likely to be endangered and keep the working places of the mine *well ventilated.*'"

In a circular to the mine officers suggesting how greater safety might be secured, issued Jan. 6, 1890, Mr. King called attention to the inadequate furnace ventilation at many collieries as follows:

"That where furnace ventilation is used, a departure should be made in the direction of deep furnace shafts, the same to be of ample area, instead of the shallow, almost useless, and wasteful furnace shafts in present use in nearly 90 per cent. of the mines ventilated by that means in this district. I would respectfully invite your attention particularly to this matter, and figure out for yourselves the great loss due to shallow furnace shafts as against deep ones, other things being equal. So great is this loss that I do not hesitate to say that—where a furnace shaft is necessary—if the mine boss would intelligently show the operator the cost of coal burned in a shallow as against a deep furnace shaft, he would undoubtedly sink a deep furnace shaft or erect a ventilating fan."

ARE YOU IN IT?

That is, are you in the ranks of those progressive colliery owners and colliery officials who keep posted on the most improved mechanical appliances? If you are not, you ought to be. It will cost you nothing to get this information. All that you need do, is to

Send for circulars illustrating and describing the Excelsior Boiler Feeder, the simplest and best Injector known, to N. A. Watson, 1603 State St., Erie, Pa.

Send for circulars illustrating and describing the new Lightning Rotary Coal Drill, to D. Corgan & Son, Luzerne, Pa.

Send for circulars illustrating and describing the Bellis Patent Mine Collar manufactured by W. L. Bellis, 76 Michigan St., Cleveland, Ohio.

Send for an illustrated catalogue of the Yough Mine Pumps, specially designed for use in coal mines, and manufactured by Boyts, Porter & Co., Connellsville, Pa.

Send for circulars illustrating and describing the Bittenbender coal drill, manufactured by F. T. Bittenbender, Nanticoke, Pa.

Send for circulars describing the asbestos boiler and pipe covering manufactured by the H. W. Johns Mfg. Co., of 170 and 172 North Fourth St., Phila.

Send for catalogue of the corrugated iron roofing, siding, etc., specially adapted for colliery buildings, manufactured by the Cincinnati Corrugating Co., Piqua, Ohio.

Send for circulars of cable grips for endless rope system manufactured by J. E. Carr & Son., Leavenworth, Kansas.

THE MINERAL PRODUCTION OF THE UNITED STATES IN 1891.

In its annual statistical number, *The Engineering and Mining Journal* gives the following interesting figures regarding the production of minerals in the United States:

In 1890 the value of its chief items at the place of production exceeded $650,000,000, and though the cash value of these products in 1891 was probably less than in 1890 owing to the lower market prices of most of them, yet the quantities produced were, with very few exceptions, much greater than in any previous year.

The output of gold is increasing, but in the absence of full returns it is placed, in 1891, at approximately 1,620,000 ounces, or $33,250,000, an increase of 312,000 ounces.

The output of silver has increased much more rapidly, and, in the absence of full returns, it is estimated that it amounted in 1891 to 58,000,000 ounces, the coining value of which would be $74,820,000.

The coal consumption is generally considered to be the best measure of the industrial activity of a country. This rule would hold good for this country during the past year, when general industry was active and prosperous, though a few branches suffered a reaction. The output of Anthracite, from full and accurate returns, amounted in 1891 to 42,839,779 tons of 2,240 pounds, while the production of Bituminous coal, which is in part estimated, amounted to 98,000,000 tons. Prices of coal were, in general, lower than in 1890, though the Anthracite trade, being "regulated," maintained during a portion of the year rather higher prices than in the previous year.

The iron industry suffered a severe "set-back" during the past year, when the make of pig iron declined from 10,307,028 tons of 2,000 pounds, in 1890, to 8,976,000 in 1891, these figures being obtained from official returns made throughout the year. This heavy falling off was caused chiefly by the decline in the make of steel rails from 2,095,996 tons of 2,240 pounds in 1890 to to 1,090,000 tons in 1892—a decline due partly to the poverty of the railroads and partly to the comparatively high price established by the steel rail association.

In phosphate rock, in pyrites, in salt, in aluminum, in copper, lead, and zinc there has been a very considerable increase in output, while tin, antimony ore, and sulphur enter the list with modest but promising beginnings.

COMPARATIVE TABLE OF MINERAL PRODUCTION IN THE UNITED STATES IN 1890 AND 1891.

	1890.	1891.
Gold, ounces	1,588,880	1,620,000
Silver, ounces	54,500,000	58,000,000
Pig Iron, tons of 2,000 lbs.	10,307,028	8,976,000
Steel Rails, tons of 2,240 lbs.	2,095,996	1,090,000
Copper, lbs.	264,920,000	292,020,000
Lead, tons of 2,000 lbs.	181,494	205,888
Zinc, tons of 2,000 lbs.	64,342	76,500
Nickle, lbs.	200,332	144,841
Quicksilver, flasks	22,926	21,022
Aluminum, lbs.	61,281	143,820
Tin, lbs.	....	124,366
Antimony ore, tons of 2,240 lbs.	....	300
Anthracite Coal, tons of 2,240 lbs.	38,006,481	42,839,779
Bituminous Coal, tons of 2,240 lbs.	93,000,000	98,000,000
Phosphate Rock, tons of 2,000 lbs.	637,000	659,731
Salt, bbls. of 280 lbs.	9,717,000	10,229,691
Bromide, lbs.	310,000	415,000
Pyrites, tons of 2,000 lbs.	109,431	122,431
Sulphur, tons of 2,000 lbs.	....	1,200

PERSONALS

Mr. Wm. Leckie, of Plymouth, Pa., District Supt. of the Lehigh & Wilkes-Barre Coal Co., has tendered his resignation, to take effect on the 5th inst., when he will assume the superintendency of the Lehigh Valley Coal Co.'s York Farm Colliery, near Pottsville, Pa. Mr. Leckie is a comparatively young man, but has won a reputation as one of the best practical colliery officials in the Anthracite region. Our acquaintance with him began some years ago when he was a fire-boss at the Phila. & Reading Coal & Iron Co.'s, Shenandoah City Colliery. He has rapidly forced his way up by hard work and a close study of the sciences pertaining to coal mining. As a fire-boss he faithfully performed his duties, and devoted his leisure moments to study, until he secured a mine foreman's certificate of competency. He did not cease his studies when this was accomplished, but continued to store in his mind all the available standard literature on mining subjects, and took advantage of every opportunity to apply his theoretical knowledge to practical use. The result has been rapid promotion and an excellent reputation as a careful and thoroughly competent official. We wish him abundant success in his new field and commend his course as a student to all fire-bosses or working miners who are ambitious to rise.

The Bellis Mining Collar has proved a success whereever introduced and the manufacturer, Mr. W. L. Belli of Cleveland, Ohio, writes us that he is rapidly extending his trade into every coal field in the country, and what is more encouraging is the fact that orders are invariably duplicated. If the collars were not appreciated this would not be the case.

ESSAY ON PENNSYLVANIA BITUMINOUS MINE LAW COMMISSIONS.

BY T. K. ADAMS, MINE INSPECTOR.

[Proceedings of December Meeting of the Western Pennsylvania Mining Institute.]

It might be of sufficient interest to the members of this Institute for me not only to direct their attention to the passage of the concurrent resoluton, at the last session of the General Assembly, creating a commission to revise the Bituminous Mining Act, but to sketch briefly in connection therewith, the reasons for the passage of the different acts, joint and concurrent resolutions, creating mine commissions for the Bituminous regions of this State.

The average citizen of this Commonwealth is very apt to look upon the introduction of resolutions in the Legislature for the purpose of creating commissions to help our usually very capable, honest, and scientific legislators formulate bills for the life preserving and sanitary benefit of certain classes of our people as superfluous, at best unproductive of much good and a useless expenditure of the public money, knowing as he does that men are selected to office at $10 *per diem* to guard and protect the interests of the whole people of the State, whose ability should be of such a character as to fit them to treat justly and intelligently any question of public moment that might be brought before them. However, no matter what the general attainments of our representatives may be, unless they have had an extensive and varied practical experience in the mines and a theoretical knowledge of all that pertains thereto, especially as to the necessary requirements to keep them in a healthful and safe condition they cannot deal intelligently with mining legislation, so that such would guarantee the greatest degree of protection to the lives and health of the miners. We have had ample opportunity of judging of the ability of our representatives in the past and know from very sad experience that they stand very much in need of assistance when attempting to legislate on mining matters.

Pennsylvania legislators do not stand alone in creating mine commissions, because long ago, such nations as Belgium, France, Germany, and England have all called in the assistance of their most expert and scientific mining engineers to help their legislators in framing mining laws, and in fact, some of these nations have been very prodigal in the expenditure of money and of time devoted to such agencies so that they could experiment, investigate, and intelligently determine what was really necessary to afford the greatest degree of protection to their workmen.

When the commissioners are selected from among the best mining talent of the State they will prove to be of incalculable assistance in formulating mining legislation, while if great care is not exercised in their selection, commissions will be burdensome to the taxpayers of the Commonwealth. Scientific knowledge, long practical experience in mines, independence and honesty should be the requisite qualifications of all applicants for appointment to such important positions. Class interests should never enter under any circumstances, as a factor into the appointments. The commissions should never be composed of more than five or seven men, as all above this number will create an unnecessary expenditure of public money. Large commissions do not work as efficiently as small ones. One of the most efficient mine commissions ever appointed in this State only consisted of three members, that was the commission of 1874.

Prior to the year 1877 there was no general mining law in force in the Bituminous regions of Pennsylvania. Prayer had been invoked by the suffering; petitions had been numerously signed and sent to the Legislature informing our representatives of the Siberian conditions of the Bituminous mines and asking for some degree of relief therefrom, but they were excessively delinquent in responding to the urgent appeals of the miners, but at last through the patience and perseverance of the petitioners the consciences of our very Hon. friends at Harrisburg were smitten resulting in the introduction of a joint resolution in the Legislature which was passed and approved the 6th day of May, 1874, said resolution authorized the Governor to appoint three practical and experienced men in mining as commissioners to investigate the condition of the Bituminous mines of the Commonwealth. In pursuance of this resolution Messrs. John O'Neil, coal operator, Augustus Stinner and John Archibald, miners, were appointed. The commissioners were allowed 100 days in which to complete the investigation and submit their report. From the date that this intelligent and honest commission made their truthful and valuable report showing the terrible condition of the mines and substantiating and reinforcing the sentiments contained in the prayers and petitions of the suffering, a better day dawned for the workmen who were required to earn an honest livelihood for themselves and families in the Bituminous mines of this State. Although John O'Neil of the commission was very anxious in having as favorable a report of the condition of the mines as could be had (he no doubt having an idea that mining legislation was unnecessary), he after a careful examination, found that truth proved stronger than fiction, and to his honor be it said he did not falter in performing his duty at the last moment. His action by signing the majority report gave weight and a degree of manliness and independence in asserting his honest conviction. This report should be secured by this Institute, read by all its members, and afterwards placed in the archives thereof. After the report of the commission was received by the Legislature the specious arguments of the enemies of mining legislation to this effect: "If mining laws are enacted, competition being so keen, the mining industry of Pennsylvania will be ruined and invested rights crushed out of existence," which previous to this had served the purposes of the selfish faithfully and well; which had had great weight with our representatives, now began to lose their force, consequently, at the session of the General Assembly of 1877 the first Bituminous mining law was passed. This humane act was not secured without a terrible struggle but justice and right triumphed and the progress of the mining industry has been phenomenal since that date and the invested rights of the capitalists go on as of yore increasing their bulwarks of defence against their enemies.

The results obtained from the enactment of the mining law of 1877 proved very beneficial to all concerned in mining, but owing to the strong opposition this measure met with in its passage through the Legislature many of its good points had to be compromised. An attempt therefore was made six years after the bill passed to perfect the law in such a manner as to meet the then existing requirements. The friends of mining legislation urged upon the members of the Legislature at the session thereof in 1885 to have a commission appointed to revise the law, consequently, "An Act" was introduced and passed the 31st day of March of that year authorizing the Governor to appoint a commission to consist of twenty-five persons, viz., six competent and experienced coal operators, six competent and practical miners, three members of the Senate; four members of the House of Representatives, together with the six mine inspectors. The time allowed the commission to revise the act was not to exceed 30 days, and as the Legislature adjourned about the 11th day of June not much time was given the commission to complete the work assigned to them. Little or nothing was accomplished by this large commission. The revised bill being presented to the Legislature in the closing days of the session and the enemies to such legislation being on hand, as usual, charged with the old arguments, always willing to tear down, but never willing to improve, the bill was finally passed with one essential improvement over the old law, viz., that of requiring mine bosses to pass an examination. This commission will not be remembered for its efficiency or for the good work it accomplished when it is considered as a whole. While there were many brilliant minds upon the commission they were certainly overshadowed by many more weaker ones. The commission was entirely too large to do efficient work and the continual clashing of class interests between coal operators and the miners destroyed the harmony and retarded the work of said commission. Many of the members of the commission had not the necessary ability and experience to perform the important duties of the position intelligently and well.

To give you some idea of the wonderful development that has taken place in the mining industry since the mining law went into effect and for the special purpose of exploding the old fallacies which have done so much duty for the enemies of mining legislation, allow me to make a comparison of its condition in 1879 with that of last year (1890) covering a period of eleven years. In 1879 the coal production was about 15,000,000 tons; 342 mines, and about 21,000 persons employed therein. For last year (1890) the coal production was 40,806,913 tons; 645 mines; and 54,000 persons employed therein. This does not include the 12,630 outside employes, thus showing a net increase in tonnage of 172 per cent., in mines 88½ per cent., and 165 per cent. in inside employes. We might well ask the question: Has mining legislation ruined the coal mining industry of the State? The number of fatal accidents in 1879 was 51, and in 1890 131, showing an increase of 96 per cent. But by taking the ratio of killed to the number of tons of coal produced and the number of employes employed the decrease in the former is 6½ per cent., and in the latter only 1½ per cent. In view of these facts in reference to fatalities the mining law has not afforded that protection to life that might have been reasonably expected from its enactment, hence the anxiety of the friends of humanity to have it thoroughly revised and amended so that such terrible disasters as have occurred in the Bituminous mines of very recent date, whereby many valuable lives were probably unnecessarily sacrificed, might be prevented in the future. With this object in view a concurrent resolution was prepared and sent to friends in the Legislature asking for the appointment of an intelligent commission to revise the Bituminous mining law. The resolution was sent at the beginning of the last session of the Legislature so that it could be presented to it as soon as business could be transacted. The original draft of said resolution provided for the appointment of a commission of twenty-eight members, viz., eight coal operators, eight miners, two senators and two representatives, these four Hon. gentlemen were to be learned in the law, they were to be constitutional lawyers, if you please, such as usually adorn the Pennsylvania Legislature, together with the eight mine inspectors, but before it was introduced the number was wisely reduced to 7 or 9 members. When the resolution went to the House committee of mines and mining it met with strong opposition from the professional labor representatives upon it, they claiming that the miners had not equal representation with the coal operators prejudging, as usual, that the mine inspectors would act and vote with the operators regardless of their honest convictions ("Oh, just Judge, righteous Judge"), consequently, the number was again changed to suit the prejudices of those honorable men so that the miners would have eight members of the commission and the coal operators four, together with four inspectors. The miners were to be appointed upon the recommendation of the labor organizations of the State. In this form the resolution passed the House after much valuable time had been wasted. It was then introduced in the Senate for the gracious consideration of that august body of learned representatives and as the labor representatives of the House had played their innings now came the innings of the senators. They too changed the number of the commission so as to consist of twenty-four members, viz., eight miners, eight operators, together with the eight mine inspectors. They also took the appointing power out of the hands of the Governor as far as the operators were concerned and placed it in that of the judges of the different inspection districts and as some of those districts include five or six different judicial districts, the motive of introducing such an amendment was for the purpose of delay. Finally the resolution passed both Houses and the jugglery was suspended for the time being. Although the concurrent resolution was introduced early in the session of the Legislature the commission was not organized before the 30th day of March, 1891. After the commission was organized the members thereof continued in session for about twenty-eight (28) days and completed the work of their appointment at a cost to the State of about $5,000. The law was changed in form and a thorough revision accomplished. As to the merit of the work of the commission we recognize it to be very meritorious and practical. It is not perfect by any means but it certainly was a great improvement on the present law and if it had passed the Legislature it would have afforded a greater degree of protection to the miners. Although temporarily defeated and almost crushed to death, like Banquo's ghost it will not down, and from its grave it will arise at no very distant date to plague its foes. The bill was presented in the Legislature on the 30th day of April, 1891. It passed the House in about two weeks with but few amendments and was then sent over to the Senate where measures for the benefit of the workingmen receive so tender attention and due consideration. The Senate committee of mines and mining had not the time to consider this humane and meritorious measure, although, those Hon. representatives of the whole people of the State had been going home for weeks previous to the presentation of this bill every Thursday at 1 o'clock P. M., not having work sufficient to keep them in mental exercise, but they were abreast of the times in one particular in that of having sufficient mental and physical ability to enable them to march up to the public crib and draw $10 per day therefrom. Those Senators who are supposed to represent the interests of the people of Western, Pennsylvania, should ever be held in grateful remembrance by the workingmen and especially the miners for the sleepless night they spent in advancing their cause and especially for the noble interest they took in having the Bituminous mining bill considered, but we leave those Hon. friends to the tender mercies of their duped and, it would seem, gullible constituencies.

The commission was composed of men of fair ability. They exercised a wonderful degree of independence and in our opinion, served the Commonwealth faithfully and well. Both the miners' and operators' interests were well and efficiently represented and guarded. The good work of this commission is not lost by any means, and can be taken up and the different provisions of the prepared bill discussed by such unprejudiced and intelligent organization as this Institute. Defects can be remedied and improvements made. No foolish, no inefficient, no unnecessary burdensome legislation should be approved of by this institute or by the Legislature, but above all, neither should the prejudices nor the dollars and cents of the selfish stand in the way of guaranteeing all necessary legislation to protect human life. No more joint or concurrent resolutions to create mine commissions are necessary in this State for many years to come. The members of this Institute, however, may find it necessary, some time in the future, to encourage and assist in having a national mine commission created so that the mining industry or interests in all of the States might become subject, in a measure, to the regulations of one national mining law. The securing of such a law would prove a potent weapon to disarm the arguments of the enemies of mining legislation.

The Lightning Rotary Coal and Rock Drill.

In another column is advertised the Lightning Rotary Coal and Rock Drill, made by D. Corgan & Son, Luzerne, Pa. This is a hand drilling machine for use in coal and rock. The most noticeable point in the machine is the bit which does the cutting. Upon the end of an ordinary twist drill is cast a head of aluminum bronze containing three sockets in which are set three small steel knives. The two outer ones are arranged like the cutting parts of an auger. These cut a ring ¾ of an inch thick around the outside of a 2¼ in. hole while the middle knife breaks up the core which comes out in pieces as large as pea coal. It will be seen that as there is only a ring of coal ¾ inch thick be cut the power required will be much less than where the whole is reduced to powder as in the ordinary machines. The knives are finely tempered and very cheap so that a man can have several sets and if those in use become dull, new ones can be inserted in a few seconds. As will be seen in the cut the machine is very simple. Its weight complete is only 30 lbs., and experience has shown that it is especially suited, on account of its lightness for use in heavy pitching and thick to veins where it is impossible to use the heavier kinds. It can also be set without the use of a hand drill and works equally well in hard or soft coal. It is no more costly than the ordinary machine and notwithstanding its great efficiency in cutting, the bills for sharpening are even less. Messrs. Corgan & Son have sold many of these, which are in daily use under the most trying conditions, and it will pay any person having use for a drilling machine to correspond with them.

The Babcock and Wilcox Company publish in our advertising columns a list of colliery operators who are successfully generating steam at a low cost, and at the same time securing better results by the use of the most improved steam plants. It will pay our readers to glance over this list and then seriously consider whether the improvements that have proven satisfactory to these operators will not be equally valuable to them.

Easy Lessons for Beginners

IN THE STUDY OF THE

Art of Mining

AND THE

SCIENCES RELATED TO IT.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the sciences related to mining and to learn how to answer the questions in ventilation, surveying, and mechanics which are asked at the examinations for mine foreman's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine foremen and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and many calculations are worked out at length for the benefit of those who are not familiar with figures.

PENMANSHIP.

One of the most difficult things encountered in teaching penmanship is to make the necessary repetition of the principles without tiring the learner. However, it must be remembered that all of the letters of the alphabet depend primarily for their correct construction upon the four laws of penmanship given in our first lesson, and which have been emphasized in all the subsequent articles.

In this issue we have for consideration the capital letters K and L. The first letter, numbering from the left of Fig. 30, shows the capital K as it should be written. The first part consists of the stem with a

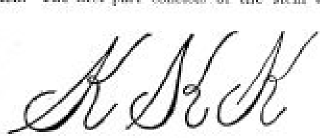


FIG. 30.

right curve extending upward to the full height. The second section begins at the full height of the letter with a graceful curve, which is drawn towards the first section, touching at the middle and connecting by a small loop. The curved line is then brought on a parallel to the bottom of the stem and completed by a right curve extending upward one-third of the full height of the letter. In letter 2, the ellipse of the first section is too large, and is otherwise imperfect. Letter 3

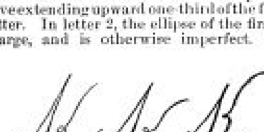


FIG. 31.

shows the first section incomplete, and a violation of the second law of penmanship, namely, all strokes must be proportionate in distance. Letters 1, 2, and 3, Fig. 31, show probable faults in making this letter. It will be seen that the strokes are not parallel; the ellipses are not proportionate in size; curves not elliptical, and in each of them the right section of the letter is not connected with the first or stem.

Figs. 32 and 33 illustrate the development of the capital letter L. Letter 1, Fig. 32, numbering from the left is drawn on correct principles, and is in conformity with the general laws of penmanship. The first curve,

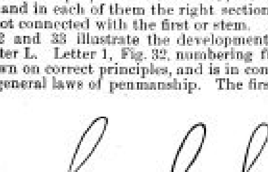


FIG. 32.

it will be noticed, divides the horizontal loop into two equal sections. Letter 2 shows several errors, the upper scroll is too large, the letter being crossed below the middle of the stem. The third letter from the left is a violation of the fourth law of penmanship, namely, all curves should be elliptical.

Fig. 33 shows common mistakes made in writing this letter. In the first letter it will be seen that the main stem has the wrong inclination and the bottom loop is too small. The second letter shows no bottom loop at all, and, as a consequence, offends the eye. Letter 3, counting from the left, is a deformity arising out of the

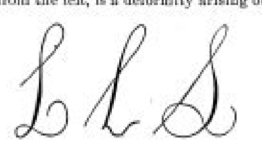


FIG. 33.

imperfect development of the ellipses and is a violation of the fourth law of penmanship.

One of the principal lessons to be learned in the development of the capitals K and L is gracefulness. If the letters are well formed, but combined and arranged without ease or gracefulness, the writing will never be thought beautiful or pleasing.

ARITHMETIC.

CANCELLATION.

Cancellation is a short method of obtaining results by omitting equal factors from a dividend and divisor and on this account it should be employed whenever possible in arithmetical operations. The sign of cancellation is an oblique mark drawn across the face of a figure, as $\cancel{2}$, $\cancel{4}$, $\cancel{6}$, etc.; therefore to *cancel* means to cross out, or reject. Two principles to be remembered in solving problems by cancellation are: First, canceling a factor of a number divides the number by that factor, and second, canceling equal factors of the divisor and dividend does not change the quotient.

In arranging the numbers for cancellation, the dividend may be written above the divisor with a horizontal line between them, as in division; or, as some prefer the dividend may be written on the right of the divisor, with a vertical line between them.

The advantage of using cancellation may be more clearly seen by the following examples:

In exchanging 24 hats at \$5 each, for coats at \$24 each; how many coats would I get?

To solve this question ordinarily we multiply 24 by 5, which gives 120 and divide this by 24 which gives a quotient of 5. Instead of performing this work, indicate it thus,

$\frac{\cancel{24} \times 5}{\cancel{24}}$ then, since dividing either factor of a product divides the product, the result is $1 \times 5 = 5$; the same as would be got by canceling or omitting the 24 from both dividend and divisor.

Multiply 105 by 18, and divide the product by 30. Indicate the operations as follows:

$$\frac{\overset{21}{\cancel{105}} \times \overset{3}{\cancel{18}}}{\underset{\cancel{5}}{\cancel{30}}}$$
$$21 \times 3 = 63,$$

First, we divide the 18 in the dividend and the divisor 30 by 6; this gives 105×3 above, and 5 below and does not alter the quotient, since multiplying or dividing both dividend and divisor by the same number does not change the quotient. Now, the 5 below the line is contained into 105, not yet cancelled, above the line 21 times, therefore we cancel and place the 21 at the left of 105. The quotient is then found to be $21 \times 3 = 63$. As each factor is used in canceling, it is crossed to indicate that there is no further use of it; and each quotient is placed beside the number from which it is obtained. The 21 and 3 being the factors left of the dividend after cancellation, are multiplied together; their product is 63, and as no factor of the divisor is left, the 63 is not to be divided, and is, therefore, the quotient required.

Again, multiply 75, 153, and 28 together, and divide by the product of 63 and 36.

SOLUTION.—The operations are indicated as shown below.

$$\frac{\overset{25}{\cancel{75}} \times \overset{17}{\cancel{153}} \times \overset{7}{\cancel{28}}}{\underset{\underset{3}{\cancel{9}}}{\cancel{63}} \times \underset{\cancel{9}}{\cancel{36}}}$$

We cancel 4 out of 28 and 36, leaving 7 above, and 9 below. Cancel this 7 out of the dividend and out of the 63 in the divisor, leaving 9 below. Cancel a 9 out of the divisor, and out of 153 in the dividend, leaving 17 above. Cancel 3 out of 9 and 75, leaving 25 above and 3 below. No further canceling is possible; the factors remaining in the dividend are 25 and 17, whose product 425, divided by the 3 in the divisor, gives $141\frac{2}{3}$, the quotient.

In the division of fractions also the work is greatly shortened by cancellation, as will be seen by the following problem:

Multiply $\frac{1}{2} \times \frac{12}{25} \times \frac{5}{8}$, and divide the result by $\frac{3}{4}$ of $\frac{2}{3}$ of $\frac{4}{5}$. In arranging the numbers for cancellation in fractions, the numerators of the dividend are placed above the line and the denominators below it. In placing the numbers of the divisor it is *vice versa*, the numerators are put below the line and the denominators above. The question is solved thus:

$$\frac{1 \times \overset{\overset{3}{\cancel{6}}}{\cancel{12}} \times \cancel{5} \times \cancel{4} \times \cancel{3} \times \cancel{5}}{\cancel{2} \times \underset{\cancel{5}}{\cancel{25}} \times 8 \times \cancel{3} \times \cancel{2} \times \cancel{4}} = \frac{3}{8}$$ the required quotient.

From the foregoing facts we deduce the following rule for working problems by cancellation:

Cancel all the factors common to the divisor and dividend, and divide the product of those remaining in the dividend by the product of those remaining in the divisor.

PROBLEMS RELATING TO MINING.

Q. 1.—A gallery in a mine is five feet high and ten feet wide, what is the measure of the perimeter and the area of section of the gallery?

A.—The perimeter of the airway in this question, called the gallery, is the measure of the sides enclosing the airway, so that if the four sides be added together the sum of them will be the perimeter required. Therefore, if twice five and twice ten be added together, we find that the perimeter of this airway is equal to thirty feet, that is thirty feet in line measure or the measure down one side, across the floor, up the other side and across the roof. But the area of section is equal to the space enclosed by these four sides, so that if five be multiplied by ten, the result will be fifty. That is, the four sides of this airway enclose a cross-section of fifty square feet.

Q. 2.—Supposing the airway just referred to was 2,000 yards in length, what number of square feet of rubbing surface would this airway have, and what would be its contents in cubic feet of air?

A.—If the perimeter of this airway in feet be multiplied by its length in feet, the result will be equal to the rubbing surface or the surface against which the air moves in its journey. Now, the perimeter we found to be equal to thirty feet, and there are 6,000 feet in 2,000 yards, therefore, $30 \times 6{,}000 = 180{,}000$ square feet of rubbing surface. Now if the area of the section of this airway which is found to be fifty square feet be multiplied by the number of feet in 2,000 yards, namely, 6,000 feet, the result will be the contents of the air in the drift in cubic feet, or $50 \times 6{,}000 = 300{,}000$.

Q. 3.—If the ventilating current is moving through the drift or airway given in Question 1, at the rate of eleven feet per second, how many cubic feet of air are passing through this gallery per minute?

A.—Eleven feet per second gives a velocity of 660 feet per minute, for in sixty seconds the air must have traveled through a distance of 660 feet. Now, what is demanded is the quantity of air passing through this airway per minute. Therefore, if 660 feet per minute be the velocity, this multiplied by the area of section must be equal to the quantity. Therefore, $660 \times 50 = 33{,}000$. It follows then that quantity of air passing through this drift is equal to 33,000 cubic feet.

Q. 4.—What does the water-gauge or current pressure-gauge measure?

A. The water or current pressure-gauge measures the pressure per square foot setting the ventilating current in motion.

Q. 5.—If a current pressure equal to one inch of water-gauge was required to produce ventilation, what pressure would that be in pounds per square foot?

A.—A cubic foot of water weighs 62·5 pounds, and if this cubic foot of water be conceived to be divided into twelve slabs, each a foot square and an inch thick, each slab must weigh 5·2 lbs., because

$$\frac{62{\cdot}5}{12} = 5{\cdot}2.$$

Therefore, one inch of water-gauge is equal to the pressure of 5·2 pounds on the square foot.

Q. 6.—Suppose the water-gauge is said to read 1·3, that is to say, one inch and three-tenths, what would be the pressure per square foot producing ventilation?

A.—If the $1\frac{3}{10}$ be multiplied by 5·2, the result will be the answer required as follows:

$$1{\cdot}3 \times 5{\cdot}2 = 6{\cdot}76.$$

Q. 7.—A circular pit shaft is eighteen feet in diameter and 500 yards deep, required the rubbing surface in square feet?

A.—First find the perimeter of the section or boundary line that encloses the space called the section, in this case the perimeter will be equal to the circumference of the circle, that is $18 \times 3{\cdot}1416 = 56{\cdot}5488$. Now, if the perimeter be multiplied by the depth of the shaft in feet, that is $56{\cdot}5488 \times 1500$ (500×3) $= 84823{\cdot}2$ the rubbing surface in square feet required.

Q. 8.—What is the rubbing surface in square feet of a shaft fourteen feet in diameter and 312 yards deep?

A.—41167·5264 square feet of rubbing surface.

Q. 9.—Find the square feet of rubbing surface for a gallery in the mine two miles long, six feet high, and ten feet broad.

A.—$32 \times 2 \times 5280$ feet in a mile $= 337{,}920$ square feet of rubbing surface. The rubbing surface is always calculated per square foot of section, the importance of this will be understood when we remark that the friction per square foot of section is smaller for large areas than for small ones, that is to say, the rubbing surface per square foot of section for square and circular airways is inversely as the areas.

Q. 10.—A pit shaft is eighteen feet in diameter and 500 yards deep, what is the rubbing surface per square foot of section?

A.—Let S equal the rubbing surface, and A equal the area of section, and R equal the resistance per square foot of section, then

$$\frac{S}{A} = R,$$

S in this case was found, by problem 7, to be 84823·2 and A will be found as follows:

$$18 \times 18 \times {\cdot}7854 = 254{\cdot}4696, \text{ then}$$

$$\frac{84823{\cdot}2}{254{\cdot}4696} = 333{\cdot}3 = \frac{S}{A} = R.$$

Q. 11. Three airways A B C are ventilated by currents moving at the same velocity each of the airways are, however, of different dimensions. A being 1,000 yards long, the height being four feet and the breadth nine feet. B 2,000 yards long, six feet high, and ten feet wide. C being 3,000 yards long, and eight feet high, and twelve feet wide. What must be the relative heights of the water-gauge in the three cases?

A. The mechanical moments of resistance would be in the proportion of the rubbing surface in each of the cases divided by the area, in short, the moments in each case would be equal to

$$\frac{S}{A}$$

the length is 1,000 yards or 3,000 feet, the perimeter being twenty-six feet, and the area of section would be equal to thirty-six square feet, therefore,

$$\frac{26 \times 3{,}000}{36} = 2166{\cdot}6.$$

And the mechanical moments in B will be as follows: 2,000 yards will be equal to 6,000 feet, the length, and the perimeter will be equal to thirty-two, and the area of section will be equal to sixty square feet, therefore,

$$\frac{32 \times 6{,}000}{60} = 3{,}200.$$

Now, the mechanical moments in C will be found as follows: Length 3,000 yards or 9,000 feet, perimeter will be equal to forty feet, and the area of section will be equal to ninety-six square feet, therefore,

$$\frac{40 \times 9{,}000}{96} = 3{,}750$$

mechanical moments. Now, the water-gauges that are required will be directly in the proportion of the mechanical moments. Then let the water-gauge for A equal one, the water-gauge for B will equal

$$\frac{B}{A} = \frac{3200}{2166{\cdot}6} = 1{\cdot}477,$$

and the water gauge for C will be equal to

$$\frac{C}{A} = \frac{3570}{2166{\cdot}6} = 1{\cdot}6477,$$

therefore, the three water-gauges will be as follows:

A = 1. B = 1·477. C = 1·6477.

Q. 12. Three airways A B C are of the same length, and the other dimensions are as those given in last question, but the velocities in the three cases are different, that in A being equal to 700 feet per minute, B 600 feet per minute, and C 500 feet per minute. If the water-gauge for A be one, what will be the water-gauges for B and C?

A. The resistances will vary as the squares of the velocities, therefore, if the squares of the velocities in each case be multiplied by the rubbing surface per square foot of section, the result will be the proportionate resistances in the three cases. Now, the rubbing surface per square foot of section, or the mechanical moments due to A are equal to 2166·6, therefore, if 2166·6 be multiplied by the square of 700, or 2166·6 × 700 × 700 = 1,061,634,000. Now, the moments in B will be equal to 3200 × 600 × 600 = 1,152,000,000, and the moments due to C will be equal to 3750 × 500 × 500 = 937,500,000, or the water-gauges will be as

$$\frac{B}{A} = \frac{1{,}152{,}000{,}000}{1{,}061{,}634{,}000} = 1{\cdot}085,$$

and the water-gauge for C will be equal to

$$\frac{C}{A} = \frac{937{,}500{,}000}{1{,}061{,}634{,}000} = {\cdot}88.$$

CHEMISTRY RELATING TO MINING.

EXPLOSIVES FOR BLASTING PURPOSES.

In mining three classes of explosives are now in use, first, slow or rending compounds, such as gunpowder for shot firing in coal seams; second, shattering compounds, such as dynamite, for stone blasting in mines; third, flameless explosives, such as roburite, for coal mines. Gunpowder is said to be slow as contrasted with dynamite. This slowness is accounted for in the following way: The nitre known as saltpetre, the sulphur, and the charcoal are ground to fine powder, and mechanically mixed into a paste with water; the paste is granulated and dried. Now as the oxygen of the saltpetre will be given off at points during combustion, it will be clear that some time will elapse between the burning at one point and the burning at another. It will be clear that powder will be relatively slow as an explosive.

Nitro-glycerine is a chemical compound, and not a mechanical mixture; therefore the atomic arrangement of the oxygen and the carbon will be such that if the temperature of the mass is uniformly raised to explosive point, almost instantaneous ignition will take place throughout. Gun-cotton and several other shattering compounds are similar in this respect to nitro-glycerine. During the last fifteen years numerous attempts have been made to displace gunpowder for blasting purposes in mines, but hitherto the great number of explosives thrown on the market have tended to bewilder the miner. This, of course, cannot be avoided during a transition period. Gunpowder shots have generally been fired with a fuse or straw, but the explosive force of gunpowder is nearly doubled when fired with a detonating cap. It would appear that none of the explosives that have been recently introduced have been found superior to powder for a rending compound for coal; but for blasting hard rock, powder has been left far behind by the shattering compounds; and this is not a matter of wonder when we consider that volume for volume the stronger varieties of dynamite are seven times the power of gunpowder; hence holes of smaller diameter may often be used with advantage when charged with shattering compounds, and even with holes of equal diameter the risk and danger of a blown out shot can be avoided.

A primer is used in firing with roburite or dynamite with the object of raising the temperature of the charge suddenly to 360° F. by pressure, because roburite and dynamite will only explode at that temperature. Below 360° F., these compounds only burn at the points where heat is present and do not explode.

We will now proceed and give the composition of the more important compounds now in use, and after doing so we will notice the more important features of the so-called flameless explosives. The blasting force of each explosive will be given bulk for bulk with gunpowder.

First, dynamite—there are many varieties:

Nitro-glycerine	75%
Unctious earth	25%
	100

Blasting force............ 7.

Second, nitrated gelatine:

Nitro-glycerine	86%
Soluble gun-cotton	10%
Camphor	4%
	100

Blasting force............ 4.

Advantages—It can be stored for long periods without danger of chemical change.

Third, litho-fracteur:

Nitro-glycerine	70%
Nitrate of barium	5%
Coal dust	2%
Unctious earth	23%
	100

Blasting force............ 5.

This is a very dangerous explosive to use, as it explodes at a temperature very little above the boiling point of water, and it is rapidly falling out of use.

Fourth, tonite or cotton powder: This is a peculiar preparation of gun-cotton, which is granulated and made up into cartridges. Gun-cotton and tonite each have an explosive force of 4.

The following flameless explosives are compounded as follows:

First carbo-dynamite, a mechanical mixture of:

Nitro-glycerine	80 parts.
Cork charcoal	10 parts.
Water	10 parts.
	100

This mixture does not, when immersed for long periods of time in water, part with its nitro-glycerine. The blasting force is about 8.

Second, bellite, a binary compound of:

Denitro-benzine	15%
Nitrate of ammonia	85%
	100

Blasting force, about............ 4.

Third, roburite, a binary compound of:

Chlorinated dinitro-benzine	30%
Nitrate of ammonia	70%
	100

Blasting force, about............ 3.

The following four binary compounds have been found to give excellent results:

First,

Gun-cotton	15%
Nitrate of ammonia	85%
	100

Second,

Dynamite	20%
Nitrate of ammonia	80%
	100

Third,

Dinitro-benzine	10%
Ammonium nitrate	90%
	100

Fourth,

Gelatinized nitro-glycerine	12%
Ammonium nitrate	88%
	100

The blasting force for each is about 1. Considerable uncertainty and doubt prevails about the behavior of the *so-called* flameless explosives, such as roburite, arising from chemical changes that take place during the storage of the material. Sometimes on firing, the front of the cartridge is exploded, sometimes the middle, while the other portion of the cartridge remains unaffected. It undergoes such a chemical change that sometimes on handling it is absorbed by the skin, and impairs the health of the miners. These facts have been taken from actual cases. It would appear, however, according to the evidence we have been able to collect, that the two flameless explosives, viz., 15 per cent. gun-cotton and 85 per cent. of nitrate of ammonia, and 20 per cent. dynamite and 80 per cent. nitrate of ammonia, promise to be the most satisfactory in use.

It is remarkable that the dilutants of flame used in these binary compounds render them difficult to explode; hence roburite requires a very powerful detonator. So much is this the case that we neutralize flame in the shot and intensify it in the detonator. Notwithstanding these remarks we believe a flameless explosive is now within easy reach.—*Tate's Chemistry.*

SCIENCE RELATED TO MINING.

PERCENTAGE OF CLAY IN PAPER.

In the manufacture of paper a kind of pipe clay is used as an adulterant, and if it be interesting for us to determine the percentage of clay in the paper, we should first determine the percentage of earthy matter such as lime and potash common to pure vegetable fiber, when it will be easy to determine the percentage of clay present in the paper. Now let us for a moment or two look the matter simply in the face: take in your hands a piece of paper whose weight, after being thoroughly dried at the temperature of boiling water, is found to be equal to half an ounce. If this piece of paper be set on fire, intense chemical action will be the result, the carbon and hydrogen elements will be burnt off, when the ashes only will remain; and if the ashes be now weighed, they will be found to be only a small fraction of the weight of the original paper if the original paper consisted of pure fiber. Let us suppose that the ashes weighed ·01 of an ounce, the percentage of ashes in the paper may now be determined as follows:

$$\frac{{\cdot}01 \times 100}{{\cdot}5} = 2 \text{ per cent. of ashes.}$$

Before proceeding further in this investigation, let us say that it is not possible to burn a piece of paper without observing that the residue consists of a tinder; further it will be noticed that the tinder is exceedingly light when contrasted with the unburnt paper. But in determining the percentage of ashes in a piece of paper it is not difficult to burn off the hydrogen elements, but the carbon requires time and great heat, and the use of a suitable crucible for its perfect combustion. To make this more plain, burn a sheet of paper with printed characters on it, when, on the tinder, the black marks of the printed characters will be so distinctly seen that the subject matter of the printing may be distinctly read. The reason of this is to be found in the circumstance that printers' ink is made up of oil and lamp black, the carbon element of which is not completely burnt, and requires for its complete combustion the use of the crucible.

PERCENTAGE OF COKE.

To find the percentage of coke produced by a sample of any coking coal, proceed as follows: Take a slice off the face of the seam, that is, take an even proportion of the whole section, break it up on an iron plate into small particles, and then mix it well with a shovel; out of this mixture take about 14 pounds, and still further beat the last sample very small, thoroughly mix this pulverized sample, and out of it take one pound, grind it very fine and mix well, and out of this carefully weigh 4 ounces. For the reception of this 4 ounces make a shot case with brown paper, into this case place the 4 ounces of carefully weighed coal, then close the upper end of the case; having done so, procure 18 inches of iron piping, 1½ inches in diameter, with an iron plug welded into the bottom end. The iron tubing being properly made may be used for thousands of experiments. Pour a little sand into the bottom of the tube, then drop in the cartridge case, which we will suppose to be about 1 inch in diameter, now fill up the tube and cover the case with sand, then with a pair of tongs place this tube with the closed end downward in a bright hot fire such as may be obtained in a house by putting up a draught plate. After the tube and its contents have been raised to a red heat and allowed to remain so for one hour the tube should be lifted out of the fire with a pair of tongs and set to one side to cool. After it has cooled to a black heat teem the sand out, when there will be a plug of coke, which, when carefully weighed, may be about 2 ounces and 12 drams. Bear in mind this weight is only imaginary, but suppose it to be correct, the plug of coke will then weigh 2·75 ounces; now 2·75 multiplied by 100 and then divided, by 4, the weight of the coal, the result will be the theoretical percentage of coke that the coal can produce, which in this case will be

$$\frac{2{\cdot}75 \times 100}{4} = 68\tfrac{3}{4}.$$ Now this theoretical percentage will always be in excess of what is obtained from the coke oven, but by means of the theoretical percentage you are at all times able to check the waste of the coke burner.

TO FIND THE PERCENTAGE OF ASH IN COAL OR COKE.

To determine the percentage of ash in a given sample of coal or coke it is necessary to describe the process of burning off in a platinum crucible about 30 grains of powdered coke or coal. Very few of our readers will have at their disposal an expensive chemical balance, a bunsen burner, and a platinum crucible, we will therefore show how to ash, or determine the percentage of ash without this expensive apparatus. Obtain a common fire clay crucible (a charcoal crucible is better), which will answer for ordinary purposes. Weigh off carefully five ounces of coal or coke, according as you require to find the ash in either coal or coke. It must next be finely powdered and passed through a sieve of about sixty lines to the inch. If you are going to find the percentage of ash coal, the powdered coal must be well stirred with an iron stirrer, when the application of heat will convert it into porous cinders. The coke only requires occasional stirring, but if it is not stirred a film of ashes will cover the top of the coke in the crucible, and prevent the oxygen of the air from acting on it. Either coal or coke is quickly ashed by stirring, but take care that none of the coal or coke adheres to the stirrer. Now to find the percentage of ash proceed as follows: Place a crucible in the heart of a hot cinder fire, having a draught plate partly covering the top of the crucible, to prevent the draught from carrying off any of the coal or coke. When the coal or coke is all burned off, no black specks will appear in the ashes. The crucible must now be covered up and set off at one side to cool, after which the ashes can be carefully weighed. The five ounces of coal will be equal to 80 drams, and let us suppose the ashes to weigh 5 drams,

Then

$$\frac{5 \times 100}{80} = 6{\cdot}25 \text{ per cent. of ashes.}$$

Now under the best conditions, with a very hot fire, it will require two hours to burn off. By this process the quickest way to ash is to inject through the lid of the crucible a very small stream of oxygen gas, but this involves the use of suitable apparatus. The way first described answers very well for persons in pursuit of useful knowledge. A nickel crucible can be purchased for less than a platinum one.

PERCENTAGE OF VOLATILE MATTER IN COAL.

To find the percentage of volatile matter in coal, we proceed as follows: Having ground up into powder a section of the seam from top to bottom, it is repeatedly ground and mixed until at last 5 ounces is taken, then after being carefully weighed, this is put into a cartridge case about 1 inch in diameter, the case being properly closed is put into an iron tube; a little sand is put into the tube, the cartridge case is dropped onto this sand, and more sand is then poured in upon the cartridge case until it is completely covered, having a clear depth of 3 inches of sand above the top of the case. The iron tube is then put into a hot fire when the tube and its contents are raised to a red heat, it is then set to one side to cool, and if the sample under notice is that of caking coal, the coke is weighed. Now let us suppose that the coke weighed 3½ ounces, one and a half have therefore been expelled as volatile matter, therefore

$$\frac{1{\cdot}5 \times 100}{5} = 30.$$

The volatile matter of the coal is therefore 30 per cent.; should the coal however, not be coking coal, the 5 ounces of coal are placed in a small iron tube with a loosely fitting lid to allow for the escape of the volatile matter; the small tube and its lid are now dropped into the large tube and covered with sand as before, and raised to a red heat, and when cool the sand is poured off and the inner small tube carefully emptied and the residue weighed, which will chiefly consist of carbon, when the percentage of volatile matter may be determined as before. To find the percentage of moisture in the coal, carefully grind to powder a sample of the section, and after being repeatedly mixed and passed through the meshes of a sieve of 50 or 60 lines to the inch, carefully weigh 2 ounces or 32 drachms in a saucer or small plate, the weight of which has been previously ascertained; place this in an oven for one hour, subjected to a temperature of about 220 degrees F., then weigh the saucer and its contents, next place the saucer in a moderately cool place (taking care not to expose the contents of the saucer to a draught) for about 5 or 6 hours, then weigh. Now let us suppose the difference in the weights is equal to one drachm, it follows then that

$$\frac{1 \times 100}{32} = 3{\cdot}125$$ the percentage of moisture in the coal.

THE BAROMETER AS A MEANS OF SECURING SAFETY IN MINING.

In a coal mine there are certain places called goaves, which are formed when the coal is taken out, when the roof of a seam is allowed to fall. The roof in falling does not entirely fill the space previously occupied by the coal, but falls irregularly, and the mass of rock, etc., composing the roof is heaped up in an irregular manner. These spaces form reservoirs of gas, because the currents of air cannot ventilate them internally, but simply passes by their edges. The barometer is used to measure the pressure of the atmosphere, and the higher the reading of the barometer the greater is the pressure. It is also well known that the volume occupied by a gas is inversely as the pressure which it bears, the temperature remaining the same. When the barometer falls, the pressure of the atmosphere is lessened, and hence the gas in the goaves expands and pours over the edges of the goaf, so to speak, into the places where the men are working, and is liable to be ignited by a naked light or a defective safety-lamp. Gas being elastic, it follows that small variations of pressure will show themselves on the gas sooner than they can be detected on the barometer. I hope these reasons will make it clear why warnings to miners should be issued in good time, and before any lowering in the height of the barometer takes place. The pressure at which gas exists in the coal itself is generally so very high that the variations of the pressure of the atmosphere (about ½ lb. per square inch for an inch variation in the height of the barometer) will not appreciably affect the quantity flowing into the workings of the mine. Hence the indications of the barometer in such cases are of little value to the miner. However, the state of the mine as regards ventilation to cope with the extra gas in times of low pressure, and discipline to ensure due precautions being taken by the officials and workmen, should not depend on such unstable quantity as the atmosphere, but should be such that in all cases it will not affect the general safety of the mine.

THE SIMPLEST GAS DETECTOR.

The gases met with in mines may be experimented with in a very simple manner. If the reader procures an india-rubber bung with two holes through it for the insertion of pipettes, one of the pipettes having a funnel on its top, and both of them being made capable of opening and closing by means of small cocks, having procured a bottle of any kind with a neck that an india-rubber bung will exactly close air-tight, armed with this simple apparatus the most fascinating experiment may be performed, if the cocks of the pipettes be shut and the bottle filled with water you carry the apparatus into the mine, and to obtain a sample of fire-damp the bottle is held in a cavity in the roof where gas is known to exist, and as the water runs out fire-damp enters the bottle, and by this simple proceeding the bottle becomes filled with the gas, before lowering the bottle the bung should be pressed tight in, and the bottle and its contents may now be carried home for experiments; when by pouring water into the funnel in one pipette the water will press out the gas through the cock of the other pipette, which may be lighted and the inflammability of the gas may be clearly proved.

Carbonic acid gas can be collected with the same bottle, and the same mode of proceeding should be followed, only the air charged with carbonic acid should be collected near the floor of the seam, unless it was required to determine the percentage of carbonic acid gas in the return current of the ventilation, when the bottle, should be filled at the mean height. That is to say, a bottle filled with water is taken down the pit with an india-rubber bung, having two pipettes with taps passing through it, to fill the bottle the taps should be shut, and where it is intended to collect the sample of mine air, the water is poured out, and as the water exhausts from the bottle, the air to be tested enters and takes its place, at this moment the bung must be tightly pressed in and the sample brought out. If the taps and the bung are perfectly airtight a very interesting experiment may be tried at once, on opening one of the taps it will be found that a portion of the air will rush out with great force, proving that the air in the mine is more dense than the air at the surface, or that the pressure of the atmosphere in the mine is greater than the pressure of the atmosphere at the surface. Now if a strong or saturated solution of caustic soda be provided in a large jug, and the bottle of mine air with its neck downward be lowered into the solution, and the bung withdrawn with the neck below the surface of the liquid, the bottle may be set aside for a few hours, when the caustic soda will absorb the whole of the carbonic acid in the air, and the watery liquid will have risen in the bottle to occupy a space equal to the volume of the carbonic acid previously present. Care must be taken to reinsert the bung before the bottle neck is withdrawn from the liquid, now weigh the bottle and its contents, next fill the bottle with the caustic soda solution and weigh that, next empty the bottle and weigh it, subtract the weight of the bottle from each of the former weights, then multiply the smaller weight by 100, and divide by the greater weight, the result will be the percentage of carbonic acid in the mine air that has been experimented on.

To make the matter still more clear, let us suppose that the solution that filled the bottle weighed two pounds, and let us suppose that two ounces of the liquid entered the bottle after the absorption of the gas. Now two pounds are equal to 32 ounces, therefore, two multiplied by 100 and divided by 32, would give the percentage of carbonic gas present in the air as by the sample, or in figures,

$$\frac{2 \times 100}{32} = 6{\cdot}25$$ per cent. of carbonic acid gas in the sample of air that has been tested.

MECHANICS IN MINING.

MAIN AND TAIL-ROPE HAULAGE.

John Cowie, an English miner, thus describes main and tail-rope haulage:

This system of haulage is very suitable for seams having a varying inclination, where two roads cannot be cheaply maintained owing to the nature of the roof or floor, and for working branch roads. It may be described as follows: A single line of tram-rails is laid down in the main road, but two lines of tram-rails are required at the junction of the branch and main roads, one for the full the other for the empty cars. The cars in large collieries are coupled in trains of from forty to ninety, and in small collieries may be as low as twenty or even less, the number of cars in a train being regulated by the output, size of cars, speed of haulage, and length of road. For hauling these trains of cars two ropes are required, a main and a tail rope, the tail-rope being usually from one-half to three-fourths the circumference of the main rope. The main rope is attached to the first car and the tail-rope to the last one. The rope is carried from the engine and along the plane, either on rollers slung from the roof, or on rollers on the floor; steel rollers are preferred, and are fixed at intervals of not more than ten yards apart to avoid unnecessary friction and damage to the ropes. The duty of the main rope is to haul the full train outbye, with the tail-rope attached to the inbye end, and the duty of the tail-rope is to haul the empty cars inbye with the main rope attached to the outbye end of the train. An independent tail-rope is required for each branch road, and when the train arrives at each branch road, or as is sometimes done before the train starts from the shaft, the branch tail-rope is attached to the main road tail-rope by a short length of chain and a shackle to allow of a train of cars being taken out of the branch way. Two drums are used on the engine, one for the main rope and one for the tail-rope, each drum being mounted on a movable carriage so that they can be thrown out of gear with the engines when required, if the engine is required to haul along two main roads, two pairs of drums are put in, all on movable carriages, and each drum is supplied with a suitable brake to allow of the speed of the cars being regulated when descending an incline, either when going inbye or coming outbye. When the cars are going in a branch road or round a curve, suitable sheaves should be put to deflect the cars into their proper course. The average speed of these trains of cars is from eight to ten miles an hour, and the road requires to be well laid and packed to prevent accidents. The kind of rail used has a great deal to do with the success of the system, and flat-bottomed rails weighing 36 lbs. per yard, with fish-plates at the joints and secured to ties by "dogs" or "spikes," the ties being not more than three feet apart, are found to give excellent results, and are now universally employed. The defects of the system may be summed up thus: A large number of stations are required to work branch roadways, more rope is required, there is a greater liability to accidents and damage, through the quick speed at which the trains are run, greater power is required as the engine has the whole work to do in one-third the working day, with a consequent increased consumption of fuel owing to the friction of the rope on rollers, the brakes, and drums, occasioned by the loss of compensatory action of gravity on undulating and inclined roadways.

MECHANICAL QUESTIONS ANSWERED.

Q. What is a unit of work?

A. A unit of work is done when one pound of force is exerted through the space of one foot.

Q. How many units of work are performed in raising a weight of 927 pounds through a space of 290 feet.

A. The weight in pounds $\times$ the distance in feet $=$ units of work, then $927 \times 290 = 268{,}830$ units of work.

Q. How many units of work are done in lifting a weight of 65 tons through the space of 20 yards?

A. Tons must be converted into pounds, and yards into feet. There are 2240 pounds in a ton, then $65 \times 2240 = 145{,}600$ pounds in 65 tons; also there are three feet in one yard, then $20 \times 3 = 60$ feet in 20 yards, now $145{,}600 \times 60 = 8{,}736{,}000$ units of work.

Q. What are the units of work in a theoretical horse power?

A. A theoretical horse power is equal to 33,000 units of work per minute.

Q. What must be the horse power of an engine to perform 396,000 units of work per minute?

A. $396{,}000 \div 33{,}000 = 12$ theoretical horse power.

Q. Water has to be pumped from a depth of 200 fathoms at the rate of 165 gallons per minute, what horse power of an engine will be required?

A. 200×6 feet in a fathom $= 1200$ depth in feet, and a gallon of water weighing 10 pounds, then $165 \times 10 = 1650$, also $1650 \times 1200 = 1{,}980{,}000 \div 33{,}000 = 60$ theoretical H. P.

Q. What is the modulus of an engine?

A. The modulus of an engine is the amount of useful work done.

Q. What is the co-efficient of friction of an engine?

A. The co-efficient of friction is the amount of work lost, by friction on the moving parts.

Q. The modulus of a winding engine being ·4, what is lost by friction?

A. $1{\cdot}0 - {\cdot}4 = {\cdot}6$ or three-fifths.

Q. The modulus of a hauling engine being ·7, what is lost by friction?

A. $1{\cdot}0 - {\cdot}7 = {\cdot}3$, or three-tenths.

Q. The modulus of a pumping engine being ·6, what is lost by friction?

A. $1{\cdot}0 - {\cdot}6 = {\cdot}4$ or two-fifths.

Q. The theoretical horse power of a winding engine is calculated to be 650, what will be the useful work done by this engine, its modulus being ·4?

A. $650 \times {\cdot}4 = 260$ H. P.

Q. The theoretical horse power of a pumping engine is 720, what will be the useful effect?

A. $720 \times {\cdot}6 = 432$ H. P.

EXAMINATION QUESTIONS ANSWERED.

QUESTION 2.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

Upon what does natural ventilation depend; is it reliable, and if not, why not?

ANSWER.—Natural ventilation depends on a difference of temperature of the air on the surface, and of that in the mine. It is not reliable, because atmospheric changes on the surface, due to change of seasons, causes the current to reverse, and because on days when the temperature of the air on the surface is the same, or nearly the same, as that in the mine, there will be no current.

QUESTION 3.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

Upon what does furnace ventilation depend; is it reliable as a means of ventilation of mines?

ANSWER.—Furnace ventilation depends on the heating of the air in the upcast, thus making it expand and become lighter. The colder air in the downcast being more dense and heavier, will force the heated air to rise, and thus produce a current in the mines. Furnace ventilation is much more reliable than natural ventilation, but not nearly as reliable as fan ventilation, and besides it is objectionable on account of the great number of accidents, underground fires, explosions, etc., that can be traced to the use of this method.

QUESTION 4.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

Which would you prefer, and why, an exhaust fan over the upcast or a force fan over the downcast?

ANSWER.—This is a question that is still in dispute by leading authorities on ventilation, and the evidence in favor of each kind of fan is about equal, and there is no apparent advantage in one system over the other, though the standard types of fans are now all exhaust fans.

QUESTION 5.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

Describe black-damp, and give its characteristics, how produced, detected, &c.

ANSWER.—Black-damp is a common name for carbonic acid gas (Symbol CO_2). Its composition is two atoms of oxygen combined with one atom of carbon. One thousand cubic feet of it at 32° F. and barometer 30 ins. weigh 128·45 lbs. It is heavier than air and therefore lies next the floor. It has neither color nor smell, but an acid taste. It is found in large quantities amongst the gases occluded in some coals; but is also produced in mines by the respiration of men and animals, by the burning of lamps, and by the oxidation of the coal and other substances. It extinguishes lights and 8 to 10% of it in the air is fatal to animal life. It may be detected by the action of the flame of a lamp. Small quantities of it will cause the flame to grow dim, and as the quantity is increased the light will become smaller, and finally go out.

QUESTION 6.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

Describe white-damp and give its characteristics, how produced, detected, &c.

ANSWER.—White-damp is a common name for carbonic oxide (Symbol CO). Its composition is one atom of oxygen combined with one atom of carbon. One thousand cubic feet of it at 32° F. and barometer 30 ins. weigh 78·305 lbs. This gas is the result of imperfect combustion. When a body containing carbon is burnt in air, each atom of carbon will combine with two atoms of oxygen to form carbonic acid gas; but, if there is not sufficient air to provide two atoms of oxygen for each atom of carbon, that is to say, if the combustion of the carbon is incomplete, carbonic oxide is formed. It has been detected in rare cases amongst the occluded gases; and is also produced by the combustion of coke, charcoal, and gunpowder; and must, in many cases, be one of the constituents of after-damp. It has neither color, taste, nor smell, but is exceedingly poisonous; one-half of one per cent. in the air, if breathed for long, producing fatal results. It does not support combustion, but itself burns with a blue flame forming carbonic acid gas. It is the most treacherous gas encountered in coal mines, as the victim will be overcome with it before it is possible to detect its presence. Mine fires frequently cause large areas of workings to fill with it.

QUESTION 7.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

What is the most effective method of dealing with fire-damp in mines?

ANSWER.—The most effective method of dealing with fire-damp is to provide a sufficiently large current of air to dilute and carry off all fire-damp generated in the mine.

QUESTION 8.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

State some essential points in regard to air-courses.

ANSWER.—Air-courses should be of as large a sectional area as they reasonably can be made, the sides should be reasonably smooth, and they should be as free as possible of short turns, and there should be no obstructions in them.

QUESTION 9.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

State some essential parts in regard to timbering main entries?

ANSWER.—The timbering of main entries should be done in a most substantial manner, if timbering is required. The timber should be sound and of a nature that will ensure long life, so that constant repairing will not be necessary.

QUESTION 10.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

What are the main features of the Longwall system?

ANSWER.—The main features of the Longwall system of working are, the coal is all worked away at once, and there is comparatively no expensive narrow work.

QUESTION 11.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

What are the advantages of the Longwall system over room and pillar workings?

ANSWER.—In seams where Longwall work is practicable, a greater percentage of large coal is obtained, from 15 to 25 per cent. more coal per acre being won. The system is simpler, ventilation easier, and the men work with greater safety.

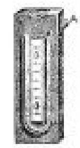
QUESTION 12.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

In what proportion will the pressure on the head of an air column have to be increased in proportion to the increased length of air-way to force the same quantity of air through an air-way 2,000 yds. long, as through an air-way 1,000 yds. long?

ANSWER.—As the perimeter of the air-way remains the same, the length only being doubled, the rubbing surface is doubled. As the pressure varies directly as the rubbing surface, to pass the same quantity of air through the 2,000 ft. air-way as through the 1,000 air-way, will require double the pressure.

QUESTION 13.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

Describe the water-gauge and its use.



ANSWER.—The water-gauge is used to measure the dynamic force of a current of air. It consists of a U-shaped tube of equal area throughout. The arms are about six inches long, provided with a scale divided into inches and fractional parts of an inch, so that the difference between the height of the water in one arm of the tube, and that of the other may be measured. One arm is placed in connection with the air passing in the mine by placing the tube A through a hole in the brattice or fan casing, while the other is opened to the airway from the mine. The difference in water-level will indicate the drag, or the resistance to the air in the mine.

The weight of one cubic foot of water at 62° F. and 30 inches barometrical pressure is 62·32102 lbs. The weight of one cu. in. is therefore 62·32102 ÷ 1728, or 0·036. When the gauge measures one inch, the pressure is $0·036 \times 144 = 5·184$ or 5·2 lbs. (nearly) to the square foot.

Example.—If a water-gauge read 0·4″, what pressure would it indicate?

$$0·036 \times 0·4 \times 144 = 2·0734 \text{ lbs. per sq. ft.}$$

The water-gauge may be used to show the force of a current produced by a fan or by a furnace, and hence it is very useful as a check to the furnace-man. As it tells the amount of resistance to the air in the air courses, their state or condition may be inferred. If the pressure per sq. ft. exerted by the motive column be known, the height of a motive-column may be determined by dividing the pressure per square foot by the weight of a cubic foot of air.

Example.—What is the height of the motive-column, if the water-gauge reads 0·4″, the temperature is 62° F., and the barometrical pressure is 30″?

The weight of one cubic foot of air at 62° F. and 30″ Bar. is 0·07629 lbs? The pressure is $0·036 \times 0·4 \times 144 = 2·0736$ lbs., and the height of motive column =

$$\frac{2·0736}{0·07629} \text{ or } 27·28 \text{ feet.}$$

To find the velocity we use the equation for falling bodies, which is

$$8·0208 \sqrt{h}$$

This equation is based on the principle that a body falls 16·08, in one second, and that it gains a velocity of 32·16 at the end of the first second. Then the velocity per second equals 8·0208 times the square root of the height of motive-column in feet.

Example.—If the height of the motive-column is 27·28 ft. the velocity per second is $8·02 \times \sqrt{27·28}$ or 41·9 ft.

These formulæ may be arranged as follows:

Let P = Pressure in pounds per sq. ft.

Let h = Height of motive-column in feet.

Let V = Velocity in feet per second.

Then:

$$P = 0·036 \times \text{water-gauge} \times 144,$$

$$h = \frac{P}{0·0763},$$

$$V = 8·02 \times \sqrt{h}$$

These formulæ, it must be remembered, are only theoretically true, on account of the enormous power required to overcome friction. In practice from 10 to 20 times the theoretical amount of motive-column is required to produce the theoretical velocity. To find the horse power expended in the power required for a ventilating current, multiply the quantity of air passing by the reading of the water-gauge, and this product by 5·2; divide the result by 33,000.

The quantity of air passing in an airway is according to the sq. root of the water-gauge.

Thus, if 10,000 cu. ft. is passing per minute with a water-gauge of 1 in., 7,071 cu. ft. is passing with a water-gauge of 0·5 in., or

$$\sqrt{1·0} : \sqrt{0·5} :: 10,000 : 7,071.$$

QUESTION 14.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

If the water-gauge shows a difference of reading of 1·2 inches between the intake and return of a certain portion of a mine, and the anemometer indicates a velocity of ten feet per second, size of entries 6 × 8 ft., what effective horse power has been expended in the ventilation of that part of the mine?

ANSWER.—As the area of the air-way is 6 × 8, or 48 square feet, and the velocity is 10 ft. per second, the volume passing equals $48 \times 10 \times 60 = 28,800$ cu. ft.

Then, according to the rule given in the preceding answer,

$$\frac{28,800 \times 1·2 \times 5·2}{33,000} = 5·45 - \text{H. P.}$$

QUESTION 15.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

Will the velocity of the ventilating current be the greater in the intake or the return, or will they be the same, and why?

ANSWER.—The velocity will be greater in the intake, because there will be a certain proportion of the current lost in leakages, and the velocity will be reduced by friction against the sides of the air courses.

QUESTION 16.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

In a non-fiery mine 500 men are employed, and forty mules, the air course is 6 × 8 ft., give plan, or describe in brief your method for the proper ventilation of such a mine?

ANSWER.—I would ventilate by fan or furnace, preferring a fan. The mine law of Iowa requires a minimum of 100 cu. ft. of air per minute for each man, and 500 cu. ft. per minute for each mule. Making the minimum quantity for the mine $(500 \times 100) + (40 \times 500) = 70,000$ cu. ft.

I would endeavor to have an excess of air above legal requirements, say 50% more, making the total volume 105,000 cu. ft., I would divide this into say six splits, each having a current of 17,500 cu. ft. per minute, which would make the velocity but little over 6 ft. per second, which is safe in non-fiery mines, and I would endeavor to have less than 100 men in each split.

QUESTION 17.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

Explain the use of the anemometer.

ANSWER.—The anemometer is an instrument used to measure the velocity of the air current. Biram's anemometer is in general use in this country. Each revolution of the vanes, which is registered on the dial plate, corresponds to one foot in the linear motion of the air. Then if the velocity per minute is multiplied by the sectional area of the air course in which the anemometer is placed, the result is the number of cubic feet of air passing per minute. These instruments do not measure the actual velocity of the air, especially in feeble currents, but the result is so nearly correct that they answer all purposes. A certain force of air is required to overcome friction and put the instrument in motion. The force varies with each and every instrument. Some anemometers will continue to revolve in a current as low as 30 ft. per minute; but with most of them a velocity of 50 ft. is required, and 40 ft. is recommended as an average allowance to be made to start them. The formula used for true velocities is:

V = ·97 R + 40.

When V = True velocity.

R = Recorded revolutions.

40 = Feet allowed to start anemometer.

QUESTION 18.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

In what part of a mine should observations with the anemometer be taken, and why?

ANSWER.—Observations with the anemometer should be made both in the intake and the return at places of regular sectional area where there are no eddies caused by short bends or turns. The succeeding measurements should be taken as nearly as possible at the same places.

QUESTION 19.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1890.

In the case cited in Question 14, where should the reading of the anemometer be taken, and why?

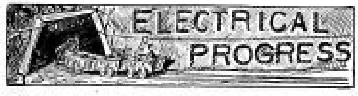
ANSWER.—Both in the intake and the return air courses, so as to get the average velocity, and thus get an average of the quantity circulating.

H. Ward Leonard & Co. have received an order from Wm. Sellers & Co., of Philadelphia, for two 40 horse-power motors for use upon traveling cranes. The motors are to be supplied under rigid specifications, as to dimensions and performance, but the decision as to particular make of motors to be used is left with H. Ward Leonard & Co.

Mr. Leonard is licensing various manufacturing and construction concerns under his recently patented system of motor regulation. The basis of the license is a charge of \$2.50 per K. W. (roughly per horse-power) in the motor. The royalty charge is not an annual charge, but is paid once for all in each case.

Messrs. Wm. Sellers & Co. have taken a license under Mr. Leonard's patent on this basis, they agreeing to use the method upon all electric cranes they build in the future, during the life of the patent.

The royalty is so small that the method will no doubt be rapidly introduced wherever it is applicable.



A Novel Electric Railway for the World's Fair.

October 7th next, the World's Fair Grounds at Chicago will be opened to visitors for the inspection of the progressing work, and for their accommodation there is being constructed an electric railway of a most ingenious and novel character, having a capacity of carrying 30,000 passengers per hour, with the greatest comfort, convenience, and safety. The railway department of the Chicago office of the Thomson-Houston Electric Company has closed a contract with the Columbian Movable Sidewalk Co., of Chicago, for the electrical and steam equipment of the movable sidewalk which is now being installed. The mechanical and electrical plans and details have been carefully worked out by Mr. G. K. Wheeler, of the company, and under his supervision the entire plant will be installed.

By the time named above there will have been nearly completed a large number of buildings, and there will be much to attract and interest visitors. The electric railway, however, will be one of the leading novelties and attractions. This railway will differ from ordinary railways, in that the passengers are transported on a movable sidewalk instead of by cars of the ordinary type. The scheme is the invention of the Columbian Movable Sidewalk Company, of Chicago, and the installation is being constructed under its patents.

The sidewalk is located on the improved and unimproved portions of Jackson Park, and is to be constructed on an elevated structure 25 feet high and 900 feet long, in the form of an ellipse and is to consist of 75 cars, each 12 feet long, connected together, making one solid train. There is to be constructed two parallel sidewalks, one running at the rate of two miles an hour, the other at four, both walks moving in the same direction. The passengers can step from the stationary walk to the one which moves at the rate of two miles an hour, and if it is desired to move at a greater speed they can step from this walk to the one running at four miles an hour. The passengers can safely walk upon either of the movable sidewalks while in motion if desired.

The structure will be illuminated at night by a number of Thomson-Houston incandescent lights, and, as the grounds are to be illuminated with arc lights, a satisfactory view can be obtained during the evening as well as during the day.

Three of the 75 cars are to be equipped, with two 15-H. P. Thomson-Houston railway motors, each mounted upon trucks with wheels 18 inches in diameter. As the car platform, or sidewalk, is arranged it is perfectly level with the stationary walk, allowing the trolley wire to be placed beneath the surface of the platform, and the current taken therefrom by means of small trolleys attached beneath the car floors.

The operation of this train of cars will be arranged in a novel manner, doing away with the use of motor men, the entire train being controlled and operated by one man.

There will be constructed at a central point, at one side of the track, a controlling station, which will contain a main switch, reversing switch, automatic circuit breaker, lightning arrester, ampere meter and rheostats, all arranged so that they can be operated by the attendant from that point who will have the train under perfect control.

The power for the operation of the sidewalk will be furnished by the Thomson-Houston 110 H. P. multipolar compound wound railway generator, located in a power house adjacent to the track. And in connection with said generator there will be placed a suitable switchboard, regulating controlling, and indicating devices of the Thomson-Houston Company's manufacture.—*Electrical World.*

Accumulator Cars at the Hague.

Six accumulator cars, says the *Electrical Engineer*, of London, are now running from the Hague to the Casino at Schevening, a distance of about three miles. The speed of running is 12 miles an hour, including stops. The loaded car weighs 16 tons; it is 32 feet long, carries 68 passengers, and the battery of accumulators weighs 4 tons. The cars constructed at Harlem, have two bogies of two axles each. Only one bogie is driven, having its wheels coupled together. The axles are connected to the motor by solid gearing, and the whole weight is carried by the axles. The motor is supplied by carbon brushes from a battery of 192 Julien accumulators, weighing 40 pounds each. This battery, when charged, provides current for a run of 45 miles, after which the cars return for change of cells. The accumulators are arranged in eight boxes or drawers, weighing half a ton each, placed under the seats. The car is provided with switches and resistances to allow the speed to be varied. The changing of the sets of cells is carried out by the aid of a special mechanical arrangement to allow rapid handling. Two sets of turntables and rolling carriers are placed at the end of a charging bench. The drawers, when taken from the car, slide easily on rollers placed on the bench and turntables, the operation of changing requiring five minutes. The spare sets of cells are always being charged as the others are being used. The connections are made with spring contacts arranged so that no mistake can occur. The charging is accomplished by means of Silverton shunt dynamos, with hand regulators, giving 60 amperes at 100 volts. The machine room contains two condensing steam engines of 210 indicated H. P. each. The condensing water is supplied by a siphon from the canal three-quarters of a mile away. The installation is completed by a small workshop driven by an electric motor, itself supplied by a small battery of 70 cells of 66 pounds each, which are also used for lighting by means of 10 arc lamps. It is intended to settle the question of maintenance by the erection of a small manufactory of battery plates on the spot, with a laboratory.

A New Electrical Carriage.

Electrically propelled vehicles are among the many conveniences which novelists and fiction writers have ascribed to future ages, while practical inventors have given their attention to subjects that bring them more satisfactory results, such as street car work. A departure from this line of thought is afforded in the electrical carriage invented by William Morrison, of Des Moines, Ia. The motive power is obtained from 24 accumulator cells placed under the seats, while the motor itself is on the rear axle. The winding of the motor is so arranged that a reversal of the current will cause the carriage to run backward as easily as forward, while the steering apparatus is arranged simply and effectively.

This carriage has been in practical operation in the streets of Des Moines for some time, and will soon be seen in Chicago.

From the satisfactory results obtained from this mode of locomotion the day does not seem so very far distant when carriages, as well as other vehicles, will be moving around our streets propelled by electric motors that receive their current from concealed batteries, and therefore effect a further emancipation of the millions of animals now performing this service.

Improved Uses of Electricity.

Dr. Louis Bell recently read an interesting paper before the Franklin Institute on "Electricity as the Rival of Steam." The author, in the course of his paper, remarked that we must still look upon electricity not in any sense as a prime mover, but simply as a powerful and convenient means of transmitting power from one point to another. It was also to be inferred that only in exceptional cases could anything but steam be employed as the prime mover. This inference was necessary because, up to the time of the writing of that paper, we had no means of transmitting power by water for any considerable distance, five miles being the longest distance of transmission, and even that at a very great loss of power.

Since that time, however, the Frankfort experiments have shown that electricity may now be transmitted upward of 100 miles, at a less loss than has heretofore been met with in a five mile distance. This fact has added immensely to the possibilities of the uses of electricity. By this increased control over the electric current, it is possible to utilize water power from great distances, and streams which have heretofore been considered of little or no worth are now regarded as of great value. Water power may now be economically and safely transmitted from any of our mountain streams into any or all of our great interior valleys and made to do all that steam can do on the spot. Such power may be made to light cities, run factories or drive trains of cars on our railroads. Power may be "bottled up," so to speak, and sent along a hundred miles of wire or more at a slight expense, divided up to any desired extent, and made to do all the work required of any power at any desired point. By this means, after a plant is once installed, the cost of power will be light—a mere bagatelle of what it is now.

A Word About Coffee.

Much has been written and printed concerning coffee. Cook-books all contain receipts for preparing it in different ways. Every housekeeper considers that coffee is something anybody can make, and therefore she takes no particular pains to make it. It is a fact that on the breakfast table of nine out of ten families, where nice cooking in other respects is the rule, the coffee will be found watery stuff, tasting strongly of chicory, or else so black and thick as to be undrinkable by whoever is used to the better-made article.

In the city the vast majority of housewives buy ground coffee at corner groceries. I think the same rule is good in the country, for most country stores have their coffee-grinder. The grocery man's profit is so large on coffee that of course it pays him well to grind it. And he can, in grinding, adulterate it to so great an extent that he would prefer to sell his "real Java" and "real Mocha" ground, even if he had to sell at a less price than in the bean. The fact that the price is the same, ground or unground, never seems to show people plainly how well it would pay them to grind their own coffee. They may be sure the grocery man does not do it for love.

It is not easy to roast coffee, for it requires much close watching, patience, and experience to bring it just to the proper shade, not burnt, nor yet too light, neither too little nor too much, but just right. It can be bought freshly and perfectly roasted in the larger grocery houses of good repute. It is best to buy not more than two pounds of this at a time, and it should be closely covered until the last grain is used. I have always found that one-third Mocha and two-thirds Java make a good combination. This costs about thirty-two cents per pound at the larger houses.

A coffee-grinder—a good one—is worth fifty cents. The comfort of the good coffee it gives you is worth far more. It is true Bridget will not grind it unless compelled, and if she hasn't any coffee but unground to use; but it should be made a case of "needs must." If she is allowed to grind it over night for use in the morning, it should be put into a tightly covered vessel until used.

I use a coffee-cup full, ground, for a family of five. This makes a pound last about a week. Put in an egg-shell, and fill the pot about a third full of cold water. When it boils hard, add boiling-hot water to the quantity you wish to make. When that boils up once, put in a dash of cold water, and cover the coffee-pot with a folded towel, and set on the back part of the stove until you wish to use it. If you pour into a silver urn, be sure to scald the urn first, that the coffee may not be chilled.

Whoever is used to drinking good coffee, bought and made in this way, will never be content with "grocers' coffee" again.

Always buy a grinder to screw against the wall. It saves time and temper, and is at hand when it is wanted.—*Harper's Bazaar.*

Cures for Warts.

The cures for warts are exceedingly numerous. These which follow are given in the order of their ease and accessibility; but the needle plan, which comes nearly last, bears the palm for speed and certainty: In all cases where a solvent is employed, the hard, insensitive crown of the wart should be previously pared off, but not so deeply as to cause bleeding. And in most cases it is advisable to protect the adjacent skin either with a circle of vaseline or a piece of plaster with a hole in the middle which just fits the wart. Then apply as often as convenient, either the white juice of sow-thistle (*sonchus oleraceus*), which grows everywhere, or the yellow juice of greater celendine (*chelidonium majus*), which prefers the vicinity of human dwellings; or the exceedingly corrosive, creamy sap of sun-spurge (*euphorbia helioscopia*), which likes gardens and cultivated fields. The next few remedies involve going to a chemist, namely: lunar caustic, once or twice a day, glacial acetic acid, salicylic acid and creosote, iodine and carbolic acid, or caustic potash, which is dangerous stuff. A piece of raw beef steeped twelve hours in vinegar and then held to the wart with rag or sticking plaster is pronounced a sure cure in about a fortnight. The needle cure does its work in about ten minutes, of course not counting the healing of the sore. It is done by running a darning-needle through the middle of the wart and holding the end of the needle in the flame of a candle. The heat is conducted along the steel so as to destroy the vitality of the wart, which is not so terrible a process as it sounds, nevertheless, as it demands a little pluck, I have put it last on the list, and advise having some kind of forceps at hand to withdraw the hot needle, if required.—*Hall's Journal of Health.*

Using the Teeth.

The law of deterioration, from disuse obtains with the teeth, as well as with other things. The constant and regular use of them in masticating hard food tends to make them continually grow harder and stronger, and better able to resist the influences that make for decay, while on the other hand, living on soft food and neglect of mastication makes them tender, softens the enamel and renders them easy succeptible to corroding effects. This is sometimes especially shown in the case of people after a long illness who find their teeth tender and sore when they begin to return to a diet of solid hard food. A dentist, speaking on this subject, says: "Some men have healthy teeth all their lives, because they were given good, hard food during infancy. That is the period to begin to save the teeth. Mothers and nurses give children soft food, utterly ignorant in many cases of the result. Crusts and hard stuffs should be given to children as soon as they can eat them. In this way the teeth begin to grow healthy, and gradually harden with time and use. The chewing-gum girl gives her molars plenty of wholesome and unwholesome exercise. But chewing-gum is not especially healthy, because only part of the teeth are used. It is jaw exercise more than anything else. But in eating hard, wholesome food, all the teeth come in contact with the substance. Tobacco chewing is not healthy for the teeth, because the tobacco is generally placed in one location, like chewing-gum, and there remains until thrown out. The Southern negroes have better teeth than most any race because they use them from childhood up in masticating hard food."—*Good Housekeeping.*

Fresh Air in Winter.

Why is fresh air, the very breath of our nostrils, treated by nine-tenths of us as an enemy, throughout the winter? It is as essential to health and life in one season as in another, and yet, from November until May, seven-eighths of us do our best to barricade our dwellings against it. It is impossible to prevent so close a besieger from gaining the advantage now and then, but we do what we can to make our castles impregnable to the outer air. We fortify our doors and windows with contrivances of all kinds to exclude it, and when, through some oversight, it gains admission, we exhaust the intruder with overheated stoves and furnaces. If we cannot altogether keep it out, we can at least poison it when it gets in.

A few hundred of us, congregated in an unventilated room, can soon deprive the air it contains of its vital principle; and were it not that this sleepless enemy outside occasionally makes a plunge into the apartment when a newcomer steps in to assist in the poisoning operation, the coroners would never have a moment they could call their own. As it is, the opponents of fresh air keep them pretty busy.

The occupants of tenement houses, by dint of stopping up crevices with rags and shutting down the dampers of their cracked stoves, so as to prevent the egress of the coal gas from their dormitories, provide the malignant typhus with "all the comforts of a home," and contrive to put a large amount of fees into the pockets of the coroners during the inclement months. Self suffocation is quite an "institution" in this community.

If we cannot have pure milk, pure flour, pure coffee, or pure wine, we can at least have pure air. The Giver of all good gifts provides us with *that* blessing, without money and without price. But ye fall in with the fashons of the time and adulterate it. We poison it and sicken by feeding on its unwholesome corpse. Thirty or forty of us stow ourselves in a horse-car with all its sashes closed, and, having asked the conductor to close both doors, there we sit engendering mutual infection.

Diphtheria, catarrh, lung fever, and consumption are often attributed to draughts of cold air, but they are more frequently caused by stagnant hot air deprived of its oxygen. If we "take cold" in consequence of stepping out of a room heated to a tropical temperature into an atmosphere below the freezing point, the primary cause of the difficulty is the overheated sealed up room, not the healthful open air.

If we were more in the habit of warming our blood in winter with brisk exercise "under the canopy," and less inclined to coddle ourselves in all but hermetically sealed rooms warmed with hot-air furnaces, we should be a healthier people than we are. The winds of heaven are hygeian. They should be permitted to circulate *freely* through every dwelling at least once a day. Warm carbonic-acid gas is not good for the lungs, but cool oxygen is. Let us ventilate!—*New York Ledger.*

Why all Milk Should be Boiled.

A French physician at a seance of the Academy of Medicine dwelt upon the dangers of using cows' milk uncooked. He described the case of a young woman twenty years of age who had tubercular inflammation of the brain. On inquiry it was found that she had been educated in a convent, in which thirteen scholars had been stricken down with tuberculosis during the preceding four years, and evidently this was where she contracted the disease.

Extended inquiry elicited the fact that the cow from which the supply came had been driven every morning to the convent to be milked. When killed she was found to be suffering from advanced tuberculosis, and from her, undoubtedly, the unfortunate girls took the disease that destroyed them.

If the disease has not far advanced it is never easy to detect tuberculosis in a cow, and there is good reason for the belief that very many cows that are in good condition and seemingly sound and healthy are yet suffering from this malady. Considering also the fact that rigid inspection of cows is seldom practiced, it is very evident that safety can only be secured by the observation of one rule, namely, boiling the milk.

If a person keeps an apparently healthy cow, feeds it well and otherwise cares for it judiciously, it would seem that he had nothing to apprehend from the milk. And yet his cow might be ailing and be not know it. Hence milk should always be thoroughly boiled, no matter where it comes from.

Scientific Advancement

University Extension.

There is a new thing under the sun. The thing that hath been is that the universities of all lands have been for the benefit of the few. The thing that is and shall be, in a rapid ratio of increase, is the extension of the resources of these great institutions for the benefit of the many.

The movement is new. Yet it is eighteen years old in England. It is but an infant of months in America, and of days in France. Because it is so new and young its history is interesting, and the promise of its future is derived from its comparatively brief but vigorous life. The seeds of its origin and growth are already sown in Philadelphia and in Boston and in the germinant and springing soil of our own expanding universities. There is every reason to expect that the movement will grow more rapidly here than in the mother country.

That a higher education may become the possession of the people at large may well be the earnest prayer of all who believe in Democracies, and in the solution under American conditions of the problems that confront all the nations. Young men are the leaders in forwarding the movement, and young people are the materials composing it. A definition of its aim, history, and method is desirable. University extension reverses the old way. It takes the teacher to the student in a transient, an itinerary way, instead of bringing the student to the teacher as a resident for a term of years. Since the child cannot come to David for mutual advantage, David goes to the child, and the essential object is secured. Hence the movement aims at universal higher education.

The phrase "University Extension" originated in England and at Oxford as far back as 1850. The movement started at Cambridge at 1873, and its founder was Hon. James Stuart, then a member of Parliament. Oxford and Cambridge, therefore, the two great universities of England, notwithstanding their conservatism, have taken the lead in popularizing their institutions and the education which they exist to promote. The idea has been accepted by all the universities of Great Britain and by many in America. The growth of the movement now covers 18 years. Experience can be given—valuable experience. Results have been attained which demonstrate beyond controversy the feasibility of the scheme, and the development of it in manifold ways. England, Scotland, Ireland, France, Australia, India and the United States are adopting it. The London *Secretary* says: "There are signs that work on similar lines is about to be established in various countries on the Continent of Europe."

The audiences secured have been variable as to sex, age and occupation. Afternoon lectures have been attended chiefly by women. Both sexes and all ages have been secured at evening lectures. Elementary teachers, business and professional men, college graduates pursuing specialties have not been wanting.

The wage earning class have been largely represented. Proofs have been furnished, numerous, pathetic, and gratifying that many toilers are devoting, and are eager to devote, their evenings and their holidays and half-holidays to intellectual pursuits. This is especially true of the labor-reform leaders.

Summer sessions at Oxford and Cambridge have been held in recent years, and those of the present year have been the best of all as regards attendance, interest and profit. This phase of the movement, like the movement itself, originated in an incidental way.

In the summer of 1884, two miners, students at extension centers in Northumberland, were spending three days at Cambridge, on a visit to one of the lecturers. As the visitors were conducted by their hosts through the beautiful library of Trinity College, and the spell of its beauty was upon them, one said to the other, "Oh, that it were possible for some of our students to come up for a short time to work in Cambridge and see all this for themselves!"

A plan was devised for bringing students to the University for a short summer term. Subsequently the same scheme was adopted at Oxford. Cambridge was invited and welcomed the better students discovered in the winter sessions throughout England. Oxford has popularized the scheme, practically for the benefit of all comers.—*Frank Leslie's Weekly.*

The Moon's Place in Nature.*

Science asserts that the moon shines with a borrowed light—a light reflected from the sun. Science also asserts that the 93,000,000 miles of space between the sun and moon is utter darkness; that the moon is dead, having no atmosphere, no water, no clouds, no life in any form; and that it is a stupendous cinder pitted with countless craters of extinct volcanoes. Contradictory and incongruous as these theories are none the less are they universally accepted to-day.

But science is fallible, and such inconsistencies must lead to the grave result of rendering suspicious all our theories pertaining to the universal space and its contents. To add to the distrust these theories awaken, it is now found that the telescope which hitherto has furnished the basis of our present conceptions of the moon, is not to be relied upon. Prof. Holden, the astronomer in charge of the new Lick telescope, the largest in the world, says of that instrument: "There is no object in the heavens which we must not observe as if viewed for the first time. It has opened a new vista of the creation. It compels us to learn everything anew. Even the most familiar of supposed facts revealed by other telescopes, as of the moon, for example, are found in this great revelator to be not facts but errors."

That the moon receives something from the sun which freely passes through the darkness and cold of space, and which is sent onward to the earth by reflection, is unquestionable, as is also the additional fact that our atmosphere is awakened to its beautiful moonlight effects by this reflected current.

Although scientists make no pretence as asserting the presence of any element or substance in the composition of the moon which is capable of producing actual reflection, yet, nevertheless, it is legitimate to infer that the moon has a medium which possesses reflecting powers adequate to all supposed necessities. The question then arises, what is that reflecting medium? The answer is drawn from analogy.

No one will claim that the dead, dull body of the moon which science depicts is capable of reflecting the currents which it receives from the sun. It is now demonstrable that electrical currents, both instantaneously and incessantly, come from the sun to the earth, and, through the resistance offered by our atmosphere, become awakened into dazzling light and burning heat. Only an atmosphere is capable of thus reflecting the sun's vivifying currents. We may therefore legitimately infer that atmospheres are indispensable to visibility in all worlds; and that a moon without an atmosphere would not be visible. The same is equally true of the sun itself. Inferentially, therefore the moon possesses an atmosphere, with all the constants of an atmosphere, viz.: heat, light animal life and intelligence, vegetable and mineral life, the property of reflection of great cosmical currents, etc.

Direct electrical sun currents come through the darkness and cold of space and develop atmospheric light and heat at the moon, as well as at the earth; and in either case there is reflection, making each a moon for the other. Such electrical sun-currents reflected from the moon to the earth, develop in the earth's atmosphere its beautiful moonlight, therefore, instead of the moon being *dead*, it is undoubtedly another world of activities like unto the earth.

The moon, awakened out of its *Rip Van Winkle* obscurity to which science hitherto has succeeded in relegating it, henceforth should be accorded a more just and honorable position among the members of the celestial family.

*By Henry Raymond Rogers, M. D., Dunkirk, N. Y., read before the Chautauqua Society of History and Natural Science.

A Non-Sinkable Ship.

A Massachusetts inventor has devised a double-hulled ship, with compartments so arranged and constructed that it supplies, he asserts, a mathematical certainty against sinking. Between the outer and inner shells of the vessel is a series of longitudinal compartments, to be filled with water, and emptied by the vessel's pumps for ballast; and about this section, on either side, and rising to the full height of the vessel's sides, is a series of chambers filled with small air-tight tanks, their capacity being figured in excess of the known displacement of the ship and cargo. Thus, a cubic foot of air has a perfect supporting capacity for a known weight. It is claimed that with a supply of air in these tanks of 25 per cent. above that required by the formula, nothing short of fragmentary destruction could sink a vessel. Any probable collision, the penetration of a shot, or the explosion of a torpedo, would injure only a small proportion of the tanks, the rest performing their work easily and safely, thus rendering the vessel non-sinkable, the only sacrifice involved in the arrangement being a decreased carrying capacity.

Useful Information

Effects of the Keeley Treatment on the System.

The effect of Dr. Keeley's treatment for intemperance, or dipsomania, as it is called, is thus described by one who took a course at one of his institutes:

After the acute symptoms of alcoholism had passed away I could recognize and study the symptoms induced by the use of the "gold cure," and by carefully collating the facts given to me by a number of patients I am able to state the effects of the Keeley remedies to be generally as follows:

Marked increase of appetite, improvement in digestive capacity, the functions of the mind became more active, a state of cheerfulness was induced, and a general feeling of "well being" was experienced.

These symptoms were in all probability produced by the bi-chloride of gold. I noted other symptoms that were due, no doubt, to the presence of other drugs used in compounding the medicines. For instance, dryness of the mouth, throat, and larynx, as well as of the lips, increased action of the heart, a rise of blood temperature, a redness of the skin, with a slight rash, not distinctly punctated, dilation of the pupil of the eye, dimness of vision, confusion of sight, slight vertigo, unsteadiness of gait. All these last enumerated symptoms may be accounted for by the use of atropine in the preparation of the "gold cure." So, too, the presence of strychnine may be assumed from the following named symptoms: Increased appetite, increased digestive power, nervous twitchings, dilated pupils, etc. It is well known that strychnine is a valuable remedy in cases of gastric catarrh and morning vomiting common to drunkards; that the poor appetite, the feeble digestion, the nervousness and tremblings which follow the withdrawal of stimulants, are alleviated by small doses of the tincture. There may also be cinchona in the mixture or alkaloid quinine which is frequently used as a remedy in cases of gastric catarrh. The same may be said of arsenic. The fluid extract of coca or even cocaine in some form may account for the feeling of cheerfulness and of well being that takes possession of the mind after using the Keeley remedies. This particular symptom may, however, be due solely to the bi-chloride of gold for as is well known his preparation, or rather the chloride of gold and sodium, is highly recommended by some of the highest medical authorities as a valuable remedy in cases of melancholia, hypochondria, and allied states accompanied by mental depression.

A Visit to Mauna-Loa, in the Sandwich Islands.

I had seen Vesuvius, Ætna, and many of the burning mountains in Central America; but I had an unconquerable desire to see that of which I had heard such wonders, Mauna-Loa. And, after arriving at the Sandwich Islands, I was not long in forming a party for the excursion. The way was toilsome; but the fatigue which it produced was forgotten when I stood upon the edge of the crater, and first cast my eyes into the immense abyss that yawned below.

The view of Vesuvius had affected me deeply, and the crater appeared to me the most gloomy gulf I could imagine, being, perhaps, at the time of my visit, about a quarter of a mile in circumference, and so filled with smoke that the lower parts were concealed from view. The crater of Ætna I found to be two or three times larger; and I contemplated it with greater admiration, mingled with awe and even fear. Can the reader imagine the two objects, in their real and relative magnitudes? Let him then fancy that another opens before him, of double the size of Ætna, then one twice the size of that. Then, instead of a crater two or three miles in circuit, let him imagine one with a circumference of *twelve miles*; and then he has before him *Mauna-Loa!*

The edge or border of that immense gulf, though somewhat irregular and broken, allowed us room to stand and walk from point to point without much inconvenience. I was engrossed with the scene, so numerous and striking were the objects discovered, as I moved from place to place.

Twelve miles in circuit! We could scarcely realize the immense extent of the gulf below us. In one place appeared a cluster of conical heaps, from the tops of which rolled out columns of smoke. Though they seemed not larger than ants' nests they were probably two hundred feet high. The crags which formed the rude wall of the water on the opposite side looking like a low ledge of rocks; but, as we followed it, with the eye, to the left and then to the right, we found it apparently rising in elevation, until we realized that it was equal to the immense perpendicular precipice on the edge of which we were walking.

Although the volcano was comparatively in a state of repose, that is, exhibited no extraordinary phenomena, and gave no symptom of an eruption or emission of lava, it was evident that an immense mass of fire was in active operation in the bowels of the mountain and far down in the earth; for there was a surface of melted lava, extending a great distance across the immense cauldron, in constant and violent undulation, and as red as blood. The heat must have been intense and equal in all parts; for no part of the surface was hardened or of a duller color, except along the extreme edges where the process of cooling seemed to be slowly going on. All the rest was one vast sheet of fluid, red-hot matter, tossed up in waves and whirled in eddies by fresh streams continually thrown up from below. Sounds of a peculiar and indescribable kind rose from one part and another, as the boiling became more violent here and there, or when a new surge rolled over the glowing surface until it dashed at the foot of the awful precipices, which impended over the the gulf at every point of its boundary.

There was a general sound continually in the air, like the roar of a distant cataract, which was caused by the combination of a thousand various noises, made by the cracking and crushing of half-cooled lava, the tumultuous swelling and rolling of the fluid masses, the issuing of steam and the rushing of air in the currents formed by the heat. But now and then one of these noises would suddenly be heard very near us, at the foot of the precipice beneath our feet, or among the rocks just below us; and sometimes a deafening roar would burst from the surface of the boiling lava, which would drown every other sound, arrest our attention, and draw our eyes to the spot where clouds of vapor or jets of shining lava would rise into the air, with shrill whistlings and sullen bellowings, like the most appalling thunder.—*New York Ledger.*

Importance of Parental Authority.

There is a growing tendency among professional reformers and humanitarians to extol kindness as the chief element—as, in fact, the very mainspring of every kind of government. They would suppress all exercise of power, and, instead of firmly enforcing obedience, they would merely solicit the submission of those who are prone to disregard the law and defy authority.

This is a pernicious theory. Unquestionably, the function of government should be pervaded with a spirit of genuine kindness; but kindness alone will not govern lawlessness, nor will it even restrain either children or men from refractory behavior when their passions are aroused.

In order to command the obedience of those whom it is necessary to govern, there must be force, authority, power. There must be in the mind of the party to be governed a full conviction that the power of the other party is superior to his own; that there is in the party claiming obedience an ample reserve of power fully adequate to enforce the claim. The more complete this conviction, the less occasion there will be for the exercise of the power.

The value of kindness should not be underrated in any system of government, whether in the household, the school, or in civil society. But kindness is not the basis of government. Obedience is yielded to authority, and authority is based on right and power. The child who complies with his father's wishes only because his parents have "reasoned" with him, or who has been wheedled into compliance by petty bribes and promises, has not learned that doctrine of obedience which lies at the foundation of all government, human and divine. God has given to the parent the right to the obedience of his children, and the power to enforce it. That parent has failed in his duty who has not trained his child, not only to love him, but to obey him, in the strict sense of the word; that is, to yield his will to the will of a superior from a sense of appointed subordination and rightful authority.

This sense of subordination and of obedience to appointed and rightful authority is of the very essence of civil government, and the place where it is to be first and chiefly learned is in the household. To teach this is a main end of the parental relation. The parent who fails to teach it fails to give his child the first element of good citizenship, and leaves him often to be in after years the victim of his own uncontrolled passions and tempers. The want of a proper exercise of parental authority is, in this age of the world, one of the most prolific sources of those frightful disorders that pervade society and that threaten to upturn the very foundations of all civil government.—*New York Ledger.*

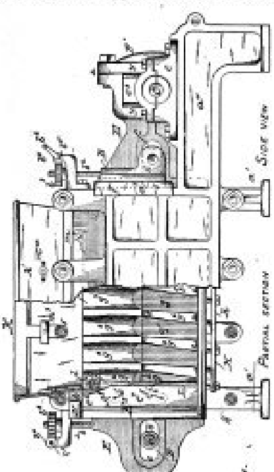
Tobacco as an Antiseptic—Bacilli Succumb to Treatment With the Weed.

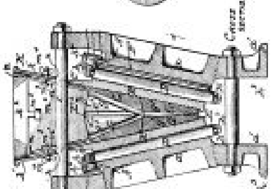
It has long been a popular opinion that tobacco is an antiseptic, and this belief seems to have some basis of fact. Professor Vincenzo Tassinari, of the Hygienic Institute of the University of Pisa, recently made some very interesting experiments on the supposed germicidal virtues of tobacco smoke, which seemed to show that it really had a destructive action upon the growth of bacilli, those minute organisms which are said to be the cause of a vast number of bodily ills that flesh is heir to. Professor Tassinari observed the action of the fumes upon seven different kinds of bacteria—the so-called cholera bacillus, the cattle distemper bacillus, the pus coccus, the Finkler-Prior bacterium, the typhus and pleuro-pneumonia bacillus, and the blue pus bacillus.

Wishing to imitate as closely as possible the processes going on in a smoker's mouth, the professor passed tobacco fumes through a horizontal tube into a receptacle kept moist by damp cotton wool, which contained also a colony of bacilli. The result showed that the smoke retards the growth of some kinds of bacilli, and absolutely prevents the growth of others. The tobacco experimented with was that which is used in making the large Cavour cigar, much favored in Italy, and it was proved that its fumes retarded the growth of pus bacilli by seventy-two hours, and of cattle distemper bacilli by one hundred hours, while they absolutely arrest the growth of the so-called cholera and typhus bacilli. If Professor Tassinari's results may be relied upon, it is evident that not only is tobacco not the deadly enemy of man—and it singular with what eagerness man takes to so many of his deadly enemies—but in many instances it is his great friend, not only by way of solace, but as a warder off and destroyer of deadly germs that insist on colonizing his body and turning it to their own uses.—*All the Year Round.*

CRUSHER AND PULVERIZER.

No. 458,638. ROBERT McCULLY, PHILADELPHIA, PA. *Patented Sept. 1, 1891.* The grinding or crushing is done between two plates E, which are reciprocated lengthways in opposite directions by eccentrics on the driving shaft C. The plates are faced with corrugated jaw plates G. These have large corrugations on the upper half, for crushing; and the lower half is provided with flat faces g^1, separated by square edged grooves g^2 g^2, for pulverizing. The plates E are inclined towards each other as shown in the cross section, and they are supported on rollers b^1 on the heavy

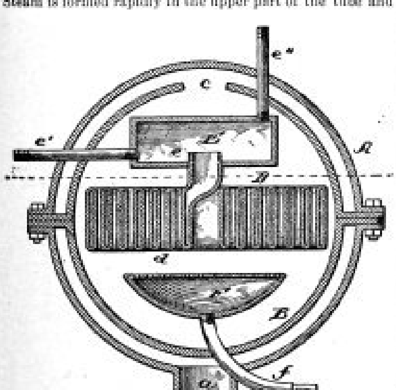




rods b, near each end. These rods are held in brackets B at each end of the machine, and the brackets can be moved up or down in suitable slides, by the screws shown. By lowering the brackets and the main plates E, the grinding faces are brought closer together, and *vice versa*. A gang of rollers D is provided between the back of each plate E and the side of the housing plates A, to relieve the friction. The material to be crushed is fed into the hopper K, and when it is ground it falls out from the lower edges of the grinding faces G.

FLASH STEAM GENERATOR.

No. 461,985. EDWIN REYNOLDS, BROOKLYN, N. Y. *Patented October 27, 1891.* The generator consists, principally, of a spiral coil of iron pipe D, which is flattened, as shown, leaving a narrow space for the passage of water and steam. The pipe is usually lined with copper to prevent corrosion and consequent stoppage of the passages. Water is pumped into the outer end of the coil, and it partly fills the tube. Steam is formed rapidly in the upper part of the tube and

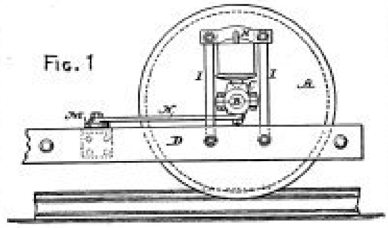


passes out into the drying box E. Here the water carried along by the rush of the steam is separated and runs off by the pipe e^1 and the steam passes out the pipe e^{11}. Heat is supplied by the burner F, which is made to use gas or oil. The casing is composed of two spherical shells, A and B, between which passages are made for the admission of air to the burner, and for the escape of the products of combustion. By this device much of the waste heat is used to heat the air supply, thus adding greatly to the effectiveness of the burner.

CAR TRUCK.

No. 461,680. CHARLES W. HUNT, WEST NEW BRIGHTON, N. Y. *Patented Oct. 20, 1891.* Figure 1 is a side view, and Fig. 2 is a top view of this improvement. The axle boxes C are of any common construction and are suspended by swing links I to the car or truck frame. They are connected by links N to a cross lever M which swings on a king bolt 4. The flanges of the wheels are reversed and are formed on the outer edge of the wheel, contrary to the common practice. When a pair of wheels rigidly fastened to their axle pass around a curve the inner wheel must slide back somewhat, and the outer wheel must slide ahead correspondingly. In the common construction the flange of the outer

FIG. 1



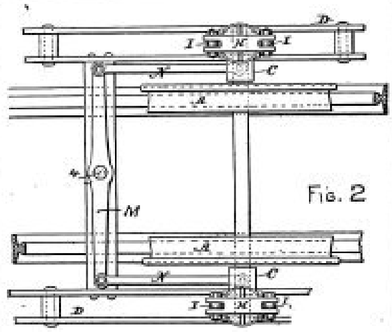
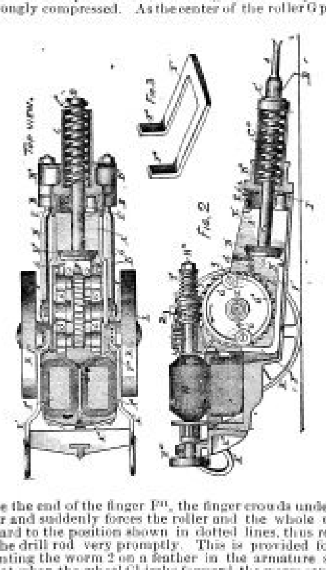


FIG. 2

wheel grinds against the outer rail and retards the wheel, but in this invention the flange of the inner wheel grinds against its rail, thus retarding the wheel that should be retarded. The resulting drag of the inner wheel acts through the links N and lever M to crowd the outer wheel ahead. This action helps the axle to assume a position radial to the curve. By this improvement cars of considerable length and of very narrow gauge (24 inches in practice) can be used, and they will pass around curves of very small radius with great freedom.

MINING MACHINE.

No. 459,596. ELMER A. SPERRY, CHICAGO, ILL. *Patented Sept. 15, 1891.* This machine is driven by an electric motor. The armature H carries a worm 2, which rotates the wheel G^1. This wheel runs on a standing spindle 1^2 which is fastened in the sides of the main frame A and it carries four rollers G on two pins 3 and 4, two rollers being on one side of the wheel and two on the other. The drill rod D has a cross head D^2 on its inner end, which carries a U shaped bar F^1 having the ends F^{11} turned up as shown in Fig. 3. These fingers F^{11} are caught by the rollers G as the wheel revolves, and the drill rod is drawn back until the parts are in the position shown in Fig. 2, and the spring C^{11} is strongly compressed. As the center of the roller G passes

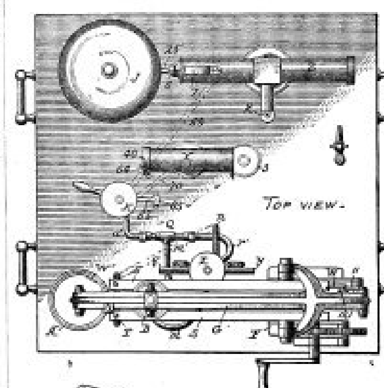


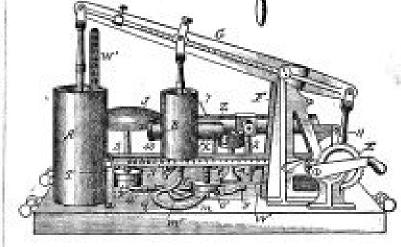
above the end of the finger F^{11}, the finger crowds under the roller and suddenly forces the roller and the whole wheel forward to the position shown in dotted lines, thus releasing the drill rod very promptly. This is provided for by mounting the worm 2 on a feather in the armature shaft, so that when the wheel G^1 jerks forward, the worm can slide along the shaft far enough to accommodate it. The spring I immediately returns the worm to its bearing against the end of the journal box. The drill rod D is provided with a piston D^{11} which enters an air trap or dash pot E, near the end of the stroke and cushions the blow in case the drill does not strike the coal. This dash pot is provided with a pet cock, by which the amount of resistance or cushioning can be easily adjusted. The case containing the spring is attached to a head B^{11} which is fastened to the machine by bolts B^1, shown in the top view. As there are two pairs of rollers G, the drill makes two strokes for each revolution of the worm wheel G^1.

APPARATUS FOR TESTING MINE GAS.

No. 460,683. THOMAS SHAW, PHILADELPHIA, PA. *Patented Oct. 6, 1891.* This apparatus is all mounted on one base which is provided with handles for convenient moving about. It consists of an air pump and gas pump combined so as to work in harmony, and deliver any desired mixture of air and gas; a combustion tube for burning suspected air and comparing it with air carrying a known percentage of gas; also an explosion tube for similar purposes; and a test tube for noting the presence of carbonic acid or choke damp.

The air cylinder A is provided with a piston and a stroke indicator W^1. The cylinder B also has a piston, and serves for pumping gas. The air piston is connected to the end of the beam G, but the gas piston is connected to a sliding block which can be set at any graduation along the beam, thus securing any desired proportion between the air and gas pumped at the same stroke. The valve L which controls the connections to the air and gas supplies is reversed automatically at each stroke of the beam, and the air and gas are brought together in a small injector or mixer Q, from whence they pass to the burning tube X or the ex-



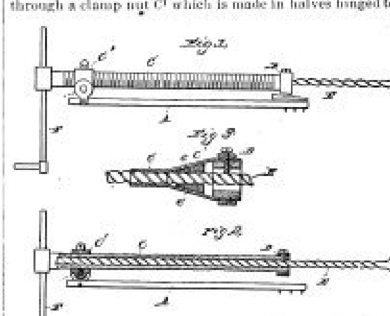


plosion tube Z, as determined by the switch K. When it is desired to pump air directly from the pipes which extend into the working chambers of the mines, the cylinder B and its beam connection are moved back to the fulcrum of the beam so that its piston makes no stroke. Then the cylinder A is connected to the pipes and the mine air is pumped into the tubes X and Y and its explosiveness is noted.

To test for carbonic acid, the air piston is raised to the top of its stroke; then the delivery tube is connected to a glass tube containing lime water. The air piston is moved slowly downward and as the suspected air bubbles up through the lime water it becomes milky. By noting the stroke of the air piston necessary to produce a certain degree of milkiness in the lime water, the percentage of choke damp is readily ascertained.

COAL DRILL.

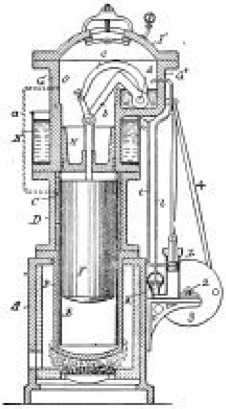
No. 462,109. WILLIAM BULLUCK, CENTRALIA, PENNA. *Patented Oct. 27, 1891.* Figure 1 shows a side view of the drill and wedge bar, Fig. 2 shows a section lengthways, and Fig. 3 shows an improved clamping device. The feed screw C is made of gas pipe, threaded on the outside, and it feeds through a clamp nut C^1 which is made in halves hinged to-



gether in the usual manner. The drill or auger E passes through the inside of the pipe C, and is held firmly by a clamp D at the front end of the tube, so as to turn with it. When the auger has penetrated the coal until the clamp D strikes the face, the clamp is loosened and the nut C^1 is opened, thus permitting the feed screw to be drawn back over the auger as far as desired. The nut and clamp are then closed and the boring is continued. The auger is thus virtually lengthened, and a deep hole can be bored with a comparatively short drilling apparatus.

HIGH PRESSURE HOT-AIR MOTOR.

No. 459,501. August J. Ventzki, Graudenz, Germany. *Patented September 15, 1891.* When at work this engine has compressed air at high pressure on both sides of the working piston. By compressing the air the same results are got as would be obtained by using the same air at atmospheric pressure in a correspondingly larger cylinder. By this means the dimensions of the machine are brought within convenient limits. The power piston H is attached to the lever b and rock shaft d, and outside the casing another arm on the rock shaft (not shown) drives a crank and fly-wheel by an ordinary connecting rod. On the other end of the fly-wheel, shaft 2, is a crank 3, which is suitably connected to move the shifting plunger F. This plunger fits closely but does not touch the lining E, which is composed of copper netting. A small space is left between the lining E and fire-pot B, through which the air passes to and through the regenerator C. At the beginning of the stroke the air in the fire-pot B is expanded by the heat, and the power piston



is forced upwards, but just before it reaches the top of its stroke the plunger F is moved rapidly downward, thus shifting the air in the fire-pot to the space under the piston H. In passing through the regenerator C, which is composed of a great number of thin metal plates, the air parts with a great part of its heat to the rege erator plates and is thereby contracted. It is further cooled by contact with the sides of the power cylinder, which are cooled by a water-jacket K. The compressed air contained in the space O above the piston was compressed still more by the rise of the piston, and when the air below the piston is cooled by the regenerator, it helps to drive the piston in its downward stroke. The working charge of air is quickly shifted to the fire-pot by the quick rise of the plunger F, and as it passes down through the regenerator it takes up the heat it left behind in its upward passage, thus partly expanding it preparatory to the next stroke. Where the rock shafts pass out of the casing through stuffing boxes the shafts are submerged in oil, which is much easier to retain than compressed air.

COAL CONVEYOR.

No. 460,643. Theodore H. Lewis, Boston, Mass. *Patented Oct. 6, 1891.* The common conveyors when lowered into the hold of a vessel will burrow in the coal in one spot, just under the hatchway, and shoveling must be resorted to in order to bring the coal lying near the sides of the vessel to the conveyor. In this apparatus three conveyors are

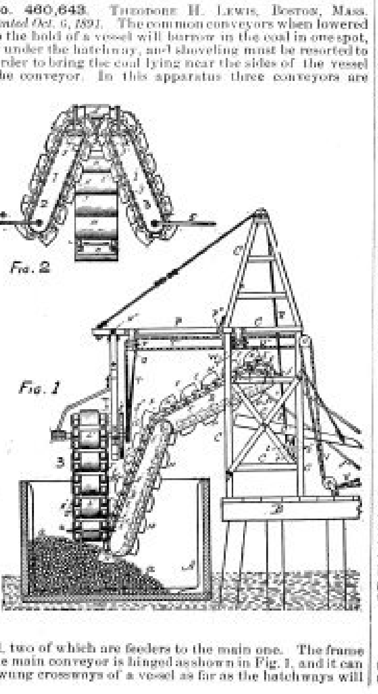


Fig. 2

Fig. 1

used, two of which are feeders to the main one. The frame of the main conveyor is hinged as shown in Fig. 1, and it can be swung crossways of a vessel as far as the hatchways will permit. The two feeders 2 and 3, in Fig. 2, are hung in a frame which is swiveled on the end of the boom P, Fig. 1. The sprocket wheels of both are geared together, and they are driven by a rope belt from an engine on the dock. Both have handles 4 and 5 at the lower end by which they may be extended sideways as far as desired. The feeding conveyors being hung on a swivel may be turned partly around, and be made to gather up the coal in almost any direction, and they may be raised or lowered by means of the hinged boom P, which is operated by the rope and windlass shown.

PUMPING ENGINE.

No. 462,061. James Pollock, Wilkes-Barre, Pa. *Patented October 27, 1891.* The object of this invention is to equalize the driving power of the steam throughout the entire stroke, in an ordinary direct acting pump. B is the steam cylinder, which may be compound if desired, and C is the pump barrel. An extra cylinder E, called the compensating cylinder, is attached as shown, and its piston is attached to the main piston-rod. Both ends of this cylinder are connected by suitable valves with a supply tank, and also with a reservoir or receiver filled with air or steam at a constant pressure, or with water under a suitable head. When steam is used expansively in the cylinder B and is cut off during the first half of the stroke, the pressure is far more than enough to drive the plunger, but as soon as the steam is cut off the pressure rapidly falls and quickly becomes insufficient to do the work required. The compensating cylinder corrects this trouble. During the first portion of the stroke the compensating cylinder draws water from the open tank and forces it into the receiver

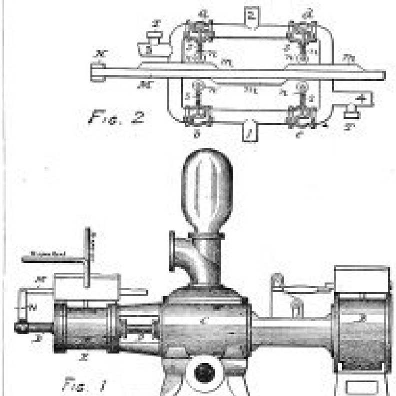


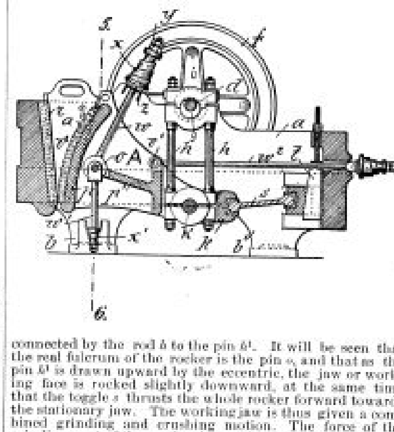
Fig. 2

Fig. 1

under pressure, thus storing up the excess of power developed in the steam cylinder. During the middle portion of the stroke both ends of the cylinder are in communication with either the receiver or the open tank, and the piston is in equilibrium, and during the latter portion of the stroke the excess of power stored in the reservoir or receiver is utilized by admitting water from it to the rear of the piston and permitting the water in front of the piston to pass into the open tank. Thus by properly regulating the pressure in the receiver the variation in steam pressure may be compensated for and the pressure on the pump-piston or other resistance rendered substantially uniform. The valves a, b, c, d, Fig. 2, which connect the compensating cylinder with the tank and pressure reservoir, are operated by cams m, which are attached to a sliding rod M. This is moved by an arm N on the piston-rod. The pipe 1 goes to the tank, pipe 2 to the pressure reservoir, and 3 and 4 go to the ends of the cylinder E.

CRUSHER.

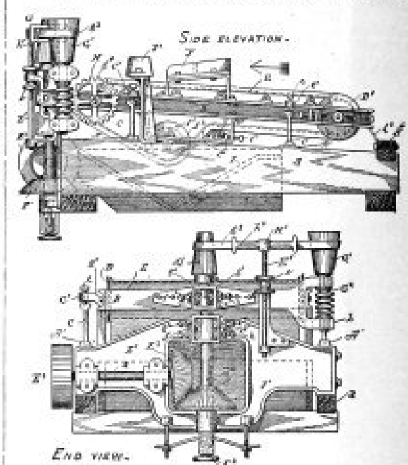
No. 461,050. Wilhelm Schranz, Laurenburg, Germany. *Patented Oct. 13, 1891.* The moving jaw of this crusher is curved, and is carried by a rocker A. This rocker is supported on spring rods a, a^1, at the pin o, and is held back by another spring rod a^2. The rear end of the rocker bears against a toggle S, which is provided with an adjusting wedge and screw, as shown. The rocker is worked by an eccentric on the driving shaft d, which is



connected by the rod h to the pin b^1. It will be seen that the real fulcrum of the rocker is the pin o, and that as the pin b^1 is drawn upward by the eccentric, the jaw or working face is rocked slightly downward, at the same time that the toggle s thrusts the whole rocker forward towards the stationary jaw. The working jaw is thus given a combined grinding and crushing motion. The force of the grinding part of the motion is regulated by adjusting the tension of the springs x and x^1.

ORE CONCENTRATOR.

No. 459,884. Andrew Fraser, San Francisco, California. *Patented Sept. 15, 1891.* The belt E runs over end rollers D and D^1 and under washing rollers I^1 and i and it is also supported by small rollers under the top side. The head roller D is driven by a worm G^2, and worm wheel H on the end of the roller shaft. The worm is driven by a belt on the cone pulleys G and G^1. The belt E, rollers D, D^1, pulp box J, and the driving worm G^2 and pulley G^1 are all carried on the frame B. This frame is supported on swinging posts C, and on a spring b^2 at the rear end. The front end of the frame has an eye or bearing through which the upper end of the driving shaft F passes. The upper part of this shaft is made eccentric to the main body of the shaft, and it serves as an eccentric to swing the end of the frame B in a circle. The rear end of the frame moves back and forth lengthways, but has little or no side motion. The pulp or ore containing the metal to be separated is distributed upon the belt while in rotary motion, by which it is



Side elevation.

End view.

carried forward and exposed to the action of the water-flow which, in connection with the oscillatory motion of the belt and frame, causes the separation of the lighter particles from the heavier. The heavier particles remaining upon the belt are carried beneath the flow of water over the front roller, while the lighter or worthless particles are carried to the rear by the downward flow of the water. As the motion imparted to the rear end of the frame and belt is very slight, whatever of the sulphurets may be contained in the lighter particles will fall and settle upon the belt, and adhering thereto, will be carried forward beneath the water-reservoir over the forward roller.

All material adhering to the belt is washed off in the wash-box I, which is fixed in the main frame below.

PULSOMETER.

No. 462,069. Henry Snooks, Jersey City, N. J. *Patented Oct. 27, 1891.* This pulsometer differs from others now in use, in having double sets of working chambers. The steam valve ball V rocks from side to side and closes the inlet ports to A or A^1 alternately, as in the ordinary pulsometers. But the steamports are branched so as to supply two chambers simultaneously. Fig. 2 is a cross section on the line 7, 8, just above the suction valves. D, D^1 are the discharge chambers. By duplicating the working chambers, the cooling surface is increased relatively to the volume of the steam, and condensation takes place quicker, thus increasing the speed of

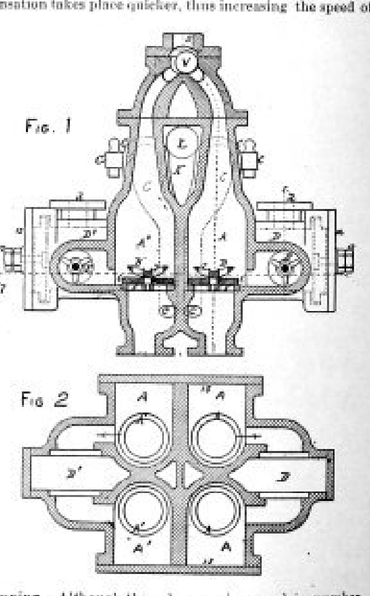


Fig. 1

Fig 2

pumping. Although the valves are increased in number, an advantage is gained from the fact that the failure of one valve will stop only one chamber, and two valves on the same side must fail to work, before the pump will stop. The chambers C shown in dotted lines are vacuum chambers, and they open into the suction pipe below the valves. The discharge branches d are connected by pipes (not shown) to the space K between the working chambers, so that the water on its way to the column pipe helps to cool the chambers and facilitate condensation.

The Colliery Engineer.

AN ILLUSTRATED JOURNAL OF

Coal and Metal Mining and Kindred Interests.

VOL. XII.—NO. 7. SCRANTON, PA., FEBRUARY, 1892. WITH WHICH IS COMBINED THE MINING HERALD

PENNSYLVANIA COAL AND OIL.

As seen from the stand-point of a Scottish Expert.

(A paper read before the November, '91, Meeting, Mining Institute of Scotland. By Henry M. Cadell, B. Sc., F. R. S. E., Member of International Geological Congress, Washington, D. C.)

The Appalachian Basin.

Before coming to details, it may be of interest to take a general view of the distribution and characteristic features of the vast carboniferous formation of Pennsylvania. The Appalachian Basin, as it is called, contains the largest coal field of any known carboniferous area. On the map it rudely resembles a canoe, lying in a N. E. and S. W. direction, and extends from the north of Pennsylvania south-westwards through West Virginia, South-Eastern Ohio, Eastern Kentucky, and Central Tennessee, to Western Alabama, a total distance of 900 miles from its northern extremity. The general structure of the field is that of a great trough, the strata in which are nearly flat in its western parts, but begin to undulate towards the east, where they finally become bent into the great anticlinal and synclinal folds of the Allegheny Mountains.

The Carboniferous System of this part of America is very variable in thickness, and it would be difficult to give anything but the most general vertical section to indicate its chief divisions. Generally speaking, it may be divided into:

Upper Barren Coal Measures or Permo-Carboniferous thickness unknown, as top not seen say,	1000 ft.
Upper Productive Coal Measures, extending from the Waynesburg sandstone and coal down to the Pittsburgh seam, its most important coal bed, thickness variable, say	450 ft.
Lower Barren Measures, shales and sandstones, say,	500 ft.
Lower Productive Coal measures, extending downwards from the Upper Freeport coal seam to the pebbly sandstones and Brookville coal bed, thickness say,	400 ft.
Pottsville Conglomerate Measures, including beds of shale, oil-bearing sandstone, and conglomerate, thickness very variable, say, Mauch Chunk Red Shale and Mountain Limestone series, with oil-bearing conglomerate.	400 ft.
Pocono Sandstone, shales and oil-bearing sands, forming base of Carboniferous system,	450 ft.
Giving a total thickness of Carboniferous rocks of say,	3200 ft.

Although no coal is found below the carboniferous series of rocks, the economic hydrocarbons are not confined to this formation, but extend far down into the underlying Devonian system, whose upper 2,000 feet contain many valuable oil and gas-bearing sandstones,

The Standard Colliery.

On reaching Pittsburgh, the chief center of the Bituminous coal, oil, and gas region, I first visited the Standard Colliery, situated at Mt. Pleasant, about thirty-five miles south-east of that city. This great colliery is the largest in America, and belongs to the H. C. Frick Coke Company, who own no less than 10,000 of the 16,000 coke ovens in the Connellsville coke district. The Standard property comprises 4,500 acres of land, under which the celebrated Pittsburgh seam exists; and of this area only 400 acres have been worked out, so that the colliery has a long life to look forward to.

Mr. Robert Ramsay, the manager of the Standard Colliery, is, I was glad to find, a native of Fife, and my letter of introduction was not needed to gain for me a cordial reception by a "brither Scot" from the old country.

The Pittsburgh, or Connellsville seam, has here a workable thickness of seven to eight feet. It is entirely used for coking purposes, and is very soft and easily worked. The colliery has two shafts and a slope or mine, by which the coal is raised. One shaft is a downcast, and is entirely used for ventilation. It is fitted with a 25-feet Guibal fan, which is directly worked by a 20-inch diameter by 36-inch engine, running at fifty revolutions per minute. Most of the coal is drawn up by the other shaft, which is 303 feet deep from the surface of the ground, the total height of the hoist from the bottom to the rail on the bank being 334½ feet.

The arrangements on the bank are very complete, and skillfully designed for a large output by Mr. Ramsay, who got his main ideas from some of the large Scottish collieries, and introduced several important improvements of his own. The usual output in the nine hours' working day is 2,000 tons of 2,000 lbs., but once to test the capacity of the arrangements for raising and handling the coal, no less than 3,021 tons were hoisted in 8½ hours from this one pit.

The coal, as I have said, is very soft and easily worked, so that each miner can produce a good darg. The seam is worked on the double-entry pillar and room system, and, as the field is very regular and free from the "troubles" and faults with which we are so well acquainted, and the dip very slight, there is no difficulty in having a very complete and regularly laid out system of underground workings.

The face men, who are mostly foreigners, are paid 1s. per ton, and they have no difficulty in putting out eight or nine tons a day, so that they can make an average wage of 8s. or 9s. —not much different from that of our

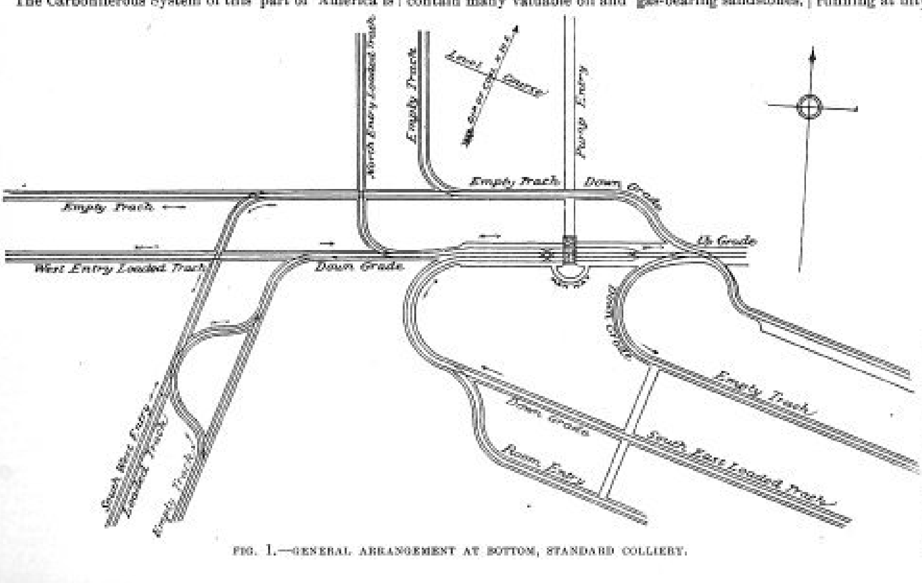


FIG. 1.—GENERAL ARRANGEMENT AT BOTTOM, STANDARD COLLIERY.

own miners here at present. I made a good many inquiries as to the relative financial position of American and Scottish miners, both here and in the Anthracite districts, of which I shall speak afterwards, and I came to the conclusion that, taking the cost of living into account, the workmen in the old country are just now much better off than their contemporaries "across the water." The Pennsylvania miner works nine hours a day and six days a week, buys his coals at market price, and lives, according to the custom of the country, in a three or four-roomed wooden cottage, for which he pays from £11 to £22 per annum. Indeed, I met a workman at Pittsburgh (who had escaped from Russia, and had been waiting for sixteen years till the expected revolution should allow him to return), who told me he had a house with three small rooms for which he paid £36 per annum, and could not keep his small family under £3 12s. a week. Of course, there is no physical necessity for an American miner occupying a larger house than a Scottish collier, but in such a case the custom of the country becomes a necessity that must be satisfied. Again, the price of food in America is not much different from that which prevails here, but the style of living is generally more expensive, as the Americans are high livers and like plenty of delicacies. Protection has raised the price of manufactured goods, and hence clothing generally costs at least double its price here, while the quality is often inferior. Taking all the circumstances of the case into consideration, I do not think that any miner from the old country, working eight hours a day and eleven days a fortnight, and making say 8s. a day, would better his condition by going to America, where, for 12s. a day, he would require to work far harder and longer for his money, and would be obliged to spend it freely on the necessities of life, and on expenses and luxuries that the laws of society in the West render necessary to respectable existence.

The Standard Colliery employs below ground altogether about 535 men and boys. Among them there are many foreigners from the south of Europe, such as Austrians, Poles, Hungarians, and Italians.

The coal is hauled from the face to the pit bottom by horses and mules, and instead of hutches, wagons holding $2\frac{1}{2}$ tons are employed. The loaded wagons from the different parts of the workings, on nearing the bottom, run down by their own weight to the shaft, and the empties run off from the cage on the opposite side, so that the minimum of labor is required in handling them.

The shaft, clear of timbering, measures ten by twenty-four feet. There are two hoisting ways, each seven by ten feet, and the remainder with a cross-section of some ninety square feet, is used as an upcast airway, and contains the steam pipes for the larger pumps, a manway, three feet wide, passes round the foot of the pit in a semi-circular direction, and no one, under any circumstances, is allowed to cross straight through the bottom of the shaft. A general plan of the pit-bottom arrangement is given in Fig. 1.

The pumping plant below ground consists of two Yough mine pumps, with twenty-six inches diameter by forty-eight inches steam cylinders, and fourteen inches diameter by forty-eight inches water cylinders, having a capacity of 1,200 gallons per minute. Besides these there are several smaller pumps for local dips, some of which are driven by compressed air.

The cages, which are very simple and strong in design, are fitted with safety-catches, which are regularly tested once a fortnight by slacking the winding rope suddenly from the drum.

Perhaps the most interesting and ingenious device in the colliery is that at the bank for taking off and tipping the full wagons and putting the empties on the cage, a general sketch of which is given in Fig. 2. On reaching the bank the full wagon is pushed off the cage by an empty one, which in turn is moved by the piston-rod of a steam ram, worked by an operator at X, who turns on the steam by means of a lever attached to a rod with a handle at *p*. The loaded wagon then gravitates down to the "tipple," situated about eight yards from the shaft, the descent being four inches. After being emptied into a hopper below, from which the coal goes direct to the ovens, the wagon is returned by a second operator at the tipple along another set of rails which run past the side of the shaft with a descent of eight inches further, and is landed just opposite the side for empties going on to the cage, but one foot lower. The part of the track on which the wagon now rests is really a traveling carriage, called the "transfer truck," which moves at right angles to the direction of the rails, and at the same time travels up an incline so as to bring the empty wagon exactly opposite its place on the cage. The transfer trucks, of which there are two, one for each line of rails, are worked by a second steam ram, and the movements of all the wagons, loaded and empty, are under the control of one man, who rules supreme at the pit-head, and has only one assistant to help in disposing of the great output. By another arrangement, not shown on Figure, it is impossible for the operator at X to work the ram except when the cage is at the top and ready to receive a wagon. After reaching the hopper or bin below the tipple, the coal is dropped into "larries," or iron hopper charging trucks, each having a capacity of seven tons. The trucks are drawn away by light locomotives and emptied direct into the ovens, which are of the Beehive pattern, and hold each 100 bushels. The average yield of coke per oven each week is $10\frac{1}{2}$ tons, and 905 ovens are supplied from this one shaft. No attempt is made to utilize the heat or gas, and at night the whole region with its long terraces of blazing ovens has a very striking and weird appearance.

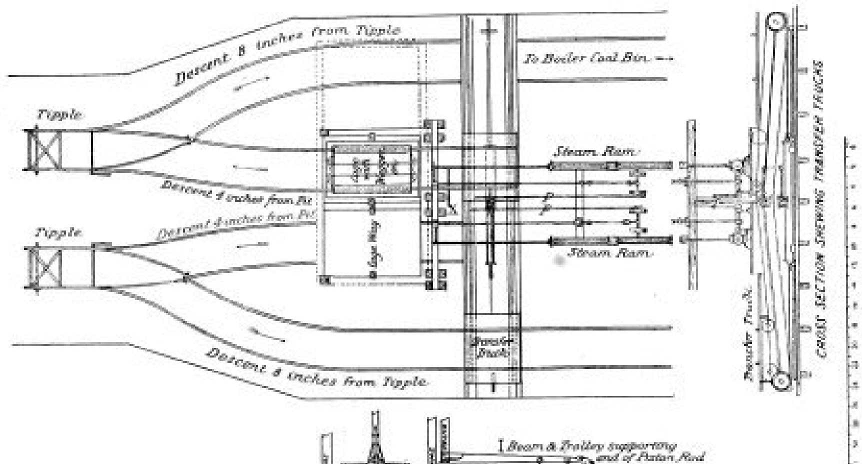


FIG. 2.—ARRANGEMENT AT BANK, STANDARD COLLIERY.

OIL WELLS.

Next day I made my way to the Forest Oil Company's office, in Pittsburgh, where Mr. Young, the Vice-President, kindly sent me out with a party of three others to see some new wells belonging to the Company. We took train to Oakdale Station, in North Fayette Township, Allegheny County, about 12 miles W.S.W. of Pittsburgh, where oil has been recently discovered in large quantities. As the Company's well is a few miles from the station, we got a buggy and drove through the country to visit it. The road, like most American country roads, was execrable, and every few minutes I expected to be pitched out when we jolted over an unusually large stone or into a particularly deep hole. At one place the road ran right along the stony bed of a river, along the sides of which some of the wells are situated. The water was covered with a film of oil, and had we dropped a light into it the results might have been disastrous. As we got into the oil belt, where the productive wells are situated, the tall lattice work "derricks" began to appear over the trees and along the sides and bottom of the glen. All the boring is done by means of a heavy tool on the end of a manilla rope. This is lifted and dropped by a primitive-looking wooden rocking beam worked by a crank, which in turn is attached to a shaft with a large wooden pulley, over which passes a belt worked by a small steam-engine going at a good speed. There is generally a considerable quantity of gas, even if there is no oil in the rocks to be pierced, and a pipe in the bore-hole conveys the gas to the grate of the steam boiler, placed perhaps 20 or 30 yards away so as to avoid the dire consequences of setting the well on fire. There is thus no need of coal, as the well supplies its own fuel.

It is of course necessary to have the bore tightly tubed, as the gas and oil come up at enormous pressures, 400 to 500 lbs. per square inch being quite common. In order to allow of boring to be done after the oil has begun to flow, an ingenious device has been adopted. The tube at the mouth of the well is fitted with a horizontal branch to carry off the oil or gas, while the rope passes straight down through a stuffing box fitted into the cap, which is secured to the vertical prolongation of the tube. As a manilla rope is rough, and could not be made to work tightly through a stuffing box, the rubbing part is surrounded tightly with a short length of smooth tube, which works up and down in the stuffing-box like the piston-rod of a steam-engine, and thus prevents the oil escaping by the wrong outlet. As the bore deepens this tube is shifted further up the rope, which is thus preserved from friction at the orifice of the pipe. The oil, and the gas which always accompanies it, are conveyed to a wooden tank made with staves and hoops like a vat, on the top of which are two square wooden ventilating pipes, through which the gas escapes into the air.

When we reached the Wright Well, where the oil had recently been got at a depth of some 1800 feet, the boring operations were still in progress. We were however, fortunate in seeing the cap taken off and the tool hauled up. As the massive rod and tool at the bottom of the rope emerged, the pressure of the oil was so great that it lifted the rod right out of the hole and shot it a few feet into the air, and the orifice being thus clear, the oil spouted upwards in a solid jet 100 feet in height. Had any of our industrious Scottish oilworks' men, who earn their hard won profits by laboriously distilling petroleum and its products from the heart of the rock, been witnesses of this wonderful spectacle they might well have fallen down to worship. The sight is one I, at least, shall not soon forget. I was told that the well was yielding 500 barrels a day, and that for the following 30 days 300 to 500 barrels might be still expected. At the end of 90 days a yield of 150 barrels daily was all that could be hoped for, and in 6 months this would probably decline to 100 barrels, while for the next 4 or 5 years only from 5 to 25 barrels a day were to be looked for, after which the well would have no commercial value.

On the average, the life of a productive oil well is said to be from 5 to 8 years. The cost of drilling is one dollar, or 4s. per foot, and a good borer can drill a hole 6 or 8 inches in diameter at the rate of from 50 to 60, or even 100 feet in 24 hours. Of course it is plain that in such cases the rock is very soft and easily pierced.

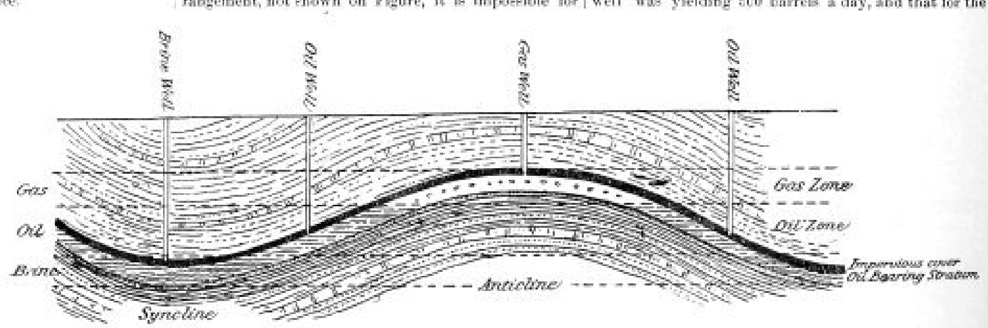


FIG. 3.—ILLUSTRATING RELATIVE MODES OF OCCURRENCE OF OIL AND GAS.

The discovery of oil greatly enhances the value of land, as about one-eighth of the production goes as royalty to the owner of the ground. There is in the old country a great outcry in certain quarters against the royalties paid by mineral tenants to the proprietors of mineral estates. In America, the land of free popular institutions, the minerals go along with the land, and there is no talk of abolishing royalties to private owners, and making them national property. In Colorado the lessees pay from 15 to 40 per cent. of the net profits of the mines after smelting the ore, as royalty to the owners, and the State makes no claim in the matter.

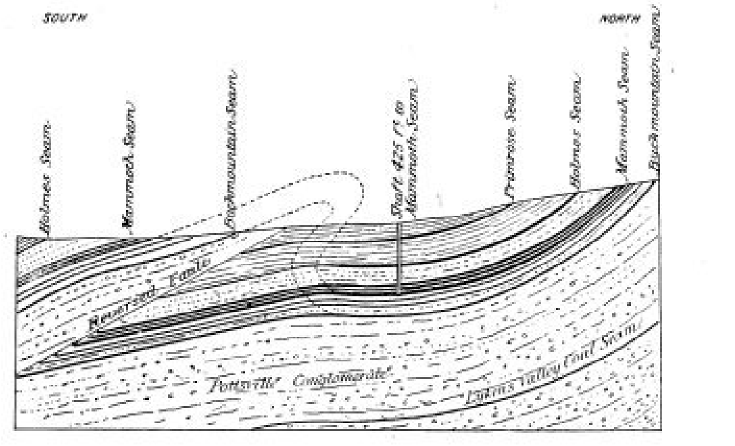


FIG. 4.—SECTION AT KOHINOOR COLLIERY, SCALE 1 INCH = 800 FEET. ILLUSTRATION OF THE EFFECT OF A REVERSED FAULT OR THRUST PLANE IN ALTERING THE STRUCTURE OF A COAL-FIELD.

After seeing a spouting well, which is by no means a common sight for a casual visitor, my curiosity was satisfied, as I had no expectation of seeing anything "bigger" that day at least. Before returning to Pittsburgh, we drove to McDonald, a small town a few miles off, where oil had been found quite lately. Like many other American townships, it is an ugly collection of two-story wooden houses with small gardens, and broad belts of ground running at right angles to one another that pass for streets, but have not yet been constructed with the help of any other tools than the theodolite at first and the cart wheel afterwards. The so-called streets are straight in plan but like a saw in section. The whole place was covered with a forest of derricks, and everyone seemed to have begun drilling in his garden, however small it might be. The sludge from the bores was being emptied out in such volumes that at one place where an unusually deep ditch ran across the street it had become filled with the gray mud to such an extent that we could not venture across for fear of being swallowed, horses, buggy, and all. There were in the town about 120 wells in course of drilling, and the engines were all driven by steam raised by the natural gas, which occurs in great abundance here and is used for lighting the town at night. Like other good gifts it is recklessly wasted, and we passed several jets blazing at noon, as it does not pay to have the gas stored against the fast approaching evil day.

Another interesting feature in the development of the great oil industry is the immense system of pipe lines that convey the oil from the productive wells to the market, perhaps several hundred miles away. The pipes are of malleable iron with screwed joints, and lie on the surface of the open ground or along the roadsides. At one place I counted six pipes from 3 to 6 inches in diameter, all running along the same track, one on the top of another. As the ground is hilly the oil cannot gravitate the whole distance to the central market. There are therefore convenient pumping stations placed at intervals along the track, where it is forced onwards by specially constructed pumps or rams driven by steam and natural gas.

The subject of the geological nature, distribution, and mode of occurrence of oil and gas is one of great interest and importance, and a short consideration of the matter may not be without its value here.

As I have already mentioned, these substances occur chiefly in the lower part of the Carboniferous, and the upper part of the Devonian formation, which lies below, and occupies the same place as the Old Red Sandstone of Scotland. This is to us interesting, as the Scottish oil shales are also chiefly found among the Lower Carboniferous rocks under the Mountain Limestone and the lowest productive coal measures. Our Lower Carboniferous rocks below the Hurlet or Mountain Limestone were, however, chiefly deposited in fresh or brackish water, while the American oil-bearing rocks are chiefly marine deposits, as is proved by the salt water which is found in many of the strata.

Oil and gas—in this case, marsh gas or light carbureted hydrogen—are secondary products, due to the slow distillation of vegetable and mineral matter embedded in the strata, which have found their way into the most open rocks in their vicinity, where they have accumulated in large quantities. It is clear that, if a quantity of salt water, oil, and gas be mixed together in a bottle, the brine, being heaviest, will sink to the bottom, and the oil will float on its surface, while the gas will accumulate in the neck. After long experience, it has been found that the occurrence of oil and gas is generally regulated on these principles, and that their distribution is not absolutely uncertain and without a law. It is true that a dry hole is often found beside a productive well, but it is also true that, outside of certain belts, there is no chance of getting oil at all. The oil and gas occur in certain course open sand-stones, in the interstices of which there is space for fluid matters to accumulate. Now, if we suppose an oil-bearing stratum to be bent into an anticlinal arch and a synclinal trough, in course of time the gas will rise through the oil, and collect at the top of the arch, where it will remain, provided the overlying bed be impervious. The oil will be found below the gas, and any brine that may originally have been mixed with the oil will sink to the bottom of the basin. This is what has actually been proved to occur over large areas. The strata where the best wells are found lie in long, low anticlinal and synclinal folds, and, generally speaking, the holes drilled through the crest of the arches to the oil sands get gas, while those in the basins get brine, the oil being found between these two limits. A reference to Fig. 3, will make the matter clear. The oil sands are not always uniformly porous, and there are spots where the texture is too close to permit of the passage of fluids through them. Hence it is, that in these spots, the wells are "dry" and unproductive. The field is, morever, practically free from faults, so that the fluids can move from one place to another without interruption, which could hardly be expected in our much faulted and irregular formations.

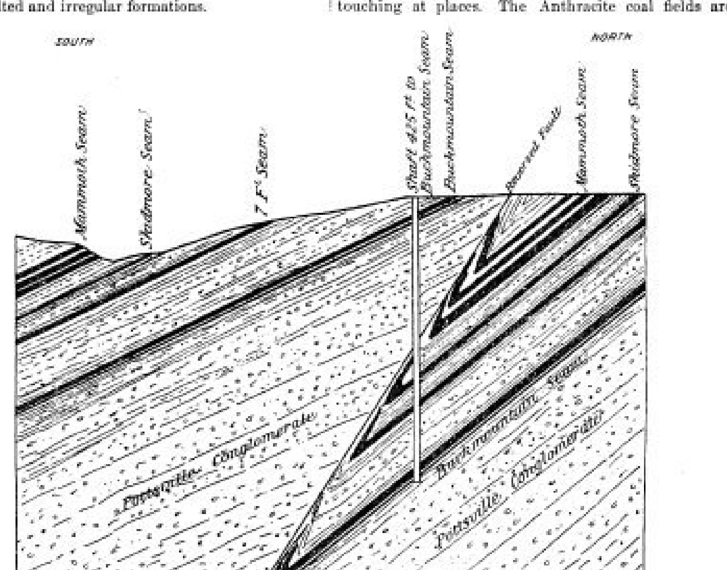


FIG. 5.—SECTION AT SHENANDOAH CITY COLLIERY. SCALE 1 INCH = 200 FEET. ILLUSTRATION OF THRUSTING OR REVERSED FAULTING OF COAL STRATA AS PROVED IN THE SHENANDOAH ANTHRACITE COLLIERIES.

The production of the American oil wells has been enormous; and, as the oil is not being manufactured in nature's laboratory at anything like the rate at which it is being consumed—if, indeed, it is now being thus manufactured at all—it is clear that, sooner or latter, the supply will begin to give out. No oil well has yet been found that goes on producing perennially, and the production is solely kept up by the discovery of new "pools." The natural gas which, for several years, supplied Pittsburgh with a clean and cheap fuel, and greatly added to the wealth and prosperity of that important manufacturing center, is already diminishing in quantity, and the city is again returning to its original smoky condition.

The following table, taken from the Annual Report of the Second Geological Survey of Pennsylvania, 1890 (by Mr. John F. Carll), shows that the total production of the oil wells of Pennsylvania and New York reached the first maximum in 1882, and declined irregularly till 1888. There has, however, since then been a rapid recovery, and the production for 1891, taking the average of the first seven months of the year, will probably be not much below that of 1882. My data for the last two years are from "Stowell's Petroleum Reporter," for August, 1891 (published monthly in Pittsburgh).

TOTAL PRODUCTION.

Years.	Barrels of 42 gals. capacity.	Years.	Barrels of 42 gals. capacity.
1859,	2,000	1876,	8,968,906
1860,	200,000	1877,	13,135,671
1861,	2,110,000	1878,	15,163,462
1862,	3,055,000	1879,	19,741,661
1863,	2,610,000	1880,	26,029,631
1864,	2,130,000	1881,	27,376,309
1865,	2,721,000	1882,	30,457,000
1866,	3,732,000	1883,	24,235,864
1867,	3,582,000	1884,	24,232,844
1868,	3,716,000	1885,	20,891,192
1869,	4,351,000	1886,	25,080,460
1870,	5,371,000	1887,	21,286,560
1871,	5,531,000	1888,	16,126,580
1872,	6,357,000	1889,	22,576,690
1873,	9,932,000	1890,	28,684,620
1874,	10,883,000		
1875,	8,801,000	Total,	397,975,450

ANTHRACITE COAL FIELDS.

After visiting three of Mr. Carnegie's great iron and steel works at Pittsburgh, as well as other places of interest, where, until quite recently, natural gas has been the sole fuel for raising steam, I left on the 20th of August for Pottsville, in the celebrated Anthracite region of Pennsylvania.

Pottsville is situated among the picturesque forest-clad ranges of the Alleghenies, 200 miles east of Pittsburgh. It is located in an isolated basin of Carboniferous rocks, which have been bent and twisted into great folds with steep sides, by the tremendous forces which ridged up this part of America into the Appalachian mountain system. When coal beds have been much squeezed by such movements, it is usually found that they have undergone more or less metamorphism, and have lost a great part of their hydrocarbons, becoming converted into blind coal or Anthracite, which contains over 90 per cent. of pure carbon. Had the crumpling and metamorphism been carried further, the coal beds would have passed from the condition of Anthracite to that of graphite, which consists of pure carbon, and is found in many old and much altered formations.

There are four tolerably distinct Anthracite coal fields, all of which are situated in the extreme eastern portion of Pennsylvania. Each coal field consists of a series of long, narrow, synclinal folds, either join ed together so as to form a single trough with a highly corrugated bottom, or isolated from one another like a collection of long thin canoes laid side by side, and sometimes touching at places. The Anthracite coal fields are entirely isolated from the great Bituminous coal fields to the west by the high forest-clad ranges of the Appalachian mountain system, along which older Paleozoic formations rise from beneath the Carboniferous strata in a series of long ridges, with a highly complicated geological structure.

The Anthracite seams are situated chiefly above the great Pottsville Conglomerate bed, which, as already stated, lies beneath the Lower Productive Coal Measures in the Bituminous coal region to the west, so that, roughly speaking, they may be regarded as the representatives of the lower coals in the Pittsburgh district. It is, however, as yet quite impossible to correlate any of the thick beds of Anthracite with any of the thin Bituminous coals of the Lower Productive measures, as they seem to have been formed under quite a different set of physical and topographical conditions. The thicknesses of the various seams of Anthracite and of the intervening strata are exceedingly variable, so that it is not possible to give a general section which can be applied over any very extensive area. The following section, however, which is taken from the Pennsylvania Geological Survey Report for 1885, p. 320, will show the great thickness and value of the formation in the Southern or Pottsville coal field :

	Thickness in Feet. Rock.	Coal.
BELMONT ESTATE, EAST OF POTTSVILLE.		
1. Lewis Coal Bed		8
2. Interval	210	
3. Spohn Coal Bed		8
4. Interval	210	
5. Palmer Coal Bed		3
6. Interval	263	
7. Charlie Pott Coal Bed		3
8. Interval	78	
9. Clarkson Coal Bed		7
10. Interval	83	
11. Selkirk Coal Bed		7
12. Interval	120	
13. Leader of Coal		5
14. Interval	45	
IN VICINITY OF POTTSVILLE SHAFTS.		
15. Peach Mountain Coal Bed		5
16. Interval	60	
17. Coal Bed		3
18. Interval	58	
19. Little Tracy Coal Bed		6
20. Interval	198	
21. Coal Bed		2
22. Interval	40	
23. Little Diamond Coal Bed		3
24. Interval	122	
25. Diamond Coal Bed		6
26. Interval	158	
27. Little Orchard Coal Bed		3
28. Interval	25	
29. Orchard Coal Bed		4
30. Interval	190	
31. Primrose Coal Bed		8
32. Interval	91	
33. Holmes Coal Bed		4
34. Interval	70	
35. Leader of Coal		4
36. Interval	140	
37. Mammoth (Top Split) C. B.		7
38. Interval	15	
39. Mammoth (Bottom Split) C. B.		25
40. Interval	60	
41. Skidmore Coal Bed		8
42. Interval	72	
43. Seven-foot Coal Bed		8
44. Interval	80	
45. Leader of Coal		
46. Interval	25	
47. Leader of Coal		2
48. Interval	25	
49. Buck Mountain Coal Bed		8
ECKERT COLLIERY, TREMONT.		
50. Interval	584	
51. Coal Bed		2
52. Interval	50	
53. Coal Bed		2
54. Interval	55	
55. Lykens Valley Coal Bed		10
Total thickness of Rock	3097	
Total thickness of Coal Bed		154
Total thickness of Coal Measures ... 3251 feet.		

On reaching Pottsville, I made my way to the office of Mr. E. C. Luther, the General Superintendent of the Philadelphia and Reading Coal and Iron Co., which owns some of the largest and most important Anthracite collieries in the region. Mr. Luther kindly sent me on to Shenandoah, ten miles north of Pottsville, in the Western Middle, or Mahanoy and Shamokin field, where some of the best developed collieries are situated within a short distance of one another, having supplied me with a letter of introduction to Mr. John L. Williams, the Division Superintendent. On nearing my destination, the train moved upwards along the bottom of a valley, the sides of which had formerly been thickly wooded, but were now to a great extent bare or covered with tree-stumps and copsewood, only a few of the old trees having been left standing. The hill sides were thickly studded with pits, mines, coal dressing and breaking works, and huge heaps of culm, and coal dirt, which was washed down the slopes at many places and spread over the bottom of the valley in hideous black mud flats, through which the blighted trunks of dead pine trees rose gaunt and grim, while the waters of the Mahanoy Creek in the center of the glen had the color of ink from the fine refuse of the coal washing carried on at every colliery along its banks.

The Western Middle Coal field has a length of about forty miles, and a maximum breadth of about five miles, while the general direction of strike and outcrop of the seams is a little north of east. Shenandoah is geologically in a basin, the thickest coal in which is the Mammoth seam, which is extensively mined in the neighboring pits, and crops out steeply on the north and south sides of the town where it is at places worked opencast. I found Mr. Williams ready to show me round, as Mr. Luther had very kindly telephoned in advance, so that my letter of introduction was not necessary. Mr. Williams is a Welshman by birth, of great experience and ability, and spared no time or trouble in explaining the system and working of the large collieries under his charge, and rendering my visit both interesting and instructive. We drove round and spent a long day in examining the surface and underground arrangements at some half-dozen of the shafts in the vicinity of Shenandoah.

The seams in the mines are thick. The Seven-Foot seam has at places a thickness of seven feet, and the Buck Mountain seam a thickness of twelve feet, while the Mammoth Bed has, with the two thick bands of dirt that it here comprises, a total thickness of over fifty feet. These dimensions, however, are very variable, and the thicknesses of the seams and intervening strata alter very rapidly within comparatively short distances. The coal is worked on the pillar and breast or pillar and room system, and the size of the pillars and percentage of coal removed vary according to the dip, thickness, and character of the roof of the seams. In some districts the proportion of coal removed where the dips are high has been as low as 51 per cent., while in other districts with flatter dips, and under the more modern improved systems of mining as much as 80 or even 85 per cent. of the original seam is said to have been taken out. These percentages, however, do not represent the amount which is converted into commercial fuel, as the coal has to be broken and separated from the large proportion of blaes and dirt it contains before it can be sent to the market. This preparation for the market is attended with great waste, as the huge culm and dirt banks round all the collieries testify. The improved methods of screening, breaking, sorting, washing, and classifying the coal which now obtain, have greatly tended to diminish this waste, and indeed, in some cases it pays to turn over the older rubbish heaps and take out much coal that could not be sold under the more wasteful methods that were in vogue ten years ago. From 1820 to 1883, of the 59 per cent. of the original contents of the coal seams which were brought to the surface, more than half was thrown on to the waste heap. Since then, of the 70 per cent. taken out, only one-third has been lost in the dressing, a circumstance due not only to better methods of cleaning, but also to the demand for small sizes of coal, which were formerly of no economic value. At the St. Nicholas Colliery there are two slopes or mines where the Mammoth seam is worked downwards from the crop. The large breaker supplied by these slopes puts through in an ordinary day of ten hours some 2,000 to 2,500 tons, and the breaker at the adjoining Ellangowan Colliery usually puts through 1,800 tons a day, but has for a month dealt successfully with 2,000 tons every working day during that period.

The huge Mammoth seam has been mined to its full thickness under the town of Shenandoah, and the reckless way in which the pillars were robbed when the workings were in progress, some twenty years ago, I was told, began to terrify the inhabitants who thought the whole place was to be engulfed. It will, I have no doubt, astonish the members of the Mining Institute of Scotland when I tell them that at one part of these old workings the present operators, under Mr. Williams, discovered that their predecessors had left a gigantic room between the pillars, 700 feet in length and no less than 300 in breadth, spanned by an arch of rock sixty feet high, at a depth of 400 feet below the surface. This extraordinary fact is perfectly well substantiated, as the breadth of the cavity is mentioned in one of the reports by Mr. William Stein, the mining inspector of the district. Mr. Stein, by the way, is another example of the successful Scot abroad, and I was glad to learn that as a young man he used to know my father. This vast cavity was found to exist just under one of the best houses in Shenandoah belonging to a Mrs. Grant, the widow of another of our thriving countrymen, who lost his life while doing his duty in one of the collieries.

The plan adopted for preventing a general subsidence was both original and effectual. An eight-inch borehole was drilled in Mrs. Grant's garden down to the highest part of the roof of the cavity below, and into this was conveyed from a neighboring waste-bank a thick stream of culm and water. The culm, when dry, packs closely together into a solid mass, while the small quantity of water required to transport the bulky volume of its light particles, filters away through the deposit, and can readily be pumped out at the nearest shaft. In this way not only has the threatened calamity to the town been successfully averted, but a good "free toom" for the colliery waste has been found. But more than this. It has been ascertained that the culm below packs so well together that headings can be driven through it, and the roof being thus held up the remaining pillar coal can be taken out with safety and profit. I went into part of the workings which had been thus silted up, and saw a heading in the dry culm, the walls of which were wonderfully steep and solid.

This system of filling up old coal wastes in thick seams has been extended to other places where the necessary conditions are present, and several holes had been drilled and were still in process of drilling at other collieries I visited. Of course, it is not everywhere that the necessary conditions for the success of the system are to be found. I bethought myself, however, of the old Wester Main coal pillar workings below Bo'ness, where the roof of a seam some eight feet thick or more, which was worked about a century ago, has within the last two years fallen in suddenly and caused some very alarming and costly subsidences. We have in Scotland, it is true, no Anthracite culm to dispose of, but I think that the idea is a brilliant one, and might in certain circumstances be well worth the consideration of our Mining Institute.

Another point that interested me greatly was the existence of a large reversed fault, or small "thrust plane," which has now been clearly proved to run through part of the Shenandoah coal field. With us ordinary or "normal" faults are, unfortunately, phenomena of every-day experience, but in the Anthracite districts they are, I believe, almost unknown. In fact, faults of any sort are so rare in that region that their nature seems to be but little understood. Of late, however, clear evidence has been obtained that at least one reversed fault, such as are common in highly crumpled and compressed mountainous regions, has been instrumental in altering the lie of the Anthracite beds, and for want of the requisite geological knowledge much money has been lost to some of the former colliery owners of the district. The section (Fig. 4), which is drawn to a true scale of 800 feet = 1 inch, from published mining plans and from information supplied by Mr. Williams, will make the matter clear. In the Kohinoor Colliery, west of Shenandoah, the shaft, 425 feet deep, is sunk on the Mammoth seam, below which, at a distance of about 160 feet the Buck Mountain bed occurs. The beds rise steeply from the bottom of the pit, on the north, and crop out on the hillside above the level of the pit, as shown on the section. South of the colliery the Buck Mountain seam has been long known to crop out, with a dip to the south however, while the Mammoth bed occurs above in its proper place. The existence of a large reversed fault or thrust not being thought of, it was formerly supposed that there must be a return outcrop, as shown in dotted lines, between the shaft and the Buck Mountain seam, and that, in fact, there must be a so-called overturned basin, the strata in the southern part of which, being steep and upside down, were not adapted for convenient working. Instead of this, it has been ascertained that the seams which are flat at the shaft do not really begin to bend up to the south and form part of a basin at all, but at a distance of 60 yards from the pit bottom they again begin to resume their southerly dip, and whereas the former operators thought the colliery practically exhausted, the present company have opened up a fine set of dip workings which run 500 yards down the seam, whose angle of inclination is about 15 degrees. It is quite clear from the figure that there must be here a large reversed fault, as there is no room for an overturn of the strata such as was formerly supposed. The actual plane of fracture has, so far as I heard, not been found in this colliery, but in the Shenandoah City Colliery, three quarters of a mile farther east it has been passed through in the shaft and proved clearly in the workings of several seams, as is shown in the accompanying Fig. 5. The Buck Mountain seam was passed through twice in the same vertical section, both times dipping to the south, and the workings in the overlying seams clearly show that there is here no overturned basin, such as is shown on the geological maps and sections of the district, but a true plane of thrust, the edges of the strata and coal beds being curled up and crumbled just below it. I have gone into some detail on these points as their significance is considerable from a miner's point of view. If, as Mr. Williams said, the life of a colliery has been increased 20 years by the discovery of a thrust plane, then the more we know about these and other out-of-the-way phenomena, the more likely are we to keep our eyes open in the future and be on the lookout for things we would not otherwise have expected to find.

The mines and breakers give employment to a large number both of men and boys. The miners get on the average 8s. a day, and laborers 6s. 6d. Boys of fourteen (the age when they go below) get for attending the doors and switches about 19s. 4d. a week of fifty-eight hours. After one or two years they get for driving one mule 24s. to 28s., and for driving two mules 32s. When they can drive three or four mules together they get about 40s. a week, which is equal to the wages of laborers working inside the breakers. The boys, twelve years of age, who pick the dirt from the coal at the breakers, get 10s. per week.

The total cost of labor in connection with the breaking and cleaning the coal is 1s. per ton, and at present, I was told, the selling price of 7s. per ton barely leaves any margin of profit over the cost of production.

The United Colliery.

Mr. Wm. West, superintendent of the United Coal and Coke Co.'s United Colliery, at United, Westmoreland Co., Pa., writes us as follows:

"We use locked safety-lamps exclusively now, and you would be surprised at the difference it makes in the sanitary condition of the mine, and we are now making about as good time as we did with the carbon oil torches. We have made many important changes and improvements inside, among which were five brick stoppings each 3 ft. thick near the bottom of the shaft. (All permanent stoppings in the future are to be brick walls 3 ft. thick.) We also rebuilt one overcast, and built a brick feed room in the inside stables, and a brick oil house in which to store car grease.

"The bottom of the shaft has all been retimbered, the double timbers on the turnouts having collars 8″ × 16″ bolted to the legs. The collars are 16 ft. long, and the spread is 18 ft., and the turnouts are 10 ft. high. The pump room has been enlarged and is now 50′ × 18′ inside of timbers. We have put in four new pumps, three of them No. 12 Cameron pumps, 18 ins. diameter, 38″ stroke, and one Yough pump, 2 ft. diameter 4 ft. stroke, manufactured by Boyts, Porter & Co., of Connellsville, Pa. The hoisting engines are first motion, 24″ cylinders, 36″ stroke, and were built at the Vulcan Iron Works, Wilkes-Barre, Pa. The cages are self-dumping, and the coal is carried 60 ft. to the bins by machinery. The hoisting ropes are 1¼″ diameter. The engine house is a brick structure 31′ × 40′, and the boiler house is 41′ × 70′. Four new tubular boilers 5′ diam., 14′ long each, with 46 tubes in each, were added to the steam plant. The smoke and gases are carried to a 70′ iron stack. The whole plant, including the stables in the mine and on the surface and the fan house is lighted by electricity."

The United plant is certainly a well equipped one, and we congratulate the United Coal and Coke Co. on its success in making it so, and trust that the coal business of the ensuing year will be such as to yield profits to the company in proportion to the enterprise and good judgment displayed in the selection and arrangement of the improvements just added to the plant.

Among the many handsome calendars sent us with the beginning of the New Year, was a remarkably handsome one sent by Mr. A. H. Christy, Cashier of the Scranton Savings Bank and Trust Co., and issued by that institution. It contains a very fine steel engraving of the D. L. & W. Co.'s Sloan Breaker, located in this city, and is a work of art.

NOTES ON FANS.

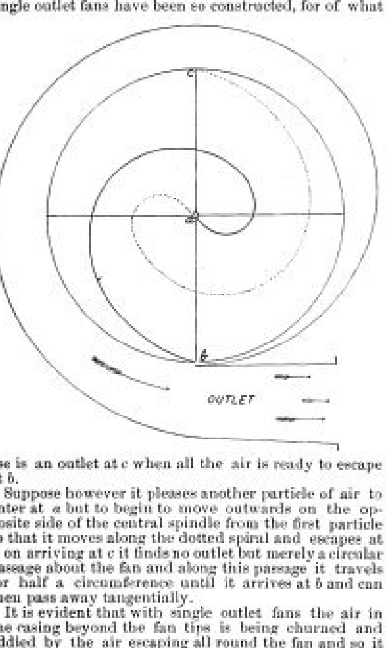
BY W. H. BOOTH, LONDON, ENGLAND.

[Written for The Colliery Engineer.]

In The Colliery Engineer for May, 1891, Mr. Wm. M. Morris, of Arkansas, sends a sketch of a fan in which the outlet is double one-half the fan discharges to one passage and the other half to the other passage, or, more correctly, one passage takes the air thrown off the fan in one-half the circumference of the casing and the air from the other half of the casing passes away by the second opening.

Mr. Morris does not, however, tell us why his improvement is an improvement, though there appears good ground for supposing that it should be.

To understand the action of the second passage we want to consider just what it is a fan is called on to do and it is simply this: to set in motion at the same velocity as the tips of the fan blades a certain quantity of air which as soon as it gets beyond the fan circumference will cease to have any radial component of motion but will move wholly tangentially. To prevent this the fan is placed in a casing which compels the tangentially moving air to travel in a circular path until it arrives at the outlet which is tangential to the tip circle. In the sketch is shown the tip circle of a fan. Let us suppose there enters this fan at the center a particle of air *a* and that as it travels to the circumference of the fan it moves in a spiral path (relative to a fixed external object) and escapes at *b* after one revolution of the fan has been made. This would tell us that no air entering the fan was thrown off sooner than after the fan had made one revolution. On this supposition single outlet fans have been so constructed, for of what



use is an outlet at *c* when all the air is ready to escape at *b*.

Suppose however it pleases another particle of air to enter at *a* but to begin to move outwards on the opposite side of the central spindle from the first particle so that it moves along the dotted spiral and escapes at *c*, on arriving at *c* it finds no outlet but merely a circular passage about the fan and along this passage it travels for half a circumference until it arrives at *b* and can then pass away tangentially.

It is evident that with single outlet fans the air in the casing beyond the fan tips is being churned and eddied by the air escaping all round the fan and so it would appear reasonable to expect Mr. Morris' idea to be productive of economy. We may calculate the angular motion of the air passing through a fan if we know the outlet volume and area in fan. In the sketch the angle is taken at 360° quite arbitrarily as an assistance in illustrating a principle, not as a hard fact.

This angle will of course vary greatly but will not vitiate the reasoning.

A fan resembles the converse of an inward flow turbine of the Thomson or Vortex type. Now we should not make such a water-wheel without guide blades to regulate the water entrance, and its flow in the vortex casing and yet with a far less solid substance, air, we make fans without guide blades on the outside, and it is a mistake to do so and though one must not carry the principle too far, there appears reason to suppose that advantage would follow three or even four outlets. Especially should this be the case with fans supplying blast to forge fires often in opposite directions from the fan.

The outlets could easily be brought more directly in line with the final direction of flow of the air and the loss due to bends and branches diminished or avoided, and these, it is so well known, are such serious factors in diminishing fan outputs. Every eddy in the outflowing stream of air means loss of forward energy and heat; the heat is a dead loss in many cases and though recovered or utilized in case of a forge fire it is expensively manufactured heat. For economy and efficiency it may be laid down as a general rule that in dealing with fluids in motion they must not be allowed to flow in two large masses or thicknesses. There is, of course, a limit to the amount of control and this of course comes at that point where gain arising from better guidance of the working stream is counterbalanced by loss arising from skin friction of guide-plates and vanes, and it becomes important therefore that the guides and vanes of fans and turbines should have the smoothest of surfaces, an item too little appreciated, but one which will enable Mr. Morris' system to be carried as far as possible.

THE PROGRESS IN MINING.

Reviews of Important Papers Relating to Mining in the Proceedings of the Mining and Scientific Societies, and in the Mining Journals of Europe, United States, and Canada.

Safety Explosives. The following is the text of a paper recently read by Mr. William Foggin before the North of England Branch of the Colliery Managers' Association.

It was not until the issuing of the Report of the Royal Commission on Accidents in Mines in 1886, that direct attention was given to the necessity of obtaining an explosive which could be used with impunity in coal mining. Previous to that date two attempts had been partially successful in solving the problem; but in both cases the objections were such as to preclude the general adoption of the explosives suggested. I allude to lime cartridges, and to the method of exploding dynamite enclosed in water invented by Professor Abel.

The first experiments which came under my notice in connection with blasting with lime were carried out at Usworth Colliery; but the results were so discouraging that nothing further at the time was attempted in this direction. The method adopted was to ram the lime well into the bottom of the hole, tightly stemming the outer end with clay, the water for slacking the lime being poured down the pricker-hole, which was afterwards stemmed. From half-an-hour to four and five hours were wasted in waiting for the results, and in about 10 per cent. of the cases no results whatever took place. A great advance was made upon this method in the introduction of compressed lime cartridges, which were manipulated somewhat similarly. These were used to a considerable extent in blasting coal at some of the large Midland collieries about ten years ago; but the time occupied (from 10 to 40 minutes) by the cartridge in doing its work was the great obstacle to its general adoption, and no doubt tended to discourage the more enthusiastic of its users.

So far as safety is concerned, the water cartridge recommended by Sir Frederick Abel really left nothing to be desired theoretically, but when submitted to numerous practical tests its weak points were found to be too objectionable to be overcome. In the first place, the unusual diameter of the hole 2½ inches added greatly to the already high first cost of the explosive and its accessories. Secondly, in spite of the extra care bestowed by the workmen in stemming the holes, my experience warrants me in stating that quite 30 per cent. of the water cartridges were burst before the firing of the enclosed shots.

These methods of securing immunity from explosions in shot-firing are, however, rapidly giving place to the more popular high-class explosives introduced to the mining world during the last half-dozen years, and it is more especially upon the qualities and capabilities of the latter that it is proposed to deal in this paper.

In passing judgment upon an explosive the following four points should be considered: 1, safety; 2, strength; 3, convenience; 4, cost.

In order to satisfy myself upon the point of safety, I carried out a series of experiments in the following manner: A cylindrical boiler 17 feet 10 inches long by 3 feet diameter, with eight apertures along one side (9 inches by 6½ inches) fitted with 1 inch plate glass, was fixed horizontally upon the ground, one end being closed with strong sheet-iron, in the center of which a hole 11 inches diameter was left in order to admit the end of the firing mortar. This latter consisted of an iron block 4 feet 7 inches long and 11 inches in diameter, with a 1½-inch hole 18 inches long drilled in the middle. A tram set upon iron rails supported the mortar, so that after each experiment it could be run back, and the process of charging and tamping the shot hole witnessed without inconvenience.

When the mortar was fixed in firing position, the outer end of the boiler was closed with a sheet of thick paper securely held in its place with an india-rubber ring.

Gas to the percentage required to form a highly explosive mixture was then let into the boiler through a 50 light meter, coal dust being sprinkled in from above, and the mixture kept in agitation by means of an iron flapper worked from the outside.

When it was thought that the mixture was thoroughly uniform, the charge was exploded electrically, and the result noted from a protected standpoint at the side of the chamber.

In designing and arranging the above apparatus, the primary object kept in view was to reproduce as nearly as possible an underground working place in its most dangerous and critical condition. And that the result was successful may be concluded from the fact that the North of England Explosive Committee, after viewing the apparatus, cancelled their previous arrangement, and adopted this plan for carrying out their experiments.

The great danger to be dreaded in underground blasting operations is undoubtedly a blown-out shot, and if this could be guarded against by any mechanical means the necessity for safety explosives would be to a considerable extent obviated; but so long as the possibility of this danger exists we shall have to depend upon one or other of the high class explosives at our disposal.

As a blown-out shot is most frequently the result of inefficient tamping, it was therefore assumed that the explosive requiring the least amount of tamping to ensure safety in the event of a blown-out shot, was the one which could be most relied upon. And on this line the experiments in connection with the gas chamber were carried out.

COMPOSITION OF EXPLOSIVES TESTED.

Dynamite consists of 75 parts by weight of nitro-glycerine uniformly mixed with 25 parts of infusorial earth, known as kieselguhr.

Tonite is a nitrated gun-cotton, the nitrate usually employed being that of barium.

Securite is a mixture of about 26 parts of meta-dinitro benzol and 74 parts of nitrate of ammonium.

Roburite consists of 7 parts of nitrate of ammonium, with 1 part of chlorinated dinitro benzol.

Ammonite is a mixture of 90 per cent. of ammonium nitrate and 10 per cent. of nitro-naphthaline.

Carbonite is composed of 25 parts of nitro-glycerine and 75 parts by weight of a pulverized preparation, consisting of not less than 40 parts of wood meal, and not more than 34 parts of nitrates of potassium and barium, with about a half per cent. of carbonate of sodium.

SAFETY.

Experiments with blown-out shots to ascertain the minimum amount of tamping required to ensure safety. Four ounces of explosive were used in each experiment.

Gunpowder was found to be unsafe in every case, irrespective of the amount of tamping employed.

Dynamite with 16 inches of wet clay stemming was safe, but shots fired with less than this amount exploded the mixture.

Tonite.—Eight shots were fired with this explosive with 16 inches and less of dry clay stemming, and each shot produced an explosion.

Securite.—Sixteen securite shots were fired, 11 with dry clay stemming from 1 to 16 inches, resulting in an explosion each time. But proved to be safe with 16 inches of coal dust or wet clay stemming.

Roburite.—Twenty-six shots were fired with this mixture, which proved to be comparatively safe with 1 inch of dry clay stemming, and absolutely safe with 1½ inch.

Carbonite.—Twelve carbonite shots were fired, with the result that 1 inch of stemming was found to be its margin of safety.

Ammonite.—Fifty-four shots were fired with ammonite, giving results more favorable than the above, inasmuch as a minimum of 1 inch of dry clay tamping, or ½ inch of wet clay were sufficient to secure safety.

It will thus be seen that out of these explosives three only can lay any claim to safety, namely: Ammonite, carbonite, and roburite. And when we can assure ourselves that an inch, or an inch-and-a-half, of stemming is all that is required to shield us from the worst effects of a blown-out shot, it must be admitted that we have every reason to be satisfied with the advance we have made in the direction of safety.

STRENGTH.

The same explosives were tested in the following manner, in order to ascertain their comparative strength.

A cylindrical shot, weighing 29 lbs., was fired from a steel mortar, and set at an angle of elevation of 45 degrees.

The following results represent the average of six shots with each explosive, a charge of five grammes (1 gramme = 15·432 grains) being used in each case:

	Range in feet.	Comparative Strength.
Ammonite	310	100
Roburite	294	94
Dynamite	264	85
Tonite	222	71
Securite	182	58
Carbonite	168	54
Gunpowder	142	45

It will thus be seen that of the three safe explosives carbonite falls a long way down in the scale of strength, being only one remove from gunpowder, and little more than half the strength of ammonite and roburite.

CONVENIENCE.

Under this head should be considered—1, susceptibility to climatic changes; 2, safety in handling; 3, resulting fumes upon explosion.

As carbonite contains 25 per cent. of nitro-glycerine, the uninterrupted use of it in the winter months cannot be relied upon. Again, should the magazine in which it is stored be at all damp, the explosive becomes perfectly useless by reason of the moisture absorbed.

Roburite is even more susceptible to moisture than the foregoing, and should be used as soon after being manufactured as possible, or kept at a constant moderate temperature.

Ammonite, on the other hand, by reason of the air-tight metallic case surrounding each cartridge, is impervious to either frost or damp, and can be kept and fired in a block of freezing ice, or used under water with impunity.

With a view of arriving at the comparative merits of these various explosives in regard to their "safety in handling," the following experiment was carried out:

A steel block, 59 lbs. weight, was hung by a rope over a pulley and allowed to drop upon the explosive, which was placed upon an anvil. In order that the block should fall evenly upon the explosive, two rigid wires were fixed perpendicularly to act as guides. A disconnecting hook was attached to the end of the rope nearest the block, so that, upon the block being wound to the requisite height, the hook could be operated by means of a light cord laid to a safe distance.

Roburite, dynamite, tonite, securite, carbonite, and gunpowder, with a fall of 5 feet, exploded in each case. Ammonite was tested at different heights, from 5 to 23 feet, without exploding.

Upon the third condition, "resulting fumes," much more has been said than can be repeated in this paper. It is a point which cannot be experimented upon in a day or a week. Much abuse was heaped upon high-class explosives in this respect shortly after their introduction, but with what amount of reason may be gathered from the recent report of the North of England Committee, which inquired into the matter, and exonerated them from the charge that any danger resulted from inhaling their fumes. The writer's experience leads him to the belief that the presence of objectionable fumes is entirely a matter of fancy.

COST.

On the score of cost, the considerations are so obvious as to scarcely require mentioning.

However, taking other points as being equal, it is only reasonable to expect that an explosive which is barely half as strong as its competitors should only be half the price.

Again, in buying an explosive, it is somewhat disappointing to have included 10 per cent. of cartridge paper, which can be bought at one-fifth of the cost.

A Method of Removing Deposit from the Inside of Column Pipes in Shafts. A paper descriptive of the above was read at the December meeting of The North of England Institute of Mining and Mechanical Engineers, by Mr. R. T. Swallow. The pipes in question formed the delivery column 1062 feet in height, of the force pumps at Hebburn Colliery. The pipes were originally 9 inches inside diameter at the bottom of the column widening out to 10½ inches at the surface and the water had a flow at first of 203 feet per minute. The pipes had been tested at the foundry previous to being put in place, to a pressure of 715 lbs. to the square inch. After having been in use 5 years one of the 9 inch pipes split down one side, and on examination the internal diameter of the pipe was found to be reduced by sedimentary deposit to 6½ inches, or little more than half their original area, so that the velocity of the water was increased very considerably. It was then decided to clean the column in position, and the following was the method adopted:

Two small pulleys were hung to the head gear at the pit mouth so that a rope passing over them hung directly over the center of the column. To the end of this rope a specially constructed cutter was fixed. This consisted of a piece of bar iron hung horizontally fitted with steel springs on each of its sides to each of which two knives were fixed, from the bottom of this cutter a length of chain weighing 448 lbs. was hung to give weight. The horizontal pipe, in the pit, leading to the foot of the rising main having been removed, the cutters were lowered to the bottom of the column and gradually chopped up and down until they reached the top of the column. After this was done the cutter was withdrawn and the knives set to the full diameter of the pipes and the operation repeated until all the pipes were apparently cleared. By this means five tons of deposit was removed at a cost of 11½ hours work and with the services of an engineman, two men on the surface and two in the pit.

Mine Ropes. The following is a summary of a report made to the French Government on the above subject for which we are indebted to the last issue of *The School of Mines Quarterly*: Iron wire rope should be strong, hard, pliable, and not galvanized. Steel wire rope should be of very homogeneous and comparatively hard quality, and suitably annealed; it should have a tensile strength of 70 to 76 tons per square inch, and should stretch from 3 to 5 per cent., and be pliable. The wire should be in all cases tested for tensile strength, stretching, bending, and torsion; and all the wires should be as closely alike as possible. Experience proves that the very material itself of every rope changes in course of working and gradually diminishes in strength until it is no longer safe. The wires become harsh and brittle. Large diameters of drums and pulleys are essential for the longevity of a rope. The smallest diameter of these should be from 1300 times the diameter of the wire for iron ropes to 2000 times the diameter of the wire for steel ropes, or from 80 to 100 times the diameter of the rope. The rope should wind smooth on the drum or pulleys without rubbing sideways, and so as to run free of jolts and flapping. The grooves of the pulleys should be lined with wood. In doubling back the rope end for attaching to the cage the loop should be kept as large as possible by inserting an iron eye or wood disc. The attachment should be made with springs to ease the strain at starting.

Ropes should be greased regularly with a grease soft enough to work into the strands right through the hemp core, but stiff enough to stick to the outside of the rope. Where the mine water is impregnated with acid, steel ropes will wear quicker than iron.

The rope should be examined every 24 hours, and this should be done by running it through the operators hands so that if he does not see all the broken wires he will feel them. Occasionally the rope should be thoroughly cleaned so that its condition may be more minutely ascertained. When broken wires are found the longest should be tucked in and the shorter ones cut off to prevent further damage by catching. When a rope is used for winding men, the shackle should be cut off regularly every two or three months, the rope thoroughly examined and the shackle re-set.

The Manufacture of Patent Fuel. A paper on this subject was lately read before the members of the Mining Institute of Scotland, by Mr. James Grant, and as the ever-increasing production of coal causes a proportionate increase in the amount of small coal sent out and the consequent call for some means of using this small coal to profit the subject is worthy of careful attention.

There are three methods of fuel making:

(1). Processes requiring drying in an oven after compression.

(2). The dry process, consisting of passing coal and pitch through hot cylinders over a furnace.

(3). The steam process which effects the melting of the pitch by hot dry steam.

This last process is the one which is now almost universally adopted.

The patent fuel is generally produced in blocks called *briquettes*. These *briquettes* are of various sizes to suit local requirements. Some works also produce egg-shaped pieces for shoveling into furnaces, these are called *ovoids*.

Patent fuel can be stowed into 31½ cubic feet per ton. Coal requires 41 cubic feet. The heat given off by

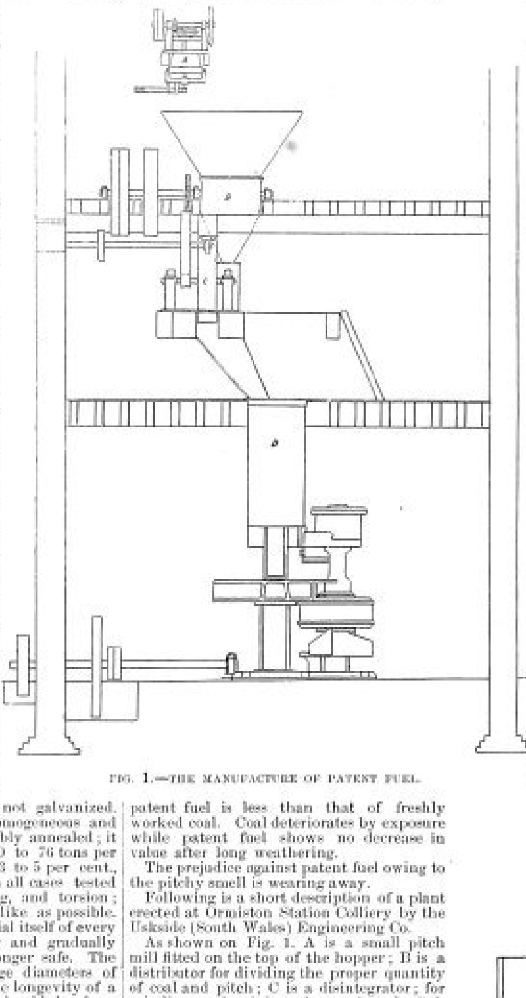


FIG. 1.—THE MANUFACTURE OF PATENT FUEL.

patent fuel is less than that of freshly worked coal. Coal deteriorates by exposure while patent fuel shows no decrease in value after long weathering.

The prejudice against patent fuel owing to the pitchy smell is wearing away.

Following is a short description of a plant erected at Ormiston Station Colliery by the Uskside (South Wales) Engineering Co.

As shown on Fig. 1. A is a small pitch mill fitted on the top of the hopper; B is a distributor for dividing the proper quantity of coal and pitch; C is a disintegrator; for grinding and mixing the coal and pitch together, D is a pug-mill where the coal and pitch are stirred and heated to the proper consistency for compression. B² Fig. 2, is a pan-mill to receive the coal and pitch, with revolving arms in it to fill the moulds; C² is the press cylinder for pressing the blocks; D² shows the amount of compression, 2½ inches on each block, which equals 1,344 lbs. pressure to the square inch of block surface. D³ is where the block is tilted off after it is finished; E is a section of the stamper that presses the block; F is the lever on the end of the piston-rod that lifts the stamper by means of what is called a hammer resting on the center of this lever. When the moulds are filled the table is turned round horizontally, a tooth at a time, by a kicker on the upright shaft that passes through the pug-mill to the top of it; and they are passed round to the top of the hammer where the blocks are pressed. After they are pressed they are passed on with the stampers rising on an inclined plane, and when the moulds get to the opposite side of the press from the hammer, the blocks are above the level of the table and are tilted off there; then the stampers are passed along on a descending plane into the pan-mill for filling. Immediately above the pan-mill, and on the bottom of the pug-mill on this upright shaft, there is an eccentric that works the slide-valve of of the press cylinder and causes the piston to give the blow. The whole of this machinery is driven by a pair of coupled engines, 10-inch cylinders and 20-inch stroke, supplied with steam at 40 lbs. pressure. The speed of the engine is sixty revolutions per minute; the speed of the main shaft of the full plant is ninety-five revolutions per minute. The pug mill and press cylinder are supplied with steam at 70 lbs. pressure from a small multitubular boiler, seven feet long by three feet six inches in diameter with twenty-eight tubes of three inches internal diameter. It requires one man on the top to fill in the coal, one boy to fill in the pitch, one pressman on the bottom floor to attend to the press and pug-mill, two laborers to take away the blocks and load or store them, and one boy to fire the boilers; in all four men and two boys. The machine turns out three tons of fuel per hour. The quantity of pitch used is from 9 to 10 per cent. of finished fuel. The principal things to attend to in making good fuel are to see that the proper quantity of pitch is filled in along with the coal; that they are both properly ground and mixed in the disintegrator; that the steam from the pug-mill is kept up to the proper pressure, and that the nozzles conveying the steam into the pug-mill are in order. There are two nozzles into the pug-mill; one about twelve inches from the bottom of the mill, and another about six inches further up on the opposite side of the mill. The diameter of these nozzles is from ⅜ in. to ½ in., screwed, into a ¾ in. tube. The height from the bottom floor to where the coal is filled into the hopper is twenty-three feet. The small coal, as it comes from the coal miners is emptied by the pit-head man into a well, made to receive it from the screening platform. The pitch is hoisted up an inclined plane in cars to the same platform, and emptied on the opposite side of the hopper.

Before this plant was erected hundreds of tons of this small coal was stowed in the workings; now it is all drawn, and whatever is left over after supplying the colliery with steam is made into patent fuel. The coal is so soft and drossy that an arrangement was entered into with the coal miners when the colliery was first opened out to screen all the coal over a ⅝ in. screen, and that enabled them to make a better job of screening it into pea and nut for the market.

The size of the briquette is 6 inches by 4 inches by 3½ inches, and it weighs four pounds.

In course of a discussion which followed the reading of the paper, Mr. Clark stated that the best coal for briquette-making was a good free-burning non-coking coal.

If the proper consistency of pitch is not used the briquettes fall in pieces after being made. One machine, such as described, made three tons per hour, or thirty four-pound briquettes per minute. The coal used was not washed. It was passed through ⅝-inch hand screen in the pit.

A New Form of Coal-Washing Machine. We are indebted to the Mining Institute of Scotland, for the following synopsis of a paper by Max Everard, on the above subject.

This is a modification of the piston-jigger, having an arrangement for scraping the surface and removing the top of the washed layer under treatment. It consists of a sieve-plate 10 feet long by 3½ feet in width, the apertures being largest next the feed end—fixed on a pyramidal hutch, having a plunger box attached to one of the long slides, and an opening variable by adjustable slides for the discharge of the heavier waste on the other. The piston is a circular wooden dish moved by an eccentric and communicating motion to the water

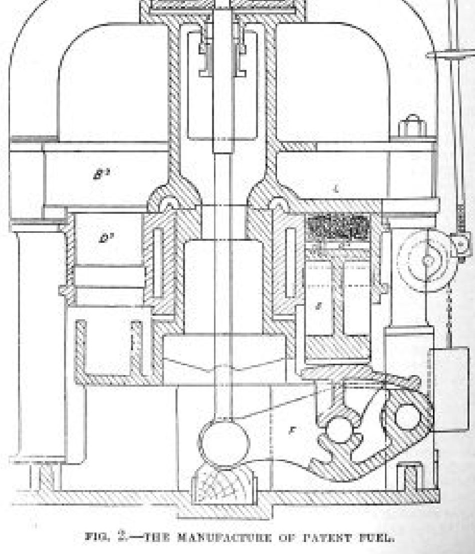


FIG. 2.—THE MANUFACTURE OF PATENT FUEL.

in the hutch through a cushion of air confined above the water in a piston box. The scraper is a harrow-like frame suspended by a system of jointed rods above the sieve-plate, and receives motion from a cam acting upon the counterpoised arm of an angle lever, which gives a slow forward and quick return motion. The frame is connected with a slide opening the feeding hopper so as to allow a fresh portion of material to be dropped upon the plate at the coarse end, at the commencement of each stroke, where it is subjected to the most energetic action of the water, while the finer portions of previous charges brought to the surface are drawn forward by the teeth projecting from the frame, towards the discharge end. Usually the frame is so suspended as to pass clear of the charge on the return stroke. The length of the stroke of the frame is 20 inches, so that the surface of the washed material is broken up six times in its passage over the 10 feet length of plate.

The machines weigh about 6 tons each, and are worked in pairs, each pair requiring a motive power of 4 to 6 H. P., and one man to attend to them; and the average produce is 15 tons per hour for the two machines.

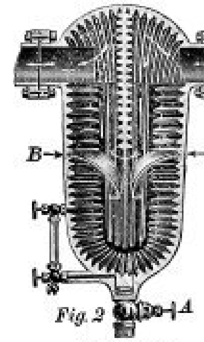
COAL-DUST AND COLLIERY EXPLOSIONS.

A series of short public lectures on "Coal and Coal Mining," in Manchester, England, was brought to a close recently by Prof. Dixon, who lectured on the action of finely divided coal-dust either in promoting or aggravating the intensity of explosions produced by fire-damp, or, on the other hand, by igniting itself and causing an explosion in mines.

Prof. Dixon believes that coal-dust of itself, under certain conditions is explosive, and the following synopsis of his lecture, from *The Colliery Guardian*, of London, is worthy the attention of American colliery managers. Attention, he said, was first directed to this question by Lyell and Faraday in the year 1845, when they found portions of charred coal-dust on the props and other articles in the pits after an explosion. The dust found by them corresponded with the dust found in the latest explosion that was attributed to the ignition of coal dust—in the Apedale Colliery, Staffordshire—but until a few years ago, although attention had been called to the *role* which dust might play in explosions, no one had attributed to dust the power of carrying on an explosion by itself, or of being the main factor of an explosion in mines. It was in connection with the explosion at Seaham Colliery, Durham, on the 8th September, 1880, that this view was first urged. Professor Dixon briefly recapitulated the circumstances of that accident and the evidence that was adduced at the time and a year afterwards—a portion of the mine having been locked up for about twelve months. It was the miners themselves, he remarked, who brought forward the theory that dust had played the principal part in the explosion, and since then particular attention had been directed to the subject, and experiments had been made, not only in this country, but also in France, Germany, and other parts of the Continent. The question which was being considered was this: "Is dust capable of producing a flame when it comes in contact with a large flame such as may be produced by a blown-out shot or produced by an explosion of gas and air?" It was not supposed that an ordinary naked light in a mine would suffice for an explosion of coal-dust and air. There must be first a great disturbance to raise the dust and mingle it with the air to make it an explosive mixture, and there must be great heat locally applied to initiate the explosion; but once that had been set up a flame might extend so far as there was the coal-dust lying on the floor or sides, and the damage done by it was comparable, at all events, with the damage done by an explosion of fire-damp and air. This was a view frequently urged, and in support of it the lecturer tried a few experiments. He showed that fine dust falling on a flame will give off flame and sparks, and that when mixed with oxygen an intense flame is produced. The difficulty, he added, was, happily, to get the requisite proportions of coal-dust and air to make an explosive mixture. The gentlemen appointed to inquire into the circumstances of the Seaham explosion came to the conclusion that there was great danger in small quantities of fire-damp in dusty mines, but they did not state that dust would explode by itself. They did not regard it as being capable or as likely to carry an explosion from end to end. From this point the lecturer went on to speak of the causes and results of the explosions at Altofts and Elemore in 1886, at Hyde in 1889, and at Llanerch and Morfa in 1890. He spoke of the inquiries which the Royal Commission are making with a view to determining the question as to whether coal-dust may be the chief factor in mine explosions. By experiments in imitation of those attempted by Mr. Hall, H. M. inspector of mines for the Liverpool district, the lecturer demonstrated that coal-dust brought into contact with flame will sometimes explode. The fact, he said, that the dust did not always explode was urged by some people as a proof that dust of itself would not produce an explosion. They said there were dusty mines that had been worked for fifty years without an explosion, and that was a stronger argument than any experiments. The lecturer, however, did not think that such an argument was sound. He hoped the Royal Commission would be able to conduct experiments on a large scale, a scale equal to the ordinary conditions of mining, so that the question might be settled. He mentioned, in conclusion, that the Austrian Commission had confirmed the German Commission in the opinion that dust could cause an explosion, and that they suggested that the danger might be met by watering the dust or by attempting to sweep it up, which of course presented great practical difficulties, or by using a particular kind of cartridge which would not produce a flame that would ignite dust or gas. If this could be done it might be possible, said Professor Dixon, to go on using shots in dusty mines.

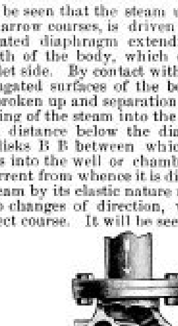
HINE'S ELIMINATOR.

We herewith present sectional views of the two forms in which this device is constructed. The Hine Eliminator is not new to the market, it was brought out in 1888, and over seven hundred of them are now in use. The exceedingly high merit it has been demonstrated to possess as a separator of water from live steam and the importance of such a device throughout the mining districts has prompted the publication. As will be seen, it is made for steam-pipe running either horizontally or vertically, and by inverting the vertical form the course of the steam, be it up or down, is immaterial. Scientific investigation has demonstrated that, to obtain complete mechanical steam separation, provision must be made for carrying the water out of and away from the action of the steam current before they can be again taken up and carried forward by the rapidly moving steam, which continually surrounds it. By reference to the horizontal style,



HORIZONTAL.

Fig. 2, it will be seen that the steam upon entering, as indicated by arrow courses, is driven against a transverse corrugated diaphragm extending vertically to half the length of the body, which divides the inlet from the outlet side. By contact with this diaphragm and the corrugated surfaces of the body the steam is thoroughly broken up and separation accomplished before the turning of the steam into the outlet side, at the proper aerial distance below the diaphragm are two converging disks B B between which the water instantly passes into the well or chamber below, out of the steam current from whence it is discharged through valve A. Steam by its elastic nature readily accommodates itself to changes of direction, while water will pass in a direct course. It will be seen, therefore, that



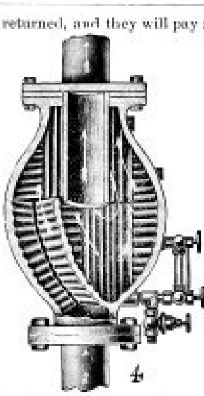
VERTICAL WHERE COURSE OF STEAM IS DOWNWARD.

the water being at once deposited in the lower chamber out of the current, the dry steam passes under the diaphragm thence upward and out, being deflected by an inward extending pipe at the immediate point of outlet.

Figure 3 (vertical). At the side on one end, a corrugated deflecting partition extends half the length of the body, forming the inlet. At the opposite end a vertical pipe, cast with a flange and standing out from the body, forms the outlet. The steam in passing through the deflecting partition obtains centrifugal action, and by contact with the inner corrugated surfaces is broken up, the water, eliminated, readily flows down the vertical corrugations and out, while the steam diverted from its direct current passes through the vertical pipe to point of delivery.

In 1891 a test of steam separators was made at Sibley College, Cornell University. The object being to determine the principle involved, the conditions necessary for the most efficient separation, and the efficiency of the best forms of separators known to the market. Suffice it to say that in twelve trials the Hine Eliminator with steam under varying conditions demonstrated an average efficiency of $98\frac{7}{10}$ per cent. dry steam, defeating in a marked degree *all* competitors.* The Eliminator is compact in construction, positive in action with nothing to get out of order, requires no attention, and is cheap.

As a manifestation of the confidence held by the manufacturers in the efficiency of the eliminator they propose to send it, in either of its forms, to any responsible party on a month's trial, with the understanding that if it fails to give entire satisfaction the same can be returned, and they will pay freight charges



VERTICAL WHERE COURSE OF STEAM IS UPWARD.

both ways. Full particulars may be had from the Hine Eliminator Co., 106 Liberty Street, New York.

*The Hine Eliminator Co. will send free the complete report of the Cornell steam separator test to any addressing them for the same.

MISSOURI'S COAL RESOURCES.

At a recent meeting of the Board of Managers of the Bureau of Geology and Mines of Missouri, a report by State Geologist Winslow was submitted, entitled: "A Preliminary report on the Coal Deposits of Missouri." It consisted of about 300 type-written pages, and was accompanied by 131 illustrations of coal beds and other subjects. An edition of 5,000 copies was ordered printed. The report contains four chapters and two appendices as follows: Chapter 1, The Coal Measures; chapter 2, The Coal Beds; chapter 3, The Coal Industry; chapter 4, A Systematic Description of Coal Beds now operated; appendix A, Notes on Coal Mining in Thin Coal Beds; appendix B, A List of the Coal Operators of Missouri.

In chapter 1 a brief outline is given of the distribution and topography of the coal measure formations, and the nature of the various rocks which exist there are described, as well as the manner in which these rocks occur. Following this is a discussion of the process by which these rocks were formed, which is especially valuable as an exposition of the laws governing the distribution of coal beds and other strata of this formation.

Chapter 2 consists of a description or the various conditions which restrict the distribution of coal and of those which restrict its availability. The general character of Missouri coals is also described here.

Chapter 3 is introduced by a few remarks on the coal production of the State, in which it is shown that Missouri ranks second among the coal producing States west of the Mississippi River and sixth among those of the whole union. Following this is a description of the geographical and geological conditions affecting the market of the coals of Missouri and adjacent States. The present uses and adaptabilities of the coals are then briefly discussed, though the lack of exact knowledge concerning these questions is deplored. An answer to the questions of the available coal in the State and the duration of the supply is dismissed as premature with the present state of our knowledge. It is estimated, however, that less than two square miles of coal land are annually exhausted in the State, and, inasmuch as there are 23,000 square miles of coal measures in the State, a small fraction of this containing workable coal would suffice to maintain the present rate of production for a thousand years. Some interesting figures are given concerning the value of coal lands, and, after recommending the coal lands of Missouri as fields for investment, the chapter concludes with the statement that we may look forward, in the march of events, to a large increase in the coal industry of the State, to profitable returns to those who invest their money sagaciously in coal lands and in the support of the dependent industry, and to an enhancement of the value of such lands now largely held and used purely for agricultural ends by private citizens of the State.

Chapter 4 contains the bulk of the report and consists of descriptions of the occurrences of coal in the State in fifty-seven counties. It is liberally illustrated by sections showing the thicknesses of the various coal beds and associated rocks, and the general character of the coal in each locality is described. The results of deep drilling and shafting in many parts of the State are included in this chapter, and the prospect of further discovery of coal in various counties is stated. A small block map showing the area of the coal measures and the general distribution of mines accompanies the report. The occurrences of isolated coal deposits or "coal pockets" in the State are also described.

In Appendix A is given an interesting description of the methods of mining thin coal beds in the State, which is an important addition, inasmuch as it demonstrates the entire availability of coal beds here, which elsewhere might be considered too thin to work.

In the preface to this report and elsewhere, the value of reliable drill-hole records for determining the extent and distribution of coal in the state is emphasized. The lack of authentic results from much drilling that has been done in the past is deplored and a plan of co-operation is suggested which deserves wide consideration, and which, if followed, will be productive of much good. It consists, in brief, of the following offer: To any private individual or community desiring to have a deep drill hole sunk, the survey offer first to recommend reliable men whom the individual or community can employ to do the work of drilling; second, it offers to supervise this drilling, and last, it offers to furnish an official statement of the results of this drilling, all free of charge, in return for this service, all that is required is that the survey be allowed full and free use of the results for the benefit of the State.

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ *Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.*

Fans in Mining.

Editor Colliery Engineer:

SIR:—Please publish the following in answer to "E. R.," of Hopwood, Pa.

(1.) The fan on a certain mine has an equivalent orifice of 37·81 square feet, the mine's equivalent orifice is 19 square feet; the size of the fan is 12 ft., making 90 revolutions per minute. What is the fan's efficiency?

The theoretical head due to the fan's velocity,

$$H = \frac{v^2}{g} = \frac{(12 \times 3{\cdot}1416 \times 15)^2}{32} = 99{\cdot}93',$$

h, the effective head equals

$$\frac{H}{1 + \frac{o^2}{o^2}} = \frac{99{\cdot}93}{1 + \frac{19^2}{37{\cdot}81^2}} = 79{\cdot}79';$$

$h\ o$ = the head lost = $H - h = 99{\cdot}93 - 79{\cdot}79 = 20{\cdot}14$.

The efficiency of the fan will be as

$$79{\cdot}79 + 20{\cdot}14 : 79{\cdot}79 :: 100 : 79{\cdot}84\%.$$

The quantity passing $= 8\sqrt{79{\cdot}79} \times {\cdot}65 \times 60 \times 19 = 52{,}937$ cu. ft.

$$\text{Proof, } a = \frac{{\cdot}000385 \times q}{\sqrt{w.g.}} = \frac{{\cdot}000385 \times 52937}{\frac{\sqrt{79{\cdot}79}}{60{\cdot}4}} = 19.$$

(2.) What size fan, giving an efficiency of 50%, would you apply to the ventilation of a mine 500′ deep, the quantity of air required being 40,000 cu. ft. per minute and the equivalent orifice of the mine being 20 sq. ft.? The effective head

$$\left(\frac{40{,}000}{8 \times {\cdot}65 \times 60 \times 20}\right)^2 = 41{\cdot}088,$$

as this is only 50% of the theoretical head

$$H \text{ will equal } 41{\cdot}088 \times 2 = 82{\cdot}17 = \frac{v^2}{g}.$$

$\sqrt{82{\cdot}17 \times 32} = \sqrt{2629{\cdot}44} = 52{\cdot}46$ = velocity per second and as the number of revolutions is not given we will assume it to be 90 per minute, or 1·5 per second, then

$$\frac{52{\cdot}46}{1{\cdot}5} = 34{\cdot}97' = \text{the circumference of fan,}$$

$$\frac{34{\cdot}97}{3{\cdot}1416} = 11{\cdot}13' = \text{diameter of fan.}$$

Yours etc.,
T. S. C.

Gardner, Ill., Dec. 21st.

Arithmetic.

Editor Colliery Engineer:

SIR:—I submit the following in reply to question by "A. A.," in the December issue:

[The solution sent is the same as that of "J. S. K.," of Canon City, Col., published in the January issue.—ED.]

Yours, etc.,
BEGINNER.

Riverton, Ill., Dec. 21st.

Mensuration.

Editor Colliery Engineer:

SIR:—In the December issue "H. L. D. W.," of Buffalo, N. Y., solves the tree question for "Trackman," of Reynoldsville, Pa., but according to the figures given his work does not prove itself. I hope he will work it out in detail so as to enlighten a mining student.

Yours, etc.,
BEGINNER.

Riverton, Ill., Dec., 21st.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to question (1), asked by "A. B.," of Hanna City, Ill.:

An air-way 8′ × 8′ × 1000′ is passing 40,000 cu. ft. of air, what diameter should a circular air-way 1200′ long be to pass one-half the quantity, the pressure remaining the same?

In solving we use the formula

$$p = \frac{k\,s\,v^2}{a},$$

substituting their values

$$p = \frac{{\cdot}0217 \times 32{,}000 \times {\cdot}39062}{64} = 4{\cdot}23 \text{ lbs.}$$

The length of first air-way is found thus, when q = 20,000, and p, a, and o remain the same. Since q varies inversely as $\sqrt{l}$, we have

$$20^2 : 40^2 :: 1000 : x, \text{ or}$$
$$400 : 1600 :: 1000 : 4000, \text{ or length.}$$

Next, we find the size of equivalent air-way 1200 long,

$$l \text{ varies as } \frac{a^3}{o} = 8195',$$

then

$$4000 : 1200 :: 8196 : \frac{a^3}{o},$$

working out we find

$$\frac{a^3}{o} = 2430,$$

therefore

$$a = 37{\cdot}5', \text{ and } o = 21{\cdot}7'$$

for the circular air-way, the diameter of which would be 6′ 11″.

Proof

$$p = \frac{k\,s\,v^2}{a},$$

or substituting

$$p = \frac{{\cdot}0217 \times 26040 \times {\cdot}284089}{37{\cdot}5} = 4{\cdot}28 \text{ lbs.}$$

Yours, etc.,
N. S.

Dagus Mines, Pa., Dec. 19th.

Algebra.

Editor Colliery Engineer:

SIR:—I submit the following in answer to "A. B. C.," of Pittston, Pa.:

[The solution sent is similar to that of "T. S. A.," of Anita, Pa., inserted in the October issue.—Ed.]

Yours, etc.,
JAY.

Nanticoke, Pa., Dec. 26th.

Ventilation.

Editor Colliery Engineer:

SIR:—In reply to question on ventilation by "S. U. P.," in the October issue, which was answered by "L. P. H.," in the November number, and corrected by "S. U. P." in your December issue, I submit the following:

Suppose a volume of 64,000 cu. ft. of air per minute is passing through a rectangular shaft 8′ × 16′ and 500′ deep, what is the pressure?

If the shaft is partitioned off, *i. e.*, a brattice run from top to bottom making two 8′ × 8′ shafts, or air passages, what volume may be expected, pressure to be the same in both cases?

I think the "correction" by "S. U. P." is also wrong, and therefore work it out as follows:

$$8' \times 16' = 128 \text{ sq. ft.} = a.$$
$$64{,}000 \div 128 = 500 \text{ cu. ft.} = v.$$
$$8' + 8' + 16' + 16' = 48 \text{ ft.} = p.$$
$$500' \times 48' = 24{,}000 \text{ sq. ft.} = s.$$

Then by formula

$$p = \frac{k\,s\,v^2}{a},$$

we have by substituting and working out

$$p = \frac{{\cdot}0000000217 \times 24{,}000 \times 250{,}000}{128} = 1{\cdot}017.$$

To find volume of divided shaft we find the velocity by following formula:

$$v = \sqrt{\frac{a \times p}{k \times s}},$$

substituting values

$$v = \sqrt{\frac{64 \times 1{\cdot}017}{{\cdot}0000000217 \times 16{,}000}} = 432{\cdot}9 +,$$

Then

$432{\cdot}9 \times 64 = 27705{\cdot}6$, and $27{,}705{\cdot}6 \times 2 = 55{,}411{\cdot}2$ cu. ft. volume, and $64{,}000 - 55{,}411{\cdot}2 = 8{,}588{\cdot}8$ difference in cu. ft. lost.

Yours, etc.,
A. G.

Falls Creek, Pa., Dec. 21st.

The Siphon.

Editor Colliery Engineer:

SIR:—Will you please publish the following question in your next issue:

A siphon 550′ long and 2″ in diameter has a lift of 8′ from sump to summit, and 25′ fall from summit to discharge. What will be the volume of water discharged per minute?

The water is allowed to accumulate 14 hours, and the siphon will run off this head in addition to the water made while running in 4 hours, thus making 18 hours water run off in 4 hours. Now, what is total amount of water conveyed in 18 hours? This being 75% of water made, what will be the total amount for 24 hours?

Yours, etc.,
S. U. P.

Lawsonham, Pa., Dec. 9th.

Ventilation.

Editor Colliery Engineer:

SIR:—Will you please insert the following in reply to "Miner," of Middleport, Ohio:

If "Miner" will examine my reply to "Inquisitive" he will find I gave the figures shown as the relative quantities and not as cu. ft., the cu. ft. were given further on. I also gave a rule "As the total relative quantity is to the relative quantity in each shaft so is the total actual quantity to the actual quantity passing in each shaft."

I will assume the "Dutchman's" right and keep on till I get it right. The formula given is

$v^2 = \frac{p\,a}{k\,s} \times a$, except that p and k being common to both are cancelled and the formula becomes

$v^2 = \frac{a}{s} \times a$, or the area divided by the rubbing surface gives the square of the velocity, the square root of which is the velocity itself; when p and k are cancelled the relative velocity is found.

Then for the 11′ shaft we proceed as follows;

$a = D^2 \times {\cdot}7854 = 95{\cdot}0334$, area; circumference $= D \times 3{\cdot}1416 = 34{\cdot}5576$, and circumference multiplied by depth, or

$34{\cdot}5576 \times 800 = 27{,}646{\cdot}08$, s, and

$95{\cdot}0334 \div 27{,}646{\cdot}08 = {\cdot}003442$, the square root of which will be

$$\sqrt{{\cdot}003442} = .059.$$

Then,

${\cdot}059 \times 95.0334 = 5{\cdot}60697$, which is the relative volume for the 11′ shaft.

Proceeding in the same way for the 10′ shaft, we find the relative volume to be 4·39824.

Then

$4{\cdot}39824 + 5{\cdot}60697 = 10{\cdot}00521$, this being the total relative volume, by proportion we can determine the actual volume, for as the total relative volume is to the relative volume in each shaft, so is the total actual volume to the volume in each shaft, or for 10′ shaft

$$10{\cdot}00521 : 4{\cdot}39824 :: 100{,}000 : x, \text{ or } 43{,}959.$$

For the 11′ shaft, we have.

$$10{\cdot}00521 : 5{\cdot}60697 :: 100{,}000 : x, \text{ or } 56{,}040,$$

then,

$43{,}959 + 56{,}040 = 99{,}999$, which is within one cubic foot of 100,000.

"Miner" requests that I show how I obtained the figures given in the August issue. In working the problem over, I find that the figures given were not absolutely correct, the error arising from dropping decimals. If "miner" will work the problem out, as I have shown he will find it is correct, or near enough, when it comes within one cubic foot. If he will furnish his address I will cheerfully forward the manuscript I have used in working it out.

Yours, etc.,
S. U. P.

Lawsonham, Pa., Dec. 21st.

The Nanticoke Disaster.

Editor Colliery Engineer:

SIR:—My views regarding the Nanticoke disaster are simply that there was an insufficiency of ventilation instead of an increased amount. Undoubtedly, in this case, the ventilation was diminished one-fourth and, perhaps, one-third by the wagon left standing in the air-way. The increased resistance to the fan, with the removal of stoppings and the liberation of gas helped to increase the temperature in the mine until it overcame the pressure and friction in the downcast, assisted, no doubt by the pressure through the bore-holes at the inside shaft. Then came the reversion of the ventilation and with it the explosion and loss of the twelve unfortunate men. It was an unlucky mistake of some one to have left the wagon standing there as the mortar should have been shoveled out and the wagon removed. It ought to be one of the rules at all mines that the air passages must not be contracted by leaving any obstructions in them longer than can possibly be avoided.

Yours, etc.,
ROBERT ROCHESTER.

Robbins Station, Pa., Dec. 27th.

Mathematics.

Editor Colliery Engineer:

SIR:—Please insert the following question in your journal:

A shaft 12′ in diameter was measured by a rod the exact depth of the shaft, and on leaning it over against the other side, thereby forming the hypothenuse of a right-angled triangle, it lacked one inch of reaching the top, what is the depth of the shaft? Please explain fully.

Yours, etc.,
F. W.

Duncan P. O., All'y Co., Pa., Dec. 30th.

Mechanics.

Editor Colliery Engineer:

SIR:—I submit the following question for solution in your journal: If the pressure of an engine is 44 lbs. per sq. in., diameter of cylinder 1′ 8″, length 6′, and paddle-wheel makes 20 revolutions per minute, what is its power?

Yours, etc.,
THOS. M. BROWN.

Pinckneyville, Ill., Jan. 2d.

Methods of Working.

Editor Colliery Engineer:

SIR:—Please insert the following question for solution by some of your able correspondents:

In a vein with 4′ of solid rock between top and bottom coal, the top coal being 3′ 8″ and the bottom coal 2′ 6″ thick and with a pitch of 63°, it is proposed to work the coal out, leaving the 4′ of rock intact. Please state how you would drive the gangway and air-way and how you would open and work the breasts. Also, how would you ventilate the same?

Yours, etc.,
J. T. HOWLAND.

Hazleton, Pa., Jan. 5th.

The Practical Work of Engines.

Editor Colliery Engineer:

SIR:—I quite agree with "R. M. H.," of Denver, Colo., that a discussion of the subject of the work of engines would be highly entertaining to your readers for it is an important one and is also very extensive. As he criticises the formula I gave in the August number of your valued journal I beg leave to ask space in which to offer the following in the hope that some of your readers may in like manner contribute to a much neglected branch of mining work.

The fundamental principles of mechanics involve two conditions depending upon the theory of the conservation of force and of motion; that equilibrium is established first when action and reaction are equal and, secondly, when the "moments" of the forces are equal to those of the resistances. To state these conditions in plainer terms, if the state of a body with respect to rest or motion is not changed, that body is in equilibrium and the forces acting upon it are not greater than the resistance which that body is capable of offering. The instant that a change does take place—that the body begins to move—then at that instant the sum of the forces is greater than the sum of the resistances offered by the body and its intervening members.

To satisfy the second condition of equilibrium which pertains, not to motion in a straight line as that of the former case, but to rotary motion, two elements are involved. Not only is the force or resistances considered but also its lever arm. When a force acts through a lever arm to produce rotation, the product of the force measured in pounds and the lever arm measured in feet, is called a "moment." Thus a man pulling on a five foot crow-bar with a force of 25 pounds is exerting a tendency to motion called a moment of 125 ft. pounds, (see January issue of THE COLLIERY ENGINEER, page 139). Now according to the "principle of moments"—the second condition of equilibrium—the sum of the moments of the forces must not exceed the sum of the moments of the resistances. If it does, motion takes place and this is true of any form of mechanism. Our muscular effort upon the crow-bar having a moment of 125 ft. lbs., can only overcome a moment equivalent to that. Thus, we can lift a 600 lb. box if it rests not further than $2\frac{1}{2}$ inches from the lower end, because $600 \times 2\frac{1}{2} \div 12 = 125$.

(1). If, on the other hand the 25 pounds operate on the 15 inch crank arm of a windless, the moment is 31·25 ft. lbs. which is only capable of balancing or holding in equilibrium $83\frac{1}{3}$ lbs. of weight suspended from the 9 in. barrel, because

$$25 \times 1\tfrac{1}{4} = 31\tfrac{1}{4} = 83\tfrac{1}{3} \times \tfrac{3}{8}.$$

If now, we measure the friction of the axle in the standards and find it to be 10 per cent., the expression becomes

$$31\tfrac{1}{4} = \tfrac{3}{8}\,(W + 0{\cdot}10\ W) \text{ whence } W = 75{\cdot}7 \text{ lbs.}$$

(2). If instead, of a windlass, we examine a winch and determine the conditions of equilibrium, we find now a complex system of levers. Nevertheless the principle is readily followed. Herein the power works on a crank arm and turns a toothed wheel (A) which engages into another toothed wheel (B) on the axle of which is the barrel carrying the rope and its load. The equilibrium is established when the pendent load (L) from the barrel is just being moved by the muscular effort P on the crank arm l. Now if the crank turns its wheel, A must move in which case the moment P l must be equal to, or greater than, the resistance R acting on the teeth with a lever arm equal to the radius r of the wheel A. Whence

$$P\,l = R\,r \text{ or } P\,l > R\,r.$$

This resistance R is received from the teeth of the wheel B and before B and its barrel can move, we have a similar condition of moments in which case

$$L\,m = R\,n \text{ or } L\,m < R\,n.$$

L m is the radius of the barrel and n, of the wheel B. Whence P l must be greater than R r and R n greater than L m. Or, P l n must exceed L m r. But as the sizes of the teeth in A and B are the same, then the number of teeth is proportional to the length of the circumference of the respective wheels and if x and y respectively represent the number of teeth we have

$$x : y :: r : n.$$

Finally P will balance a load, not to exceed

$$L = \frac{P\,l\,y}{m\,x}.$$

With fairly good castings, the friction of the toothed wheels should not exceed 25% of the pressure in which case

$$P = \frac{m\,x}{l\,y}\,(L + \tfrac{1}{4}\ L) \text{ and } L = \tfrac{4}{5}\,\frac{P\,l\,y}{m\,x}.$$

Let us now apply the same rules to the examination of the steam engine hoister, the pitman rod from the piston being directly connected by crank pin to the hoisting drum. Here we have the first case (1 above). With the area of each cylinder designated by A, the boiler pressure, by p, the length of the stroke by 2 C, and the diameter of the drum by D 2 R, we have P, the steam pressure on each piston as the active force with a lever arm C, giving a moment P C to balance that of the friction and the load with a lever arm R.

If c is the number of cylinders, one or two, and a plain slide valve engine be assumed with an internal friction of 10%, leaving 0·90 P as effective; and if the external friction of the sheave and the stiffness of rope be taken at 4% of the load, we have

$$0{\cdot}90\ p\ A\ c\ C = (L + 0{\cdot}04\,L)\ R$$

If the engine is double cylinder and if the cranks are set "at quarters," then one piston is operating at a dead point while the other is at full lever arm, whence

$$0{\cdot}90\ p\ A\ C = 1{\cdot}04\ L\ R.$$

When, however the crank pins are at 45° from the dead points, the maximum effect of the steam is exerted, in which case we have

$$0{\cdot}90\ p\ A\ c \times 0{\cdot}707\ C = 1{\cdot}04\ L\ R.$$

The relative length of the connecting rod has a very great influence in the calculation, but unless we have an expression for its length we must neglect it. The load L, therefore which a double cylinder direct-acting, cylindrical drum hoister can start will be between

$$0{\cdot}865\ \frac{p\ A\ c}{R} \text{ and } 1{\cdot}223\ \frac{p\ A\ c}{R}$$

according to the position of the crank pin.

(2). For a second motion engine, we have the case already mentioned where P is again $c\,p\,A$ with the similar limitations as to position of pin.

When, however we examine the case of a cut-off engine we are met with the question as to the least steam pressure which the piston exerts, not the boiler or throttle pressure, nor even the mean effective pressure, but the force operating at any given instant as compared with the resistances then operating. Engines in good working order provided with cut-off, allow the expansion substantially according to the law that the pressure falls in inverse ratio with the expansion of the steam. A $\frac{1}{2}$ cut-off gives a $\frac{1}{2}$ steam pressure at the end of the stroke. As a hoisting engine must be capable of starting the load from any point in its stroke, its weakest position must be examined. Then if f indicates the fractional part of the cut-off, the weakest condition of the hoister is at the end of the stroke when

$$L = 0{\cdot}865\ \frac{f\,p\ A\ c}{R}.$$

Here surely it would be advisable for the engineer to endeavor to stop the engine with its crank pins at 45° from the dead points.

If there are 2 cylinders the values for the steam pressure at the 45° points can only be given when the amount of the cut-off is known. For the steam pressure p^1 at any point, k, *beyond the point of cut-off*, is always a fractional part of the throttle-valve pressure p expressed by

$$p^1 = \frac{f}{k}\,p.$$

All of the above calculations were for the purpose of ascertaining the load which an engine can *start*. The operation of starting requires greater energy than is afterwards necessary to keep up the proper mean velocity of the combination. When once in motion, the velocity is more easily maintained. Moreover, the parts of the engine having acquired a certain momentum can thereby assist the piston at such points as its steam pressure is weakened by expansion and also at dead points. Hence the excess of power during one portion of the stroke may be availed of at other points of the stroke. Such consideration introduces the additional element of time, and the *work* (not the *power*) of an engine is measured by the time occupied in its performance.

As this portion of the discussion was so fully treated in recent issues of THE COLLIERY ENGINEER, I would not occupy valuable space by repetition, except to review two cases. The capacity of a plain slide-valve engine to do work, varies with its consumption of steam; and the load it will hoist at a given speed s, increases with the area of the piston, the length and number of strokes and the pressure of the steam.

A direct connection, plain slide-valve hoister with cylindrical drum, offers the following condition of equality of momentum at t strokes per minute.

$$0{\cdot}90\ p\ A\ s\ c\ t = 1{\cdot}04\ L\ v = 1{\cdot}04\ L \times 3{\cdot}1416\ R\ t,$$

whence

$$L = 0{\cdot}275\ \frac{c\ p\ A\ s}{R}$$

allowing for 10% internal and 4% external friction. One book gives an erroneous formula as follows:

$$0{\cdot}90\ p\ A\ c\ t\ 3{\cdot}1416\ s = 1{\cdot}04\ L\ 3{\cdot}1416\ R\ t.$$

A geared slide-valve engine, with 20% internal and 4% external friction gives

$$0{\cdot}80\ p\ A\ s\ c\ t = 1{\cdot}04\ L\ v = 1{\cdot}04\ L\ \frac{x\ t}{2\ y}\ 2\ 3{\cdot}1416\ R,$$

and

$$L = 0{\cdot}245\ \frac{c\ p\ A\ s\ y}{R\ x}.$$

Cut-off engines are not so easily calculated, for we have now to deal with the mean effective pressure of the steam during the entire stroke. This, in the formulæ given by "Equity," in the July number, is represented by $a\,p$. Though it may be calculated, many works on steam give tables for the mean pressure, which value is to be introduced above instead of p. Below is an abbreviated table of this kind in which the initial pressure is represented by unity, 1·00.

Period of Cut-off.	Mean Pressure a.
0·20	0·567
0·25	0·637
0·333	0·726
0·40	0·787
0·50	0·890
0·60	0·913
0·666	0·942
0·75	0·969
0·875	0·992

This discussion has taken more space than I had intended to consume, but it is my understanding of the case, and as I have verified many of the formulæ on large hoisters by indicator cards and otherwise, I believe that whatever discrepancies may appear to exist or become manifest by the use of the numerous formulæ offered for solution arise only from the variation of allowances made for the various frictions, clearance, the effect of position, and length of the connecting rod or pitman, and the friction of sheaves or stiffness of rope—not from any error of principle or theory. I trust that some of our fellow readers will contribute to the general good, as it was this thought that prompted me to offer the present.

Yours, etc.,
THEORIST.

Golden, Colorado, Jan. 17th.

P. S.—The equations given above assume a connecting rod between piston and crank pin, of very great length (in fact, of an infinite length) such that its various positions are parallel, and the steam pressure is always exerted horizontally upon the crank. Strictly speaking, the equations only apply to that condition.

But as the pitman is of finite length and quite short, its several positions are not parallel, but are measured between two convergent positions, each at the angle above or below the horizontal whose *sine* is equal to the quotient of the crank-arm by the connecting rod. Between these two extremes, the rod assumes various angular positions and hence imparts to the crank-arm a driving power which is neither horizontal nor tangential to the crank circle. This force for the instant, is less than it would be in either of the other cases.

The result is that during the period of time while a piston moves through the rectilinear path of its stroke, "at a rate which is gradually increasing until it attains a maximum, and then as gradually diminishing until the piston comes to rest," the crank-pin travels in a circular path with a "velocity which, though actually variable, may be considered as uniform for all calculations possessing sufficient refinement for practical requirements." The work being the same for one stroke as that of the resistance during the same time, but over the semi-circumferential path of the crank-pin, it follows that the mean driving power on the pin bears the same ratio to the total steam pressure as does the length of the stroke to the semi-circumference of the crank circle.

These variations influence the steadiness of driving; for the uniformity depends solely upon the "ratio subsisting between the work imparted to an engine by the steam pressure, and that given out to overcome resistance."

The variations in the effect produced by a finite connecting rod are only spent in pressure downward on the slide-bars and upwards on the crank-shaft journal. No power is lost except that consumed in overcoming the increased friction.

A fly-wheel would regulate this irregularity if it could be applied to a hoister, but that is out of question. Hence the methods must be by the use of duplex cylinders with their "cranks at quarters," or by the compound system which lends itself well to the plan.

T.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to question by "Carbon," of Lemont Furnace, Pa., in your last issue: If we have 6,250 cubic feet of air traveling in a mine through an area of 25 sq. ft., and wishing to have 22,500 cubic feet per minute in the mine with the same power, how large should the area be?

Since the quantity passing is in proportion to the area, other things being equal, therefore

$$6{,}250 : 22{,}500 :: 25 \text{ sq. ft.} : x, \text{ or } 90 \text{ sq. ft.}$$

Again, as the power is the same in both, the velocity is also, and by the formula $\frac{q}{a}$ we find the velocity to be 250 cubic feet per minute. We have by the formula

$$\frac{q}{v}, \text{ or } \frac{22{,}500}{250} = 90 \text{ sq. ft.},$$

the same as before.

Yours, etc.,
L. P. H.

Avoca, Pa., Jan. 13th.

Ventilation.

Editor Colliery Engineer:

SIR:—Will some of your correspondents kindly explain the following facts:

A mine, drift opening, has the inlet and furnace on same level; the diameter of shaft being 6′, and depth 70′; area of inlet 6′ × 9′. Size of furnace: width 6′ from grate to arch 4′, arch 14′ long, and dip 24′ in 1200′. The intake goes down the dip and return air comes back parallel with intake but rising to same level when it reaches the furnace. With a good clear fire a volume of from 10,000 to 15,000 cubic feet is obtained. Another mine, also drift opening, has noa furnace or shaft, but a small fire-place built under a 20′ stack. The area of inlet is 5′ × 7′ and area of return airway 4′ × 5′. The rise being 30′ in 1200′. The intake air rises and return air comes down to same level as inlet. With a very small fire from 2500 to 4000 cubic feet of air can be obtained. Please explain fully why more air in proportion to amount of fire can be obtained in the mine in which the intake air rises. In both cases the air must travel against dips, in the first case the intake goes down the dip, and in the second case the return air comes down the dip.

Yours, etc.,
S. U. P.

Lawsonham, Pa., Jan. 15th.

IMPORTANT INFORMATION FOR STEAM USERS.

How Boilers May be Cheaply and Effectually Protected from Scale, Corrosion and Pitting.

The corrosion and pitting in steam boilers and deposition of mineral in form of scale is one of the greatest evils that steam users in general have to contend with, but more particularly does this problem confront the owners of mines, from the fact that in nearly every case the feed water contains, besides the usual amount of scale forming mineral, more or less sulphur, which at the ordinary boiler temperature is transformed into sulphuric acid. This acid is cumulative and having a somewhat greater specific gravity than water, usually finds its way to the lowest parts of the boiler or in such nooks and corners as have the least circulation. The destruction of steam boilers from this source is often very rapid and frequently takes place under a covering of scale, which hides the mischief until the boiler is nearly eaten through.

Much effort has been expended in devising ways and means to neutralize the effects of the acid. The prevalent idea has been to fight the acid with an alkali, but aside from the excessive cost there are a number of objections to setting up a chemical laboratory in a steam boiler. Foaming and the saponification of the oil used in the cylinders with the result of destroying the lubrication, are two objections of several we might mention. A most successful method of dealing with the problem of scale and corrosion and which has been adopted by many of the largest mining companies in the United States and Mexico, is by the use of a non-chemical compound, the base of which is a heavy natural oil having a vaporizing point in excess of the highest temperature of the boiler, thus preventing its evaporation with the steam. This oil is freed from the residuum products incident to all natural oils, which if allowed to enter the boiler, would unite with the mineral and form a substance resembling putty, infinitely worse in its effects than the ordinary scale.

This compound acts by coating the inside of the boiler in a manner so slight as to be scarcely perceptible, yet sufficient to prevent adhesion of mineral particles contained in the feed water and being proof against the action of the most violent acids, prevents them from attacking the metal. A letter from the engineer of the Paris [Tex.] Compress Co. states that four years ago they put in a new set of boilers, the old ones having been eaten up by the acid in the feed water while using the best known of the alkali compounds, to prevent such a result. The boilers were started with the petroleum compound described above and although the water is so bad as to turn a tin dipper into a sieve in three weeks use, there are no signs of any corrosion or pitting in the four years use and in that time they have evaporated 20% more water than when they were using the old boilers.

The individual atoms of scale forming mineral boiling up through this compound become coated with it and their tendency to crystalize or aggregate in the form of scale is prevented, and they are held in solution until the boiler can be emptied and washed out.

The cost of preserving and keeping boilers clean by this compound is but one third of that by any other method, and the cost is offset several times over in the saving of fuel to say nothing of repairs.

A pamphlet containing further particulars will be mailed free on application to the Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

[Among the large number of users of this compound are Carnegie Bros & Co., Oliver & Roberts Wire Co., Dilworth Porter & Co., of Pittsburgh, Pa.; Des Moines Edison Light Co., Des Moines, Iowa; Union Bridge Co., Athens, Pa.; Pottsville Iron & Steel Co., Pottsville, Pa.; etc., etc. These parties use the compound continuously, and the fact that it proves satisfactory to them, and saves them money by saving their boilers should be argument enough to induce all mine owners and superintendents having any trouble from corrosion and pitting of boilers to try a remedy that is so cheap and that has received the indorsement of many of the largest and most prominent steam users in America. Ed.]

The Acme Coal Drill.

One of the most successful hand coal and rock drills on the market is known as the Acme Drill, and is manufactured at the Peoria Coal Drill Works, Peoria, Ill.

Mr. James T. Johnson, the proprietor of the works, is the patentee of the drill. He informs us that he established his works in 1887, and that during the past five years, he has introduced his drill in every mining region of the West. It will drill a hole at any angle, and will do equally well in an 18 in. seam or a 20 ft. seam. It is light and handy, and can be worked easily with one hand. There are three kinds manufactured, and he is about introducing an improved drill with bearings in boxes that can be taken out and replaced, instead of replacing the box, which lessens the cost for repairs more than one-half. He claims this to be the most important improvement in coal drills yet made. He is also manufacturing coal-cutting machines and coal mining machines which will prove both effective and economical. When ready to place on the market, these machines will also be described and advertised in our columns. Descriptive pamphlets fully illustrating the Acme Drills will be sent free on application to the Peoria Coal Drill Works, Peoria, Ill.

The Stratton Separator Company, 32 Cortland Street New York City have recently furnished to the Columbian Iron Works & Dry Dock Co., of Baltimore, Md., several large separators for use in the new cruisers Nos. 9 and 10, which they are now constructing for the government. These separators are of the naval type especially constructed with steel shells and brass heads to meet the requirements of the United States navy.

THE WEATHER AND ANTHRACITE COAL.

A Measure of the Influence of Warm and Cold Winters Upon the Consumption of Anthracite Coal.

BY H. GAWTHROP, PHILADELPHIA.

[Written for The Colliery Engineer].

In every week's report of the coal trade, and every letter from local correspondents to the trade journals, for the greater part of the year, reference is made to the effect of temperature. As the mercury goes up, coal goes

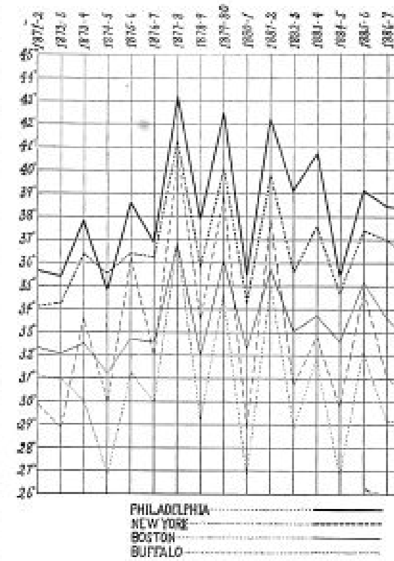


CHART NO. 1.

Mean Temperature of the five largest Cities for the six coldest months—November to April, inclusive.

down, and the reverse. Reference is more frequently made, of late years, to temperature, because buyers are content to let first hands carry the stocks, knowing that the coal can be had when they wish it, and at little difference in prices throughout the year, thus making the trade more sensitive to influences. Every cold wave causes an active demand which quickly falls off during the intervening warm spells. As the vast "areas" of "high" and "low" barometer and thermometer cross our so-called temperate zone many times in a month, the countenances of those engaged in the business are subjected to a lengthening and shortening process which, as most of them become used to it, affords a striking example of human endurance.

When we consider that for twenty years the government has recorded the temperature closer than ever before, it is reasonable that its influence on the consumption of coal should be measured, and at request, the writer will attempt the problem.

The yearly tonnage of Anthracite coal is chiefly influenced by three causes: (1). The increase because of the growth of the country in new houses and new manufactories, and by its substitution for other fuel, all of which for want of a better name, we will call the "normal increase". (2). The fluctuations by reason of the activity or depression of manufacturing industries,

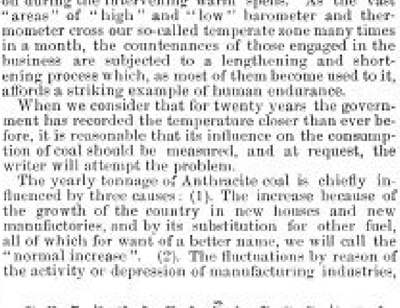


CHART NO. 2.

Average Mean Temperature for Six Months—November to April, inclusive, of Philadelphia, New York, Boston, Buffalo and Chicago for Twenty Years.

and (3) the variations of temperature. It is proposed to examine more particularly as to the influence last mentioned and to measure it, but the others must be considered incidentally.

The quantity of coal carried over on the first of January, from one year to another, is so small in comparison with the years' tonnage, that we are safe in considering the production of the mines, or rather the coal shipped from the mines, as being the same as the consumption, for the *difference* between the stock in first hands at one first of January, and another, is only about half a million tons, or three days production. Moreover we must have in mind, that, as a rule, when stocks are low in first hands, the dealers and consumers bins are full, and the reverse, so that practically there is little difference in the quantity of coal above ground at the close of the years.

Reference has been made to the similarity in the changes of the temperature at the five cities of Boston, New York, Philadelphia, Buffalo, and Chicago in the winter season. This is illustrated in Chart No. 1, and shows that we have to deal with a homogeneous condition of temperature in what may be considered the territory in which Anthracite coal is consumed. It is remarkable that it should be so, and simplifies our problem. Except in case of Chicago, it will be seen that there was only one crossing of the lines in the twenty years. That city was wayward for a time, but of late years, has kept lock step with the others.

The annual, seasonal and diurnal variations of temperature are so countless that it renews one's confidence in the fundamental causes governing climate to see the parallelism of temperatures shown in the Chart.

For our purpose, we will take the average mean temperature of the six coldest months for each of the twenty years, November to April inclusive, in the cities mentioned to see the effect of the changes upon the tonnage of the year following. In the twenty years there were thirteen years in which the winter season alternated cold and warm. At the commencement of the twenty years there was a cold period of four years, and at the close, as we all know, there has been a warm period of three years. In detail, the temperature and tonnage of the ten years, midway of the twenty, divided under head of cold winters and warm winters, as they were below or above the average temperature, were as follows:

COLD WINTERS.

1877.	Temperature of previous winter.....	33·5°.	20,828,179 tons.
1879.	Temperature of previous winter.....	33·7°.	26,142,689 tons.
1881.	Temperature of previous winter.....	31·5°.	28,500,017 tons.
1883.	Temperature of previous winter.....	33·4°.	31,793,027 tons.
1885.	Temperature of previous winter.....	31·3°.	31,623,530 tons.
	Average of five years.....	32·8°.	27,777,488 tons.

WARM WINTERS.

1878.	Temperature of previous winter	39·5°.	17,605,262 tons.
1880.	Temperature of previous winter	38·5°.	23,437,242 tons.
1882.	Temperature of previous winter	38·1°.	29,120,096 tons.
1884.	Temperature of previous winter	35·8°.	30,718,293 tons.
1886.	Temperature of previous winter	35·7°.	32,136,362 tons.
	Average of five years.....	37·5°.	26,603,451 tons.

The difference between the average of the two groups is 1,174,037 tons, but as the warm winters were one year later than the cold winters, there must be added to this the normal or average increase for a year. For our purpose, in this instance, we will take the average tonnage of the last ten years, 1882 to 1891 inclusive, 33,989,926 and deduct from it the average of the first ten years, 1872 to 1881 inclusive, 21,579,972 leaving 12,409,954 as the increase in ten years, the temperature of which we are considering. This method eliminates the influence of general business which, in a period of ten years, may be both good and bad. We thus find that the average for the ten years was 1,240,995 tons. This we add to the 1,174,037 and the result is 2,415,032 tons as the effect of temperature for one year. Fortunately we can test this roundabout process, for we have three other groups of ten years each. By summing up in the same way, the tonnage following five cold winters is found to be in excess of that for the five warm winters as follows:

Ten years 1875-1884..........	1,518,896 tons.
Ten years 1876-1885..........	3,901,107 tons.
Ten years 1877-1886..........	1,174,037 tons.
Ten years 1878-1887..........	3,536,695 tons.

To or from these results we must add or deduct the normal increase to find the effect of temperature for one year, accordingly as the warm winters follow the cold or the reverse, but as one condition offsets the other, the easiest way is to add the figures of the four groups and divide by four. The result is 2,032,661 tons, as the effect of temperature for one year.

We may consider from this that the result of our first process is conservative and proceed with it. The average temperature of the warm winters was 37·5°, and that of the cold winters 32·8°, the difference was 4·7°. If this range of temperature effected the product to the extent of 2,415,032 tons, as shown above, then the effect of one degree would be 513,836 tons. The average tonnage of the ten years, 1877 to 1886, during which we find this effect, was 27,190,470 tons. Hence we find that the influence for one degree of temperature was ·0189 per cent. of the tonnage. From our study of the subject and giving consideration to the result in the other groups, we feel warranted in claiming that the influence of temperature is two per cent. for every change of one degree in the cities named.

Now for the application. In the table below, opposite the year, will be found the average mean temperature of the five cities for the winter (or correctly speaking, the six coldest months); the variation from the average; the percentage at 2% for each degree, and the resultant effect on the tonnage.

nage of those years. Then the times improved until 1882, followed by the reaction which culminated in 1885. The effect of this reaction in business is strikingly shown in the transportation bulletins, recently issued by the Census Bureau. Then occurred the only break in the otherwise steady advance for the 10 years in railroad traffic. Anthracite in that year was evidently saved from serious depression by the previous

TABLE NO 1.—INFLUENCE OF TEMPERATURE.

November to April, inclusive of the years.	Average Mean Temperature of the five cities for six months.	Variation from average temperature.	Percentage at 2% for each degree.	To or from tonnage of years following the periods of temperature given:	
				Add.	Deduct.
1871-2	32·6°	— 2·3°	·046		995,338 tons.
1872-3	32·3°	— 2·6°	·052		1,049,290 tons.
1873-4	34·1°	— 0·8°	·016		317,246 tons.
1874-5	31·7°	— 3·2°	·064		1,185,712 tons.
1875-6	35·1°	+ 0·2°	·004	74,301 tons.	
1876-7	33·5°	— 1·4°	·028		567,304 tons.
1877-8	39·8°	+ 4·9°	·098	1,912,767 tons.	
1878-9	33·7°	— 1·2°	·024		630,390 tons.
1879-80	38·5°	+ 3·6°	·072	1,818,406 tons.	
1880-1	31·5°	— 3·4°	·068		1,814,608 tons.
1881-2	38·1°	+ 3·2°	·064	1,991,118 tons.	
1882-3	33·4°	— 1·5°	·03		926,011 tons.
1883-4	35·3°	+ 0·4°	·008	247,728 tons.	
1884-5	31·8°	— 3·1°	·062		1,846,195 tons.
1885-6	35·7°	+ 0·8°	·016	502,543 tons.	
1886-7	33·9°	— 1·0°	·02		679,236 tons.
1887-8	33·3°	— 1·6°	·032		1,182,833 tons.
1888-9	37·2°	+ 2·3°	·046	1,707,290 tons.	
1889-90	39·5°	+ 4·6°	·092	3,633,916 tons.	
1890-1	36·9°	+ 2·0°	·04	1,685,347 tons.	
Average	34·9°	2·2°	·044		

Attention is called to the fact that the average variation of the temperature was 2·2° and the range from 3·4° below to 4·9° above the normal temperature, or altogether 8·3°; and the average percentage of influence on the tonnage was ·044 with a range of ·166 per cent. This is one-sixth, and if applied to the present product represents an extreme influence from temperature of nearly seven million tons, a factor well worth considering.

In the next table, we give in the first column, the Anthracite product and in the second column the result of correction for temperature, reached by adding or deducting from the production the figures in the foregoing table.

TABLE NO. 2.—ANTHRACITE TONNAGE.

Years.	Production shipped from mines.	Corrected for temperature.
	Tons.	Tons.
1872	19,669,778	18,833,440
1873	21,227,952	20,178,662
1874	20,145,121	19,827,875
1875	19,712,472	18,526,760
1876	18,501,011	18,575,312
1877	20,828,179	20,260,875
1878	17,605,262	19,518,030
1879	26,142,689	25,529,970
1880	23,437,242	25,255,648
1881	28,500,017	26,685,409
1882	29,120,096	31,111,214
1883	31,793,027	30,867,016
1884	30,718,293	30,966,021
1885	31,623,530	29,777,335
1886	32,136,362	32,638,905
1887	34,641,018	33,961,782
1888	38,145,718	36,962,885
1889	35,407,710	37,115,000
1890	35,865,174	39,499,090
1891	40,448,336	42,133,683

In chart No. 2, the average monthly temperature of the five cities given above are shown by the heavy line drawn to the scale of degrees on the margin, and the average for the six months by the dotted line. Chart No. 3 exhibits the tonnage figures given in the table.

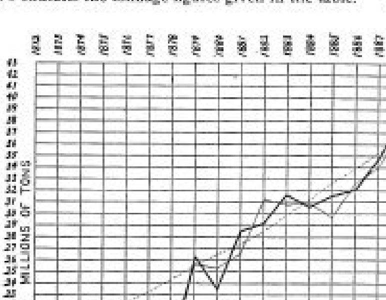


CHART NO. 3.

Glancing from one chart to the other, it can be seen that as the temperature goes up, the output, as shown by the heavy line in tonnage chart, falls off, and as the temperature goes down, the output increases.

If we are correct in our adjustment for temperature, the light line should in a general way, indicate the effect of activity or depression of general business. The long period of depression from 1873 to 1878, as shown by such tests as Dun's report of failures and the statistics of bank clearings, will account for the light ton-

cold winter. Since then the coal tonnage has had the benefit of the general activity only checked by the adverse winters.

Serious objections will be made to a correction for temperature which increases the normal tonnage so much above last year, the tonnage of which is considered so large, but we can make this further test. Early in our calculations we showed that grouping the first 10 years and the second 10 years, one year's average of the actual output was 1,240,995 tons. The last ten years averaged warmer than the first ten years. If the two groups of the output are corrected for temperature, the result of one year's average is 1,300,222 while the column "corrected for temperature," if tested in same manner by groups, shows an average normal increase of 1,308,227 tons.

Moreover the conditions in 1872 were in some respects, not unlike those of 1891. Both were years of steady work compared with other years, and each showed an increase of more than four million tons as compared with the year immediately preceding, but it will be claimed that the utilization of small sizes has swollen the tonnage of 1891. On the other hand in the year 1872, the use of the large sizes of Anthracite by the iron furnaces was much greater *in proportion* than now, Coke and Bituminous having been substituted.

A period of high temperature is a missionary era, when by reason of low price, and active competition, the trade is carried into new fields. No doubt there was some increase last year from this cause, but it, as well as the increase in quantity of the small sizes, is a phase of the normal increase as we have defined it and effects future years as well.

After some disappointment in prophesying as to temperature, we conclude that it is wise to adopt the advice of the philosopher, to predict only *after* the fact. Therefore the rule that we have reached will be available in May of each year. It is as follows:

For every degree of the average mean monthly temperature of the cities of Boston, New York, Philadelphia, Buffalo and Chicago, for the six months, November to April, inclusive below or above 34·9° (the average of twenty years), add or deduct two per cent. from the estimated normal output of Anthracite for the year. This result is subject to the effect of the activity or depression of general business.

There is now left the difficult problem to solve as to what the output will be in normal times and at normal temperature. The average increase of the column "corrected for temperature" is about 1,225,000 tons per year for the 19 years intervening from 1872 to 1891, but this represents the increase midway of the period or about 10 years ago, and will not do for either of the extremes, for there is a gain upon the gain each year to be considered. The above average gain is about four per cent. upon the average tonnage of the period and this is close to the ratio of increase.

In Chart No. 3, the dotted line represents an increase of 4½ per cent. compounded yearly, commencing with 18,833,440 tons in 1872, and ending with a tonnage of 41,028,884 in 1891. We are satisfied however that compounding upon the whole tonnage is not a correct ratio of increase but that it is somewhere between this and the average increase.

As a compromise, we offer a scale increased, one-half at the average of twenty years, and the other half at 4½ per cent. compounded annually. On this basis the estimate of the normal output is as follows:

1891	42,133,683 tons.
1892	43,681,500 "
1893	45,187,500 "
1894	46,773,000 "
1895	48,492,000 "
1896	50,161,000 "

The method may be questioned but the result has the merit of showing less increase than the last six years of actual output.

In the table showing effect of temperature, the calculation is so made that the percentage is upon the corrected-for-temperature tonnage, as being closer to the averages upon which the formula is based, than if taken upon the actual product, so that our rule is more closely applicable to such estimates as above.

The producer gets the credit in popular belief of controlling the business by combination, but it is evident that the struggle is to fit his supply to variations in demand to which no other business is subjected in like degree. Formerly Anthracite was mined primarily for both manufacturing and family use. Now it can almost be claimed that it is produced primarily for the family and secondarily (in the refuse sizes) for manufactures. Our conclusion is that the great uncombined consumer, through demand, regulates the output, and he in turn is largely influenced by the temperatures of the winters.

Mr. L. A. Gabanyi writes us that the first fire was lighted at the new furnace of the Allegheny Iron Company, Iron Gate, Va., on the 12th of January. This company was incorporated in 1890 and controls 3,500 acres of iron ore land (the ores are brown ore and red hematite ore ranging from 45% to 64%). The ore is partly mined and partly quarried. Four miles of three feet gauge railroad and two self-acting inclines are in course of construction. The furnace plant when completed will be one of the largest and best in the State, with an estimated daily capacity of from 150 to 200 tons of pig iron.

The Colliery Engineer.

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CONTRACT LABOR IN THE MINES.

LABOR Inspectors Conkling and Osborne, of New York City, who were recently detailed to report on violations of the alien contract law in the coal regions of Pennsylvania, have submitted their report to Secretary Foster, of the Treasury Department.

If the newspaper summary of this report is true, it is a tissue of falsehoods from beginning to end, and shows that the authors were never in the coal regions of Pennsylvania, or, if they were they are either gullible fools or deliberate falsifiers. No other excuse can be offered for such a report as they have submitted, and it is evident that they are unfitted for their positions and should be speedily replaced by men who will carefully investigate and truthfully report on this and kindred matters. Their statement that nine-tenths of the miners employed in the mines surrounding Scranton are Hungarians, Italians, and Slavs, is a falsehood of the first magnitude. Less that 10 per cent. of the men employed inside the mines, whether as miners or laborers, are of the three nationalities mentioned, and less than 5 per cent. of the miners in the Anthracite regions are Hungarians, Italians, or Slavs.

It is true that there are large numbers of Hungarians and Slavs employed on the surface and around the breaker as laborers, but that is because no other nationality will do the work, which is such that no skill is required. Operators and superintendents do not employ these nationalities from choice. They employ them because no other labor is available for the work they do. They were not brought here by the operators and coal companies, but came of their own accord at the solicitation of friends who had found employment in the mines, and who were sharp enough to see that the scarcity of unskilled labor, and the wages paid made desirable openings for their starving friends in Europe, and they urged them to come.

One statement of the report that particularly stamps the whole of it as untruthful and unreliable is the following:

"At the mines near Carbondale, in 1886 there were 600 miners, all American citizens. While the miners' strike was on in 1889 and 1890, large numbers of Slavs and Hungarians were brought to the mines from Castle Garden under the protection of Pinkerton's detectives. At the last election, out of 787 miners employed there were just 68 entitled to vote."

In the first place the number of miners employed in the mines near Carbondale greatly exceeds 600, and the same statement as to the proportion of Huns, Slavs, and Italians (less than 10 per cent.) applies here as well as at Scranton.

In the second place there was no strike in the Lackawanna region in 1889 and 1890, and no Pinkerton detectives were employed. There has been no strike of any magnitude in the entire northern coal field since 1877.

In this connection it is well to state that the Poles are an entirely different race than the Huns and Slavs. The Poles are naturally intelligent, and when they come to America they come to stay. They soon become Americanized, and it is safe to say that they will in time become as a class equally as prominent in business and politics as have any other race in this cosmopolitan nation.

A fair estimate of the proportions in which the various nationalities are employed in the Anthracite mines may be obtained by taking the classification of the workmen of the Phila. & Reading Coal & Iron Co. This company operates 61 collieries and employs 24,754 men and boys, of whom 9,709 are of foreign birth. Of the total number 4,718 are of American parentage, 6887 are of Irish birth or parentage, 4287 are of Polish birth or parentage, 3,709 are of German birth or parentage, 2,089 are of English birth or parentage, 1,466 are of Hungarian birth or parentage, 1,282 are of Welsh birth or parentage, 210 are of Scotch birth or parentage, 86 are of Italian birth or parentage, and 20 are French.

The above list comprises about 20 per cent. of the employes in the mines of the Anthracite region, and if each nationality's number be multiplied by 5, an approximate estimate of the nationality of all the mine workers in the Anthracite region may be arrived at. It is true that at individual collieries, there will be found wide divergences from these figures, but they are approximately correct for the whole region.

However, this must be said: The number of Hungarian, Slav, and Italian miners will increase each year, owing to the operation of the foolish "Miners' Examination Act" passed by the Pennsylvania Legislature in 1887. This act forbids the employment as miners in Anthracite mines of any man who has not worked at least two years as a laborer in such mines. No English, Welsh, Scotch, or German miner can emigrate to this country, and take employment in an Anthracite mine, no matter how skillful he may be, unless he performs the drudgery of a laborer for a laborer's pay for two years. This he will not do. No intelligent young man of American birth can become a miner, unless he complies with the same conditions. The ignorant Hun, Slav, or Italian, at the end of two years work as a laborer in the mines, can be certificated as a miner, and is certificated as such, even if, as is usually the case, he is fit for no other work than cleaning out ditches. The operators and superintendents, owing to lack of better material to draw from, will in time be compelled to employ them as miners or close the collieries.

A REWARD OF MERIT.

ALMOST every nation has some distinctive medal or cross which is conferred for eminent worth or noble conduct. Such medals of honor are seldom of any intrinsic value, their worth depending on the associations connected with them. The Victoria Cross of Great Britain is the great object of attainment with naval and military men, and any one from the general or admiral to the private soldier or sailor can gain this distinction by the performance of some act of individual heroism in battle.

The French Legion of Honor ribbon is conferred for bravery on land or sea and is also given to distinguished men of science, art, or letters.

It is to Queen Victoria however, that the credit is due of installing an order of heroes of quite another class. As the Victoria Cross is only given to military and naval men, the Albert Medal is reserved to civilians, and there is a large representation of mining men of all ranks in the roll-call of the order. The intrinsic value of this medal is almost *nil*, but it is a pleasing thing to have a distinctive badge for deeds of individual bravery in the industrial ranks. No man is a hero from mercenary motives. He acts generally on the spur of the moment and no money consideration can compensate him. In such a case a medal that can be worn is better than great riches.

Among other persons who enjoy the proud distinction of possessing the Albert Medal received for acts of heroism in connection with coal mining are A. H. Stokes, the Inspector of Mines, Derby, and Reuben Smallman, Mining Engineer, of Nuneaton, England. We should have such a badge of distinction in this country, as the opportunities for the display of heroism are just as frequent, and the number of heroes as great on this side of the Atlantic as on the other. If the establishment of such an order by the Government is contrary to American practice and precedent and therefore not advisable then it might be well to organize a society for the encouragement of heroism in the industrial walks of life and this society might at the same time provide the ambulance service in our mines, &c., which is so greatly needed.

EXTRAVAGANCE AT AMERICAN COLLIERIES.

THE time is rapidly approaching when the production of American coal and coke must of necessity be effected with greater economy than is now exercised. This will not be due to a scarcity of coal in the ground but to increased and aggressive competition in the markets. The time has already arrived when only those miners of coal, who either work under fortunate natural conditions, or who exercise strict economies succeed in securing a fair profit.

Americans are noted for their extravagances in both their domestic and business habits, but in no case is this extravagance more apparent than in our methods of mining coal and manufacturing coke.

In mining coal, entirely too much labor is performed by men and animal power. Mechanical appliances are cheaper in the long run, though their initial cost may seem high to the operator. Our system of conveying power from the steam plant to the machinery is also, as a rule, wasteful.

In the matter of underground haulage alone, hundreds of thousands of dollars are annually wasted at American mines by the use of mules in cases where the use of machinery would reduce the cost of haulage anywhere from twenty-five to seventy-five per cent.

In timbering our mines, valuable timber is wasted by being either poorly placed, placed where not necessary, or wasted in the cutting to sizes required.

Lubricants and oils are wasted by the use of wasteful lubricating appliances and slovenly habits on the part of oilers.

Tools are not taken care of and are rusted and ruined, if not lost, by being carelessly left lying around in out of the way places.

Rails in mine tracks are allowed to corrode and waste away when the use of a shovel in opening the ditch would drain off the acidulated water often covering and flowing over them.

Mules are worn out by being driven over muddy inside roads that could at a trifling cost be kept dry.

Lumber is allowed to rot in old brattices that are of no earthly use, instead of being taken out for use in some other place where brattices are necessary.

Steam pipe lines are put in that are of larger diameter than is necessary and the entire steam plant is larger than necessary because the value of good non-conducting steam pipe covering is not appreciated.

Machinery is allowed to run long after the necessity of important repairs is evident to every intelligent mechanic, and in the end a serious break-down resulting in infinitely more cost than timely repairs, is the result.

Duplicate parts of machinery are not kept in stock, and when an unavoidable breakdown occurs, the whole colliery is shut down until such parts can be secured from the machine shops. Decrepit and worn-out mine cars are sent in the mines, and when on the outward trip, loaded with coal, they give out, vexatious and expensive delays are the result.

The mine tracks are not kept in good order, and the result is frequent delays caused by mine cars jumping the track, and frequently making matters still worse by knocking out timbers.

In fact there are "a hundred and one" places in which economies at American coal mines can be practiced with good results.

Some of these economies may make necessary the initial expenditure of a little money, but they will pay in the long run.

This extravagant method of doing things is the natural result of the phenomenally profitable coal business of a quarter of a century ago, when the producing fields were few and the markets demanded more than could be supplied. But this is not the case now. New fields are constantly being developed and the production keeps well apace with the demand. The coal that can be placed in the market at the lowest price is the coal that as a rule is purchased by consumers. Therefore it is essential that the cost of production must be lowered if profits are to be realized on the mining. This lowering of cost cannot be effected by slovenly management and wasteful habits.

In coke making we are especially wasteful. None of the by-products are saved at American coke works. If they were saved they would materially add to the income derived from the coke plant and thus lessen the cost of the production of coke.

This matter of greater economy at collieries is not a matter for future consideration. It is a matter for immediate consideration, and the operator or colliery manager who first adopts and carries out a systematic plan of economizing in every detail, great or small, is the man who will reap the profits so ardently wished for, but often unreached by the majority of colliery owners of to-day.

THE McALESTER DISASTER.

IN another column we publish a description of the Osage Coal and Mining Co.'s Mine No. 11, which was the scene of an explosion on January 7th that resulted in the death of 56 men, and the injury of 120 more. For the excellent description and drawings illustrating the scene of the disaster, we are indebted to the engineer of the company, Mr. W. Farnham.

Mr. Farnham shows in his article that the officers of the Osage Co. paid more than usual attention to the dangers attending the presence of coal-dust, by damping the roadways. The fact that this was done leads some of the committee, that inspected the mine and inquired into the cause of the accident, to think that the explosion was not extended by dust, because the floors of the entries and rooms were damped. But, the damping of the floors is not sufficient to overcome the dangers incident to the presence of coal-dust in the mine. The danger still remains, unless the dust is either swept from the sides and roof, or thoroughly saturated by water sprayed on it.

That the primal cause of the accident was a blown-out or "windy" shot is certain, and that this was due to disregard of the rules of the company is also certain. But the cause of the explosion extending over so large an area of workings is not so clear, unless the sides and roof contained large quantities of dry dust.

That the coal-dusts containing high percentages of volatile hydro-carbons are explosive is a settled fact. They not only intensify the initial explosion, but they may be the primal cause of the explosion. Therefore, it will pay colliery officials to pay just as much attention to its complete removal or complete damping, as they do to the removal of explosive gas. Till this fact is recognized by colliery owners and colliery officials, in all regions producing Bituminous coal, immunity from widespread and disastrous explosions cannot be obtained.

Indeed, in the light of the investigations made during the past few years, it is doubtful if any of the large explosions that extended over large areas in the coal mines of America or Europe can truthfully be charged entirely to gas. If the gas alone was a factor, the explosions would be confined to comparatively small areas. Dust is the factor that extends them, even when originated by gas, and it should be removed so as to add to the security of both the workmen and the colliery.

This explosion is remarkable in that so many persons who were injured escaped with their lives. As a rule, in extensive mine explosions, those who are uninjured by the explosion afterwards die from the effects of the after-damp which frequently kills many who are not burned or otherwise injured. Many so lost their lives in this instance, but many escaped, and this was probably due to the fact that the ventilation was not interrupted. As appears from the report the fan was not stopped by the explosion and its speed was increased immediately after it occurred. The noxious gasses resulting from the explosion were thus carried off in the ventilation and the injured had pure air to breathe until they were rescued or escaped from the workings themselves. The officers of the mine merit commendation because they had provided an extra fan to use in case the other should be disabled. Fortunately, the running fan was not disabled on this occasion, but if it had been, there was one in place to do its work. Mr. Cameron, the superintendent, did the right thing at the right time when, after the explosion occurred, he at once increased the speed of the fan, and we think the precaution taken to provide against accident previous to the explosion and his conduct when the disaster occurred proved him to be the right man in the right place.

EDITORIAL NOTES.

THE difficulty experienced by the mine inspectors in enforcing the mine law has again been illustrated in the Lackawanna County courts, by the disagreement of the jury in the case of the Commonwealth vs. James Smith, on the 29th ult. Smith was prosecuted by Inspector McDonald for firing a shot in a narrow pillar without warning the men employed in the adjoining chamber, one of whom was killed and the other injured. A clear case was made against him, and his own evidence showed his guilt, but the jury failed to agree after being out twenty-four hours, and it was accordingly discharged. If a few such violations of the mine law as Smith was guilty of, could be punished, the law would be found much more effective in saving life in the mines. A false notion of sympathy prevents the average jury from convicting the *poor miner* guilty of a violation of the law, but it forgets the hundreds of other poor miners whose lives are jeopardized by such actions as Smith's was.

MR. Wm. Griffith, Inspector of Mines for the Second Mining District for the State of Washington, sends us the following statistics for his district for the year ending December 31, 1891: Amount of coal produced, 287,513 tons; number of men employed, 674; number of boys employed, 20; number of persons killed by accidents in the mine, 6; number of persons injured, 1.

THE COAL TRADE

The Anthracite Trade.

During the past month, the Anthracite trade had several days of demoralization due to the cut of fifty cents per ton in prices, made by the Lehigh and Wilkes-Barre Coal Co. The other interests immediately met the reduction, but none seemed anxious to secure orders at the cut rate. On the 28th ult. the sales-agents of the various companies met in New York, and harmony was restored by an advance of twenty-five cents on the Lehigh and Wilkes-Barre circular prices, making them f. o. b. tide water as follows, with twenty cents per ton added alongside in New York: Broken, $3.45; egg, $3.60; stove, $3.75; and chestnut, $3.25. The output for February was placed at 2,500,000 tons. The allotment question will soon come up, and this may make some trouble. It came up at a meeting of the sales-agents during the month, but was laid on the table as a question with which that body was not competent to deal. It will be settled by higher powers if settled at all, and that in the near future.

The new prices took effect on the 28th, immediately after adoption, and they will be strictly adhered to. The action of the agents meets the approval of everybody in the trade, except the retailers who failed to profit by the low prices prevailing for the week previous to the meeting.

A meeting of the general freight agents of the Anthracite carrying roads, called by the Lehigh Valley Railroad Co., was held on the morning of the 28th to consider the question of east bound freights on Anthracite coal. The meeting was called to consider a reduction so as to enable the individual operators, who claimed to be oppressed, to realize a profit on their shipments. But as the meeting evidently had some knowledge of the subsequent action of the sales-agents, nothing was done in the way of a reduction of tolls, and the meeting adjourned for two weeks. The general outlook for the Anthracite trade is very fair and, if there is no war over the allotment question, the prospects are that business will be comparatively brisk for this season of the year.

The Bituminous Trade.

The Bituminous trade is dull. The new business offering is light and the supply on hand is comparatively large. The cold weather has not had much effect on the demand and what little extra demand there is can be easily supplied from stocks on hand. Prices, however, are about as low as they will go, and there will, no doubt, soon be an increased demand and prices will advance. Most of the demand now is for coal contracted for some months ago.

The Coke Trade.

The coke trade shows no change and prices remain the same as they have for months past. In the Connellsville region about 83% of the ovens are in blast, and they are running on an average of about five days per week. Prices are well maintained at the same figures as have been quoted for the past year. *The Connellsville Courier*, which makes a specialty of local coke news states in its last issue that "the outlook for a good business in 1892 grows brighter."

MINING ENGINEERS OF OHIO.

The Annual Meeting of the Ohio Institute of Mining Engineers.

The Twelfth Annual Meeting of the Ohio Institute of Mining Engineers was held in Celtic Hall, Columbus, Ohio, January 21 and 22, 1892. The meeting was well attended and the following papers were read:

1. The Coal Seams of Jackson County, by Hon. Andrew Roy.
2. The use of the Prismatic Compass in Mine Surveying, by E. D. Wileman.
3. The Necessity of Making Break-throughs Even and Uniform at the Mines, by James W. Haughee.
4. Mining Limestone by Underground Instead of Open Quarry Work, by E. B. Willard.
5. Comparison of the Composition of Certain Coals with their Evaporating Powers in Locomotive Boilers, by Prof. N. W. Lord.
6. The Original Members of the Institute, by J. L. Morris.
7. Improved Methods of Mining, by Mr. Jos. W. Blower.
8. Split Air Courses vs. Continuous Currents in Mine Ventilation, by Prof. F. W. Speer.
9. The Harrison County Oil Fields, by Wm. B. Hanlon.
10. The Wasteful Methods being Practiced in Mining Coal in Ohio, by Inspector R. M. Hazeltine.

A resolution was adopted tendering Dr. Edward Orton, State Geologist, the sympathy of the Institute in his present affliction.

The summer meeting of the Institute will be held in West Virginia.

The following officers were elected for the ensuing year:

President, Mr. A. Howells; Vice-President, Prof. N. W. Lord; Secretary, and Treasurer, R. M. Hazeltine; Executive Board, Hon. A. Roy, Prof. F. W. Speer, and Capt. J. L. Morris.

The meeting was one of the most interesting ever held by the Institute. Profs. Lord and Speer, of the School of Mines of the State University, gave the students a holiday on Friday afternoon and many of them were present at that session of the Institute. The members of the Institute also visited the Mining School and many of them expressed much satisfaction at its growth and development. There are more students studying mining in the University of Ohio now than any other branch of education.

ANTHRACITE COAL STATISTICS.

Statement of shipments of Anthracite coal for month of Dec., 1891, compared with the corresponding period last year. Compiled from the returns furnished by the Mine Operators.

	December, 1891.	December, 1890.	Difference.		For Year 1891.	For Year 1890.	Difference.	
From Wyoming Region,	1,885,041·05	1,672,748·12	Inc.	212,292·13	21,325,239·18	18,657,694·14	Inc.	2,667,545·04
From Lehigh Region,	581,389·12	487,209·15	Inc.	94,179·17	6,381,838·08	6,329,658·07	Inc.	52,180·01
From Schuylkill Region,	1,121,540·16	905,249·19	Inc.	216,290·17	12,741,258·05	10,867,821·18	Inc.	1,873,436,07
Total	3,587,971·13	3,065,208·06	Inc.	522,763·07	40,448,336·11	35,855,174·19	Inc.	4,593,161·12

The stock of coal on hand at tide-water shipping points, December 31, 1891, was 754,432 tons; on November 30, 1891, 637,846 tons; increase, 116,586 tons.

Of the total product in 1891, 52·72 per cent. was from the Wyoming Region; 15·78 per cent. from the Lehigh Region, and 31·50 per cent. from the Schuylkill Region.

Eastern competitive tonnage, including all coal which for final consumption or in transit, reaches any point on the Hudson River or the Bay of New York, or which passes out of the capes of the Delaware.

1890 .... 11,799,317 tons.
1891 .... 12,313,719 tons.

AN ELEMENTARY TREATISE ON THE PRINCIPLES OF COAL MINING.

For the Use of Candidates for Mine-Foremen's Certificates, Mining Students, Mine-Foremen, Mine-Superintendents, Mining-Engineers, etc.

BY A. A. ATKINSON, DURHAM, ENG.

Methods of Working.

Passing on from the subject of ventilation we will now consider some of the different methods of working coal, and the bord and pillar system will be noticed first. The following description of this mode is in practice at a colliery in the North of England with which the writer is acquainted, and it will be treated under two heads:

First. The method of working, including proportionate costs of the different methods and classes of labor connected with them.

Second. Ventilation, describing how the air is coursed round the mine in the whole and broken workings.

GENERAL REMARKS.

The system of pillar and bord working was introduced at this colliery some years ago, and since that time a large number of pillars have been formed and removed by the different methods without any accident of a serious nature, and with a mere trifling loss of coal; therefore it may be justly considered that a system has been hit upon to suit the working of each district. The Hutton Seam is the one under consideration and here lies at 54 fathoms from the surface at the shaft, and the dip which is to the North and West does not affect the working; but the greatest irregularities are caused by "swellies," or sudden depressions of the seam, it again rising ultimately to its former level at some distance. These depressions cause considerable annoyance in consequence of water lodging in them. Faults are not large or numerous and have a bearing North-West and South-East.

The roof varies in each district and is intersected by "backs" or "slips" which give much trouble; their general bearing is about parallel to the line of faults, and should a lift of coal come to stand any length of time in some districts the roof is apt to break off at the face, more especially if near one of these backs or slips.

The following is a general section of the roof:

Ironstone girdles	0′ 1½″
Blue metal shale	0′ 9″
Post girdle sandstone	0′ 3½″
Blue Metal	1′ 9″
Ironstone girdles	0′ 2″
Blue metal	0′ 9″
	3′ 1″

The average thickness of the seam is 3′ 6″ and it is a household coal. The nature of the coal varies somewhat, being generally found harder to the West and North or dip side. It may be remarked that the present output is from the two East districts where it is tender and the system of taking the pillars out to the best advantage cannot be employed.

METHOD OF WORKING.

It has been considered judicious that panel barriers of solid coal 22 yards thick should be left about 330 yards apart, or 165 yards on each side of the wagon-way bord; these are for the purpose of dividing the pit into districts, and possess the following advantages:

First. Should an explosion occur in the district, it may not communicate with any of the other districts by having them so isolated.

Second. Naked lights may be used in the "whole mine," by splitting the air at the face of the main intake and carrying it along the face before allowing it to ventilate the broken and waste or goaf.

The panels at this colliery were laid out with a view to exceed the "putting rank" as little as possible (which for hand-putting the first rank is 80 yards), but at the same time to leave sufficient coal for the "broken working." The method of following up the whole with the broken is adopted, and requires three sheaths of bords on either side of the wagon-way to keep it good.

The size of the pillars depends on the following circumstances:

First. Thickness of cover or depth from the surface.

Second. Nature of the roof and bottom.

Third. Quality of the coal—hard or soft.

Should the size of the pillars determined on be too small the effect upon the "whole" or "broken mine" will be very different: in the "whole," little or no effect will be experienced; but in the "broken" the coal will be crushed, yielding but a small percentage of round coal and a heavy cost in timber as well as in clearing away falls of roof-stone.

The advantage of a large pillar is evidently giving a better support to the roof, the cost of timber is reduced, and when the pillars are being worked off fewer last lifts occur which reduces the risk of loss. Care was taken when fixing the size for the pillars at this colliery to meet the known circumstances. The rectangular form of figure was preferred so that most of the coal might be taken off bordway course.

The pillars are 31 yards bordway course by 18 yards headway course and contain 0·115 of an acre, thus yielding:

Tons of coal at 3′ 0″ thick	540
Tons of bottom coal at 6″ thick	90
	630

OPENING OUT THE COAL.

Three headways are driven abreast in the direction of the cleat (N. 13° W.) for the purpose of winning the coal. The middle headway serves as a main intake for the air and wagon-way, along which from the different off-takes, the coal is brought to the shaft. The back headways act as the return and traveling road for the workings on each side of the wagon-way. Holings are made at every 44 yards; this distance requires fewer stoppings and less narrow work (stenton price) over the whole length of way. The thickness of pillars between the headways is 18 yards.

The main wagon-way bord is turned out of the headway course by driving a gentle curve till it cuts the course of the bords, which are driven N. 77° E. in the middle of the panel.

This has the advantage of bringing the coal worked from each side out by one way, thus reducing the cost of making another horse road and separates the putting.

The panel is further opened out by driving a set or sheath of bords, viz., seven on either side of the wagon-way bord, the seventh being the panel or barrier bord. When the bords have reached a distance of thirty-three yards walls are turned out of them from either side.

After the working face of the sheath of bords has reached seven pillars from the wagon-way head-ways, the broken working may be commenced: the working face should always be not less than three pillars in advance of the broken.

The wagon-way bord is supported by whole pillars on either side of it, so that it may not be crushed by the extra weight thrown on to it; they also keep the return air-ways in a better condition.

After the broken has been worked up to the boundary, the remaining pillars are worked off outbye over.

The largest output worked from a district by this system is 250 tons per day of 10 hours, and requires the following labor:

Class of Labor.	Number of Hands.	Rate of wages in U. S. Money per day.	Amount.	Cost per Ton.
Hewers: Whole Mine	36	$1.944	$69·98	$.436
Broken Mine	20	1.944	38.88	
Hand Putters	10	1.73	17.30	.068
Deputies	3	2.03	6.09	.024
Drivers	1	.54	.54	.015
Flatters	1	.54	.54	
Switch Keeper	1	.46	.46	
Landing Boy	1	.59	.59	
Wagonway-man	1	1.46	1.46	
	74		135.84	.543

the bottom of the old whole pillar. The last of the pillar is generally taken off by holing into the headway in the middle of the lift and working back to the bords with a wedge-shaped piece of coal. The chocks are drawn out and the roof is allowed to break off at the chocks in the headway course.

The proportion of round coal obtained by this method is much larger than by any other method of taking out pillars at this colliery. At a neighboring colliery it is stated that upwards of 60% of round coal is obtained by the same method.

The chocks used are of oak wood 24″ and 22″ long by 5″ square, the number of nobs in each chock in this seam being fifteen, each nob costing about ten cents, so that the cost of each chock is about $1.50.

In setting it is necessary to so fix them that in drawing them they may not fall towards the goaf, thus running the risk of being lost. They are set in the following manner: The first tier of nobs are set on the bottom at one end, the opposite ends being on the nobs in the second tier, one nob being set forward five inches from the goaf side. In drawing one of the bottom chocks is kirved out and the remainder knocked out with a mall or hammer, a few smart blows will generally throw the remaining part of the chock forward.

NO. 2 METHOD.—DOWN THE OLD BORD.

This method is generally adopted when the old bord has not fallen. It stands most favorably at this colliery as compared with the cost of working. The tram-road is laid out of the going headway down one side of the pillar. Then a wall twenty-two yards from the headway is driven across the pillar, and a lift is turned away five yards wide and worked up to the goaf nine yards from the wall. As soon as the lift is done the timber is drawn out by the deputies who are paid days' wages, and nothing extra is paid for overtime; it is to their benefit to try and get the lift finished during working hours. The roof generally subsides immediately, and is supposed to fall about five fathoms up to some post-stone. By this method one and sometimes two men can work in a lift, and it generally takes about seven weeks to work out a pillar. The narrow-work in one of these pillars is 2 split-walls twenty-three yards long and nine feet wide at $ ·243 per yard = $5.59.

The average quantity of timber required to work off one pillar by the old bord method is:

	Old Bord.	Split Walls.	Lifts.
Props	80	38	60
Crowns	30	13	30
Chocks	3		

SCHEDULE OF HEWING PRICES.

Description of Work.	Price.	Remarks.
Hewing—Whole Mine	$3·29	Per XX.
Hewing—Broken Mine	2.89	"
ALLOWANCE.		
Hewing—Double	·24	"
Hewing—Wet	·14	"
Hewing—Ramble	·11	"
Hewing—Bottom	·14	"
Hewing—Yard Work: Cross-cuts 7 feet wide	·44	Per Yard.
Hewing—Winning Headways 7 feet wide	·46	"
Hewing—Winning Walls 7 feet wide	·43	"
Hewing—Winning Walls 9 feet wide	·32	"
Hewing—Bords 6 feet wide	·27	"
Hewing—Bords 7 feet wide	·24	"
Hewing—Bords 9 feet wide	·16	"
Hewing—Splitting Walls 6 feet wide	·24	"
Hewing—Jenkin Fast	·11	"
Hewing—Jenkin Loose	·08	"
Hewing—Side Coal	·11	"
Hewing—Skirting 6 feet wide	·08	"
Hewing—Jenkin 9 feet wide	·11	"
Hewing—Holing Round Stooks	·14	"
Hewing—Splitting Walls in Broken	·19	"
Hand-Putters	·43	Per XX.

Per X X means a score of 21 tubs.
In Hand-Putting the first rank is 80 yards.

NO. 3 METHOD.—REMOVING PILLAR BY HALF-PILLAR WALLS AND JENKINS.

This method has been proved to be safest and best for removing the pillar where the stone is bad, although it requires more narrow work than the former method and the cost of taking the pillar off will compare favorably with it: this may be accounted for by the removal being effected in much shorter time, in this case about three weeks sooner.

The pillar is split by a Jenkin 3 yards wide driven 22 yards down the pillar, so as to leave 9 yards of coal for the bottom end lifts, and right and left half-pillar walls are either driven over singly or simultaneously as pit room may be required. The pillar is then removed taking the lifts off as numbered in the accompanying sketch:

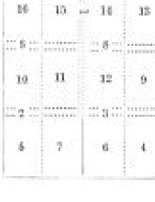


TABLE SHOWING COST PER TON ON WORKING THE BROKEN AS DESCRIBED.

No. of Pay.	Hewing.				Off-hand Labor.					Total Hewing and Off-hand Labor.	Cost of Shift Work.	Total Cost.	Tons of Coal Worked in the Broken.
	Hewing.	Yard Work.	Consideration.	Total.	Putting and Driving.	Overmen and Deputies	Pumping Water.	Sundries.	Total Off-hand Labor.				
7	$·32	·022	·017	·359	·034	·06	·009	·068	·191	·55	·037	·587	800
8	·27	·021	·027	·318	·06	·057	·01	·092	·219	·537	·047	·584	978
9	·27	·01	·03	·31	·052	·059	·01	·074	·195	·505	·04	·545	1027
Average	·29	·017	·025	·329	·055	·059	·0097	·078	·20	·53	·041	·572	935

NO. 1 METHOD.—REMOVING PILLARS BY LONGWALL.

This method, under suitable circumstances, is the best and cheapest; it requires little narrow-work, and the pillar can be worked off sooner, as four men can be placed in each.

The first broken was worked by this method in the First South-East District, but it was not a great success owing to the roof breaking off short and the bottom being soft and wet, which has the following section:

Fire-Clay	1′ 3″	
Bottom Coal	5″	
Fire-Clay	3′ 6″	5′ 2″

The pillars are taken off bordways course in two lifts face on nine yards wide. The tramway to each lift is turned out of the going headway down the old bord and along the face, there being a separate tramway with a row of chocks between to each lift. Two rows or tiers of chocks, each consisting of fifteen nobs, or pieces of wood, are set off and on about two feet from the face. Props are used next to the face if required. As the face advances the back chocks are drawn out and re-set in front of the first row, allowing the roof to fall. When the last lift is being taken off, the flat is moved a pillar higher up and the old headway course double-chocked, leaving room for the tramway next to

Nos. 1, 2, 3, 8, and 8 being narrow work, and the other numbers represent the lifts in the order in which they are removed, after 1, 2, and 3 are driven lift 4 is then taken off, and after drawing the timber out lift 5 is taken off; Nos. 6 and 7 are then removed, the latter being a loose lift. Walls 8 are then driven and lifts 9, 10, and 11 are taken off down to the old walls 2 and 3, which is now goafed. When lift 12 is being removed a stook is left at the corner, and the old bord-room chocked. Lifts 13, 14, 15, and 16 are removed from the going headways. A stook is also left at the outbye corner of lifts 14 and 16 to keep the outcome good. In this method lifts are divided into

Fast Lifts	4, 5, 6, 9, 10, 13, and 15
Loose Lifts	7, 11, 12, 14, and 16.

Narrow work in removing one pillar:

Jenkins 22 yards @ $·11	$ 2.42
Split-Work 32 yards @ $·243	7.80
	$10.22

TIMBER REQUIRED FOR ONE PILLAR.

	Walls.	Jenkins.	Lifts.	Total.
Props	60	80	60	200
Crowns	20	30	30	80
Chocks (for bordrooms)			3	3

The cost of narrow-work is sometimes further reduced by driving the two top walls 8 8 only over the width of one lift either way. The lifts are then taken off in the following order: First lift 4 is taken off and the timber drawn out. Lift 9 is then turned out of the opposite side of the wall. Lifts 5 and 10 are then taken off in similar manner. Lifts 6 and 7 are next removed. In order to remove lifts 12 and 11 (12 first) the short wall 8 is only driven over the width of each lift. Lifts 13, 14, 15, and 16 are removed from the headways same as in the previous method.

The narrow-work in this case is

Jenkins, 22 yards at $.11	$2.42
Split Walls, 24 yards at $.243	5.83
	$8.25

This is equivalent to a saving of 19 per cent. on the previous narrow-work, or about $·0026 per ton on the whole pillar of coal.

NO. 4 METHOD.—REMOVING PILLAR BY HEADWAY LIFTS.

The middle of the pillar in this case is removed by taking it off headways course, and although there is a considerable saving in yard work, yet the quantity of round coal is greatly reduced so that it cannot be recommended on this point.

COST OF NARROW WORK.

	Walls.	Jenkins.	Total.	Cost per ton.
No. 1 Method				
No. 2 Method	5·59		5·59	.01
No. 3 Method	7·77	2·37	10·15	.019
No. 4 Method	5·83	2·37	8.20	.015

In No. 4 method a jenkin is first driven down the middle of the pillar distance of 22 yards and a wall set away right and left at this point, each going to the old bord on either side of the pillar; then the 4 bottom lifts are taken off in the same order as previously described by the sketch. The middle portion of the pillar is next taken off by driving four lifts headways course, two lifts on either side of the first jenkin. These headways lifts require extra timber on the goaf side, as the roof stone is more open. Then the last four lifts are taken off in the same manner and order as given in the sketch.

VENTILATION.

The ventilation at this colliery is produced by a Schiele fan, centrifugal in action and 5 feet diameter. Depth of upcast shaft is 70 yards. The guarantee of the maker of the fan was:

Cubic feet of air per minute	50,000
Revolutions of fan	400
Water-gauge	1"

The results were satisfactory as the full quantity was obtained with $\frac{7}{8}$ of an inch of water-gauge.

The fan is driven by a double cylindered horizontal engine which was purchased at a cost of about $1,000 and is of the following dimensions:

Diameter of cylinders	12"
Length of stroke	18"
Revolutions per minute	40

The H. P. developed as shown at the test experiments was 32.

The intake air after leaving the downcast pit is taken in one main current of 24,000 cu. ft. per minute along the North wagonway till it reaches the first split at the first East and West Way Ends; it proceeds from this point in a current of 15,600 cu. ft. to the face of the North Headways. After airing the whole workings in the Far North, it is again split, part returning along the West side, and the remaining portion which is the greater, along the East side. Wood doors are placed in the second East and West Ways to bear up the air coming back from the Far North round the workings in those districts. Following the course of the East side current after it enters the second East panel, it is sheathed up to the face, there being no "broken" on this side; it then crosses to the right-hand side "whole" workings and after being coursed along three headways is carried around the broken workings and thence into the return. The quantities of air are proportioned according to the number of men, acreage of goaf, etc., which they have to pass, being so regulated by "regulators" placed in the returns.

GLOSSARY.

"WHOLE MINE."—Any section of the mine which has been divided up into pillars but in which the pillars have not been taken out.

"BROKEN MINE."—Any section of the mine where the pillars are in course of being taken out.

"PUTTING BANK."—The distance over which the "putters" or "trolley-boys" have to run the cars from the working place to the point where they are taken up by the general haulage.

DIRECTION OF CLEAT.—The line of cleavage of the coal.

STENTON PRICE.—The price paid for stentons or narrow cross-cuts connecting parallel headings.

OUTBYE OVER.—Commencing at the innermost end of the mine and extracting the coal backwards towards the shaft.

DEPUTIES.—Assistant mine foremen or fire-bosses.

KIRVED OUT.—Hacked out.

JENKIN.—A broad heading cut down the center of a pillar to give more room for working while extracting it.

STOOK.—A small pillar of coal left in at the outbye corner when a large pillar is being taken out to maintain a way of egress.

TUBS.—Small coal cars carrying about $\frac{3}{4}$ of a ton.

CROWNS.—Roof timber.

SWELLEY.—A thickening out of a seam of coal over a limited area.

BACKS.—Cracks or fissures in the solid coal running from roof to floor by which the coal readily parts.

FLATTERS.—Boys who work on the main road, greasing cars, etc.

WALLS.—Coal faces.

HEADWAYS.—Headings.

REPORTS OF INSPECTORS OF MINES.

Kentucky.

The eighth annual report, dated October 10, 1891, has just been issued by Mr. C. J. Norwood, the Inspector. Throughout the State of Kentucky there are innumerable small pits or banks scattered through both the Bituminous and Cannel coal fields, and with the facilities at the disposal of the inspector it is impossible to determine the tonnage raised at these or to obtain particulars of the accidents which occur at them. The figures which are given in the report are therefore confined to the operations of the larger companies and private operators.

The total quantity of coal raised during the six months ending June 30, 1891, was:

Bituminous	1,373,665 tons.
Cannel	20,244 tons.
	1,393,909 tons.

The average number of employes for this output was 6,208, and the number of mines at work was 88.

There are 259 bee-hive ovens in the state for making coke. The total quantity produced during the six months ending June 30, 1891, was 9,766 tons.

There are 57 mining machines in the state, 6 of which are worked by electricity and the others by compressed air.

Mr. Norwood devotes a chapter to notes on ventilation, etc., and in it he embodies many hints of a practical and useful character. Speaking of air-ways he speaks strongly of the necessity for maintaining them free of obstruction so that the air may not be impeded. "As the strength of a chain is determined by its weakest link, so is the capacity of an air passage limited by its smallest area."

Attention is also drawn to the expression so common amongst mining men when the flame of a candle or lamp is sharply deflected by the current. It is then said that there is "good air."

But Mr. Norwood points out that while there may be the regulation total quantity of air passing down the downcast to equal 100 cubic feet per minute per person employed there is not always *a proper distribution* of the air to ensure every man receiving his quantity.

An electric mine haulage has been installed at Hecla Mine to haul the coal over a distance of 5,000 feet.

Mr. Norwood devotes considerable space to the question of coal washing. There are two coal washing plants in the State—at Lily and Earlington.

The Lily plant is erected for the purpose of separating the slack and dust from the small coals.

The smaller coals produced in process of screening lump is passed into a receptacle from which they are raised (nut, pea, and slack all mixed) by elevator buckets, and dropped into a chute by which they pass to the washer. Then the heavier impurities, such as iron pyrites, are separated, dropping to the bottom, while the lighter coal, dust, and slate pass over the rim to a revolving cylinder of network of an ever increasing size of mesh. The dust and fine coal drop through the first length of this revolving screen, the pea passes through the next length of mesh, and so on according to the various sizes of coal required. A description of a coal washer in somewhat similar principles is given in THE COLLIERY ENGINEER for July, 1890, page 268.

The coal washing plant of The St. Bernard Coal Co., at Earlington, is described in the report of Mr. Frank Cawley, mechanical engineer. The machine used here is a patent of Prof. A. C. Campbell, of Nashville, and the following is a short description of its action:

The machine or table as it is called, is 8 to 10 feet long by 30 inches wide. The bottom is made of No. 20 galvanized iron and the sides of ash or oak. Above the bottom is another sheet of iron of same size and gauge which is called the "false bottom." This is perforated with peculiarly shaped slots, and is held about a quarter of an inch from the first or true bottom by strips. These bottoms have a peculiar curvature, which, by experiment, has been found necessary to give the best efficiency.

This table is suspended or supported, as the case may be, on hangers from above or rockers from below, which allow it to move endways through from three to six inches, at the end of which stroke it strikes a percussion post, firmly braced to receive the blow, and so arranged that the strains are all transmitted vertically to the building. Water is supplied to the table between bottoms and by two spray-pipes, one at head or percussion end, and the other just in front of the coal feed or two and a half feet from that end. An inch pipe under from ten to twenty feet of head will supply water for one table. Motion is given these tables by a combination of cams, rockers, and levers of a peculiar nature. The required motion being to move the table back from the percussion post with a slow and gentle movement, and return to it with a movement, slow at first, but increasing rapidly in velocity until the moment of percussion.

The principle on which the table operates is that during the slow backward movement the slack coal is slightly moved and jarred, and the impurities, which are heavier than the coal, are thus caused to form a layer next the perforated sheet. Water flowing through the perforations of the sheet aids this separation, and the return or percussion movement still further carries it on. On this portion of the stroke all the work of entirely separating the impurities from the coal is done, for it is the rapid forward movement that carries away the impurities sticking to the bottom of the table while the coal is forced to remain stationary, or nearly so, until at the end of the stroke it will be found a distance equal to the stroke of the table, nearer the coal-discharge or tail end. The impurities, by adhering to the table, gather considerable momentum, and when the percussion occurs this momentum carries them some distance ahead of their former position on the table and finally they are discharged at the head or percussion end. Each stroke of the table, therefore, discharges a quantity of pure coal at one end and a quantity of refuse at the other.

The slack coal is conveyed to these tables by traveling belts. About one-half horse power is required for each table exclusive of that used to elevate and convey the coal to the tables. One man can operate and keep in repair ten machines.

A paper by P. N. Moore, on coal washing, extracted from the Kentucky Geological Survey Reports, is reprinted in the report.

Ohio.

Mr. Robert M. Haseltine has just issued his annual report for 1890.

The total output of coal in the state was 11,788,859 tons, an increase of 881,474 tons over the previous year.

There is also an output of 833,150 tons of clay for the manufacture of the wares and material used in building.

The output of iron ore in the state is gradually diminishing. In 1890 the quantity mined was 169,088 tons. As in all other states so is it in Ohio regarding the causes of accidents. Falls of roof and sides were the cause of 62·4 per cent. of the entire number of casualties, and it is wearisome to read the ever repeated warnings which all mine inspectors issue to miners to be careful *for their own sake* in timbering and supporting roof and sides.

During the year 57 new furnaces for ventilation have been built, 20 new ventilating fans erected, 66 air shafts sunk, and 46 second openings made. Copious reports are given by the sub-inspectors, showing that the mines have been very thoroughly inspected and that great effort is being made to increase the volume and improve the systems of ventilation. Coal is mined in seven different counties by machinery. The power is either compressed air or electricity. Mr. Haseltine submits a report of experiments made on the efficiency of the electrical installations, and he also gives a description of some trials of gas and safety-lamps by the Shaw Instrument for Testing Mine Gases.

Iowa.

The issue of the Fifth Biennial Report of the State Mine Inspectors of Iowa, dated June 30, 1891, is another gentle hint to Pennsylvania.

No. 1 District.—Mr. Binks, the inspector, advises that all mine managers employing over twenty miners should have a certificate of competency.

Mr. Binks describes an explosion which occurred by a blown-out shot igniting coal-dust. The dust was ignited by the flame and traveled back through the workings until a damp part of the mine was reached, which was free from dust, and here the course of the explosion ended.

A short description is given of the Stanley Heading machine at work in Forebush Mines, Iowa. It is cutting fifteen feet per day in solid coal with slate roof and fire-clay floor.

There are very few fans in this district, the chief mode of ventilation is by means of furnaces and many of the smaller mines depend entirely on natural ventilation.

No. 2 District.—In this, as in all the other districts, over sixty per cent. of the accidents occurred from falls of roof and sides, and these were mainly due to want of knowledge and care on the part of the miners.

We would like to reproduce in full the chapter of "Complaints," which Mr. James Gildroy, the inspector of this district, has written, but space will not permit. He complains of want of education on the part of mine bosses, and he has much cause. He tells of finding the ventilating furnace of a colliery extinguished when all the ventilation of the mine depended on it. One mine boss said that there was no air outside and how could any be expected in the mine? We presume he meant that it was a calm day. Another suggested to paint the fan house to get more air in the mine. Mr. Gildroy devotes a chapter to the "Principles of Ventilation," and it is apparently much needed.

No. 3 District.—In this district, which is under the charge of Mr. Morgan G. Thomas, the furnace is the chief means of ventilation. Mr. Thomas devotes a chapter to "Suggestions to Miners," which is of value, and he strongly urges the establishment of a School of Mines by the state, and presents excellent reasons why it should be done.

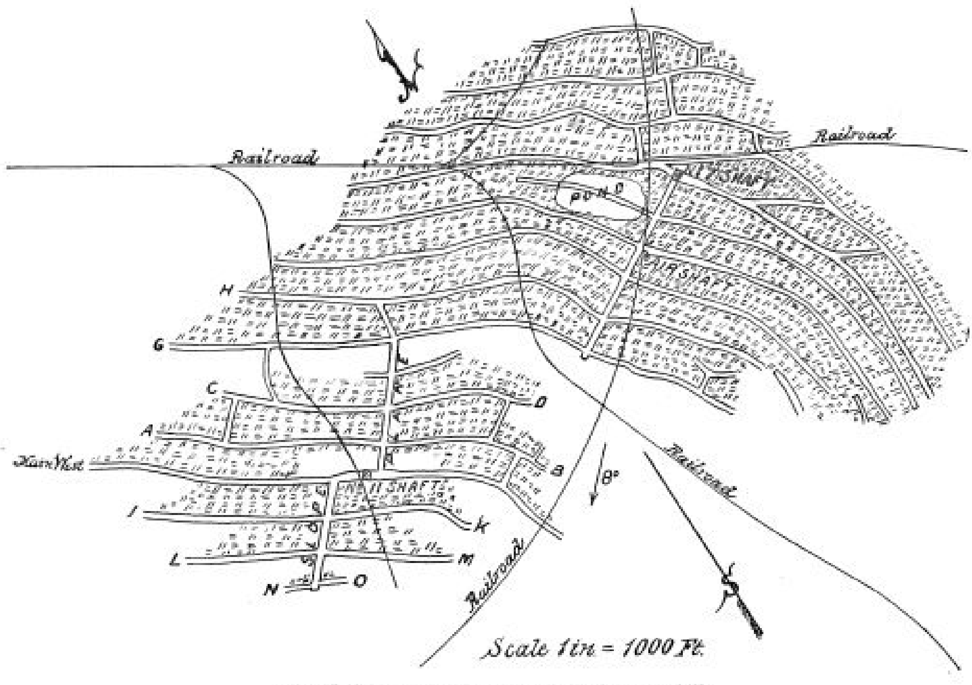
THE McALESTER EXPLOSION.

A Description of the Plant and Account of the Circumstances Attending the Disaster.

BY WHITFIELD FARNHAM, M. E.

[Written for the Colliery Engineer.]

On the afternoon of January 7th, occurred one of the most disastrous colliery explosions that has ever happened in the Southwest. Mine Eleven, of the Osage Coal & Mining Company, near McAlester, Indian Territory, was the scene of this accident. Of the four mines operated by this company in the McAlester Valley, Mine Eleven had the largest capacity, and was the deepest hoisting shaft, being 475 feet deep. The equipment is, in part, as follows:



PLAN OF MINES 7 AND 11 McALESTER, INDIAN TERRITORY.

Entries indicated by letters. All entries are driven double and are shown by a single line.

On the surface near the hoisting shaft, a battery of five boilers of about 300 horse power, aggregate capacity; a pair of 18 in. by 32 in. Litchfield hoisting engines, coupled direct to a nine foot drum; a 35 horse power Thomson-Houston dynamo used for lighting and pumping; all the above in substantial stone buildings.

In the mine near the foot of the shaft one 20 horse power and one 10-horse power electric motor, with corresponding power pumps; two engines and drums for handling empty and loaded trips of pit cars (about one ton capacity each) on the "plane" and "slope" (by which names the inclined roads are known, the former going directly to the rise, and the latter to the dip); one Blake steam pump, 18 inch steam cylinder, 7 inch water cylinder, 18 inch stroke, held as reserve.

An air shaft 238 feet deep in abandoned Mine Seven is used as the upcast, and is one-half mile from the hoisting shaft of Mine Eleven, which latter is used as the downcast. A Crawford & McCrimmon fan, 15 feet in diameter, and a Murphy double fan, 8 feet in diameter are set at this shaft, but only one is used at a time, the other being for reserve, either one being sufficient for ventilating the mine. At the foot of this air shaft is another pump. Steam for these fans and pump is furnished by the boilers at the hoisting shaft of abandoned Mine Seven, which is five-eighths of a mile from Number Eleven shaft.

Three grades or sizes of coal are made, all over straight bar screens, viz: lump, nut, and slack, the daily capacity being 1,000 tons.

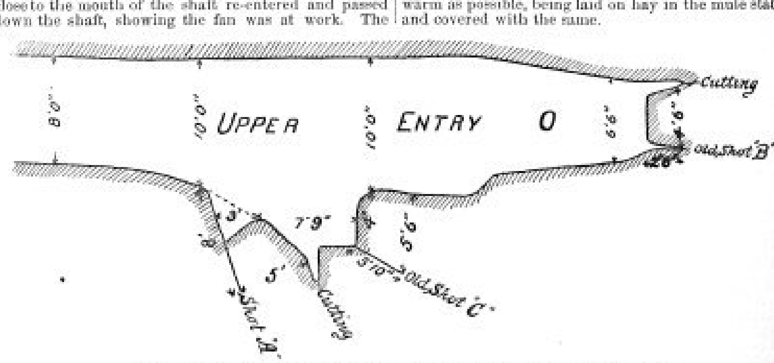
The coal vein is four feet thick, with a nearly uniform pitch of eight degrees or five inches to the yard. It is worked on the room and pillar plan, the mule roads or entries being driven nearly level, and the rooms worked up the pitch.

The plan of ventilation is simple. The air current passes down the main shaft, thence west about 200 feet, to the head of the slope, thence down the slope to its foot, where it is split, about one-half passing into the air course of entry O on the East, and half into air course of entry N on the West. From the faces of these entries, the air currents pass through the working places up from entry to entry until the two are reunited in the entries of abandoned Mine Seven, and pass to air shaft.

The mine has always given off a moderate amount of gas, but no sudden outbursts. The miners work with naked lights, and the mine is carefully inspected for gas every morning before the miners go to work. Shot-firers are employed, going into the mine after all the miners are out, the firing being done between 6 P. M. and midnight. The entry men are the only miners allowed to fire their own shots, and the rule is for them not to commence firing until 5.30 P. M., when it is expected all the other miners will be out of the mine. Coal is hoisted from 7 A. M. until 5 P. M., a half hour being allowed for dinner. No men are hoisted between these hours, except in case of sickness or emergency, or when there is no coal to hoist. Miners begin gathering at the bottom of the shaft before five o'clock, and each one in turn is given a check, so all can be hoisted in proper order. Only six men are allowed on the cage at once. Safety-catches are used, and dusty roads are sprinkled. The number of men employed in the mine was about as follows: 275 coal diggers, 24 drivers, 14 roadmen and timbermen, 7 trappers and 12 miscellaneous. Twenty-six mules were kept in the mine, the stables being between 240 and 300 feet East of the hoisting shaft.

By the above general description it will be seen that the mine is well equipped, and that every reasonable precaution was taken to prevent accident, notwithstanding, there has been no mining law until last summer, and there is no inspector.

On Thursday, January 7th, the mine was running as usual up to 5 o'clock, 850 tons of coal being hoisted. At exactly that hour, the hoisting of the men began. Five cages had been raised, and thirty men safely landed at the surface. As the upper cage had almost reached the upper landing, and the lower cage was yet three feet above the bottom, a cloud of smoke and dust burst forth from the shaft, accompanied by a report and severe jarring. Before the noise died away, the smoke close to the mouth of the shaft re-entered and passed down the shaft, showing the fan was at work. The



SKETCH SHOWING FACE OF UPPER ENTRY O, WHERE EXPLOSION STARTED.

A break through to lower entry O was started where shot A was fired.

man in charge of the fans and their boilers rushed to the air shaft, expecting to find the covering blown off, but everything was undisturbed. He gave the engine more steam, considerably increasing the speed of the fan, which did not stop for an instant.

The superintendent, Mr. William Cameron, was at his office, less than half a mile from the shaft, receiving by telephone the report of the day's work, when notice of the accident came, and he immediately repaired to the mine, first seeing, as he could from his office door, that the fan was running.

The news spread rapidly, and in a few minutes the scene always enacted at such an accident was repeated here, women and children crying for their loved ones, and suffering the terrible anxiety and suspense which only such a calamity can bring.

It was found that the lower cage was fast, and the slides were broken. The upper cage was hardly moved. One of the ropes was taken off the drum, and the other attached to an iron bucket (used in sinking shafts), and volunteers called for, to go to the rescue of those below, which call was bravely and promptly responded to. Three men entered the bucket, and in fifty minutes after the explosion were at the bottom of this deep shaft, helping the injured. Other rescuers were speedily lowered, and the work of hoisting the wounded and burnt men began. Meanwhile, parties were replacing the broken down doors and blown-out stoppings with canvas, and in a short time the air was traveling in its accustomed channels, and every part of the mine was accessible.

The newspaper reports of "200 Men Entombed Alive Beyond Hope of Rescue," and that men were shut in behind falls of slate and could be heard calling and rapping on the rails, was a pure fabrication, without the least shadow of foundation. The fact of the air shaft being so far from the main shaft saved the fan from any harm or even from stopping, and insured a fair current of air over all or nearly all the mine lying to the rise from the main shaft, even before the stoppings were replaced. Large falls of roof slate occurred on the west side adjoining the shaft and at the head of the slope, retarding the work of rescue. Meanwhile, many men who were uninjured or only slightly burned by the flame passing over them, walked through the return airways and made their escape by the stairway in No. 7 shaft, men having already been sent to help them along. One hundred and three made their escape in this way. But some brave men who were in the mine when the accident occurred, and were unhurt, refused to go out, but remained to assist in the work of rescue. One determined miner climbed the whole 475 feet from the bottom to the top of the shaft, hand over hand, on the buntons, between the two hoisting compartments, before the bucket was first lowered. Another had started, and with heroic self-denial said to the men in the bucket, as they passed him, "Go ahead and help those below. I can hold on awhile." He was taken off on the third trip.

After a time the slides were repaired temporarily, and one of the cages substituted for the bucket, making it easier and safer to bring out the injured. At 2 A. M., nine hours after the accident, every live man was believed to be out of the mine, which was true with a single exception. A young man had been overcome and left by his father for dead. At noon Friday he was found alive and uninjured, having been conscious for some hours. He had been pounding on an empty powder can in hopes of attracting notice. His feelings during these hours can be imagined.

The bitter cold prevailing made it impossible to keep the injured men comfortable at the foot of the shaft while waiting to be hoisted, but they were made as warm as possible, being laid on hay in the mule stable, and covered with the same.

None of the mules were injured, but the mule tender was killed. He was washing a mule at the time, and was evidently killed by the mule in his terror.

Fourteen or fifteen miners were killed near the foot of the shaft, where they were waiting their turn to be hoisted, being hurled against timbers or other obstacles, or were struck by flying objects, and many others were injured. A young man stood on the east side of the shaft, exactly in line with the timbers forming the center partition, giving the signals to the engineer above as each six men stepped on the cage. He escaped without a scratch, the force of the explosion coming from the opposite side of the shaft, dealing death and destruction on both sides of him. The middle partition, one foot thick, saved him. Some of the men were probably killed by falling slate, but the larger number succumbed to the deadly after-damp; most of them were prostrated in the vicinity of the slope. Nine were found in entry K, on the west side of the slope, one lift below the shaft. Everyone who followed the return airways escaped.

Let us now consider the cause and course of the explosion. In the first place, it was not a gas explosion. The mine was inspected in the morning, and no gas found. Miners had been working all day with naked lights. All agree that it started near the face of these parallel entries upper entry O (the two parallel entries thirty feet apart, both being called O) were in the "first of the air," the very first working faces to receive the current, where it must have been perfectly pure. This same air current passes through scores of working faces after leaving entry O, but at any point it is safe to work in it with naked lights. Furthermore, no signs of gas could be found in entry O, after the accident, when only the loose canvas curtains had been substituted for the tight doors and stoppings which were blown to pieces by the force of the explosion. I myself saw the face of both entries, and of each of the five rooms on this entry carefully inspected for gas three days after. Enough gas could not be found to burn with a naked light, even close to the roof, and at the extreme face of the rooms, which are all driven to the rise. The course followed by the destructive force was out entry O to the slope and up the slope to the main west entry. Near this point, and between it and the shaft, only 200 feet away, most of the damage to the mine was done. All doors and stopping along its course were destroyed, and its force was evident for considerable distance on the entries to the right and left, especially on the main west and up the plane, but the greatest force was shown in the course first described, and it seemed to increase as it advanced, till the climax was reached near the shaft. Now this travel was in and against the strong current of fresh air which passed down the shaft, swept along the main west and down the slope undivided and unobstructed. This seems to do away with any idea of gas playing any appreciable part in this accident. There had been a fire in the face of entry M, one lift above O, some time since, which proved too difficult to handle and it was walled off and flooded, and the entry allowed to stand. To avoid any suspicion of danger, a pipe was walled in the stopping near the roof, and provided with a valve and a pressure gauge, which was regularly inspected. No pressure was ever noticeable or gas discovered when this valve was opened. After the accident, it was rumored that the explosion was connected in some way with this walled-off entry face, but all the walls or stoppings were found intact, even to the pipe with its valve and gauge.

In the second place, it was not a powder explosion. In saying this, I refer of course to kegs of powder, not to the shots prepared for blasting down the coal. Entries N and O were the lowest in the mine, and were new entries, extending less than 300 feet from the slope. No powder was allowed to be stored in these entries, but was kept on entries L and M, several hundred feet from any working face, the rule requiring the iron powder kegs to be locked in wooden boxes. Cartridges for blasting were made here, and carried to the working faces and immediately inserted in the drill holes prepared for them. Similar precaution was taken everywhere to keep the powder out of reach of shots. No powder or exploded kegs were found in the lower entries, and no exploded kegs or other signs of powder explosion in any part of the mine. The powder used by the men working in entries N and O, was found in its proper place in entries L and M, except that two kegs were found in the center of the entry (not in any box), where they had evidently been thrown by the force of the explosion, with paper plugs in the holes, and unexploded. Other powder was found in boxes over which the fire had passed, but no signs of any having been exploded.

What then was the cause? It has been the custom for the miners to appoint a committee to investigate any serious accident, as there is no mine inspector in the Indian Territory. That was done in this case, and the committee included two or three miners from other coal fields, men who had flocked to McAlester, generously offering their assistance in this sad hour. This committee spent two days in examining the mine, and were unanimously of the opinion that it was not a gas or powder explosion. As to the real cause, or at least the cause of its extending so far they did not so well agree. As ready as they always are, each one with his particular theory, one at least called it a mystery. As to the primary cause and starting point, however, they and all who have carefully examined the mine agree. It came from one or two shots fired by the entrymen working in upper entry O, shots which were badly located, showing very bad judgment, or perhaps disregard of judgment, shots which if found in a room, the regular shot firers would have refused to fire. But the entrymen fire their own shots, and so the shots cannot be condemned before firing, as in the rooms. In another respect these shot firers violated the rule agreed to by themselves, viz.: not to fire before 5.30 P.M. If this rule had been adhered to, while the damage to the mine might have been the same, very few lives would have been lost, as all the regular miners would have been hoisted. These shots were fired at 5.03 or 5.04 P.M., twenty-six minutes before the time, just when the men were all congregated at the most dangerous place (as it proved in this case), the bottom of the shaft. If the two men who fired the fatal shots were to blame, they have at least paid the penalty with their lives. Both they and the two entrymen working in the parallel air course or lower entry O, who lit their shots at the same time, were killed on the slope on their way out. The three entrymen working in entry N, and its air course, just across the slope, felt the force of the explosion, and leaving their shots unfired, rushed out and up the slope, and escaped unhurt. Entrymen in some distant parts of the mine, not knowing that there had been any explosion, fired their shots later, and only learned of it when they met the wreck and the after-damp, as they leisurely made their way out. Hastily retracing their steps, they followed the return airways and escaped unhurt by Number Seven Shaft.

There is a difference of opinion as to how many shots were fired in upper entry O, whether one or two. The miners' committee thinks two were fired, one being in an old hole marked on the sketch B, which had been fired the night before and failed to do its work, and which was recharged and fired again, again failing to do the work expected of it, but succeeding, in connection with the other bad shot, marked A (known to be fired), in wrecking the mine and turning a whole community into mourning. The shot first referred to, marked B on plan, is at the extreme face of the entry, is 2 feet 8 inches deep, and at the point has 4 feet 6 inches solid coal between it and the cutting, too much coal to break out with a shot of that depth. It would naturally belch forth like a cannon, making what is called a "windy shot." C is another old shot previously fired, which had undoubtedly acted in a similar way, although it had broken out or loosened a block of coal at its "heel" or mouth. This hole is now 3 feet 10 inches deep, was probably 5 feet 6 inches or 6 feet when drilled, and the point or inner end of the hole is 5 feet 6 inches from the face of the coal. In other words, it is 5 feet 6 inches "on the solid." No undercutting was done in this entry. A is a shot certainly fired on the fatal night. The hole was 8 feet deep, with the point 5 feet "on the solid," diminishing to nothing at the "heel" or mouth of the hole-weal, where it should be strong, and strong where is should be weak. As might have been expected, it only broke out a triangular block of coal at the mouth of the hole, a ton or less in weight, which was hurled against the opposite rib with such force as to crush it almost to powder, filling the air of the entry with fine coal-dust, which either exploded with the flame of the same shot, or by the flame of the other shot, just at the right instant blazing forth the length of the dust-laden chamber. The entry was well sprinkled, as testified to by the man who did it under orders from the pit-boss; by the man who was ordered to see that he did it (all these men were saved), and as shown by the dampness of the floor three or four days after the explosion. The explosion in entry O may be thus explained, but it is more difficult to see why it should travel with such force the length of the slope 1,000 feet. Water constantly gathers in the sump at the foot of the slope, where it is baled into water boxes or cars, and if not needed for sprinkling, hauled up the slope and emptied into the sump there. This of itself keeps the floor wet, and on the level track from the "knuckle" to the shaft it is decidedly muddy. Water trickling down the shaft keeps everything in that immediate vicinity wet. And yet over this muddy road the greatest damage was done. This level part is double tracked, and is about 300 feet long. It may be this broke down quicker because it was so wide. Near the shaft the entry was ten feet high, while at other places the entries are from five to five and one-half feet high.

Saltpetre powder made by the Laflin & Rand Powder Co., has been exclusively used in the McAlester mines for a long time, as it was considered safer and better than the soda powder in use in the other districts. The tendency of the men here, as elsewhere, is to do less mining, *i. e.*, less shearing or undercutting, and depend on the powder to do the work. In driving entries, about nine pounds of powder per day were used by the two men working together, generally in two unequal shots, one containing about 3½ pounds and the other 5½ pounds. About eleven tons of coal were produced to one keg of powder in this narrow work.

Miners are paid high wages at McAlester, a good miner readily earning $4.00 per day. The price per bushel of coal passing over a one-inch screen is 4¼ cents in summer, and 4¾ cents in winter. Entrymen are paid from $2.00 to $2.50 per yard in addition to the coal. In December, the wages of the two entrymen working in lower entry O for 22 days work, after paying for their powder, was $92.22 each, or $4.19 per day.

37 dead were taken out of the mine and up to the time of this writing 19 more have died. About 120 more were injured, mostly by being burned, and will nearly all recover.

OBITUARY.

Neil Beattie.

Mr. Neil Beattie, inside foreman of the Adelaide Mine, of the H. C. Frick Coke Co., died on the 5th ult., aged 44 years. Mr. Beattie was born at Cumbernauld, a mining village in Scotland. When 17 years of age he enlisted in the 78th Highlanders at Glasgow, and served eight years in this famous regiment at Gibraltar and also in Canada. He came to the United States in 1871 and worked in the Arnot Mine, in Tioga County, Pennsylvania. In 1880 he went to the Connellsville region and secured employment in the Mines of the Cambria Iron Co. He was promoted to the inside foremanship of the Morrell Mine shortly after, and was subsequently transferred to the Wheeler Mine, where he remained as inside foreman for ten years, when he resigned on account of ill heath. At the time of his death, he had again secured employment at the Adelaide Mine.

Mr. Beattie was a man of more than average intelligence and was a constant student of the best mining literature. He had the faculty of handling his men so that the interests of his employers were protected, and, at the same time, he always had the friendship and respect of his subordinates. In his twenty years of mining life in America, he made hosts of friends, many of whom will regretfully learn of his early death through this notice. In his death the Frick Coke Co. has lost a faithful official and THE COLLIERY ENGINEER a valued friend.

NEW MINING INSULATOR AND CLAMPING EAR

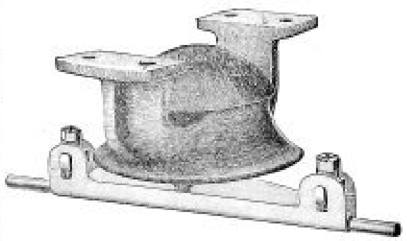
The requirements of electrical appliances, for use in mines, has necessitated the production of a type varying considerably from those employed above ground. The condition in the former case being much more severe than in the latter.

The insulator and ear shown in the accompanying cut was designed for the use of the Thomson-Van Depoele Electric Mining Company, and is particularly suited to the purpose for which it was made.

The insulator body is of iron, thoroughly painted with Graphite paint, to withstand the action of the sulphuric acid in the mines, the insulator itself being made of pieces of porcelain, rubber, or other suitable material, strong and large to withstand severe strains. Its construction is such that the insulation is entirely protected from the blows of the trolley, should it leave the trolley wire, and at the same time little opportunity occurs for grounding, as the head of the hanger-bolt is embedded in the porcelain or rubber, and the only joint in the insulation filled by a soft rubber washer firmly forced into position when the trolley wire ear is screwed into place.

The only opportunity for surface leakage is on the under side of the insulator along the surface of the cone, and as this has been corrugated the liability of leakage is reduced to a minimum.

The clamping trolley ear which was designed by Mr. J. P. B. Fiske of the Thomson-Houston Electric Company is very easy to install, as no soldering is necessary.



Its security is greater than any soldered ear, as the wire cannot come down until the phosphor bronze clamp is worn through. Its life is almost indefinite, as the clamp is ·032 in. thick and 8 in. long.

As the clamp can be loosened in a moment's time, the slack in the wire can be taken up at a little expense of time and trouble, a feature not possessed by the soldered ear.

The excessive sparking which occurs with the other types of clamping ear is entirely obviated by making the bronze very thin, so that it can be easily reduced to a knife edge, at the end, where the trolley runs on. The clamping devices being located at the end just over the point where the trolley runs on the phosphor bronze, the latter is sure to be pulled tight against the wire at this point, thereby securing a good fit and preventing sparking.

The clamping devices are positively locked by means of a stout German silver lock-wire. It is not possible for the screw to back out even the fraction of a turn, without shearing off this wire, which is quite improbable, as the shearing force is practically nothing. There can be no corrosion or rusting of the clamping ear as in its construction, iron and steel have been entirely eliminated. Should the bronze clamping strip wear out, a new one can be substituted at a moment's notice

Announcement.

We desire to call the attention of our readers to the advertisement of Messrs. G. L. Stuebner & Co., of Long Island City, N. Y., in another column. Messrs. Stuebner & Co. are extensive manufacturers of self-dumping steel iron hoisting tubs, side and bottom dumping cars, and iron wheelbarrows, hoisting blocks, etc. Their works are very complete, and they have facilities for manufacturing of such a nature that they can furnish high grade goods at prices that will compete with inferior manufacturers. Their location is such that freight rates do not enter into the question of cost. By the peculiar arrangement of tariff sheets, freights from Long Island City are lower than from most places several hundred miles nearer the place of delivery. They issue a handsome illustrated catalogue of their various products, which will be sent free on application.

An Enterprising and Successful Firm.

It is with pleasure we note the success of Messrs. H Ward Leonard & Co., Electrical Engineers, Electrical Exchange Building, New York. A recent letter from Mr. A. S. Vance, General Superintendent, informs us that among the prominent plants they are at present installing, as contractors, are the following:

Mail and Express Building, New York City.
Catherine Bradley Building, New York City.
Geraldine Building, New York City.
Germania Fire Insurance Building, New York City.
Du Vivier & Co. Building, New York City.
F. O. Du Lous Building, New York City.
Franklin Trust Building, Brooklyn.
Fifth Avenue Theater, New York City.
Columbia Theater, Brooklyn.
Graham Hotel, New York City.
Mr. John H. Inman's residence, New York City.
Curtis residence, Greenwich Conn.

Among the leading concerns for whom they are acting as Consulting Engineers, are the following:

Otis Elevator Co., New York City.
Wm. Sellers & Co., Philadelphia.
Ingersoll-Sergeant Drill Co., New York City.
Eastern Electric Co., Limited, St. Johns, N. B.
Providence Journal Co., Providence, R. I.
Rock Hill Electric Light Co., Rock Hill, S. C.
Middletown Music Hall, Middletown, Conn.

Easy Lessons for Beginners in the Study of the Art of Mining and the Sciences Related to It.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the sciences related to mining and to learn how to answer the questions in ventilation, surveying, and mechanics which are asked at the examinations for mine foremen's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine foremen and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and many calculations are worked out at length for the benefit of those who are not familiar with figures.

PENMANSHIP.

Practice is indispensable in bringing to perfection any art, science, or profession, and this is especially true in the study of penmanship. It will not do for the student to merely read over these articles, but considerable time must be spent in faithful practice, if he would write a good business hand.

The capital letter M is generated by the same elements as the letters already given. Letter 1, Fig. 34 beginning at the left is drawn on correct principles

Fig. 34.

It consists of the capital stem united at the top with a downward left curve which is joined in a short turn at base to an ascending left curve which is drawn to the same height as the stem of the letter; it is completed by a downward curve, the upper portion of which is on the same slant as the stem, together with another ascending left curve one-third of the full height of the letter. In letter 2, the first and fourth laws of penmanship are violated; and further, the second left curve retraces the first half way. In letter 3 the strokes are not parallel and the left curve is imperfectly developed.

Fig. 35.

The scroll of the capital stem of the fourth letter is left out entirely and it is otherwise imperfect.

In Fig. 35, we have the letter N as it should be made in letter 1. The capital stem and descending left curve are united as in M, the left curve is joined by a turn at the base to another curve rising two-thirds of the full height of the stem. The probable faults in making the capital N are shown in letters 2, 3, and 4 of the figure, counting from the left. In letter 2, the descending left curve is carried too far to the right of the stem, and the ascending curve should have been made just as long again. In letter 3, the ascending left curve is carried too far to the right of the capital

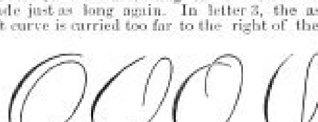


Fig. 36.

stem and the strokes are not parallel. The scroll to letter 4 is imperfectly made and all its parts are disproportionate.

The capital letter O as it should be made, is shown in letter 1, Fig. 36. It is drawn on a slant and is composed entirely of curved lines. Its width is one-half its slanting height. Letter 2 is faulty in that the lower section of the first curve is drawn to the left instead of to the right thus spoiling the ellipse. Letter 3 is a violation of the fourth law of penmanship, namely, all curves should be elliptical. Letter 4 is made without enough slant and is displeasing to the eye. It is also terminated with a straight line instead of a curve.

UNITS OF WORK.

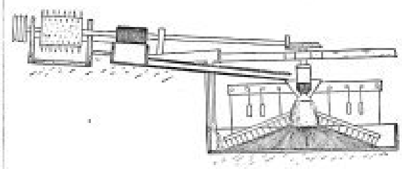
Education is simply a process for training the mind to understand and apply unit values. Without these units, no definite ideas can exist in the mind, nor could we estimate the values of the great forces which are used by man to soften his toil and increase his comforts. We have units of time, units of length, units of area, units of volume, units of weight, units of money value, units of heat, units of pressure, and many others; and in addition, units of work. It is with the latter that we propose now to deal. A unit of work then, is the work done when a pound of force is exerted in any direction, through the space of one foot, we have work lost and work usefully applied. Work lost should properly consist of that which cannot be prevented, such as the friction due to the moving parts of machinery. Work usefully applied, so far as machinery is applied, is that which adds to the wealth and comfort of man; in some men's lives, nearly all the work is lost work or work wasted. Wise men seek to minimize lost work, and expend their energies on such useful work as will upraise them, and make them honorable members of human society. We intend, in succeeding numbers, to treat under the head of Stepping Stones, on all the great and mechanical principles that are of value to mining students. Let us then proceed with a few examples, and first notice, that the distances in feet through which a force is exerted, multiplied by the value of the force in pounds, in the equivalent of the units of work done; observe then, that we have three units before us: first, the foot unit; second, the pound unit; and the foot and the pound unit when involved, generate another unit, called, a foot pound, or unit of work.

Example 1. A stone 2 pounds weight is thrown upwards into the air to an elevation of 30 feet. How many units of work were exerted by the throwing of a stone in projecting it upwards? Here then $2 \times 30 = 60$ foot pounds or units of work.

SOME TERMS USED IN METAL MINING EXPLAINED AND ILLUSTRATED.

THE BUDDLE.

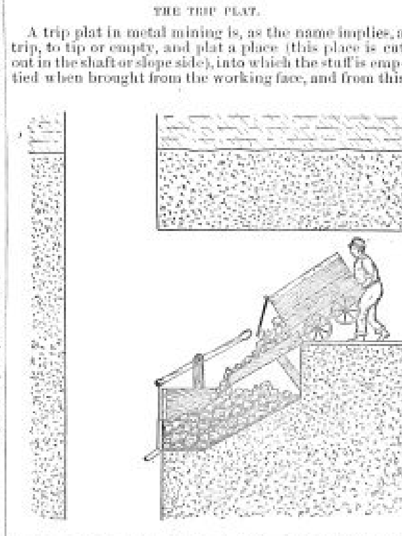
Buddles are for the purpose of separating the very finely powdered material which cannot otherwise be separated, into useful and useless. They depend for their action upon the principle that if a uniform stream of water carries down along a suitable slope a mixture of fine particles, some of which are very heavy, and others much lighter, the friction of the heavier particles will be greatest, and they will be carried a less distance down the slope, the very lightest going farthest.



The sketch represents a machine buddle, which is a conical structure, eighteen to twenty feet in diameter, and circular in plan, the surfaces are set at a suitable angle, and smooth beams receiving motion from shafts, to which are attached other beams, having brooms which just touch the surface of the buddle as they revolve. The fine material comes in along with water in the form of mud by spout into the funnel, the spout leading from a cistern, in which the fine material is kept agitated in the water as in the hand buddle. The heavier the material the nearer to the top of the cone it will be found, the light material being nearer to the bottom. At intervals the different classes of material are washed off to suitable channels, by which they are led into settling tanks.

THE TRIP PLAT.

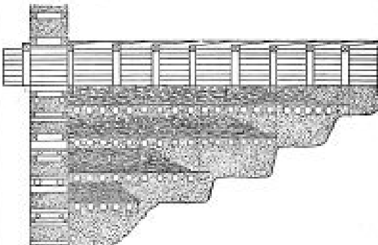
A trip plat in metal mining is, as the name implies, a trip, to tip or empty, and plat a place (this place is cut out in the shaft or slope side), into which the stuff is emptied when brought from the working face, and from this



"trip plat" the skip in the shaft is easily filled (as the plat slopes toward the shaft), by means of a slide which is worked with a lever being raised to allow the stuff to run into the skip, which is stopped just immediately below the trip plat side.

DRAWING A STULL.

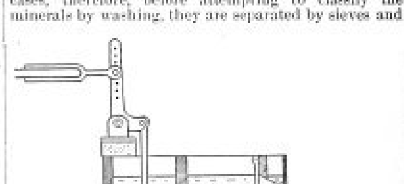
In metal mining the term stull has the same meaning as the scaffold in coal mining. In the operation of metal mining, when the shafts have been sunk in the lode, levels are driven about ten fathoms apart one above another, cut-throughs are also made from one to another for ventilation. The metal is worked either by overhand stoping, or underhand stoping from the levels. In the overhand stoping the roof is plucked to as great a height as it is convenient. The face of the metal being now out of reach, stout pieces of timber 8″ or 9″ square are placed across the place in order to make a scaffold to work upon, whilst they are proceeding with their work. Holes are made in the side for the lower end of the timber, and a groove is made in the opposite side for the upper end, then it is driven down into a level position. These timbers are placed about two to three feet apart, and planks 2″ thick are placed across these. The whole, when finished, makes a cover to keep all the rubbish from falling down and



filling the level up. As the stoping is proceeded with, pieces of wood cut the required lengths and shapes are sent down and built up, and these when finished form a wooden trough two feet square, which is used for sending down the metal as it is worked. At the lower end there is a door, and when the drawer comes along with his wagon he runs it under the trough's end and opens the door, filling the wagon immediately with the metal sent down by the workmen. The wagon, when full, is taken to the shaft bottom and thence to the surface. The stulls are very rarely drawn except when the rubbish plucked onto them is mixed with the metal, and it has to be sorted out. They commence by chipping one of the timbers in the center, and opening the boards above with a bar, so that as the rubbish slides down gradually it is filled into the wagons and sent away. Where the stull has to be drawn and the rubbish not to be assorted, they commence by chipping away one side of the level at one end of the stull, and proceed backwards until the whole have been drawn.

THE JIG.

The dressing of the metallic ores by jigging is that process in which advantage is taken of the difference in the specific gravities of the useful ore and the gangue. It is of the greatest importance that the grains or particles of ore to be classified by washing should be of uniform size, otherwise the less surface of one fragment in proportion to its weight may make up for the greater density of another fragment. In all cases, therefore, before attempting to classify the minerals by washing, they are separated by sieves and



trommels into distinct parcels, the fragments of each parcel being as nearly as possible of the same size. The character of machinery for jigging purposes, shown in the figure, ought to be influenced by the character of the ores it has to wash. Each fragment of material when ready for washing or jigging must be in one of the following three classes: First, Useful mineral with practically no admixture of earthy material. Second, A mixture of useful mineral and earthy matter in different proportions. Third, Earthy matter or gangue itself without any useful mineral attached. The most difficult ores to wash are those where the mineral is distributed sparingly, but pretty evenly through a very heavy gangue, *i. e.*, where the specific gravity of gangue and mineral are somewhat alike. In this case there will be very much loss during the washing. If the ore is fairly distinct from the gangue, and the specific gravity of the mineral and gangue differ considerably, the separation by washing will be simple and cheap, and with comparatively little loss in the operation. These are the considerations which influence the character of the machinery to be erected for washing purposes.

PROBLEMS ANSWERED.

Q. 1.—The anemometer reads 564 in. 47 seconds, what is the velocity in feet per minute and per second?

A.—To find the velocity in feet per minute and per second, proceed as follows:

$$\text{Velocity} = \frac{564 \times 60}{47} = \frac{33840}{47} = 720 \text{ feet per minute.}$$

$$\text{Velocity} = \frac{564}{47} = 12 \text{ feet per second.}$$

Q. 2.—The form of an air-way is that of an arch with a semi-circular top, it is 8 feet high and 8 feet wide, what is the area of the section?

A.—Assuming the arch to be 4 feet from the bottom of the arch to where it begins to circle, then the bottom part will be equal to $8 \times 4 = 32$ feet, take the top part as a circular arch, whose diameter is equal to 8 feet, then we have $8 \times 8 \times \cdot 7854 = 50 \cdot 2656$ area of circular arch, therefore, $50 \cdot 2656 \div 2 = 25 \cdot 1328$ area of the circular part of the arch, then $32 + 25 \cdot 1328 = 57 \cdot 1328$ feet area of section.

Q. 3.—The velocity is equal to 10 feet per second, and the area of section is equal to 80 square feet; what is the quantity of air passing through the arch per minute?

A.—10 ft. $\times$ 60 secs. $\times$ 80 = 48,000 cubic feet per minute passing through the arch.

Q. 4.—Which portion of an air-current moves quickest, and which slowest?

A.—The air-current moves the quickest in the center of the air-way, and slowest at the sides of the air-way; but it depends on the smoothness of the sides of the air-way; when the sides are smooth the air-current moves quicker than it does when the sides are rough and uneven, that is, the current moves faster against the sides when they are smooth than it does when they are rough, but under all conditions the center of the air-current moves the quickest.

Q. 5.—Show how you would handle the instrument in measuring air.

A.—I would first find a measured area, then I would examine the instrument, to see what it really indicated at the time, and note it down in my book. I would then have the instrument fastened on to a rod, and hold it in my right hand and my watch in my left. After setting the instrument away, I would move it from the middle up to the top, back to the middle, then to the bottom, and back to the middle, then over to the left side and back to the middle. By so doing, I would get the most correct velocity; after letting the instrument run for one minute, I would stop it by the little catch at the side. By subtracting the former reading from what it now indicates, I get the velocity of the current in feet per minute.

Q. 6.—How would you test for gas with an ordinary safety-lamp?

A.—Before entering a place for the purpose of testing for gas with an ordinary safety-lamp, I should first subdue the light, with the aid of the pricker, by drawing down the wick, and then, screening the eyes from the light with one hand, cautiously raise the lamp towards the roof with the other. And if there be any gas present, which will be detected by a blue halo or cap appearing on the top of the flame, slowly and carefully retire with the lamp to a safe place.

Q. 7.—If a puff of powder smoke traveled 123 yards along an air-way measuring 8 feet by 7 feet in 1 minute and 18 seconds, what would be the total quantity of air passing per minute?

A.—1 minute 18 seconds = 78 seconds, therefore, if the smoke traveled 123 yards in 78 seconds it would only travel

$$\frac{60}{78} \times 123 = 94 \cdot 61538 \text{ yds.} = 283 \cdot 846 \text{ ft.}$$

per minute. The area of the road being $8' \times 7' = 56$ square feet of section, then

$$56 \times 283 \cdot 846 = 15{,}895 \cdot 376$$

cu. ft. of air passing per minute.

Q. 8.—What is the area of a road which is passing 15,000 cubic feet of air per minute at a velocity of 5 feet per second?

A.—

$$\frac{15{,}000}{5 \times 60} = 50 \text{ feet of area.}$$

Q. 9.—How many tons of coal are contained in a pillar of coal 60 yards long and 30 yards broad, the seam being 5 feet 6 inches thick, and the coal weighing 80 lbs. per cubic foot?

A.—Reduce all the dimensions to feet and multiply the length, breadth, and thickness of the pillar together then multiply by 80 and divide by the number of pounds in a ton, thus

$$\frac{180 \times 90 \times 5\frac{1}{2} \times 80}{2240} = 3{,}182\tfrac{4}{28} \text{ tons.}$$

Q. 10.—How much work would be required to pump 7,400 cubic feet of water from a mine 280 feet deep?

A.—One cubic foot of water weighs $62\frac{1}{2}$ lbs., therefore, $7{,}400 \times 62\frac{1}{2} = 462{,}500$ lbs., and as this weight has to be raised 280 feet, $462{,}500 \times 280 = 129{,}500{,}000$ pounds to be raised 1 foot high, or one pound to be raised 129,500,000 feet high. The work required to do this would, therefore, be stated as 129,500,000 foot pounds or units of work.

Q. 11.—What is a horse power?

A.—A horse power is the power required to perform 33,000 units of work, or in other words to raise 33,000 lbs. one foot high or one pound 33,000 feet high in one minute. In the previous question the power required to raise the water was 129,500,000 units of work, therefore,

$$\frac{129{,}500{,}000}{33{,}000} = 3{,}924 \cdot 24 \text{ H. P.}$$

Q. 12.—What is the theoretical horse power of a steam engine of the following dimensions: Diameter of cylinder 15 inches, length of stroke 2 ft. 6 ins., number of strokes per minute 50, pressure of steam 40 lbs. per square inch?

A.—The units of work of an engine are found by multiplying the steam pressure, length of stroke in feet, area of cylinder in square inches, and number of strokes per minute by each other, and if this result is divided by 33,000 the quotient will be the horse power. An excellent way of remembering this is as follows:

Call the steam pressure P.
Call the length of stroke L.
Call the area of piston A.
Call the number of strokes N.
and multiply all together.

Now, divide the word P L A N by 33,000 to obtain the H. P. In this case P = 40, L = 2·5, A = $15 \times 15 \times \cdot 7854 = 176 \cdot 715$, N = 50, therefore,

$$\frac{\text{P L A N}}{33{,}000} = \frac{40 \times 2 \cdot 5 \times 176 \cdot 715 \times 50}{33{,}000} = \frac{883{,}575}{33{,}000}$$

= 26·77 + horse power.

Q. 13.—What is the difference between the theoretical horse power and the calculated horse power of an engine?

A.—The theoretical horse power is obtained as shown in answer to the previous question, and is the amount of work which would be performed by a *perfect* engine, supposing the pressure of steam was the same at the piston as it was when it left the boiler, and supposing there were no friction of its parts, nor leakages, but as these are impossible conditions it is found in practice that an engine loses a certain amount of its efficiency in working owing to these causes, and the efficiency of an engine is found by dividing the actual work performed by the theoretical horse power. For instance, if the theoretical horse power of an engine is 50, and the work performed in horse powers is only 40, then

$$\frac{40}{50} = \cdot 8$$

which is the modulus or percentage of the efficiency of the engine.

Q. 14.—What is the calculated horse power of a winding engine to raise 1,000 tons from a depth of 268 fathoms in 11 hours?

The modulus of a winding engine is very low because the engine only runs intermittently, and to obtain a high speed in the shaft the horse power is greater than is required at the lift, so much so that full steam is only given for the first few strokes, and all these things require that the engine be constructed of greater power than the actual load to be lifted would seem to demand. In this case, therefore, we will call the modulus of the machine ·4. To find the horse power we first find the units of work, thus, 1,000 tons $\times$ 2,240 = 2,240,000 lbs., and 268 fathoms = 1,608 feet, therefore, $2{,}240{,}000 \times 1{,}608 = 3{,}601{,}920{,}000$ units of work. Now, divide this by 33,000 multiplied by the modulus and the time in minutes in which the load has to be lifted, thus

$$\frac{3{,}601{,}920{,}000}{33{,}000 \times \cdot 4 \times 11 \times 60} = 413 \cdot 44$$

actual horse power.

WHY THE E. AND W. POINTS ON THE MINER'S COMPASS ARE REVERSED.

QUESTION.—Why, as in Fig. No. 1, is the E. marked to left of the North and W. to the right of North in the miner's compass?

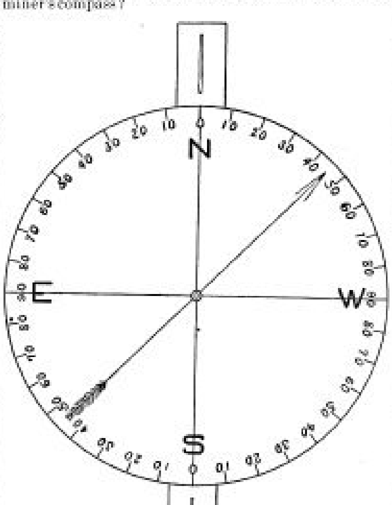


FIG. 1.

ANSWER.—To thoroughly comprehend the reason for this seeming anomaly it must first be thoroughly understood that the magnetic needle is the fixed point and it is the plate of the dial that moves, not the needle. Suppose, in the first place, the compass is set up in a gangway going due North, as in Fig. 2. The needle is exactly over the letter N. on the dial plate.

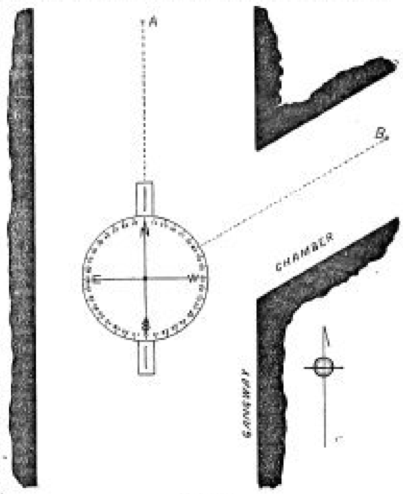


FIG. 2.

This would make the course or direction from the compass to A, North, Now, turn the compass gradually round so that the end of the dial plate with the letter N. on it will point to B, as in Fig. 3, up-chamber.

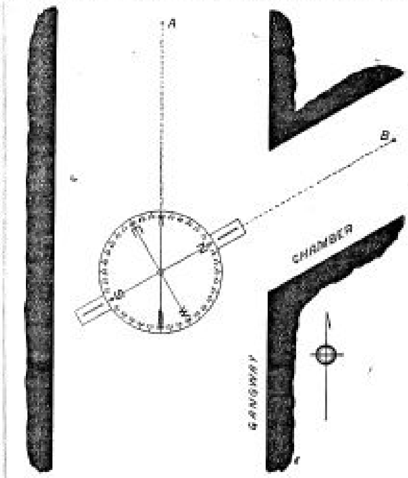


FIG. 3.

It will now be observed that although the direction of the sights of the compass is changed, the magnetic needle remains pointing to the North at A. By the figures on the face of the dial it will be observed a turn has been made to the *right* of 60 degrees. It is well known that *East* is to the *right* of *North* and, therefore, the chamber will be going *North 60° East*, and by looking on the dial plate of the compass (Fig. 3) it will be seen that the magnetic needle is pointing *60°* from the letter N. in the direction of the letter E. Now if the E. and W. were in their *true* positions, the course of the chamber would read N. 60 W., which would be wrong.

FAULTS.—WHIN DYKES AND WASHES OUT.

The rocks forming the earth's crust may be grouped under two great heads—stratified and unstratified; and may be again divided into three classes—aqueous, igneous, and metamorphic, which names indicate the agency which brought them to their present state.

Aqueous rocks, forming the greater portion of the earth's crust, are formed by the agency of water, and deposited in layers or beds.

Igneous rocks do not lie in layers or beds, but are intermixed with aqueous rocks, and appear to have been once in a molten state, and forced outwards from the center of the earth through the cracks or fissures produced in the aqueous rocks by internal heat or latent pressure, and afterwards cooled by contact with the adjoining rocks.

Metamorphic rocks were formerly aqueous rocks, but have been changed when at a great depth by a chemical action called metamorphism, by which their particles are slowly crystalized.

Stratified rocks are divided into three groups according to age, beginning with the older group, the primary; with the secondary group next, and the tertiary, or most recent group, nearest the surface.

Each group is again subdivided into formations. One of these, the carboniferous formation, a member of the primary group, is of especial interest to coal miners, as being the great coal-containing formation.

The substance from which coal is derived is organic matter, apparently bog deposits, which when isolated from air but exposed to moisture (which are the conditions of vegetable matter overlaid by a water deposit) chemical changes set in, and it is gradually converted into peat, from peat it passes to lignite, and from lignite to Bituminous coal and Anthracite.

So that each stratum or bed of coal is a separate surface growth, and each stratum of sandstone, shale, seggar, or ironstone, however small, which separate beds or seams of coal, are water deposits; so that in the formation of the coal measures the portions of the earth where coal is found would be alternately covered with vegetable matter and water.

Coal may, therefore, be defined as a mineralized vegetable substance, consisting principally of carbon, and derived from organic matter, which has undergone considerable chemical and physical changes.

Seams of coal are frequently interrupted in their continuity by faults, such as dis-jointing of the seams, brought about by the action of earthquakes, or by side pressure produced by shrinkage of the rocks, and generally causing the upheaval of the strata on one side of the fault.

The coal is generally found on the side of the greater angle, which means, that when you get the fault at first near the thill, and it inclines towards the roof, you may expect a rise fault, but if you find the fault near the roof first, and it inclines towards the thill, you may expect a dip fault.

Whin-dykes interrupt the continuity of coal seams, by forming a nearly vertical partition through the strata, and destroy considerable quantities of coal on each side of it, by the great heat of the once molten or liquid matter.

Washes-out also destroy the continuity of coal seams. They appear to have been rivers or streams of water which have become silted up, and filled in with sand, pebbles, clay, or soil.

We have also minor washes, which only cut through a portion of the seam, and these, when found near the roof, are known as rolls or balks; and when found near the thill are named horse-backs.

EXAMINATION QUESTIONS ANSWERED.

QUESTION 20. Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1889.

In the section of the mine mentioned in Question 14 (see January COLLIERY ENGINEER, page 140), which we will designate as Section "A," the air travels 6,000 ft. of entry, including the return. In Section "B" of the same mine there is required 14,400 cu. ft. of air per minute, but it must travel 12,000 ft. of entry, including the return, how would you arrange the regulator, or in what proportion would you split the air for these two sections to equalize the ventilating currents in them? Size of entries in both sections is the same.

ANSWER.—This question was ably and clearly answered on page 140 of last month's COLLIERY ENGINEER, by Mr. J. L. Beard, and we refer our readers to that answer.

QUESTION 21.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1889.

How would the friction of the air current in section A compare with the friction in section B?

ANSWER.—By referring to the answer of question 20 it will be seen that the conditions are as follows:

Section A is 6,000 ft. long, and the volume of air in circulation in it is 28,800 cu. ft.

Section B is 12,000 ft. long, and the volume of air in circulation in it is 14,400 cu. ft. In other words, section A is only one-half as long as section B and therefore presents only one-half as much rubbing surface as section B; and as the volume in section A is double that in section B the velocity is twice as great. Now as friction varies directly as the rubbing surface and increases as the squares of the velocities we have the following compound proportion, if we assume the friction in section B to be 1:

$\frac{2}{1^2} : \frac{1}{2^2} :: 1 : ()$, or $\frac{2}{1} : \frac{1}{4} :: 1 : 2$ therefore the friction in section A is twice as great as in section B.

QUESTION 22.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1889.

Describe the style or form of regulator you would advocate?

ANSWER.—In practice it is seldom possible to so arrange the splits in a mine that the resistance from rubbing surface shall be equal in each; and it is also generally necessary to have more air in the longer splits than in the shorter ones; so that some means must be used to increase the resistance in the shorter roads and so prevent their getting more than a proper share of the air circulating in the mine. This artificial resistance is obtained by placing a regulator in the return airway.

The best form for a regulator is a sliding shutter, the frame of which is fixed either in a stopping or a door. By moving the shutter, the aperture through which the air passes can be made larger or smaller according as the quantity of air in the split is required to be more or less.

The power necessary to overcome the resistance offered by a regulator to a current of air is, of course, a waste of energy, and every regulator placed in a mine means an expenditure of work that would otherwise be available for increasing the total quantity of air in the mine.

QUESTION 23.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1889.

Two airways having each an area of sixty-four square feet, and their lengths are each three thousand ft., one of the airways is circular and the other square, is there any difference in their rubbing surface?

ANSWER.—Yes. The circular airway has 85,076 sq. ft. rubbing surface, and the square airway has 96,000 sq. ft. For the square airway has a perimeter of 8 + 8 + 8 + 8 = 32 ft., and 3,000 × 32 = 96,000 sq. ft.

Then the circular airway has a perimeter of

$$\sqrt{\frac{64}{\cdot 07958}} \text{ or } 28{\cdot}36 \text{ ft.},$$

and 3,000 × 28·36 = 85,076 sq. ft.

QUESTION 24.—Asked at the Examination of Candidates for Mine Inspector, held at Des Moines, Iowa, April 9, 1889.

What is meant by magnetic variation?

ANSWER.—The magnetic variation is the distance East or West of a true North and South line that the needle of a compass points. It is not constant but increases or decreases to a limited extent, (from six to ten minutes) during the course of a day, and finally returns to its former position. This is called diurnal variation. If the observations be continued throughout an entire year, it will be found that the diurnal changes vary with the seasons, being greater in summer than in winter. The period of this variation being a year it is called the *Annular Variation*. The needle is also subject to local attraction and the variation thus produced might be called local variation, because it ceases when the instrument is removed some distance from the cause.

NEW MINING COMPANIES.

Names and Post-Office Addresses of the New Mining Companies Incorporated in the United States Since our Last Issue.

Security Land and Exploration Co.,	Duluth, Minn.
The Beaver Creek Mining and Milling Co.,	Colorado Springs, Colo.
Kansas City Clay and Coal Co.,	Kansas City, Mo.
The Capitalists and Investors Company of the Pacific Coast,	Spokane, Wash.
Lithemur Milling Co.,	Alexandria, Va.
Greene Bodine Coal Co.,	Tacoma, Va.
The New Crescent Mining Co.,	Roseville, Ohio.
Old Provincial Gold Mining Co.,	Portland, Me.
Royal Phosphate Co.,	Kansas City, Mo.
Pioneer Tin Plate Co.,	Joliet, Ill.
Lick Creek Coal Co.,	Chatham, Ill.
The Spooner Refractory Ore Smelter Co.,	East St. Louis, Ill.
The American Onyx Co.,	Louisville, Ky.
Superior Smelting and Refining Co.,	Superior, Wis.
Loretta Gold and Silver Mining Co.,	Milwaukee, Wis.
The Scranton New Tripoli Slate Co.,	Scranton, Pa.
Sonman Coal Mining Co.,	Philadelphia, Pa.
The Tavern Rock Sand Co.,	Becker's Station, Mo.
The Sophie I. Mining Co.,	Rolla, Mo.
Morning Star Mining Co.,	Joplin, Mo.
The Confidence Mining Co.,	Jersey City, N. J.
The Hall Chemical and Gas Co.,	Chicago, Ill.
Mesabe Central Land and Exploration Co.,	Duluth, Minn.
Great Northern Mining Co.,	Duluth, Minn.
Philadelphia and Boston Petroleum Co.,	Philadelphia, Pa.
The Birdseye Mining Co.,	Leadville, Colo.
The Fortunatus Mining and Milling Co.,	Denver, Colo.
The Colorado Prospecting Co. Limited,	136-137 Paternoster Building, London, Eng.
The Mount Elbert Mining and Milling Co.,	Denver, Colo.
The Shoe Basin Mining Co.,	Peoria, Ill.
Atlantic Mining and Milling Co.,	Great Falls, Mont.
The Tacoma Prospect Mining and Milling Co.,	Tacoma, Washington.
Bainbridge Placer and Quartz Mining Co.,	San Francisco, Cal.
Ophir Gold and Silver Mining Co.,	San Francisco, Cal.
Riverside Silver Development Co.,	Riverside, Cal.
Junior Coal Co.,	Elkins, W. Va.
The Citizens Gas Co.,	Delphi, Ind.
The Lucky Boy Mining Co.,	Prineville, Oregon.
Pawtucket Mining Co.,	Pawtucket, R. I.
Hanover Improvement Co.,	Hanover, N. M.
The Incorporators and Underwriters Co., of New York,	Jersey City, N. J.
The Buckeye Coal and Iron Co.,	Jackson, Ohio.
The Enterprise Mining Co.,	Rico, Colo.
The Tower Smelting Co.,	Colorado Springs, Colo.
The Silver Ledge Syndicate, Limited,	London, Eng.
Warsaw Blue Stone Co.,	Warsaw, N. Y.
The Kickapoo Valley Mining Co.,	Springfield, Mo.
The Elk Creek Mining Co.,	Seattle, Wash.
The Cascade Mining Developing and Milling Co.,	Tacoma, Wash.
The Montana Mining, Loan and Investment Co.,	Butte, Mont.
American Mining and Improvement Co.,	St. Paul, Minn.
The Central Mining Co.,	New Lisbon, Ohio.
The Bay State Lead and Zinc Co.,	Mansfield, Ohio.
The Savage Mining Co.,	Great Falls, Mont.
Whitney Water Supply Co.,	St. Louis, Mo.
The Quaker Valley Mining Co.,	Youngstown, Ohio.
The Taylor and Rathven Investment Co.,	Denver, Colo.
Master-Lode Nickel Mining Co.,	Chicago, Ill.
Black Boy Mine and Quarry Co.,	Chicago, Ill.
The Wilson Oil Co.,	Washington, Pa.
The French Creek Mining and Milling Co.,	Chicago, Ill.
Loomis Coal Co.,	Bevier, Mo.
The Union Leasing and Mining Co.,	Denver, Colo.
The Yule Creek Slate and Mining Co.,	Colorado Springs, Colo.
The Yule Creek Marble and Mining Co.,	Colorado Springs, Colo.
The Mt. Rosa Mining, Milling and Land Co.,	Colorado Springs, Colo.
Metropolitan Land and Investment Co.,	Joplin, Mo.
Buena Vista Mining Co.,	Stevensville, Mont.
Victor and Burnt Fork Mining Co.,	Victor, Mont.
The Boston Structural Steel Co.,	New York, N. Y.
Lake Hancock Pebble Phosphate Co.,	Bartow, Fla.
Eagle Mining and Milling Co.,	Seattle, Wash.
Keystone Mining and Milling Co.,	Spokane, Wash.
The Washington Improvement and Investment Co.,	Port Angeles, Wash.
Utah Reduction and Refining Co.,	Washington, D. C.
Witte Water Power Co.,	New York City, N. Y.
Central City Brick Co.,	Central City, W. Va.
Old Dominion Mining Co.,	Richmond, Va.
Columbia Smelting and Refining Co.,	Cerrillos, N. M.
Lehigh Coal Co.,	Alma, Kans.
The Union Pacific Coal Co.,	Rock Springs, Wyo.
The Green Mountain Mining Co.,	Chicago, Ill.
The Union Mining and Smelting Co.,	Denver, Colo.
The Spur Daisy Mining Co.,	Denver, Colo.
Rocklin Granite Co.,	Oakland, Cal.
San Luis Mining Co.,	San Francisco, Cal.
Black Hawk Gravel Mining Co.,	Downieville, Cal.
Breyfogle Mining and Milling Co.,	San Francisco, Cal.
Kansas City Sand and Dredging Co.,	Kansas City, Kans.
Blacksburg Mining and Milling Co.,	Blacksburg, S. C.
Monte Cristo Mining and Improvement Co.,	Seattle Wash.
Galena City Mining and Investment Co.,	Seattle, Washington.
Brush Heap Mining Co.,	Detroit, Mich.
The King Solomon Mining Co.,	Denver, Colo.
Angus Coal Co.,	Angus, Boone Co., Iowa.
Fresno Construction Co.,	Fresno, Cal.
Gaviota Mining Co.,	Los Angeles, Cal.
Alcyone Gold, Silver and Copper Mining Co.,	San Francisco, Cal.
Danville Mining Co.,	Danville, Ill.
Atlas Phosphate Co.,	Chicago, Ill.
Jellico Bird's Eye Coal Co.,	Louisville, Ky.
San Juan Mining and Milling Co.,	71 Fulton St., New York, N. Y.
The Seneca Mining Co.,	Pueblo, Colo.
The Bianca Mining Co.,	Pueblo, Colo.
The Weis Stone Co.,	Toledo, Ohio.
The Mineral Point and Lumber Co.,	Stillwater, Minn.
Niantic Coal Co.,	Niantic, Ill.
Rusk Mining Co.,	Kansas City, Mo.
The Slough Creek Mining Co.,	Tacoma, Wash.
The Little Maiden Mining Co.,	Garfield, Wash.
Washington Central Mining and Reduction Co.,	Conconully, Wash.
The Chat Mining and Milling Co.,	Colorado Springs, Colo.
Lehigh Coal Mining Co.,	Lehigh, Stark Co., N. D.
The Peoples Manufacturing and Investment Co.,	Denver, Colo.
The Sixty-Six Mining Co.,	Topeka, Kans.
The Lower California Sulphur Mining and Manufacturing Co.,	New York, N. Y.
The Citizens Gas Co.,	St. Henry's, Ohio.
The Eagle Coal Co.,	New Whatcom, Wash.
The Castle Rock Mining Co.,	Portland, Oregon.
The Williams Coal Co.,	St. Joseph, Mo.
The Belknap Granite Co.,	Berwick, Me.
The San Carlos Coal Co.,	Pittsburgh, Pa.
Emma Mining Co.,	St. Paul, Minn.
The Henry Huber Co.,	New York, N. Y.
The Galesburg Mica Mining Co., of Galesburg, Ill.,	Galesburg, Ill.
American Land Co.,	Louisville, Ky.
The Citizens Gas Co.,	Sharpsville, Ind.
Washington Reduction Co.,	Portland, Oregon.
Detroit Graphite Manufacturing Co.,	Detroit, Mich.
The Silver King Mining Co.,	Ouray, Colo.
The Yosemite Hydraulic Mining Co.,	Denver, Colo.
The Amherst Mining Co.,	Denver, Colo.
Abundancia Mining and Smelting Co.,	San Francisco, Cal.
Stanly Gold and Silver Mill and Mining Co.,	San Francisco, Cal.
The Mining Separating Fluid and Mining Co.,	Denver, Colo.
Mineral Hill Mining Co.,	Portland, Oregon.
Clark Coal and Coke Co.,	Fairmount W. Va.
Machiasport Granite Co.,	Machiasport, Me.
Kittson, Browne Process Co.,	Portland, Me.
Mohawk Furnace Co.,	Geddes, N. Y.
Kentucky Land and Improvement Co.,	Louisville, Ky.
Atikojan Iron Co.,	Duluth, Minn.
Gray Jockey Mining Co.,	Minneapolis, Minn.
The Home Oil Co.,	New Bremen, Ohio.
The T. G. Lamar Co.,	Langley, S. C.
Sioux Falls Granite Co., Consolidated,	Sioux Falls, S. D.
The Black Diamond Coal and Coke Co.,	New York, N. Y.
The Lake Shore Gold and Silver Mining Co.,	Yolo, Yolo Co., Cal.
The Burra Burra Co.,	East Orange, N. J.
Boise Iron and Reduction Works, Limited,	Boise City, Idaho.
Barbee Mining Co.,	Joplin, Mo.
The Tacoma Mining Exchange,	Tacoma, Wash.
Junction Mining and Milling Co.,	Centralia, Wash.
The Bridgeport Mining and Milling Co.,	Spokane, Wash.
Idaho Improvement and Developing Co., Limited,	Boise City, Idaho.
Gallatin Asbestos Mining Co.,	Bozeman, Mont.
Butte Consolidated Mining and Reduction Co.,	Butte, Mont.
Highland Mining Co.,	Helena Mont.
The Syracuse Pride Mining Co.,	Silverton, San Juan Co., Colo.
The Ouray Mining and Milling Co.,	Breckenridge, Colo.
The Colorado and Utah Natural Gas, Oil and Coal Co.,	Denver, Colo.
Rachel Mining Co.,	Iron Mountain, Mich.
Ruth Mining Co.,	Iron Mountain, Mich.
Westmoreland Oil Co.,	Greensburg, Pa.
Scranton Stone Co.,	Scranton, Pa.
The Wabash Clay Co.,	Veedersburgh, Ind.
Volcano Gulch Mining Co.,	Deer Lodge, Mont.
The Calumet Mining and Milling Co.,	Manitou, Colo.
The Farmington Mining Co.,	Farmington, Ind.
Central California Oil Co.,	Los Angeles, Cal.
Puente Oil Co.,	Los Angeles, Cal.
The Excelsior Pebble Phosphate Co.,	New York, N. Y.
The Golden Kising Mining and Milling Co.,	Idaho Springs, Colo.
Congo Coal Mining Co.,	Chicago, Ill.

Acknowledgement.

The Canton Steel Roofing Co., of Canton, Ohio, with a desire to excel in everything issued from its works or office, has just issued a handsome office calendar, good for two years, framed most conveniently in Russia leather. It is the finest calendar that we have seen this season and is typical of the corrugated metal manufactured by the company—the best. Accompanying the calendar was a beautiful and convenient leather bound memoranda book, for both of which we extend thanks

Dissolution.

Messrs. Pepper & Register, manufacturing and contracting electrical engineers whose office is in the Provident Building, Fourth and Chestnut Streets, Philadelphia, sends us the following announcement under date of January 15th:

"The firm of Clay, Pepper & Register has this day been dissolved by mutual consent. The business will be carried on as heretofore by the remaining partners under the firm name of Pepper & Register."

ENGINEERING

Progress of the Inter-Continental Railway.

The following is an abstract of the report of Mr. L. J. Blanco, member of the Inter-Continental Railway Commission for Venezuela, concerning that work:

United States and Mexico—The railways in these two countries, being in perfect communication, the Commission has only been occupied with their continuation and the choice of the most suitable point of departure. It has decided for Ayutla, on the Guatemala frontier.

Guatemala—From Ayutla, the Inter-Continental Line will descend by the Pacific coast, passing in the neighborhood of Rotalhuleu and Mazatenango as far as Santa Lucia. Thence will be used the branch, in course of construction, of the Central Railway from Guatemala to Escuintla, and will pass from Cujinjilapa to Santa Anna, in the Republic of Salvador.

Salvador—In this Republic the route of the proposed Central line will be utilized, passing by Santa Anna, Nuevo, San Salvador, Cujutepeque, San Vincent, and San Miguel, entering Honduras by Guascoran.

Honduras—From Guascoran the line will continue by the shore of Gulf Fonseca, crossing the State of Cholutcen via the town of that name, going thence to the south towards Nicaragua.

Nicaragua—In this Republic the line will arrive at the town of Chinandega, where it will join the railway from Corinto to Lake Managua, utilizing this line up to a suitable point, for example, Pueblo Viejo, skirting the lake and coming to the town of Managua, where it will take the line already constructed from Managua to Masaya. From Masaya the line will pass to Rivas, will cross the proposed Nicaragua Canal, and will enter into the Republic of Costa Rica.

Costa Rica—Following the shores of the Lake of Nicaragua and penetrating the country by the plains of Guatuso and San Carlos, the line will continue as far as the town of Alajeula, where there is a branch to the capital. From Alajeula a continuation will be made by the railway from San Jose to Puerto Limon, thence, by points which are not yet determined, the length of the Isthmus of Panama, as far as the entry of the Atrato Valley in Colombia, will be traversed.

Colombia—Colombia being reached, the Inter-Continental will traverse the western cordillera of the Andes, entering into the Cauca Valley, and, reaching the environs of the town of Antioquia, it will ascend by this valley, connecting the principal localities met with, and arriving at Popayan. The central cordillera will be crossed in order to survey the branch intended to connect Bogota with the main line. From Popayan the line will pass into the Patia Valley, making toward Pasto or Ipiales, with continuation towards Ecuador. The passage of the cordillera on the route from Popayan to Pasto will be one of the greatest difficulties met with in Colombia; it is at this point that the great ramifications of the Colombian Andes commence.

Venezuela—In order to place this Republic in communication with the trunk line, a branch will start from a point (still undetermined) of the route in the Cauca Valley, going to Medellin, where it will rejoin the line, running from that town to Puerto Berrio, on the Magdalena; thence it will go to Bucaramanga, and thence to San Jose de Cuitica and San Cristobal, La Grita, Merida, Trugillo, Barquisimeto, terminating at Valencia.

From Valencia to Caracas via La Victoria a railway is in course of construction and will be completed in a few years. Other lines, having been conceded, are being surveyed in the regions just indicated, and the route of the Inter-Continental will undoubtedly adapt itself to circumstances at the time of the execution of the project, whenever that may be.

Ecuador—The line will touch at the town of Tulcan, then, descending by the central valley of Quito, will serve the towns of Ibarra, Quito, Latacunga, Ambato, Cuenca, and Loja, there entering Peru.

Peru—The line will traverse the Department of Cajamarca, or the Amazonas, till it meets the river Maranon, and will ascend by that valley as far as Cerro de Pasco. From the latter point it will follow the course of the Perene up to a suitable point for a deviation to Santa Anna, then to Cuzco, Santa Rosa, and Puno, skirting Lake Titicaca in order to penetrate Bolivia.

Bolivi—The Inter-Continental will connect the towns of La Paz, Oruro, and Huanchaca, where it will divide into several branches, going to Chili, the Argentine Republic, Brazil, Paraguay, and Uruguay.

Chili—The Chilian branch goes from Huanchaca to Antofagasta, a port on the Pacific.

Argentine Republic—This branch, which has already been surveyed, goes from Huanchaca to Jujuy, the extreme point of the railway system of this Republic.

Paraguay and Uruguay—The line which is to connect these two countries to the proposed system will start from Huanchaca, will follow the left bank of the Pilcomayo, in order to rejoin the Osborn concession, which from Asuncion goes to the north of Paraguay. From Asuncion use will be made of the lines already constructed, or in way of construction, as far as Montevideo.

Brazil—The Brazilian branch starts from Huanchaca, going eastward, clearing the Paraguay River at Corumba, where, penetrating on Brazilian territory, it follows the river Taguary as far as Coxim, a railway the concession for which is granted from this point to Uberaba; from this latter city are existing lines to Rio de Janeiro.

The scientific commissions are authorized to search out and survey the best directions and routes. The above plan must only be considered as a general idea, which, according to the plans drawn up at the Washington Central Bureau, would appear to have met most effectually the interests of the American Republics.

Some Historic Canals.

The canal is an ancient institution. It co-exists with the remotest periods of human history, since primitive man discovered the value of an artificial water-way across a peninsula, or from one remote stream to the navigable waters of another. Historians allude to these artificial channels as existing in Egypt and elsewhere in the far away centuries preceding the Christian area.

In the year 1282 the Chinese completed an imperial canal that traversed a distance of 1000 miles, a forty days' sail for the Mongolian junk.

In 1681 the famous Languedoc Canal was completed. This gave France an artificial water-way 148 miles in length with, a summit level of 600 feet above the the sea, and including upwards of 100 locks and fifty aqueducts.

In Great Britain Roman spades dug the first canal one or more of which are holding water to-day. The canals of the United Kingdom now exceed 47,000 miles in length and are amongst the best of their kind in the world. The Manchester canal now in course of construction will, when completed, be a masterpiece of enterprise and engineering skill, and will place the Manchester manufacturer in direct and unbroken communication with the ocean.

The North Holland canal was completed in 1822 and is fifty miles in length. The Amsterdam and other artificial water-ways are among the most vital auxiliaries of Dutch commerce and prosperity.

The Suez Canal, which up to the date of its completion was the most stupendous undertaking of its kind in modern history, extends from Port Said on the Mediterranean to Suez on the Red Sea, the whole length of navigation being eighty-eight geographical miles. This trans-Egyptian water-way is navigable by steamers 400 feet in length and 50 feet beam, the cost of this gigantic enterprise, including its harbors, being about $100,000,000.

In the western hemisphere, both in the United States and the Canadas, the inland canal has long been an economic necessity, and in the Erie and the Welland, etc., we have examples of their service.

In a strictly national sense we have the magnificent mistake of Panama, with its big holes and insolvent stockholders. At Nicaragua American enterprise is already at work. The importance of this canal to the United States and to other commercial nations, as a route between the Atlantic and Pacific, is probably beyond any present calculation, and is of so undeniable value, that be the engineering difficulties what they may, the consummation of the idea is among the historic certainties of the future.

A Prospective Railroad.

The survey of the canyon of the Colorado has been completed, and Mr. R. B. Stanton has given a full account of it in the *Engineering News*. In spite of the great depths of the canyon and the cliffs of sandstone, marble, and granite composing it, a railway can in his opinion be built through it without much tunneling, thus opening up some of the grandest scenery of the world. In many places the canyon expands into wide valleys, and even where it narrows there are terraces along the sides like the "parallel roads" of Glen Roy in Scotland, which seem designed by nature for track and rail. The tributaries which enter the canyon laterally are, as a rule, small, and can be easily bridged. The distance of 1,049 miles through the canyon district will comprise only 20 miles of tunneling and 90 miles of granite cutting.

USEFUL INFORMATION

Choosing a Business.

The all-important question to every young man when he arrives at that age where he begins to look about him for the purpose of settling upon something as his life's work, is one that is not always easily determined or judiciously considered.

Advice upon this subject is frequently but slightly appreciated, as most young men consider themselves capable of choosing for themselves. However, it is fair to suppose that the experiences of others are worth something, and when these experiences have proved successful they are all the more worthy of consideration.

We judge of a man's success by the fortune he has accumulated in the business he has chosen to follow, and upon this theory the following advice, from one of the most successful men of the present time, Mr. Russell Sage, is worth a careful study. He says: "The question of choosing a business is a serious one. As a rule, a young man should adopt the calling for which he has a preference. If he has no particular choice, it would be well for him to try different occupations, until he finds one that suits him. I do not counsel changing about to gratify a spirit of uneasiness, for once a young man is installed in the business that he is suited to, he ought to stick to it. I have known young men who entered employments reluctantly, and after a trial became fond of them. A young man must be determined to succeed. After all, there is one great lever, and that is will power. Without it very few men succeed.

"It depends on the circumstances whether failures betray incapacity in a man. If a failure is due to a cause not general, then it may be attributed to a lack of foresight and understanding. A shrewd merchant will not stock up with unsalable things; a shrewd farmer will not plant his ground to raise unsalable crops. Both the merchant and the farmer must find out what is salable, and act accordingly. There are exigencies, to be sure, like contagions, disasters, combinations, strikes, and boycotts, that cannot be foreseen. The prudent man of business has prepared himself to stand losses from such causes, and when the troubles have passed the fact of his having weathered them makes his financial position in the community stronger than ever. The present condition of the coal trade well illustrates the uncertainity of things. The mild, open winter could not be foreseen, and has caused great dullness and loss in the trade. Then there is the march of improvement. This is an age of competition, and it requires energy and perception to meet it. It used to take ninety days to find out the conditions of the tea crop in Japan or the coffee crop in Brazil. Now the inquiry can be sent and an answer secured in a single day.

"The young man should start out in the world by the time he is twenty-one. If he is qualified to begin life at an earlier age he should do it. I begun as a clerk when I was twelve. At eighteen I was in business for myself, and I have kept my sign up ever since. I should say that the average boy could take a clerkship at the age of 16 or 18. A wrong start may not mean a permanent failure. Many of the most successful men have started wrong and afterward righted themselves. There are many instances where men educated for the pulpit have gone to the bar and been conspicuous successes. Then, again, men educated for the bar have gone to the pulpit and achieved success."—*The Manufacturers' Gazette, Boston.*

How to Make Gas.

To make coal gas is very easy. Most schoolboys know how to do it at a few minute's notice. Here is the process which I tried a hundred times or more before I was ten years old:

Get a little bit of Bituminous coal—as much as the size a walnut will answer. Pound it small, almost into dust, with a hammer or cobblestone. Take an ordinary tobacco pipe (one with a long stem is preferable) and fill it with the pounded coal, pressing it pretty closely with your thumb—I should have said nearly fill it. On the top press down some tough clay, reduced to the consistency of putty by being tempered with a little water. Then insert the pipe, filled with coal and closely covered with the tenacious clay, carefully between the bars of the grate, so that the clay on the top of the bowl may not be disturbed. In a minute or two the heat of the fire evolves carbureted hydrogen gas from the coal in the pipe.

If the covering be compact and complete the gas flows out of the long stem of the pipe, which projects out of the fire, and you can immediately see and smell it.

The smell is that of escaped gas—which is so unpleasant and unwholesome when perceived in a room—and the appearance is that of a thick smoke. Then apply a lighted match to this vapor which, being inflammable, instantly is all aflame—burning brightly until all the coal in the bowl of the pipe has parted with its gas. When this is done there is an end of the flame.

Take the pipe out of the fire, remove the clay cover of the bowl, and the residuum remaining therein is coke.

Now, this is the distillation of gas from coal, which lights our houses and streets—only at the gas works the vapor is submitted to processes which purify it, thereby producing a clearer and brighter light when burning. What is left after making the gas has a commercial value.—*New York Recorder.*

The Poison of the Toad.

Lovers of Shakespeare will be glad to see the credit of their favorite poet rehabilitated even in a small matter. The lines:

> "Toad that under the cold stone
> Days and nights hath thirty-one,
> Sweated venom,"

have of late years been looked upon as simply the expression of a popular prejudice current in Shakespeare's time, but now completely exploded. A correspondent of the *Field* remarks that "Fleming, in his well-known 'History of British Animals,' maintains that the toad is destitute of any venomous quality, and is only despised, hated and persecuted by the ignorant; and he remarks that it is surprising that prejudices so unjustifiable still continue to prevail." In two letters which appeared in the *Lancet* of August 29, a large amount of evidence is brought forward to show that Shakespeare's word's, instead of being merely an expression of a mistaken popular idea, are really a most truthful description of fact.

The toad does secrete a venom of a tolerably powerful character; and instead of this secretion taking place, as in the case of snakes, entirely through the salivary glands, it is actually secreted by the skin, so that the word "sweated" is most accurately descriptive. In his interesting letter, Doctor Leonard Guthrie mentions that the secretion also occurs in the toad through the parotid glands, and that the venom is a thick milky fluid like the juice of dandelion stalks in taste and appearance. When inoculated subcutaneously, it kills small birds in six minutes, and dogs and guinea-pigs in half an hour to an hour and a half; the symptoms in birds being loss of co-ordination, followed by death; in guinea pigs convulsions, and in the dog depression, vomiting, and intoxication.

Dr. Guthrie describes two very interesting observations of his own on the effect of toad's venom. He kept a small toad in a cage with some common lizards, and, one day, a lizard, having bitten the toad, immediately afterward rushed wildly round the cage, burrowing its head in the sand, became convulsed, and died in less than two minutes. His dog, having seized a toad, was attacked by instantaneous and profuse salivation, violent vomiting and collapse. He also noticed that the venom has a most powerful local action on the skin, so that, after carrying a toad in his hand, he got numbness and tingling in it, with a slight swelling and dryness of the skin lasting for several hours.—*Lancet.*

Razors, Safety-Pins, and other Inventions of 3000, B. C.

The *Washington Star* has been through the patent office in Washington in pursuit of inventions of antiquity and finds that not only were telephones used by the ancients of some thousands of years back, but several other alleged inventions of modern times, are duplicated in the collection of remote antiquities at the Smithsonian Institute.

The relics exhibited in this collection are mostly of the bronze age, from 2000 B. C. to 400 B. C. Among them are razors of bronze, some of which nearly resemble in form the razors of the nineteenth century, while others are crescent-shaped, with modern handles. They are not in condition now to shave with, though hardly less so than the tools employed by the astute barber upon the customer who never pays a fee. Even more wonderful is the safety-pin with which the Roman women in the time before Christ was born, fastened their garments. It was precisely like the safety pin of the year A. D. 1892, with the little coiled spring at one end and the catch at the other. Fish hooks in the bronze age were in shape precisely what they are now, with the same barbs and the same bends, of which the famous Limerick and Shaughnessy types are merely copies. The ends of their shanks, to hold the lines, were either flattened or looped, just as at present. In short, they were the same articles exactly, barring the nature of the metal.

In the Smithsonian collection referred to are shown hat-pins with big round heads more than twenty centuries old, in all respects resembling those of to-day, though they may have been employed merely to bind the hair together. Also there are ordinary hair-pins, equally ancient, like those sold at dry goods shops now, and likewise thimbles of bronze with the customary indentations, though such implements are generally supposed to have been invented in the Middle ages under the name of "thumb bells." Tweezers and strainers, after the modern fashion, are included in the same assemblage of curiosities.

Others of the same epoch are woven goods from the Swiss lake dwellings that were built on piles, bronze beads from Rome actually plated with gold, bronze buttons made just like those of to-day, bronze chains with the same mesh precisely as is employed now by jewelers for watch guards, bronze mirrors, bronze awls, bronze bodkins, bronze needles, and bronze sickles for cutting grass or grain, with wooden handles—the originals of the McCormick reaper.

One of the funniest things in the collection is a small vase with a hinge at the top for a cover—just like the modern beer mug. It dates from before Christ. There are also stone molds of the same epoch for casting bronze knives, spear heads, hatchets, sickles, and other implements precisely in the manner followed now. An ancient Etruscan vase shows mending with rivets after the same method as is employed in this day.

MECHANICAL NOTES

Antiquity of the Carpenter's Plane.

A very interesting discovery has been made at the Roman city of Silchester. The excavators came across a dry well, which, on being explored, proved quite a museum of antiquities. Some fifteen feet down, a correspondent says, the diggers found an urn-shaped pottery vase, about a foot in length, quite intact, and curiously enough, protected by lumps of chalk built around it. The vase, which probably originally contained some precious substance, was, however, quite empty. Above it were deposited a great number of iron implements, most of which were in a wonderful state of preservation. They seem to have been the tools of a carpenter and a coppersmith, with some miscellaneous objects of blacksmith's work thrown in. The principal specimen is a carpenter's plane of quite modern type, although unquestionably more than fifteen hundred years old, three or four axes retaining their fine cutting edges and quite serviceable, a number of chisels and gauges of all shapes and sizes, hammers, adzes, saws, files, etc.

In the smith department may be specified a brazier for burning charcoal, quite complete; two or three anvils of different sizes and shapes, a fine pair of tongs adapted for lifting crucibles, a curious tripod candelabrum lamp, or candlestick, and several other curious objects, the precise uses of which have not yet been determined.

Fire-Arms of Early Settlers.

The precise population of New England, either Indian or white, at the time of Philip's war cannot be stated, but for the purpose of war it may be said that the forces on one side and the other were equal. At that time the Indians were as well used to fire-arms as the whites, but the firelock of those days was but an inefficient weapon compared with the musket of later times or with the rifle of to-day.

It seems certain that in Europe flintlocks had been introduced before this time; but, on the whole, the concurrence of evidence shows that such locks were not used in the civil war in England, and that both the king's party and the Puritans still relied on the matchlock. The form of this can be readily explained to any person who has seen the old flintlock of the present century. A hammer—a good deal larger than the hammer which afterward held the flint, but quite like it—had a screw which tightened or loosened the hold which two pieces of iron had upon a match.

Each soldier was obliged to carry some yards of this match with him, and when the battle began he lighted the piece of this match which was fixed to the hammer of the gun. A pan which held powder, exactly as the pan of a flintlock afterward did, was in front of the hammer, with a cover projecting, from which a sort of a horn ran up nearly vertical, to be opened by the hammer when the soldier pulled the trigger. The fire of the match communicated with the powder, and the gun went off.

This was a sufficiently complicated way in which men should go to battle, perhaps, in a wilderness, where even the procuring of fire at that time was attended with some difficulty. The accounts of skirmishes of those times are full of occasions when a shower put a stop to the whole battle. This is because the fire of the matches was extinguished by the rain.

To change this rather clumsy lock into a flintlock simply required that a flint of sufficient size should be screwed into the hammer in the place made for the match. The flint, then striking upon the cover of the pan, made a spark which fell at the moment the pan opened into the powder. Eventually these locks were made with great precision, so that the gun missed fire very seldom.

I have no doubt that one and another soldier in Philip's war found for himself that a flint Indian arrow-head screwed in the place of his match could be made to answer the purpose of firing the powder much more readily than the match itself could do. A similar invention, however, as I have said, had already been made in Europe, so that it is thought that flintlock guns had been found in France as early as 1640. In 1672, however, just before the war with Philip began, the law of Massachusetts and the provision made for her soldiers still required the use of matchlock.—*The Chautauquan.*

Some Successful Mechanics.

In this country there is practically no end to the number of men who found a trade the most valuable of all helps on the road to fame and fortune, writes Foster Coates in his boys' department in the January *Ladies' Home Journal.* There is Thomas A. Edison, the greatest genius of our day. Learning telegraphy was the first thing that led him into that intimacy with electricity which has ended with him being its master; Andrew Carnegie was a telegrapher; Charles Pratt, who did more to help young men to acquire trades than any man whom I can mention, started in life as a machinist; Judge Daniels, of the Supreme Court of the State of New York, was a shoemaker; William R. Grace, who was Mayor of New York, and who is worth some $20,000,000, was a butcher; the late George Jones, who, as editor of the New Lork *Times*, was one of the most powerful men of his day, was a printer's "devil," in the same office with Horace Greeley when both were boys; Jay Gould, the great financier, was first a tanner and then a surveyor; Dr. John R. Paxton, D. D., who preaches to the wealthiest congregation in the world, began life as a carpenter; Philip Armour, the Chicago millionaire, was a moulder; the late John Kelly, the famous politician, was a grate setter; John D. Rockefeller, now worth $125,000,000, was a mechanic in iron; Rev. Robert Collyer, D. D., was a blacksmith; John A. Mackay was a stone-mason before he became the owner of the Comstock Lode, and one of the richest men in the world; Jesse Seligman, the eminent banker and philanthropist, laid the foundation of his fortune by studying in the very poor night trade schools that existed when he was young; United States Senator Hill, of New York, was a printer; the late Henry W. Grady, the greatest orator the South has given us since the days of Calhoun, was also a printer. And so it goes. I could give scores of other names of men who were mechanics, or were skilled in trades and became great after serving faithfully at their various tasks.

To Remove Iron Rust.

The engineer who is so unfortunate as to have a portion of his engine become rusted, or the more unfortunate man who takes charge of an engine which has been neglected and is covered with rust, finds before him a tedious job in cleaning and getting the metal to again present a polished surface. Rust, chemically considered, is an oxide of iron when it appears on iron or steel; but the combination of oxygen and any other metal will form a rust, although in such cases it is usually given another name. The combination of oxygen with iron can only take place to an appreciable extent in the presence of moisture or hydrogen and, if extensive, leaves little depressions in the metal when the rust is removed. This occurs from the fact that when the oxygen combines with the iron, that portion of the iron forming the combination is loosened or separated from the mass. There are two ways in which rust may be removed from iron or steel. The first and most common practice is by the use of some abrasive material, and the process is usually termed scouring. Another method is by chemical action, by the application of some chemical applied in solution, which has a high affinity for oxygen, and which withdraws the oxygen, leaving the iron particles free.

One of the best compounds for such purposes is given by the *Chronique Industrielle*, as follows: Potassium cyanide, 15 grammes; soft soap, 15 grammes; whiting, 30 grammes, and sufficient water to form the ingredients into a paste. This is to be applied as a scouring material and well rubbed over the rusted surface, after which it is to be thoroughly wiped off, and a coating of oil applied to stop further action. The active material in this composition is the potassium cyanide, which has the strongest deoxidizing property of any substance with which we are acquainted; and, further, it is one of the most poisonous substances known, the base being potassium, which is combined with cyanic acid, and cyanic acid is so poisonous that it is extremely dangerous to use in any manner unless partially neutralized by combination with some other substance, as in the present case.

Cyanic acid is of itself a gas, and in this condition it is extremely destructive to life, the inhalation of even a small quantity being sufficient to cause instantaneous death. When in solution in water, the liquid is called hydrocyanic acid, a single drop of which, if taken internally or entering the system in any manner, being sufficient to cause death within the short space of two seconds of time.

No particular danger is to be apprehended from the use of the composition given for removing rust, as the addition of soft soap, which is of equal weight with the cyanide of potassium, goes far to counteract the acridity of the cyanide. Then the further addition of whiting in double the amount of cyanide reduces the strength of the compound so much that it is relieved of the greater part of its dangerous properties.

If any one attempts to make use of this compound for scouring purposes, we would suggest that he do so only when the hands are free from abrasions of any kind, as, if it should come in contact with any portion of the flesh where the skin is removed, a very bad sore would probably be the result.—*Progressive Age.*

Combustion by the Steam Jet.

The steam jet is no aid to combustion. The only way in which steam in the fire box proves a help to combustion, is by carrying with it considerable air which would not otherwise be forced into the furnace. Steam or water in any form is not a benefit to fuel, or on fuel. Every pound of water thrown upon coal "to help it burn," only absorbs a certain quantity of heat from the fire. It is claimed that a like amount of heat is returned by combustion of hydrogen yielded up by the steam when disassociated.

Even if this is true, there is a loss instead of gain by the operation. It is too much like a piece of iron in the furnace, with the exception that after the iron becomes heated by the burning coal, it will give out, on cooling, as much or more heat than was put into it.

Keep steam or water out of the fire-box; put in a certain amount of hot air, the hotter the better, but do not force in too much. Too much air extinguishes a flame about as quickly as so much water. This is proved by the blowing out an ordinary kerosene light. A great volume of air forced against the blazing wick by the breath, cools off the hot gases so suddenly that they can unite with oxygen of the air and the flame is extinguished, and the gas, which would burn if it had the chance, may continue to rise during several seconds from the hot wick.—*The Tradesman.*

HOW TO LIVE

To Prevent and Restrict Diphtheria.

The Board of Health of Philadelphia, has issued a circular giving the following regulations for the prevention and restriction of diphtheria:

Recent investigations having proved that the poison of diphtheria is portable, communicable by infection, and capable of reproducing itself outside of the human body, diphtheria must now be ranked as both a contagious and infectious disease. The following rules are therefore more imperative than ever before:

First. When a child or young person has a sore throat, a bad odor to its breath, and especially if it has fever, it should immediately be separated and kept secluded from all other persons except necessary attendants, until it be ascertained whether or not it has diphtheria, or some other communicable disease.

Second. Every person known to be sick with diphtheria should be promptly and effectually isolated from the public. Only those persons who are actually necessary should have charge of or visit the patient, and these visitors should be restricted in their intercourse with other individuals. Children residing in a house where there is a case of diphtheria should not be permitted to attend school.

Third. When a case of diphtheria is fully developed the same precautions in regard to free ventilation, disposal and disinfection of discharges, bed or body linen, etc., isolation during convalescence (or management of the corpse should death unfortunately occur), etc., etc., ought to be enforced which have already been recommended in regard to small-pox.

Fourth. It is particularly important that persons whose throats are tender or sore from any cause should avoid possible exposure to the contagion of diphtheria. Children under 10 years of age are in much greater danger of taking the disease, and, after they do take it, of dying from it, than are grown persons. But adults are not exempt, and mild cases in them may cause whole series of fatal attacks among children.

Fifth. Numerous instances are recorded where the contagion of diphtheria has retained its virulence for weeks or months, in cesspools, heaps of decaying vegetable matter, damp walls, etc., and been carried for long distances in clothing, in sewers, in waste-pipes from stationary washstands, and in other conduits. Hence all sewer connections and other carriers of filth should be well ventilated and disinfected, and children particularly should not be allowed to breathe the air of any water-closet, cesspool, or sewer into which discharges from patients sick with diphtheria have entered, nor to drink water or milk which has been exposed to such air or the atmosphere of the sick room.

Sixth. Beware of any person who has a sore throat; do not kiss such a person or take his or her breath; do not drink from the same cup, blow the same whistle, nor put his pencil or pen into your mouth.

Seventh. Do not wear nor handle clothing which has been worn by a person during sickness or convalescence from diphtheria.

Danger in Wearing Rubbers.

A chiropodist says: Since the streets became so muddy I have had a number of sufferers apply to me for relief. If a man has a corn I can take it out and relieve him, but if he is suffering from what I call "rubber fever" I can't help him and can only prescribe liberal foot bathing and a removal of the cause of the trouble. Rubbers should only be worn to keep the wet out, and they should be removed the moment the wearer gets indoors. Failure to note this gives a man wet feet in a far worse sense than if he had waded through mud ankle deep. It was the trouble resulting from forcing the perspiration to soak the stockings and keep the feet perpetually damp that drove rubber-soled boots out of the market. Even loose rubbers are a source of danger and the cause of many more serious colds than they avert.—*St. Louis Globe-Democrat.*

Prevention and Treatment of Influenza.

The article "What the Doctors Say," which we reprinted recently from the European edition of the *Herald*, was devoted to a timely discussion of the influenza, its symptoms and three leading forms, the history of previous epidemics, the mode of treatment, and the precautions which are demanded during convalescence.

The first question for the great mass of people is, How shall we prevent ourselves from catching the grip? Our foreign medical correspondent answers, "Avoid fatigue, live well, dress warmly, and keep dry, avoid all fogs." If this advice is lived up to the present epidemic is not likely to become pandemic, as it was in last year and in 1890. But we venture to suggest that to these precautions one or two others may be judiciously added.

The most fatal complications of influenza are those of tubercular and heart disease, and unquestionably dust is the most prolific source of infection with tuberculosis. Crowded apartments and all assemblages in which we are liable to breathe air containing the germs of the disease are especially to be shunned. Wherever headache and malaise are suffered in theatres, the air is foul, but, as an authority says, "the most subtle dangers lurk in the dust, which, equally with the bad air, is forced upon us." On the streets, where in windy weather one is compelled to inhale much infected dust, the danger may be considerably lessened by taking the leeward side of the street. While the grip is not very contagious it is infectious, and prudence dictates an avoidance of all unnecessary contact with influenza patients.

But, after taking all due precautions, if the epidemic continues many may be stricken down with the grip and all should be instructed in the diagnosis and treatment of the disease. Its attack is sometimes slow and very insidious, sometimes very sudden and overwhelming, though in cases of the latter type a careful study of the patient's previous history will probably show that he has been run down by overwork or dissipation. When the attack is decided the temperature of the body rises to 102 degrees Fahrenheit, or thereabouts, and sometimes even higher, with loss of appetite, thirst and febrile conditions, and in many, but by no means all cases intense pain in the side and more or less coughing. The immediate sequel of the attack is great weakness. If this were all, the malady might not be so dreaded. But the tendency to grave complications and relapses is so marked that often the grip retiring, like an army on the retreat, strikes more deadly blows than when advancing.

Our medical correspondent discusses the treatment demanded for this fierce malady. Of course, as he shows, the medication must be varied according to the many phases of the attack. There is no specific remedy for influenza, and, once it is contracted, no time should be lost in summoning a competent physician, no matter how mild the first symptoms appear.

But perhaps the most urgent injunction our correspondent gives is to convalescents: "When convalescence sets in," he says, "it is of the utmost importance to prevent the patients from going out too soon and from being in too much of a hurry about resuming their ordinary occupations." The medical profession and also the public will do wisely to consider the points brought out by our correspondent.—*New York Herald.*

Three Perils to Avoid in Winter.

1. Perils from heedless exposure. Winter is the gay season, the season of balls and dancing parties, and, in general, of prolonged amusements and excitements. We need not say how common it is for young ladies to attend such gatherings imperfectly clad.

The excitement, physical and mental, extending to a late hour of the night, renders the surface of the body peculiarly susceptible to the outside chill; the susceptibility is enhanced by the exhaustion, which at the same time lessens the power of resistance.

The danger is especially great in rural districts, where so many must ride long distances to their homes through the icy air. Tens of thousands have in this way laid the foundation of fatal disease.

2. Perils from infectious diseases. In summer our dwellings ventilate themselves, with little care on our part; but in winter we economize heat at the expense of ventilation. Few houses are provided with artificial ventilators, while the drainage is generally far from perfect. Even houses supposed to be above suspicion in this respect are often found to be dangerously defective.

Unnoticed leaks are common and a bad leak in a neighbor's house may long have been discharging itself freely beneath the wooden floor of our own cellar. The main sewer is seldom or never free from the microbes of disease, and these may find entrance into our rooms through untrapped or imperfectly trapped connecting pipes. It was from this cause that the noble and good Prince Albert came to his untimely end.

3. Perils from school rooms. Comparatively few schoolrooms are furnished with adequate adjustments for ventilation. Hence the pupils at an age of great susceptibility, breathe much bad air, often from diseased lungs, and always charged with deleterious bodily exhalations.

At the very least, the vital resistance of the system is dangerously lowered. On the other hand, when the air becomes insufferable the teacher may order the windows opened, thus endangering those who sit within the draught, at a time when they are least able to bear exposure.—*Youth's Companion.*

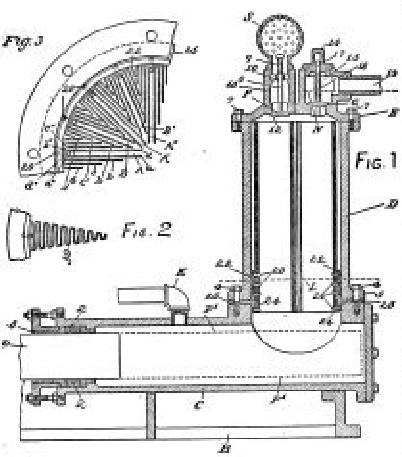
NEW INVENTIONS

AIR COMPRESSOR.

No. 462,776. Francis H. Richards, Hartford, Conn. *Patented Nov. 10, 1891.* The compression cylinder C is partly filled with water, which stands at about the line L when the plunger P is at the outer end of its stroke as shown, and which rises to the line N in the delivery valve chamber at the other end of the stroke. The chamber D is partly filled with metal plates shown in end view in Fig. 3, and a different style in Fig. 2. When air is compressed heat is also generated, which increases the pressure of the air and so increases the resistance to the plunger. This heat is soon radiated and the power it represents is thereby lost.

These plates are designed to abstract the heat during the act of compression and so prevent the undue increase of resistance and waste of power. A small pump, not shown, slowly changes the water in the cylinder and prevents it from getting too warm.

At each stroke the heat-abstracting plates are entirely immersed in the fluid, and thereby thoroughly cooled, ready

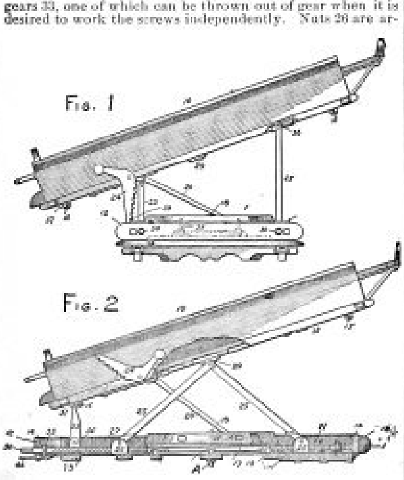


for effective operation at the next stroke of the compressor The plates, being continuous solid metal to a point below the water-line, act during the compression to receive the heat and rapidly conduct the same downward and discharge it into the fluid, thereby materially reducing the heating of the upper portions of the plates, and maintaining those portions in the most effective condition. During the compression the plates are submerged from the lower end upwardly.

The plates or other forms of heat-abstractors, divide the chamber into a multitude of narrow spaces, and being immersed at each stroke of the plunger in the fluid are on the descent of the fluid covered with a thin coating or layer of water, which promotes the action of the plates for cooling, the air being compressed.

COAL WAGON.

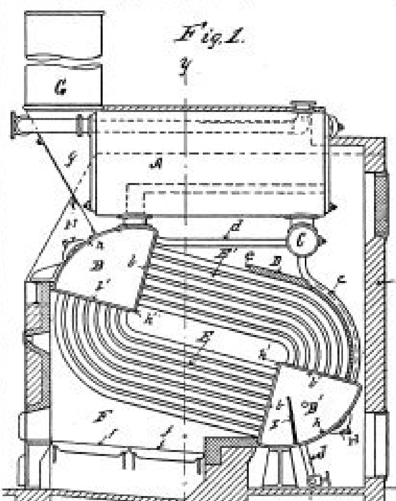
No. 463,251. Edward L. Layton, Trenton, N. J. *Patented November 17, 1891.* The main frame is composed of two side-bars 11, united by end-bars 12 and several cross-bars 13. A ring or turn-table 17 is secured by a center pin A to the middle cross-bar, and it runs on castors attached to the cross-bars, as shown. The wagon body is attached to the ring 17 by links 20, so that it cannot slide out of place. On each side of the frame there is a long right and left screw which can be turned by a crank slipped on the rear end. The screws are geared together by a cross-shaft and bevel gears 33, one of which can be thrown out of gear when it is desired to work the screws independently. Nuts 26 are ar-



ranged to travel along these screws, and toggle-rods 25 are hinged to them. The middle joint and block 29 is not attached to the box but merely bears under it. To dump to the rear, both screws are turned simultaneously, thus elevating the front end of the box, which tilts on the posts 35. To dump to either side, the box is first swung around on the turn-table and locked against further turning by a hook not shown. Both screws are turned until the box is high enough to deliver properly, and the notched legs 24 are then turned down until they hook over the edge of the frame. The screws are disconnected, and the toggle under the front end is operated until the load slides out.

WATER-TUBE BOILER.

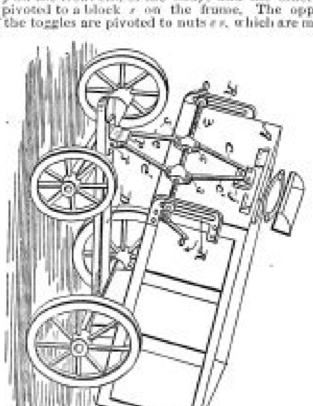
No. 464,109. Harry W. Seller, Brooklyn, N. Y. *Patented Dec. 1, 1891.* The drawing shows a boiler constructed with two tubular steam-drums A, the front ends of both of which are connected to the upper sector-shaped box B and at their rear ends to a large cross pipe C, from which pipe a row of small tubes *e* extend down to and enter the rear portion of the lower sector-shaped box B' at the rear of the bridge-wall D, the pipe C being also connected to the upper box B by means of a row of horizontal pipes *d*. The boxes B and B' are connected by means of water-tubes E and E', the ends of which enter the plane surfaces *b* and *b'* of the boxes B and B' and are secured therein, preferably, by expanding the ends in the manner ordinarily employed in securing tubes in boiler-heads. The tubes E and E' are preferably located at an inclination of about thirty degrees from a horizontal, so as to admit of room under the front ends for a furnace F. At the rear of and above the upper tier of tubes E', is a bridge or fire wall, which extends from the upper face *b'*, of the box B', forming the rear of the furnace F, up, say, about three-fifths of the distance from the face *b'* of the box B' (following the curve of the bank of tubes E') to the face *b* of the box B, so that the heat from



the fire-box F passes up between the tubes E and E' and out between the end *e* of the bridge-wall D and the face *b* of the box B and up between the horizontal pipes *d* against the lower sides of the steam-drums A, and along to the front ends thereof, and out through a chimney G, secured to the front ends of said steam-drums A by breeching *g* of ordinary construction. The boxes B and B' are provided with man-holes H on the curved sides *k*, so as to admit of access to the inside, and in the lower and rear box B' is a partition I, extending from the lower and curved side *k* upward, about two-thirds of the distance to the angle *k'*, the object of this partition being to form a chamber in the rear portion of the box B' for the reception of sediment, which can readily be blown out therefrom through the blow-off pipe J in the usual way.

COAL WAGON.

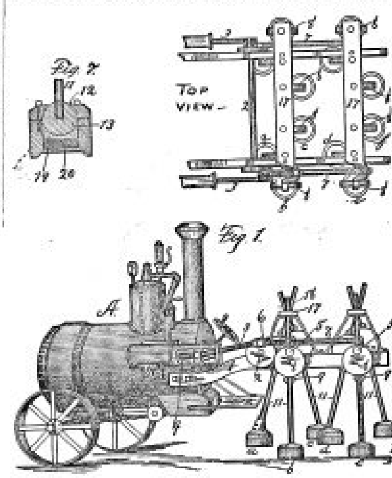
No. 463,254. Charles Fay, Providence, R. I. *Patented November 17, 1891.* The wagon-body tilts on the back axle in the usual manner. The front end is lifted by four toggles arranged as shown. Two toggles *c* c^1 are pivoted to a block *j* on the front end of the body, and the other two *e* c^1 are pivoted to a block *s* on the frame. The opposite ends of the toggles are pivoted to nuts *e e*, which are moved



to or from each other by a right and left screw 5. This screw has a square shank on each end, for a crank by which the driver operates the device. Slotted guards R guide the ends of the screw and prevent the toggles from buckling or springing forward out of line with each other. The effort required to lift the load is small, and the box will remain suspended at any point without danger of the screw running down.

WALKING TRACTION ENGINE.

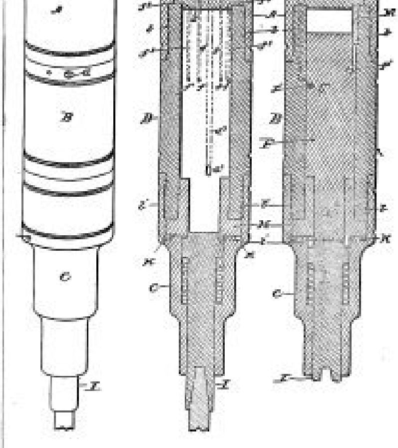
No. 461,441. Edward M. Knollin, Lacona, N. Y. *Patented October 20, 1891.* The front end of the boiler is carried on a pair of wheels which are controlled by steering chains in the usual manner. At the rear end of the machine twelve "legs" are arranged in two sets of six each. Each rod 11 plays through a hole in the top bars 17, and carries on its lower end a pedal or hoof, constructed as shown in Fig. 7. The rod 11 ends in a ball which bears in a block 19, and a block of rubber 20 is placed under 19 to ease off shocks. The rods or legs are operated by eccentrics on the shafts 5, and the shafts are driven by cranks and coupling



rods attached to the main driving shaft 2. The eccentrics are all set at angles of 90° with each other. It will be seen that *b* and *e* are on the ground and are pushing the machine forward, *a* and *d* are ready to descend, and *c* and *f* have risen and are about to pass forward to make new steps. By reversing the driving engine the machine will "back" as powerfully as it will go ahead. The feet take hold of the ground like a horse's hoofs, and consequently they will not slip as the wheels of ordinary traction engines do when on muddy ground. The firm bearing of the feet enables the machine to climb very steep grades.

PNEUMATIC STONE DRILL.

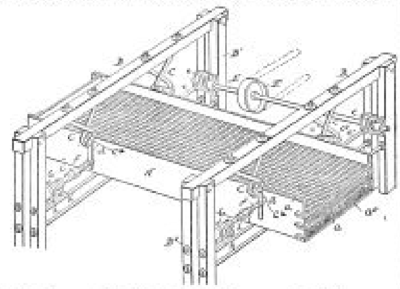
No. 464,820. Daniel Drawbaugh, Eberly's Mill, Pa. *Patented December 8, 1891.* This tool is designed for drilling and dressing stone and similar operations. It is held in the hands by means of handles attached to the collar A^1. Air under pressure is supplied by a hose attached to the plug-cock on the top end. Fig. 1 is a perspective view, Fig. 2 is a lengthways section, and Fig. 3 is a similar section at right angles to Fig. 2. The shank I holds the tool, and is held up to its stops, as in Fig. 2, by a coiled spring, as shown. The piston or hammer F is shown in Fig. 3 at the end of its stroke. The valve-chest D is clamped between the collar A and the body B, and it consists of a solid block



bored to receive a small piston-valve E which moves crossways of the cylinder. Small holes are drilled in the top side to serve as inlet ports, and other holes in the under side lead to the opposite ends of the working cylinder. Other passages *f* are made in the metal of the cylinder which register with grooves 5 in the piston, and serve as exhaust ports. A small pin-valve G, Fig. 1, serves to choke the exhaust and reduce the number of strokes per minute without reducing the force of the blows. To reduce both at the same time the air is throttled by the plug-cock *g* at the top. The inventor declares that this tool will strike thirty thousand blows per minute under favorable circumstances, and will penetrate stone very rapidly.

SCREEN.

No. 464,776. JAMES POLLOCK, WILKES-BARRE, PA. *Patented December 8, 1891.* A number of ordinary flat screens are combined in a single frame, as shown, the coarsest one on top, and all are inclined in the usual manner. The set of screens are suspended from the cross-beams B by links C, which are hinged by jaw bolts and pins to the beams above, and are connected at



their lower ends by links C^2. The hangers *d* of the screen frame take hold of a pin in the middle of the links C^2, thus forming a practicable straight line motion. The screens are shaken sideways by the eccentrics shown on the driving shaft E, and on the opposite side they are connected to air cylinders or cushions G, which are designed to absorb the momentum of the screens and thus soften and diminish the shocks incident to the shaking movement. Turnbuckles *i* are provided by which the air cushions may be regulated.

ORE CRUSHER.

No. 464,083. GEORGE AND ALBERT RAYMOND, CHICAGO, ILL. *Patented Dec. 1, 1891.* The crushing head K is globular in form, and is carried on the top end of a stiff spindle J. The lower end of this spindle is moved in a circle by the crosshead I, which is moved by two eccentrics *d* on the driving shafts D. They are driven at equal speeds in the same direction by the bevel gearing shown. The crushing head with its shaft, and the crosshead I are adjusted vertically by two hanger rods H, which support their weight.

Fig. 1.

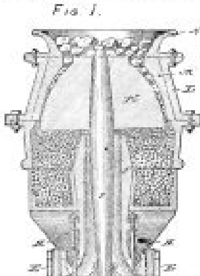
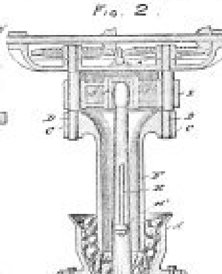


Fig. 2.

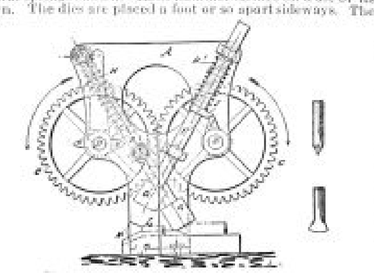


The crushing head has no fixed center to vibrate upon, but is centered by the material passing between it and the sides of the hopper M. The head has the greatest motion near its lower edge, where the finest crushing is done, consequently all packing or clogging with fine stuff is easily avoided.

Fig. 2 shows another form of the machine in which the driving gear is placed at the top, and the hopper and crushing head at the bottom. With this form of machine the material is shoveled in from the floor, and is preferable for many uses.

MACHINE FOR SHARPENING DRILLS.

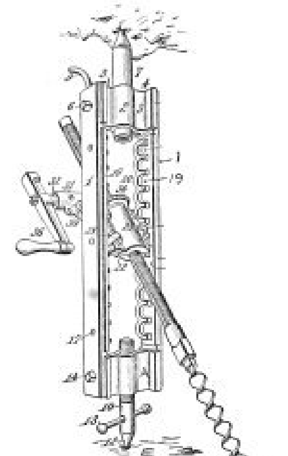
No. 459,931. JOHANNES GUTHERLET, JERSEY CITY, N. J. *Patented Sept. 22, 1891.* This machine is intended to aid the blacksmith in sharpening rock drills. The hammers are attached to rods which slide in guides as shown. They are lifted by cams on the shafts B B^1, and are thrown by the spiral springs shown. Each hammer strikes on a die of its own. The dies are placed a foot or so apart sideways. The



hammer G^1 serves to swage the shoulders of the drill, and the hammer G draws down the cutting edge. As this part of the work requires more blows than the other, the shaft B is provided with a double cam, so that the hammer G makes two strokes to one of G^1. The machine can be operated by a crank, or it can be driven by a belt.

DRILLING POST.

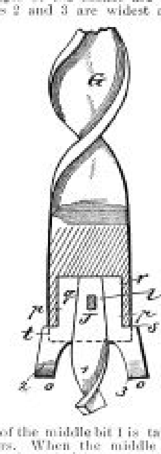
No. 463,469. ALEXANDER WALKER, WHAT CHEER, IOWA. *Patented November 17, 1891.* This post is composed of two end castings A and 3, which are united by wrought iron side plates 1. The top casting is provided with an adjustable center 7, and the lower one is threaded to suit the jack screw 10. Long cast plates 19 are made with a



flange on the front edge to lap over the edge of the bars 1, and are fastened to them by suitable rivets. Each plate is provided with ribs 20 which form a series of pockets to receive the trunnions of the drill nut 22. This nut is made in halves hinged together in the usual manner. The drill is supported in any direction without tendency to run sideways or twist.

COAL-DRILL BITS.

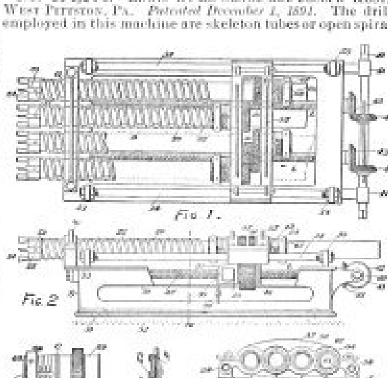
No. 464,497. JAMES EAGEN, WYOMING, PA. *Patented Dec. 8, 1891.* The auger is provided with a flat socket at the front end, which holds the shanks of three bits as shown. The edges of the socket are parallel, and the shanks of the bits 2 and 3 are widest at the inner end,



while the shank of the middle bit 1 is tapered to suit the taper of the others. When the middle bit is put in its place and the cross key *t* is driven up tight, the side bits are securely held in place. The cutting edges of 2 and 3 are lipped in the usual manner.

MINING MACHINE.

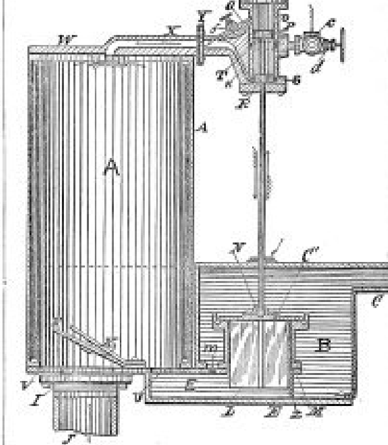
No. 464,374. LEWIS W. LE GRAND AND JOSEPH KLOTZ, WEST PITTSTON, PA. *Patented December 1, 1891.* The drills employed in this machine are skeleton tubes or open spirals



52, armed with removable bits 54, which are held in dovetail slots in the heads 53. The spiral is made by winding a bar into a spiral and making occasional connections between the coils as shown by 51 in Fig. 4. The bar 52 is grooved on the outside, as shown. Power is applied to the end shaft 40, which drives the feed-screws L by bevel gears. These screws are slotted to engage feathers in the gears 46 on the cross-head 35. Behind each gear 46 is a divided nut, the halves of which are operated by the slotted levers 29, Fig. 3. The pinions 40 drive several gears 61, each of which turns a chuck C, shown in detail in Fig. 5. This consists of a shell through which the drill-tube passes, and the end of the shell is tapered and threaded for the collar nut 64. Slots 62 make the shell compressible, and by screwing up the nut the drill-tube may be gripped at any part of its length. The drill-tubes may be of any length desired. Each drill leaves a solid core, and the borings pass out along the groove in the outside of the spiral bars 52. When the cross-head is fed forward as far as it can go, the nuts 36 are thrown out of gear by the handle 39, the nut on each chuck is slacked off, and it is run back as far as desired, the chucks are again tightened, and the drills are ready to bore still deeper. Any depth of undercut can thus be made.

STEAM VACUUM PUMP.

No. 464,037. GEORGE H. NYE, CHICAGO, ILL. *Patented Dec. 1, 1891.* This pump employs but one cylinder or working chamber A. K is the suction valve and C^1 is the discharge valve. Steam is admitted by the globe valve *d* to the steam chest O. Two grooves T and S are made in the bore of the steam chest, which are covered and uncovered by the valve rings P and R. When they are in the position shown, with the steam groove T uncovered and the lower groove S closed, the pump is ready to start. The chamber B is primed with water enough to cover the discharge valve C^1, and this water makes its way through a small hole *w* into E and into the working chamber A. Steam is turned into the chest O and it passes through the valve ring P, and the port *a*, small throttle valve *f*, and pipe X to



the chamber A. The jet is very small, only enough to displace the air, and it quickly condenses. Water enters by the valve K and fills the chamber. When the chamber is about full and the vacuum is gone, the head of water in A above that in B is sufficient to lift the discharge valve which was held down by air pressure as long as there was vacuum in A, and also shift the steam valve which is attached to C^1 by a rod as shown. The groove S is thus uncovered and steam in larger quantities is admitted by port *s* to the cylinder A, which drives the water out into B and off by the pipe C. The valve C^1 now falls by gravity and diminishes the supply of steam, condensation again begins and the order of operations is repeated. The machine is intended for low lifts, for irrigation and washing purposes, and for small steam consumption.

"Rose Must Wait."

Our readers will remember that a short time ago we called their attention to two valuable little books published by the Mason Regulator Co., of Boston, Mass. These books have met with a very warm reception from steam users in all parts of the country, and the following letter from Mr. James H. Hocking, of Paterson, N. J., shows how they are appreciated by practical men:

MASON REGULATOR CO.,
Boston, Mass.

SIRS:

Enclosed find 35 cents, for one copy each of "Common Sense in Making and Using Steam," and "Key to Engineering." Our machine shop has just been burned to the ground, and the two above copies added to the flames, together with "Rose's Machine Shop Practice." "Rose" will have to wait, but I must have the above works at once.

PERSONALS

MR. ROBT. SPENCE, formerly mine boss under Messrs. Sommerville and Buchanan, at Winburne, Pa. has accepted a similar position under Supt. R. A. Shillingford, of the Clearfield Bituminous Coal Corporation, at Pleasant Hill Colliery, near Peale, Pa.

MR. C. B. ROSS has resigned his position as Assistant Mine Boss at Brownfield, Pa., and accepted a similar position at the Oliver Coke and Furnace Company's new works, near Uniontown, Pa. The exchange took effect Jan. 1st last.

The Colliery Engineer.

AN ILLUSTRATED JOURNAL OF

Coal and Metal Mining and Kindred Interests.

VOL. XII.—NO. 8. SCRANTON, PA., MARCH, 1892. WITH WHICH IS COMBINED THE MINING HERALD.

MACHINE MINING.

Its Advantages—Under What Conditions the Various Types of Machines are Most Successful—The Method of Keeping Accounts of Cost of Mining.

BY LEWIS STOCKETT, ST. LOUIS, MO.

Ten years ago, in this country, machine mining was looked upon almost entirely as an experiment in which few had any faith, or were willing to hazard capital in. To-day the experiment has become an assured success, and machine mining is fast becoming the rule and not the exception. In the State of Illinois, for the year ending July 1st, 1890, out of a total of 12,638,364 tons mined by all methods, 2,881,983 tons were mined by machinery, being 23% of the total. In the Fourth Inspection District of this State for the same period, of a total of 3,716,464 tons mined, 1,615,453 tons, or 43.5% of the total, were mined by machinery; and in the Fifth Inspection District, covering the same period, of a total of 3,240,004 tons mined, 1,101,262 tons, or 34% of the total, were mined by machinery; and succeeding reports will show increased percentages.

Pennsylvania, Ohio, Indiana, Michigan, Iowa, Missouri, Kentucky, Alabama, and several western states, will show percentages that compared with previous years, will show that machine mining is steadily increasing, and there are scarcely any of the coal producing states or territories of the Union where machines are not being or have been used with more or less degree of success, in other respects as well as financially, when under proper conditions, and earnest effort has been made to make them succeed.

Ten years ago the miner that worked with or after machines was a "blackleg" to be shunned by his fellow workmen, and often followed his occupation at the risk of the "boycott," personal injury, and even loss of life from those opposed to the innovation. This has all changed, and to day the machine miner and laborer form a large portion of the mining class, and are often the commanding influence. Where machine mining has been successfully organized and carried out the result has been greater regularity of work and better wages for the employes.

So far machinery for mining is confined to machines for "undercutting," "shearing," and "drilling," and which by cutting the vein horizontally or vertically, and drilling the holes for blasting, prepare it for the work of the miner in charging, blasting, assorting, loading, and timbering. Machinery for these latter purposes has not been introduced, though experiments are continually being made with machines for loading, and the writer has seen two patterns that in a large vein with good roof would do the work very well; it is to be hoped that a successful machine will finally be devised to relieve this the most laborious portion of securing coal. The cleaning of the coal from its impurities, where the same exist, and throwing of them back into the gob is a task that can hardly be accomplished by machinery, which can only be expected to lift the mass from the floor and deposit it in the cars. Where these impurities do not exist in too great an amount the cleaning can be done more thoroughly and more economically by proper coal cleaning machinery placed in the tipple outside.

Electric batteries for firing the blasts after the charges are tamped, and the use of lime cartridges and power wedges for breaking down the coal may be mentioned as attempts to do the breaking down by machinery, but have not come into general use.

For timbering, machinery has nothing to offer and it is only indirectly that a saving can be effected in this department of the work; by deep undercuttings, the roof if tender is shattered less by the blasts, and as machine mining gets over the ground much quicker than the older method, rooms are driven their length and finished before timbers need replacing. To offset this places for machinery are generally driven as wide as possible in order to give the machine the advantage of working steadily and preventing the loss of time in moving frequently from one face to another; this will take more timber, and it becomes a nice point to determine on the score of economy just where to draw the line between the two.

The power used to operate mining machinery has been almost entirely compressed air, of late electricity has become a recognized factor as such, and there is no doubt but that in time, with improvements in application, it will become more and more so. At present the most successful machinery being driven by compressed air necessitates its use, and for this reason is preferred by the writer.

DRILLING MACHINES

are of two classes, revolving and reciprocating, the first of which classes can be again divided into those that leave cores, and those that take out the full space. For blasting purposes the first are seldom used, and of the latter we have those operated by hand and those operated by power; both consist of a worm or auger, one end of which is dressed to an edge to cut the coal and the other end fitting into the socket, or *vice versa*, of a threaded feed-bar, and which revolving forces the cutting edge against the coal, cutting off a portion the diameter of the hole and equal in thickness to the advance of the screw per revolution. The box through which the feed-bar revolves is held in place either by a post held to place by pressure of a screw-jack against the top and bottom or by a wedge fastened in the face of the coal; in a strong coal where the roof is high this latter is preferable, and in a soft, slippery coal, with low roof, the post is preferable. In some soft, pure coals an auger turned by a brace and held to its work by the pressure of the breast is all that is necessary, and where the same can be accomplished it is undoubtedly the most economical mode of drilling, both for cost of equipment and cost of operating.

Where power is used for this class of drills, its application is generally a high speed engine of the rotary, trunk, or oscillating types, geared down to give the required speed to the drill and for power, and the power itself is compressed air or electricity. The rotary, when used for compressed air, is the most wasteful form of application, its simplicity and few wearing parts, however, have brought it into general use, the later patterns fitted with double rotaries at right angles to prevent dead centering, are an improvement.

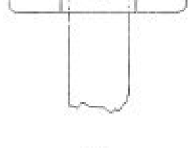
The augers for both machine and hand drills are generally in sets of three, the first two feet long, the second four feet long, and the third one six feet long; when the first one has gone in its full depth it is removed, the hole carefully but rapidly scraped or cleaned, the second one entered and so on until the required depth is reached. These augers requiring frequent sharpening, it is done by means of a file in the hands of the driller who keeps up the edges as long as possible by this means, until they become too thick or broken off, when it becomes necessary to send them to the shop for sharpening at the forge by the smith. Care must be taken to keep these augers of standard width so that the succeeding length will easily follow and not bind in the hole; where it is necessary to concentrate the powder in the back of the hole, the shortest length can be made $2\frac{1}{2}$ inches wide, the next or middle length $2\frac{1}{4}$ inches wide, and the last or longest length 2 inches, and where it requires that the powder be spread out more in the length of the hole, these widths can be made $2''$, $1\frac{3}{4}''$ and $1\frac{1}{2}''$ for the respective lengths. A little experimenting will soon show the best form of bit to meet the requirements of the particular coal in question, a little change in this respect sometimes being the difference between failure and success of the machine. These augers are now, in some cases, being made with removable points, which allow of them being taken out and ground on an emery wheel when requiring sharpening; this is a very convenient arrangement and saves the carrying out and in of the long augers, a driller going in at the beginning of a shift carries in as many bits as will suffice for the shift's work, strung on a piece of wire through a small hole drilled in the bits for that purpose, taking them out at the close of the shift to be ground and made ready for the next shift, or where a duplicate set can await the opposite shift. The necessity for carrying in and out the augers being thus done away with, it allows of their being made much heavier and stiffer, preventing their bending and binding in the sides of the holes. The feed-bars have screws of different pitch varying from 6 to 20 threads per inch, and with such give positive feeds. Drills are now being made with variable feeds, by means of ball bearings and friction clutches, and where the same are made strong enough to stand the work intended are a decided advantage giving an almost instantaneous change of feed from 4 to 1,000 threads per inch, adjusting itself to the changes of material in the hole. Other drills are fed by the air pressure, the feed-bar being the piston rod of a long cylinder, and others are fastened against the top by the same means, a piston and rod taking the place of the screw-jack.

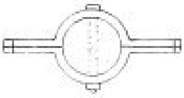
In order to facilitate the rapid handling of these machines, all screws and jacks that require turning should be fitted with large-sized hand wheels, by means of which they can be tightened or loosened much more rapidly than if turned by a wrench on a nut or a bar through an eye. A set of blocks, say a foot long and three, six, nine, and twelve inches thick, shod with iron on the side next the drill and bolted through horizontally to keep them from splitting, will help the rapid setting up of the column or frame, as well as give a better bearing against the top and bottom. All frames should be made sufficiently stiff to stand the thrust of the feed-bar without the assistance of any back-jacks, which not only take time to place them, but are apt to throw the machine out of line and cause binding in the hole.

In fairly clear coal or where the impurities are mostly slates, the auger drill is the most convenient and rapid, but in some coals that are liberally and irregularly interspersed with pyrites in the shape of round or flattened nodules, the revolving drill will not do the work satisfactorily, and recourse is then had to drills with reciprocating motion. The writer has seen nodules of pyrites that could not be drilled in a drill press of a machine shop with twist drills, easily shattered by the light blow of a hammer. So it is with reciprocating drills, a nodule that would completely stall a revolving drill, is shattered into small particles by the continuous blows of one of these drills, and is passed out with the other drillings.

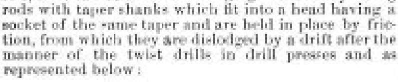
Of this class of drills we have the hand or churn drills, and the power percussion drills, both of the same principle and working exactly alike, in the first the blow is given and the drill turned by hand power and in the latter by power applied through machinery. Both of these drills are familiar enough to the mining public not to need any description; the hand drill should be double-bitted, that is, with a bit on either end, except one which will need a head on one end for the purpose of knocking off sulphurs, four drills constituting an outfit for a day,s work.

Any standard rock drill, such as the Ingersoll, Burleigh, Rand, or Edison Electric, with a few modifications, will do the work. it is essential that they be as light as possible in order that two men may easily and quickly move them, a column of four-inch gas pipe is sufficiently heavy and stiff for any height not exceeding eight feet, the top of the column should be as represented below in order to prevent the possibility of any turning of the same, and all clamps,





saddles, etc., should be sufficiently large to hold the shell rigidly in place. The drill is the same as that used for rock, requiring only the smallest size, time can be saved in changing the bits by using rods with taper shanks which fit into a head having a socket of the same taper and are held in place by friction, from which they are dislodged by a drift after the manner of the twist drills in drill presses and as represented below:



The drill rods should be of cross steel about 1¼″ × ¾″, and made up in sets according to the travel of the drill in the shell, if this is 18″, a convenient set would be four of the following lengths in addition to shank, 24″, 42″, 60″, and 78″, care being taken to preserve the difference of lengths in the rods, for if they are less than the travel of the drill, time is lost in drilling, and if they exceed it the rod cannot be entered without first increasing the length of the hole by churning in the rod by hand. The bits should be of the following widths:

24″ long, 2⅜″ wide, or 2¼″ wide,
42″ long, 2¼″ wide, or 2″ wide,
60″ long, 2⅛″ wide, or 1¾″ wide,
78″ long, 2″ wide, or 1½″ wide,

and are made by forging out the cross steel by special swedges and dies to the required width; gauges should be provided the smith and every bit sharpened accurately to its gauge, the cutting edge is filed hot and of the same angle as a hand drill. The channel of the cross steel cleans out the hole as the bits turn round, but time will be saved by cleaning out the hole at every change of bits, by a few rapid strokes of the ordinary scraper. These drills should also be fitted with the same complement of blocks as the power auger drills to ensure rapid setting of the same, and if the variation in the height of the rooms, entries, and so on, is too great, a saving of time will be found in using two columns, each one a different length, as required, and having its own clamp and saddle.

The number of holes that will be bored by each class of machine per shift is as follows:

Hand Churn Drill	6 to 10,
Hand Auger Drill	8 to 15,
Power Auger Drill	20 to 50,
Power Percussion Drill	20 to 40,

the first two requiring one skilled man to operate, the latter two requiring one skilled man and one laborer each, so that if due allowance is made for the amount of labor required and to this be added the cost of repairs and interest on the investment, it will not always follow that machine drilling is the cheaper, besides which the following should be considered, the greater rapidity with which a man carrying a drill on his shoulder can move from place to place as compared with a machine drill and its accessories loaded on a truck, and which must be pushed from place to place on the truck dodging trips, cars, mules, etc.; and, as is often the case, from failure of the shots to do their work, a single "pop" shot is wanted, a man with a hand drill can have the same drilled while the machine is getting around to the work. This with delays from break downs, which will at times happen and which must be provided against, as far as possible by duplicate parts conveniently kept, make the question of how the drilling is to be done, one for careful consideration. There are some veins so full of impurities and pyrites that the only way to drill them is with power drills, and no choice presents itself in the matter; in some localities scarcity of skilled labor makes it a necessity to drill with power, but when the vein is ordinarily pure and skilled labor abounds, the hand drill will be found the cheaper.

In entry and narrow work hand drills can attack the work quicker, as a rule, and have it prepared for the blasting, loading out, timbering, and cutting again sooner than the power drill can leave the locality it is working at, and it will not pay to load up a drill before it has finished *all* the drilling in a room or face to go and do some other work load up again and come back and finish. Where the narrow work is being pushed this is an item of considerable importance. The rule prevalent at so many mines of requiring all the shots to be fired at a certain hour or hours of the shift is also detrimental to getting entry and narrow work ahead. The true plan for economy is always having the entry and opening work ahead of all requirements and to proceed with it in regular routine, to push anything means to add extra expense, and may often eliminate all profit. Entry and narrow work should be blasted as soon as it is cut and drilled and gotten ready for the cutting machine as soon as possible; the ventilation should be such that the smoke from the blasts is quickly carried off; if not true economy demands a sufficient volume of air for this purpose, and that the air current be carried in "splits" so that the smoke of one section is not carried into and interferes with another section.

It can readily be seen that while the hand miner can work ahead in the "tights" or on the "bench" and keep entry work going during delays and idle time, the machine requires that every portion of the work go ahead regularly without delay, and that any block in any particular department works through and delays the whole.

MINING MACHINES.

Cutting machines can be divided into three classes as follows:

1. Those that plane or scrape the face of the coal or along the face of the same.
2. Those that bore the coal.
3. Those having a reciprocating motion, attacking the coal by a blow.

Examples of the first class are the Kangley Longwall Machine, Legg, Lechner New Arc Machines and others.

Of the second class the Smith, Van Depoele and Stanley Entry Driver.

And of the third class the Ingersoll-Sergeant, Chouteau, Harrison, Sperry, and others.

This last class has the advantage of the same machine being also a "shearing machine."

Like the drilling machines, there are some conditions under which a revolving mining machine cannot do the work, and where a blow is required to shatter and displace impurities. In a clear coal or undermining not too hard, machines of Classes 1 and 2 will not only do the work well but more rapidly than those of Class 3 and have the advantage that more of the work is done by the machine, less depending upon the operator, whose work consists only of setting the machine and stopping and starting the same; with them a cut of a positive depth is made, though with some of them this cut is not of sufficient height to tumble the coal when blasted; and when the cutting is done in the coal a smaller percentage of it is lost in the cuttings than with those of Class 3. Machines of Classes 1 and 2 require a better roof and more room at the face clear of the props, and for this reason cannot be used at all in some localities where these conditions are unfavorable; running at high speeds their wear and tear is heavy and require considerable expenditure for renewals and labor of repairs.

Machines of Class 3 would be better named "power tools" than machines, and differ from Classes 1 and 2 in that a large part of the work requires to be done by the operator and requires more or less training and skill on his part to manipulate them, like the percussion drill they can cut coal containing nodules that would entirely baffle a revolving cutter or drill, accomplishing it by either cutting around and dislodging them or shattering them by a blow or blows. This gives them the advantage of being able to cut coals that other classes fail on as well as those they succeed with, and as they can be handled where there is very little room between props and props and faces, together with the fact they can both "shear" and "cut," and that wear and tear and consequent cost of repairs is light, make this class of machines the best "all around" machine for the purpose for which they were intended.

Having selected one of this latter class as the machine we will use, and compressed air as the power let us proceed to investigate the elements that enter into a successful machine organization, these may be listed as follows:

1. Machinery used.
2. Conditions of mining.
3. Organization of working faces.
4. Regularity of work.

With a properly selected and installed plant, that its success will largely depend upon the mining conditions must be self-evident, these are enumerated below, giving the extremes, variations being found all the way between:

Clear cutting.	Cuttings full of nodules.
Soft cutting.	Hand cutting.
Free cutting.	Woody cutting.
Dry face.	Wet faces.
Strong coal.	Free slippery coal.
Top and bottom partings.	Lack of top and bottom partings.
Freedom from impurities.	Containing impurities.
Partings from impurities.	Lack of partings from impurities.
Good roof.	Poor roof.
Face and end joints.	Knotty curly coal.
Regularity of floor.	Irregularity of floor.
Width of work.	Narrowness of work.
Freedom from faults.	Faults.

With the conditions enumerated in the first column we can expect exceedingly favorable results, and need not despair of results with those in the second, though for machinery with conditions in second column to compete with hand mining under conditions of first column would be almost a foregone conclusion, unless part of it can be made up by a superior organization of the machine forces, as compared with a loose organization of the hand mining, which brings the point that after all it is largely in the organization and control of forces which machinery enables, that the true success of machine mining lays. By it each person located at just the kind of work he is particularly fitted for and by continued practice at the same kind of work soon becomes very skillful and quick at it; and no needles props are set, no useless holes are drilled, powder is not wasted, no false blows of the cutting machine and so on, by the workman; and water drained, ventilation secured, roads, cars, and motive power in best of condition, tools and equipment kept in order, and everything up to the top notch for results, on the part of the management; are the benefits which will result from organization and count in the direct cost per ton. The same may, in part, be true of hand mining forces, but it cannot be as thoroughly carried out where the miner has to do all departments of the work and no arrangement by which each person is put at the particular work he is particularly good at.

By no means least, comes the regularity of work without which a successful machine organization cannot be maintained. The different portions of the work being carried on by separate gangs, it becomes very necessary that an unbroken routine be kept up, and that the several portions join together as the tenons of a dove tail to form a complete whole. The exigencies of trade, car supply, etc., can best practically be met by the mine having a large number of working places sufficient for several days work of the machines, and no more machines than that by working every day can cut the required amount of coal. This will keep the machine forces steadily at work and when trade demands and car supply warrants, a large force of loaders and timbermen can be put on, and the product of several days cutting loaded and hoisted. The usual difference between summer and winter trade is best met by running the machines single shift during the summer and when the fall trade comes, running the same double shift, putting the helpers of the day shift through the summer on as runners for the second shift of winter, their places in turn as well as extra loaders to be filled by the labor that naturally comes to the mines in winter when much out-door employment ceases. Extra timbermen and blasters having been educated during the summer from the ranks of the loaders.

In starting a machine organization, the better plan is to have every one connected with the working forces paid by day's wages or by the hour, with an allowance for use of tools, and for furnishing lamp, oil, and wicking, a premature attempt to force contract prices upon the men before they know what the machines are capable of doing, and what they are capable of doing themselves under the new order, and before even the management are practically posted on these points, nearly always resulting disastrously. Contract or piece-work for the *different portions* of the work after two or three years running when every one has become entirely familiar with the work then becomes an advantage to both parties, and is to be preferred to any *lump* contract.

In organizing machine forces the following portions of the work are entirely distinct from each other and should be kept as entirely separate departments.

Undercutting and shearing.
Drilling.
Blasting and timbering.
Loading.
Mechanical.

Variations of the above are allowable as follows: if hand drills are used it may be advantageous to combine the drilling and blasting, and where the roof is good and little timber is required, the timbering and loading may go together, but generally the best results will come from an organization laid out as above.

The whole to be placed under a general foreman or machine boss, who has entire charge of the machines and all men working with them, but in everything else is subordinate to the pit boss or underground manager who directs the workings, see that they are kept in safe and proper condition, mine properly ventilated and drained, coal hauled away, etc. The line is easily drawn, one directs what work is to be done, the other directs the men and machines to do it; on a proper understanding and carrying out of this, success or failure may often depend, and unless the organization is small, it is impossible for one man to attend to the duties of both places and do either of them anything like justice. If a second or night shift is needed, a night foreman will be necessary and this is all; too common a mistake made is to load down organizations with several foremen for different departments whose jealousies and bickerings entirely destroy any possible chance of success. This foreman may, in the early stages of the installation and at various times need several instructors, who should simply be competent workmen, on workmen's pay and without any authority whatever.

The general foreman should be a person with the following qualifications:

1. Ability to get along with and handle men.
2. General knowledge of mining.
3. General knowledge of machinery.
4. Sufficient schooling to keep time and record.

As said before he should have the entire charge of the men and machines, and be responsible for results, hiring such men as he may need and discharging or changing those that will not carry out his instructions, or who may not in his judgment, after sufficient time has elapsed for them to become competent, give required results.

The undercutting is generally done by two persons, one called the "runner" and the other the "helper," some conditions requiring a third man or second helper called "slackman," as in soft fire-clay mining, in which the machine cuttings are of such large quantity, that to store them away in the gob before the coal is blasted down is the work of another man. The runner operates the machine, directing the cutting, the helper changes the cutters as they become dull, and shovels back the cuttings; the two move the machine from cut to cut and from place to place. Every machine should be supplied with the necessary tools to operate same, and an oil can (the size to contain the proper quantity for one day and no more), these to be charged the runner when taken out, and to be returned by him at the close of his shift when reporting his time and amount cut. The amount cut in lineal feet by feet in depth, the number of entries or narrow places and the number of shearings should be reported at the close of every shift and entered upon a record. If these measurements are reported to the general foreman he will, from his own personal knowledge of the day's work, be able to check the reliability of the same, and should give them frequent checks by actual measurement, especially as to depth, for on this one particular the success or failure of the undertaking will greatly depend. Every inch increased depth of cutting, not only counts directly on the amount of coal produced, but also indirectly in the decreased cost of blasting, the less shattering of roof, and consequent saving of timber, and large percentage of large coal. Other matters of importance to be looked after, are that no more of the coal is cut than is necessary to get back the full depth, and that when there are no partings the cutting is kept to its proper place, and loss avoided by this means.

Runners are taught by first working as a helper to a competent runner, then by cutting turn about with him or another helper, under the instruction of an instructor or the general foreman, until by practice he becomes sufficiently skillful to take a machine, after which much depends upon himself; any ordinarily intelligent workman possessed of either mining or mechanical skill, and capable of doing a day's work at other branches of labor, can in from six weeks to six months, according to conditions, become good runners.

Entry and narrow work often requires shearing or cutting up and down vertically in addition to the undercutting, and under some conditions this shearing of itself is all that is needed, without any previous undercutting.

The drilling, as conditions may decide, will, in some cases, be most economically done by hand and in others by power; if done by hand either with the churn or auger drill, each man called a "driller" is supplied with drills or augers sufficient for a days work, and follows after the cutting machine, drilling such holes as directed by the general foreman, at such places, angles, and depths as experience gained from day to day may prove to be best. Some coal will allow of shooting over the mining from six inches to one foot, and when this is the case advantage should be taken of it, as all coal gained in this way is almost a direct profit; other coals again will shoot short of the mining, and it is better to let this be done, than to

SHEET A.

Machine Mining .... *Mine* .... *189*....

GENERAL.			MECHANICAL.			POWER.		
NO.		AMOUNT.	NO.		AMOUNT.	NO.		AMOUNT.
	Foremen			Machinist			Engineer	
	Clerk			Blacksmith			Fireman	
	Instructors			Helpers			Ashman	
	Miscellaneous			Forge			Fuel. Tons @	
	Depreciation			Pipeman			Water Supply	
				Carpenter			Oil and Waste	
				Tool Boy			Depreciation	
	Total			Total			Total	

No. of Machines	
No. of Drills	
Total	

General Expenditure per Machine	
Mechanical " " "	
Power " " "	
Total	

COST PER MACHINE AND DRILL.	
Runner	
Helper	
Pro rata General Expense	
Pro rata Mechanical Expense	
Pro rata Power Expense	
Oil and Supplies	
Total	

Total Cost of Operations	
Less .... Yards Entry @	
Less .... Room Turning @	
Cost of Coal	
.... Tons Mined, per ton	

REMARKS.

SUPPLIES.				DRILLS.				
NO.	KIND.	RATE.	COST.	NO.	DRILLER.	HOLES.	TIME.	COST.
	Kegs Powder							
	Boxes Squibs							
	Lbs. Paper							
	Total				Total			
	Cost per Ton				Cost per ton			

Total Cost Per Ton, Supplies and Drilling ....

SHEET B.

Machine Mining .... *Mine* .... *189*....

No.	RUNNER.	Check.	Feet.	Yards.		Tons.	Hours.	Mining.	Drilling and Explos.	T. and Blast		Loaders.		Total Cost.	COST PER TON.				
				E.	N.					No.	Cost.	No.	Cost.		Mining.	Drilling.	Timber.	Loading.	Total.
	Total																		
	Average																		

attempt to get it all down at a waste of powder and sacrifice of coal blown into slack.

In Longwall work, work having a good top parting, and weight from the roof, and gaseous coals, drilling and blasting are not always necessary, in these cases wedges under the cutting or sprags against the face are needed to hold the coal while being undercut, the removal of which afterwards allows the coal to drop, with now and then an occasional pop-shot to bring down some portions that may have failed to come.

With power drills, the work is done by two men, a "driller" and "helper," the two together set and connect up the machine, the former runs or feeds the same, the latter taking his station close to the hole to quickly change drills and scrape out the hole, or while one looks after the running of the machine, the other with a file sharpens up such bits as may have become dull and yet not sufficiently so to be sent to the forge. With power drills it is an advantage to drill ahead of the cutting machines avoiding the cuttings which, if of coal, are left laying in a heap, about the place the drill column or frame is set up. Like the machine runner, each driller should be supplied with the necessary tools and oil cans to be charged up to him and returned by him at the end of each shift.

The blasting and timbering together are usually done by the same persons and their duties consist of charging and firing the holes drilled by the driller, breaking up large coal, trimming the face and top and setting the required timbers, and are responsible for the safe conditions of their places. To them the powder and other blasting supplies are given out each shift and they are accountable for the same and their proper use, and by them the timber needed is ordered from the party whose business it is to see that the same is sent into the mine. Each blaster and timberman should have a box or shanty made in a cross-cut, under lock and key to keep his tools in, and which will consist of the following: Light trimming picks, heavy breaking picks, wedges, sledge, needles, tamping bars, scraper, powder can, cartridge stick, axe, saw, hatchet, etc.

The loading is done by men called "loaders," who work singly or in pairs, as circumstances suggest. Their duty consists of loading up the loose coal into the pit cars, cleaning it of impurities and casting the same back into the gob; their tools are the shovel or fork, a heavy breaking pick, and their own hands. Much of the loader's success will depend upon the shape the coal is thrown down to him, the distance from car to loose coal and which should not exceed twenty feet to the extreme end, the regularity with which empty cars are supplied to him and the loaded ones taken away, and the amount of impurities to be picked out. An average day's work will vary according to conditions from eight tons per man to fifteen tons per man, to make which average means that at days it will run below this and others beyond it; under very favorable circumstances a good loader has been known to load twenty tons per day for several days.

No more important division of the work is there than that of the mechanical, for on proper sharpening and tempering of cutting tools, and general overhauling, repairing, and keeping up of machinery the success of the entire plant depends. The mechanical force of a machine plant will consist of one or more smiths and helpers as may be required, pipeman, machinist, the occasional services of a carpenter and the tool boys whose business it is to get in and out the sharp and dull tools from the workman at the face to the shop outside, unless as is seldom the case, the cutting is so exceedingly favorable as to allow each runner and driller with their helpers to carry in sufficient tools to do a shift's work, to be brought out again by them at the close of the shift.

The shop should be fitted up with the required number of forges, the blast for which can be taken direct from the compressed air pipes or receiver, a wet emery wheel, grind-stone, drill press, lathe, and small planer, and if so equipped will put in order many a part that otherwise would be thrown aside, as well as make many of the parts needed for renewals. A small steam hammer will soon pay for itself in drawing out picks and drills and re-steeling the same, and if supplemented by a heating furnace will be still more efficient. If the vein of coal is not or has not any bench sufficiently good for the purpose, it will pay to procure a good blacksmith coal even at a pretty high figure, and boxes of dry sand ashes or slacked lime should be provided in which to put the tools to cool off after the same have been tempered.

All machinery should be regularly inspected and the machinist should not wait to receive word that something has broken down to go into same, but endeavor by anticipating such and keeping everything in first class order to lessen the number of breaks and keep the machinery up to its highest mechanical efficiency. Runners should, under no circumstances, be allowed to attempt any repairs of their machines but should report the same to the general foreman, who will call in the machinist to attend to same; by this the runner will understand that his business is to run the machine and keep it going during working hours, and will avoid the habit of constantly tinkering, to which so many are prone, and which, if allowed, is not only done at the direct cost of the owner but finally ends in a lot of very inefficient machinery.

An extra machine always ready to use, to take the place of a disabled or irregular running machine should be kept where the same can be quickly reached in case of need; and a supply of duplicate parts kept on hand to quickly replace and repair any broken or worn out parts should be in the hands of the machinist and kept by him under lock and key.

Next to the general foreman on no one depends the success of machine mining so much as upon a careful, painstaking, active, and economical machinist. A careless one, not only by allowing the machinery to run down may prevent a profit from being made, but many to keep up their machinery may spend in doing so any profit there is to be made.

The pipeman's duties consist of taking care of and extending the pipe lines, and taking up such as are no longer needed, being careful to so arrange his work and the time of the same as not to stop or interfere in any way with the continuous working of the machines. In small operations these duties may devolve upon the machinist. The pipeman should be furnished with a place under lock and key in which to keep the several tools needed for his work and the necessary valves, fittings, etc.

When a carpenter's services are needed, as will sometimes be the case for such matters as boards, trestles, tool boxes, blocks, sprags, wedges, etc., the carpenter employed about the mine for other purposes can be used and that portion of his time engaged upon the same charged to the machine mining account.

The tool boys keeping the runners and drillers at the face of the work constantly in sharp tools have much to do with the success of the work, for any delay for want of tools is a direct loss, and running with dull tools is very little better. Sufficient tools must be furnished by the management to keep a supply at the face, and for the same number in the shop being sharpened, and a like number on the road either in or out. A hole bored through (if one is not already there) the tools, allowing them to be strung together by a rod or heavy wire will assist to keep them from getting scattered in transit, and they should not be sent out on top of loaded cars, but when a sufficient number are ready, loaded into an empty car, care being taken that one is selected which has a tight bottom and sides. As a general thing there is some one out side with other duties, part of whose time can be given to getting the tools from the top of the shaft mouth of the drift or slope to the shop and back again, and which portion of his time can be charged to the machine mining account. Inside, one or perhaps two boys (remember the old saying) will be required to meet the incoming cars, take them to where they are needed, unload them and reload the car with dull tools. The unloading should be done at central points where the machine helpers can come with their dull tools and take back to the machines a supply of sharp ones.

Records sufficient to enable the general foreman to know just what each individual or set of men have done each day should be kept in a clear concise form; if made up every evening and results furnished the foreman it will enable him to look after weak points and correct them the following day. Such records should show the number of lineal or square feet cut by each machine, whether in rooms or entries, yards of narrow work cut, and the number of tons produced per machine; number of holes drilled by each drilling machine or man; number of blasters and timbermen and tons per man; number of loaders and tons per loader; all mechanical and general expense; powder and blasting supplies and tons per keg; oil and supplies used; cost of power and a general charge for depreciation, based upon the footings of the equipment account, a certain percentage of which should be charged off daily to finally retire the cost of the plant.

A convenient form is given on preceding page.

Sheet A is a basis sheet to get at the proportionate expense per machine of general, mechanical, and power expenses, under each head blank lines are left for other items that may from time to time come up. The amounts of these charges are divided by the number of machines and drills and give the *pro rata* chargeable to each machine. The total cost of running each machine a shift (cutting machines and drills) is then arrived at by adding together the wages of the runner, helper, and *pro rata* of general, of mechanical and of power expenses; to this is added an arbitrary charge based on experience and corrected from time to time of the amount to be charged each machine for the oil and waste used, parts for repairs, steel for cutting tools, etc., and which will vary in different localities and machines from 50 cents to $2.00 per day; on blank lines below may be added any other expense for which provision has not been made before. The total of this column gives the total cost of a mining machine per shift, and will be found to vary from $8.00 to $12.00, according to conditions and location.

Below is given a column for the record of the drilling machines (or drillers if hand drills are used) giving the name of the driller, number of holes drilled, time in hours and cost of running taken from the basis sheet. The addition of these figures gives the total number of holes drilled and total cost of same, the latter divided by the shift's production gives the cost per ton for this item. Also, a column for the record of blasting supplies, in which are entered the supplies when given out; blank lines below providing for dynamite, caps, fuse, barrels, soap, grease, and other supplies that may from time to time be needed; the addition of these figures give the total cost of supplies, and divided by the shift's production in tons, the cost per ton for supplies; which added to the cost of drilling gives total cost per ton for this department of the work.

On the lower left hand portion of the sheet the total cost for the day is entered as taken from the second sheet, this is entitled to a credit for the yardage driven and rooms turned either at prices previously paid for hand work, or the prevailing district prices. This, divided by the day's tonnage, will give the actual cost per ton and show at once whether the same is being conducted at a profit or loss.

On Sheet B is entered the number of the machine, the name of the runner, the check number the coal from the machine is being loaded on, the number of feet cut, yards of entry and room work, tons produced by the machine, time worked in hours and cost as shown by the basis sheet. The cost of drilling and blasting supplies is approximated by multiplying tons produced per machine by the cost per ton as shown by basis sheet, or if a drill does the work for a group of machines, the actual cost of the drilling and blasting supplies that went to this group can be charged directly to them. The number of timbermen and blasters or parts of timbermen and blasters chargeable to each machine is next entered and their cost for wages; likewise the number of loaders and their cost for wages. All of which added together will give the total cost, connected with the tonnage of the machine from cutting the same to placing it on the pit cars at face, beyond which it is not necessary to go, the cost thereafter being the same whether cut by hand or by machinery.

In succeeding columns will be found space for entering the cost per ton for each of the previous items, which are found by dividing the cost by the tonnage of the machine.

Each mining machine having been entered up in this way totals are made, and from these totals averages arrived at, a comparison of which from day to day and with each separate machine will show weak points and what need looking after, and where they are located.

ENGINEERING ASSOCIATION OF THE SOUTH.

The regular February meeting of the Engineering Association of the South was held at the headquarters of the association at Nashville, on Thursday evening, Feb. 11, Vice-President Jas. Geddes presiding.

The Standing Committees for the ensuing year were announced by the Board of Directors as follows; Committee on Finance, W. F. Foster, W. L. Dudley and John MacLeod; Committee on Rooms and Library, E. C. Lewis, Jas. Geddes and F. P. Clute; Committee on Papers and Printing, Olin H. Landreth, W. B. Ross, Chas. B. Percy, Hunter McDonald and John B. Atkinson. Applications for membership were received from E. B. Cushing, Resident Engineer Southern Pacific R. R., Houston, Texas, W. N. McDonald, Asst. Engineer N. C. & St. L. R. R., Nashville, Tenn. and A. H. Wood, Asst. Engineer T. C., I. & R. R. Co. Tracy City, Tenn.

The President of the Association, Mr. A. V. Gude, of Atlanta, who was unavoidably absent, sent a communication inviting the Association to hold the March meeting at Atlanta. The invitation was accepted and a committee was appointed to make provisions for transportation. This committee subsequently reported that Maj. J. W. Thomas, President of the N. C. & St. L. R. R. had very generously offered to furnish transportation to the members of the Association to the meeting at Atlanta, and would place a private car at their disposal. The trip will be made by daylight in order to give the members of the Association an opportunity to inspect the extensive improvements being made on the Western and Atlantic R. R., which has recently been acquired by the N. C. & St. L. R. R. Co.

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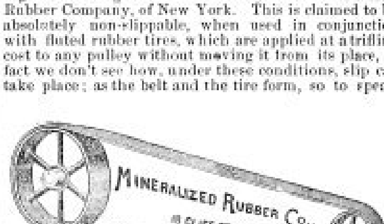
Mr Olin H. Landreth then spoke on the subject of "The Calorific Power of the Southern Coal Fields." One of the results presented was that a series of coal tests covering a large number of southern coals had developed the fact that there were at least three southern coals which were superior in calorific power to the standard second pool Pittsburgh coal and but slightly below Cumberland, Md. semi-bituminous coal. The paper was discussed by Messrs. Hunter McDonald, J. B. Atkinson, W. L. Dudley, J. S. Walker, W. G. Kirkpatrick, and Gordon Hicks.

Fluted Rubber Belting.

We annex a cut of the new patent fluted rubber belting now being manufactured by the Mineralized Rubber Company, of New York. This is claimed to be absolutely non-slippable, when used in conjunction with fluted rubber tires, which are applied at a trifling cost to any pulley without moving it from its place, in fact we don't see how, under these conditions, slip can take place; as the belt and the tire form, so to speak,



an elastic cog-wheel. Even when the fluted belt is run on an ordinary uncovered pulley it is claimed that much of the slip is prevented, as the flutings in the belt prevent all air-cushioning (a great provocator of slip) and the elastic flutings or ridges act as claws and take hold of the pulleys much as a man's finger nails or teeth hold an article that would slip from the fingers. For outdoor or exposed work it would seem as if a new and valuable invention had appeared.

Reduced Rates and Enlarged Privileges for Clergymen on the Pennsylvania Railroad.

The Pennsylvania Railroad Company announces that commencing on February 15th, 1892, tickets will be sold to Ministers of the Gospel, holding proper clerical orders, at half rates. This arrangement will apply to all tickets sold on the Pennsylvania Railroad lines east of Pittsburg and Erie as well as to the Pennsylvania lines west of Pittsburgh, so that a clergyman may not only be able to secure a ticket at half fare between any stations east of Pittsburgh and Erie, but may enjoy the same privilege in the purchase of a ticket to Cleveland, Chicago, Columbus, Cincinnati, Indianapolis, St. Louis, or intermediate points.

This concession in the interest of so deserving a class is fresh evidence of the liberality of the Pennsylvania Railroad, and cannot fail to impress itself upon the appreciation of those whom it is designed to benefit.

THE PROGRESS IN MINING.

Reviews of Important Papers Relating to Mining in the Proceedings of the Mining and Scientific Societies, and in the Mining Journals of Europe, United States, and Canada.

Automatic Dumping Device. The following described dumping arrangement has been in use for some time past at the main hoist of the Schubert's Pent Coal Mines, at Olbersdorf, near Zittau. Being completely self-acting, it offers the advantage of saving the expense of the workman that receives the coal at the top of the hoist. Its construction originated with the proprietor of the above mentioned mines.

THE HOISTING CAGE

can be considered as the skeleton of a horizontal cylinder which is suspended on the bail *a*, made of strong square iron, so that it can rotate around its axis. The circular sides are connected with each other by the bars 1, 2, 3, 4, and receive through them as well as the broad vertical bar *b* and the bottom band *c* the required

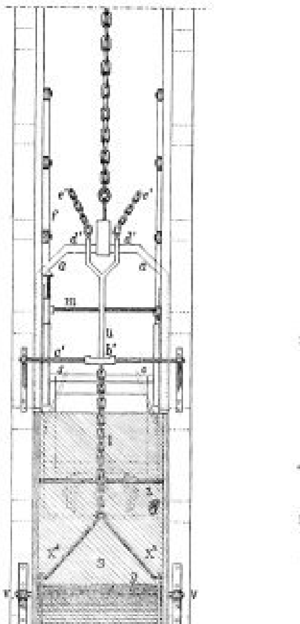


FIG. 1.—FRONT VIEW. Scale 40 to 1.

stiffness. The lower bars 1 and 2 carry the rails for receiving the car. The frame 4 is made of angle iron and placed at a convenient height to serve as a reliable support for the upper edge of the car whenever the cage is tilting. To lock the latter, and to hold the car in its place, there are two flat bars 5 and 6 placed on the sides of the shaft in strong hinges in such a manner that they slide along the cage as it ascends and grip over the top of the car with their hooks which

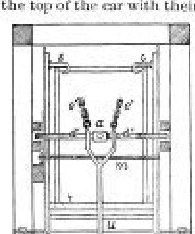


FIG. 2.—TOP PLAN. Scale 40 to 1.

are bent towards the inside and come to lay angling across them. In emptying the car the latter is thus prevented from dropping out.

For the purpose of dumping, the two circular sides are provided with a segment from *d* to *e* which, as the cage ascends, gears into the rack *f* which is bolted to one of the guide posts at the proper height. To hold the cage in its ordinary position, an eye *g*, Fig. 5, is cast on the segment pointing inward and in the direction of the vertical axis of the cage. The bolt *h* which slides up and down, and is pressed down by the spring

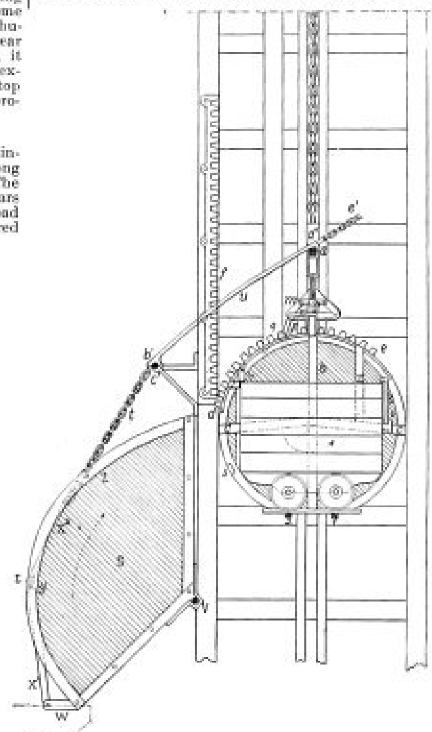


FIG. 3. SIDE VIEW: AT THE BEGINNING OF THE EMPTYING OF THE CAR. Scale 40 to 1.

i, fits into this eye or slot. Whenever the cage is ready to tilt this bolt is raised in the following way:

The shaft *m* is placed parallel to the axis of the cage

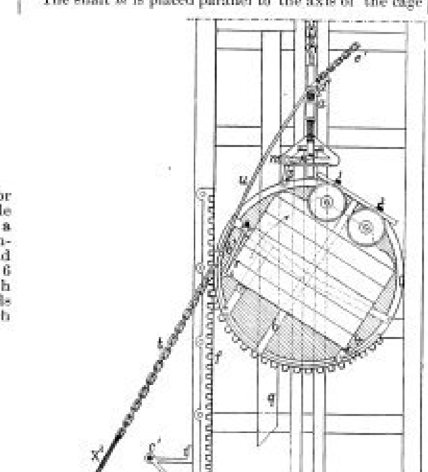


FIG. 4. SIDE VIEW: AFTER THE CAR HAS BEEN EMPTIED. Scale 40 to 1.

in the two strong wrought iron bearings *k*, Fig. 5, which are bolted to the bail *a*. This shaft carries the lever *n* which acts upon the little toe *o* of the bolt *h* and raises the latter when turned upward.

The lever *p*, provided with a small roller, is keyed to the same shaft, pointing half downward and half outward. This lever *p* strikes on the up-trip of the cage the guide bar *q*, which is beveled at its lower end under 45° and fastened to the sides of the shaft at the required height, in such a way that it is first pushed with its little roller to the inside, rolling along the beveled side and then slides upward along the inner face of the guide bar *q*.

Through the first part of the movement, the shaft *m* is turned and consequently the bolt *h* raised out of the slot by the lever *n* pushing against the toe *o*, and thus the cage is free to rotate.

To secure with the descending cage always a reliable and correct setting of the bolt *h* into its place, so that the cage comes again into its normal position and is kept there, the slot has been tapered from above to about ⅓ of the thickness of the metal. The guide bar *q* has a set screw on the side of the shaft for the purpose of bringing it into the right position. This adjusting, which is only done once, must be such that the bolt leaves the square part in the slot in the moment when the segment gears into the rack, and then, as the cage begins to rotate, leaves the slot on the tapered part, to be kept in its highest position until with the down-trips of the cage the levers *n* and *p* return into their original position. The bolt *h* is forced into the slot as soon as the segment leaves the rack.

THE SCOOP.

As a receptacle for the dumped coal for each hoist serves a scoop *s* and for both hoists a common receiver *r*, as indicated in Fig. 3, from which latter the coal is taken to the separators.

The shape of the two scoops is that of a cylinder segment with an angle of 135° with parallel sides. They rotate on the strong axis *v*.

Two stay bolts are placed near the upper edge at *y* and *z* for stiffening the scoop. The two flat bars *w* are fastened to the sides and to these are hinged the two rods x^1 and x^2, which latter join into one at the top. The lower rods x^1 each have a slot *z*, Fig. 4, into which fits the stay-bolt y, Fig. 3. The rods x^1 and x^2 are continued by a chain *t*, the rod *u* and the chains e^1. The latter are fastened with their upper ends to some support and only have the purpose to keep the rod *u* swinging in its ordinary position, Fig. 3, so that it is free to move according to the requirements, as will be shown below.

The rod *u* is provided on both ends with claws that point downward. It generally rests with its lower claw b^1 on the cross-bar c^1, and the scoop then has the position shown in Fig. 3.

The upper claws d^1 are taken hold of by the bail of the ascending cage and carried along. The scoop is thereby placed in a position as shown in Fig. 4 and in which it receives the coal that is dumped from the car,

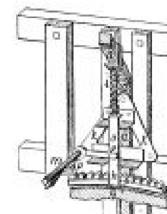


FIG. 5.—UNCOUPLING ARRANGEMENT.

To prevent it tilting from this position toward the shaft and empty into it, it is made heavier on the side of the receiver so that the center of gravity remains on this side. With the return of the cage the scoop goes back to its normal position and at the same time empties its contents into the receiver.

As the cage descends, the lower claw of the rod *u* catches again the cross-bar c^1 the upper claws are left by the bail of the cage and the rod suspends from the chains e^1 across the shaft.

This whole arrangement makes it necessary that the cage shall not be lifted beyond a certain height, since otherwise some of the working parts would have to break. At the Schubert mines this is done without difficulty with a little attention by the engineer.

The Columbia Daily Calendar.

An old friend in a new dress, and an article that has come to be one of the indispensables of an editor's desk, comes to hand in the Columbia Daily Calendar for 1892. The calendar is in the form of a pad containing 367 leaves, each 5½ x 2½ inches; one for each day of the year, to be removed daily, and one for the entire year. Each slip bears a short paragraph pertaining to cycling or some kindred subject. At the bottom of each leaf is a blank for memoranda. The stand is an entirely new departure, being made of sheet metal finished in ivory black, and is very compact. At the close of the year the stand will be available for another pad. This is the seventh issue of this now well known calendar, yet all the matter is fresh and new, and comprises notable events in cycling, opinions of physicians and clergymen, hints about road making, and numerous other topics.

AN ELEMENTARY TREATISE ON THE PRINCIPLES OF COAL MINING.

For the Use of Candidates for Mine-Foremen's Certificates, Mining Students, Mine Foremen, Mine-Superintendents, Mining Engineers, etc.

BY A. A. ATKINSON, DURHAM, ENG.

Methods of Working.

The Longwall Method of Coal Working.

The following system has come under the notice of the writer and as he believes it to possess some special advantages, it will no doubt prove interesting to those for whom it is intended. The method was introduced into a seam lying about 300 yards from the surface and of about 3′ 6″ in thickness. The floor of the seam is a fire clay of not very good quality, of variable thickness from a few inches up to as much as two feet occasionally. The roof is composed of blue shale, with layers of sandstone running intermittently through it—there being always a few inches of shale next the coal. The top of the seam always adheres very strongly to the roof, so that it is necessary to use explosives to bring it down.

The coal was previously worked Longwall but under another system that did not give a very satisfactory result as regards the percentage of round coal it made, so it was decided to try working the seam in a straight face as long as possible under the existing conditions, and to underhole the band of fire clay at the bottom of the seam, and apportioning the labor into the following three divisions:

(a.) The holer, to be paid by the yard.
(b.) The getter, to be paid by the shift.
(c.) The filler, to be paid by the score.

The two first classes of men may be termed skilled, but the third is not, and of course receives a much lower rate of wages than do the others.

It took some little time to get the new system properly under way, as there was opposition displayed towards it from all sides, but which a masterly determination in time overcame.

The work assigned to the different sets of men may be described thus:

The holers cut in under the seam to a depth of 3 ft. 6 in., or such other depth as may be at any time determined on. They have to cast back into the waste gob or goaf all *debris* made in holing, and to keep it behind the front of the timber and pack walls, and to put in their own sprags as may be required. When the holing has been completed to the required depth and length, all stone and *debris* are to be cleared away along the line of coal face, so that there may be no chance of the coal falling upon it when it comes down.

The getters have to take down during the night time the coal that has been undercut during the previous daytime.

The fillers have to fill up into tubs the coal taken down, dressing off all loose coal that may be hanging and has been loosened by either shots or wedging, as the case may be: the hours of the latter are eight a shift, from bank to bank. On the commencement of the system some years ago, a face of about 250 yds. in length was chosen for the experiment, which gradually extended and the roads were made and kept in the goaf, other districts have been opened out until three-quarters of a mile of face are working under this method.

Some modification in the method of keeping the faces is necessary owing to the thickness of the band changing; it will be an advantage to give details of the methods pursued, in the case of where the band is thick and where it is thin. In the former case the gate-ways are about 40 yds. apart, the wagonway gateways being 9 ft. between the pack walls, which are 4 yds. wide on either side of the road. It is an advantage to build these pack walls with the roof stone that is taken down for height in the gate roads, as this stone is harder and in larger pieces than that which comes from the band and consequently bears more weight, and answers the purpose better than a smaller and softer stone would afford. The other roads are packed on either side to 3 yds. in width. Smaller packs are put in along the faces and between the roads to support the roof. These are about 5 or 6 ft. in thickness and are kept up to within about 6 ft. of the face, and are built with the largest pieces of stone from the band. These packs materially lessen the amount of timber required, which is in the shape of props from 4 ft. 6 in. to 5 ft. 6 in. in length and 8 inches in diameter, one being required about every 2 yds. on an average. The small *debris* and refuse made is thrown into the gob and fills it.

On an average there is a holer for each 20 yds. of face, working in alternate shifts. The undercutting is effected in the bottom coal of 4 to 5 ins. in thickness, and as this work progresses the band is liberated from the seam of coal by the weight on the coal face, sprags and stays being used to support the coal. On the holing being finished, fresh timber is set close up to the face, and the standing timber drawn out.

During the night the getters are at work taking down the coal that has been made ready during the previous day. A chargeman is there with these men who carefully examines all the faces to see that all is safe, that all *debris* is out of the way where the coal has to come down and to fire any shots that may be required, and to see that no timber is wasted. The fillers go to work in batches of two shifts early in the morning, the second shift going down two hours after the first men, and all coming to bank at their eight hours end.

The hands employed in working the coal are as follows:

Holers,	56 per cent.
Fillers,	22 " "
Getters,	22 " "

The tram rails are laid down right and left from the face of each gate-way, branching off at a double turn, and the tubs are taken along the faces. The rails are laid down by the fillers as they fill up the coals, and they are laid upon sleepers that have notches in them for their reception—a quicker method than nailing them. As the coal face advances new cross-gateways are formed at distances varying from 80 to 100 yds., as circumstances decide. It is found that the faces advance at the rate of 80 yds. per annum.

In the places where the band of stone is thin it is found there is not sufficient material for building the middle packs with, so that it has been necessary to resort to the use of wooden chocks for the support of the roof. What small dirt is made in undercutting is thrown into the goaf as before stated.

Where the band is thick and the goaf consequently well packed, the roof does not fall, but rather gradually sinks on to the packs and stowed dirt behind the faces. Even where the dirt is thin and the goaf not stowed tight very little roof stone falls: it is more of a gradual subsidence and goes on for some 100 yards back from the face, where it is found to have become settled. The roof stone in all the roadways is exceptionally good, the use of timber for supporting it being exceptional. The faces are very seldom lost from the roof coming in except perhaps when the first weight or crush comes in a new district.

The ventilation is very simple and effective as the air is taken in the first instance to the innermost end of the faces and brought back along them, the quantity varying according to the length of face to be ventilated.

In the same seam of coal where the bord and pillar system is at work it is found that the produce of round coal is 46 per cent. taken upon a district after the coal has been exhausted. Assuming a loss in working of 5% in bord and pillar workings and half that quantity is Longwall, and taking into consideration the larger yield of round coal by the latter method—68 per cent. of round coal in this case—then in an acre of the coal worked we get 1200 tons more round coal, a most important consideration.

The cost of working the coal by this method is somewhat higher than if worked by bord and pillar, something near sixpence per ton more; but this might be reduced were the roadways driven in the coal to the boundary first and the coal worked homeward, leaving the goaf behind, as the roads in the coal would take so much less to make and maintain, than in the goaf as at present.

It has been found that the consumption of timber is extremely low—thanks to the good roof—on an output of 14,000 tons it was found to be under 0·02 of a penny per ton. Taking in consideration the difference in the amount of round coal obtained from this method of working as compared with the bord and pillar system, the effect financially is very considerable. Assuming the difference in value of round and small to be 4s. a ton, then in an acre of coal, say one foot thick for comparison, there is pecuniary advantage of about £30, or about 5d. per ton on the whole output. And as the present extra cost of working is certain to be reduced by at least 4d. per ton, a saving will ultimately be effected.

The effect on the economy of coal producing which the method of working exerts, calls for the most careful consideration in deciding on the system to be adopted. The competition of the present day causes every one to attain to cheapness and efficiency, and only those who attain this object can expect to work to an advantage. Some of the advantages of Longwall working may be stated as follows:

1. Greater produce than by the pillar and stall system—the loss in working being perhaps only one-half as compared with the latter mode: thus effecting a better return for the lessee, as well as the lessor when the royalty rent is at so much per acre.

2. A larger produce of round coal: the immense advantages of this point are so obvious as to require no remarks.

3. There is less straight or narrow work and consequently less hard labor required in cutting, nicking, or shearing.

4. The weight of the overlying strata so acts on the face of the coal as to cause it to be worked more easily, and consequently more cheaply. It also acts in a beneficial manner on the holing dirt, making it work more freely, as well as assisting to bring down the coal itself after the holing is performed.

5. Ventilation is more simple and more effective, as the air has a much less circuitous route to travel.

6. A larger output can be obtained from a given area, as more men can be employed in getting coal.

Some of the disadvantages may be stated as follows:

1. Greater expense in maintaining and forming the roadways in the goaf—and unless the pack-walls are fully efficient the expense may become very heavy; they should be built perfectly solid, with as hard a stone as can be obtained.

2. Unless the faces advance regularly and constantly, the roadways and faces are more difficult to keep.

3. Faults and dykes are more difficult to deal with when met.

The following are some conditions which may be considered as favorable for adopting Longwall:

1. If the seam of coal is hard and strong and thin, and if the top and bottom are not too hard in case extra height is to be made for roads.

2. If there are bands of dirt in the seam which require to be stowed below ground thus affording good opportunities of stowing the gob or goaf well.

3. If the boundary be not a great distance away, so that there will not be long roads to keep in the goaf.

4. If the overlying strata do not contain water, which would get into the workings and thus increase the cost of working.

5. If the surface is free from buildings, railways, water-ways, &c., which might be damaged by subsidence.

In a general way it may be said that depth is immaterial so long as surface buildings will not be injured nor water let into the workings. It is better adapted for moderate areas and outputs than very large ones. That where the coal is tender and will not bear the extra pressure produced by the weight occasioned, it will be more advantageous to go in for bord and pillar. The best position for the undercut is decidedly when the bottom is suitable for it, as for instance, a soft warrant of six inches to a foot in thickness. The cost of getting the coal at the face is generally less than would have to be paid for the same under bord and pillar, and more especially if the work advances regularly and is worked in the direction most suitable to the circumstances of each particular case. There is always a larger yield of round coal and a larger yield per acre as compared with the other system.

Perhaps the most important point to be considered is the cost of the necessary pack-walls and buildings. It will rarely, if ever, pay when the material for this work and for stowing has to be brought any distance—it must either be got from the roof or floor close at hand or out of the seam itself, where bands of dirt or stone exist. The size of the packs varies from say 4 feet to 12 feet in width and according to the thickness of the seam. The cost per ton of the packs depends upon their size, the labor expended in getting the material for them and the width of face between the roadways: the nearer together the roadways are the more packs are to build, and *vice versa*. But the greater the width between the roadways the greater will be the pressure upon the packs, and therefore there must be greater strength in them. The cost of these packs varies considerably as will be readily understood, but if the price ever exceeds 6d. a ton, it may be taken as being abnormally high—3d. or 4d. may perhaps be taken as about a fair average cost for them.

The following particulars apply to some collieries in Derbyshire, and for the purpose of simplification they will be divided into the following heads:

1. As to the method of working.
2. The conditions under which the Longwall system can be adopted.
3. In relation to ventilation.
4. Comparison of the Longwall system with that of bord and pillar.

The method of working coal seams by the Longwall system is exceedingly simple, and may be described in general terms as follows:

Two or more parallel levels are driven from the pit, for main roads, opening winnings, water-levels, and return air-ways, as the case may require. From the main road, at a suitable distance from the pit, and at convenient distances from each other, roads are driven to the rise of the seam, and after a certain distance has been left solid for the support of the main road, Longwall working is started. The faces average a width of from 100 to 500 yards; the length however being much influenced by the nature of the roof and floor, and the quality of the coal to be worked. The working may be thus described: A gang of men called holers proceed usually through the night to cut away or undermine the face of the coal, usually to the extent of from three to four feet, and averaging six to eight inches high in front, and tapering down to nothing at the back of the undercut. Sprags of wood are fixed between the coal and the floor, at distances of about six feet or less if necessary if it appears probable that the coal may fall after being undercut. At the end of the holing or last side of the coal the men make a vertical nicking or cut into the coal at right angles with that under the coal. This work having been finished, another set of men come to work and proceed to take down the coal that has been undercut, by means of picks, wedges or blasting, as the case requires. By this means large blocks of coal are obtained, which in some cases necessitate being broken into smaller pieces before being loaded into tubs for conveyance to the surface. Lastly after the coal has been removed from the face, the packers come in and it is their duty to keep the faces and roads, which are in the goaf, well timbered and secure. At short distances, according to the strength of the roof, they set props, placing a cap or head (a flat piece of wood) between the props and the roof. When there is a good roof, it is generally necessary only to advance the same props, care being taken to place them opposite to the intervals or spaces between the props in their former position. When however the roof is bad, it becomes necessary to place good and new props more frequently and nearer together or else to build packs of stone or chocks of wood at intervals. Iron props have been much used. The coal having been thus got, the smaller coal and refuse remaining are thrown behind into the goaf or waste, often completely filling it, and as the roof breaks or bends down, a solid mass is formed.

This minute description of working may appear to some to be unnecessary, as almost all persons connected in any way with collieries are conversant with hewing coal; but the Longwall system, well carried out, differs so materially in management, that it is necessary to call attention to the smallest details. In some districts where the coal is cubical in structure, and pillar work is adopted, the hewing process is done in a very slovenly and wasteful manner, the hewers hacking and cutting in all directions (commonly termed "scalloping"); but in strong coals worked by Longwall, this cannot be done.

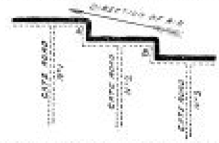
Where two or three seams are to be worked one after the other, the whole success of the undertaking depends on the soundness and good packing of the goaf, together with the entire extraction of the coal. The proper construction of the pack walls for supporting the main goaf roads is of great importance. The circumstances which are favorable to Longwall working are, a good roof and a hard stratum below the holing. Sometimes the holing is made in the middle of the seam, when a more convenient pricking is not found underneath, but if this is to be done in the coal it is wasteful, inasmuch as it breaks it up into small pieces. Wherever these favorable conditions are found, the

Longwall method is to be recommended, both on account of the simplicity of arrangement, the ease and efficiency of ventilation, and the economical manner in which the coal may be got.

The method of ventilation may be described in general terms, as the passing of an adequate amount of air in a continuous stream along each face, and which, entering at one end passes out at the other and then through a length of generally goaf road (the return air-way) and so on to the upcast shaft. The main road is used as the main intake, and the air is distributed from this to the different faces. Stoppings and regulators and doors and air crossings are placed in the necessary positions. When the seam is fiery the return air may be carried to the upcast shaft by a dumb drift, entering the pit some distance above the furnace. Such is the very simple method of ventilation usually adopted in Longwall workings; of course there are cases where necessity compels a modified plan, but that now stated may be considered the one generally in use.

Many modified forms of Longwall working have been adopted in various districts, such as the long work of the Yorkshire coal field, in which the coal is worked in faces of various widths, separated from each other by thick pillars of coal, which are afterwards taken out while working back. Another modification, called narrow bords and long work, is where two narrow and parallel bords are driven, a pillar of coal of about 30 yds. in width being left between each pair of bords. These having been driven the required distance, a communication is made between the pairs of bords, and the coal worked similar to Longwall towards the pit. By this means the goaf is left behind, and there is no necessity of keeping it up by walls or packs.

WOODEN-CHOCKS.—Square pillars built of slabs of wood.
WARRANT.—A tough fire-clay underlying the seam of coal.
PACKS.—The walls built along each side of the gateways to support the roof.
FAST SIDE.—In accompanying sketch three working places or

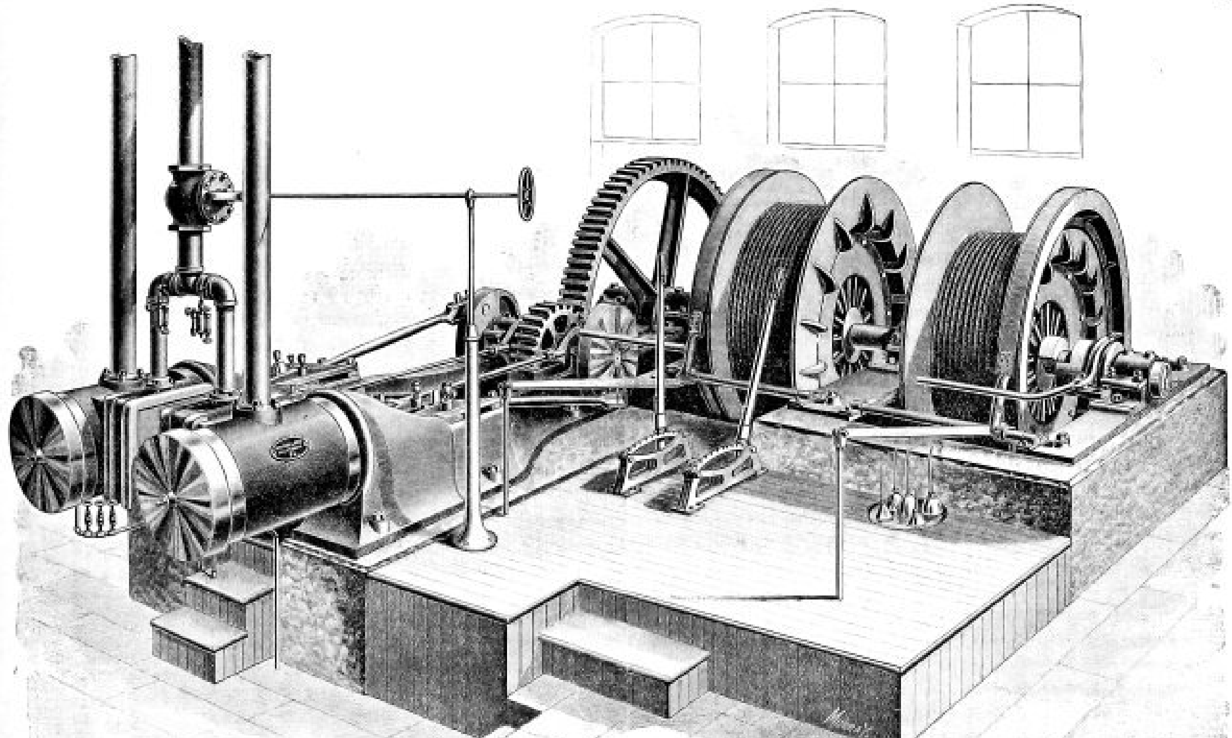


stalls are shown with a "fast side" or "cutting" between each A is the "fast side" to No. 1 because they have to nick or shear it as they advance their face. B is "fast side" to No 2 while A is "loose side" to No 2 and B is "loose side" to No. 3.
PRICKING.—Soft coal or earth for holing in.
BORD AND PILLAR.—Pillar and chamber.
BORD.—A chamber of work.

WIRE ROPE HAULAGE ENGINES AND PLANT.

In Operation at Lonaconing, Md.

With this we give an illustration of a complete plant of a pair of wire rope haulage engines and apparatus designed to haul mine cars through a distance of 2½ miles on a grade of 4 feet in 100, the load consisting of 40 to 60 mine cars, each weighing 6,200 pounds. The engines have cylinders 14 inches diameter; stroke of piston, 24 inches. The connecting rods, piston rods, and valve stems are made of hammered steel; and phosphor bronze bearings are used in all the boxes.



WIRE ROPE HAULAGE ENGINES AND PLANT.

The drums are 5 feet in diameter, width of faces 36 inches, with flanges on drums 12 inches deep; they are turned all over. A brake is attached to each drum for controlling the motion of the mine cars during the descent on grades. These brakes are operated by the quadrant levers on the platform shown in front of the drums. The throttle valve is operated by the small wheel placed at some distance from the valve, so as to bring it and the quadrant levers within convenient reach of the engineer.

The power is transmitted from the engine to the drums through the spur gearing, having a proportion of 3½ to 1. The ropes, which will be eventually 2½ miles long, are arranged so that a rope is wound on one drum while the other is unwound.

This plant has been erected at Lonaconing, Md., in the Georges Creek District, for the American Coal Co., of New York City, and has been in operation for several months, working very satisfactorily. During a trial, 45 mine cars were hauled up the 4 per cent. grade through a distance of 5,000 feet in 8 minutes with comparative ease.

This plant is equipped with all the modern appliances, including sight-feed lubricators, drain pipe connections, and all such as will be conducive to convenience and durability, and no pains have been spared in making it durable, convenient, and modern in design. Although the builders of this plant, Messrs. J. & J. B. Milholland, of 240 Fifth Avenue, Pittsburgh, Pa., have now over one hundred haulage plants in successful operation, they take particular pride in this one, and believe it to be one of the best haulage plants that has been erected. In connection with this plant, they have two steam boilers, of the return-tubular make; 85 horse power each, which can be worked together or separately, at the will of the operator. Messrs. Milholland are at present erecting a very large haulage plant in the same district for the New Central Coal Co., of New York City.

On consideration it will be seen, that as the output in bord and pillar working is limited by the number of working places open, so in Longwall work it is limited by the length of faces open, and the number of gateways open in such faces. Taking a case where the coal lies tolerably level, loaders will be at work on each side of the gateways; and as under ordinary circumstances, where the coals are properly prepared for the loaders, by what is called turning the coal out, or splitting them up ready for the loaders, thirty tons per day may be sent from each side; each gate will produce sixty tons per day, which multiplied by the number of gates at work, gives the quantity of coal which can be produced. Of the comparative merits of the Longwall and bord and pillar system it is not difficult to decide. Supposing all the seams were of the same quality and structure, either one mode or the other would be adopted, without any question being raised as to its merits; but as the component parts of the roof and floor vary in innumerable ways, the mode of working must be adapted to the circumstances.

GLOSSARY.

SPRAGS.—Short wooden props placed in a slanting direction against the bottom of the solid coal face to support it during the operation of holing.
STAYS.—Somewhat similar to sprags, only longer.
GATEWAYS.—Parallel roads running through the goaf from the main haulage road to the working face.
WAGONWAY GATEWAYS.—Auxiliary haulage roads running through the goaf parallel to the main haulage roads. These wagonways are set out to cut off great lengths of gateways.

Packing.

Every engineer knows the importance of having his engines, pumps, etc., properly packed. How to do this tight enough to prevent leaks of steam or water, and not at the same time cause unnecessary friction is a problem that many have attempted to solve with varying degrees of success.

A good packing should be tough and elastic, not affected by heat, and so made that it can be easily applied.

For many years the Gould Packing Co., of East Cambridge, Mass., has been studying this question, and, after putting their work to severe practical tests, has produced a packing which is a sure cure for leaky stuffing-boxes, whether the motion is rotary or reciprocating, or whether the rod is round or worn oval or hollow.

This packing is self-lubricating, thus economizing oil and enabling the pistons, etc., to be made steam and water-tight with very slight friction. It is practically indestructible, as it does not become hard with use, and hence does not have to be removed from the stuffing boxes; and, as it contains nothing of a hard or gritty nature, it does not wear the rods or cylinders.

The company has done a remarkably good business during the past year, and is in receipt of many testimonials as to the solid worth of its goods. The packing is largely used in government work, and a large number of electric light and power stations are using it for high speed engines.

Parties troubled with leaky stuffing-boxes in engines or pumps will do well to write to The Gould Packing Co., 36 Cambridge St., East Cambridge, Mass. They can obtain a supply on thirty days trial, and if not satisfactory, it can be returned at the manufacturer's expense.

A Large Company.

The *Manufacturer's Record* states that the broadest plan of development in the South ever undertaken which will involve the initial investments by New York and Pennsylvania capitalists of many millions of dollars, has been consummated by Alex. A. Arthur, who founded the English town of Middlesborough, Ky.

The operations of this company include the purchase and development on a very large scale of extensive coal and Bessemer iron ore properties in East Tennessee, the purchase of furnaces and coke ovens already completed, the building of furnaces, steel works and coke ovens, the establishment of two manufacturing towns and the construction of several important railroads to tap extensive systems now in operation.

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

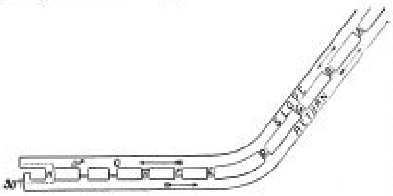
☞ *Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.*

Ventilation.

Editor Colliery Engineer:

SIR:—I will be greatly obliged if some of your able correspondents will furnish me with an explanation of the following phenomenon:

A slope and air way are each 2,000 ft. long. At the foot of the slope a lift turns off, forming a gangway and air-way about 700 ft. long each.



REFERENCES.

Course of air is shown by finished arrows.
Dips are shown by unfinished arrows.
Stoppings are shown by parallel lines.
Brattice is shown by dotted lines.
Beginning of grade in gangway shown by O.

All the headings above A were walled and plastered with mortar, but below A they were only bratticed across with boards, the last heading not being quite through. The fan had to be stopped for two days, therefore no air circulated except what was produced from the difference of temperature caused by the heat of a pump situated at A and exhausting into the return. While the fan was stopped, the gangway and air-way were filled from their faces down to the point O, or for a distance of 400 ft. with fire-damp. When the fan started, I was under the impression that the gas would all clear away in about 12 hours' time. But, 3 days elapsed and the fire-damp held the same position. I then thought a "cave" or something similar had occurred in heading or cross-hole H, as the pressure of the air current was very marked upon headings or cross-holes A, B, C, D, E, F, and G. The headings A, B, and C were walled up and plastered with mortar. The pressure, then became very marked on headings D, E, F, and G. In 24 hours after this, about one-third of the fire-damp was cleared away. D and E were now walled up again and plastered with the result that the pressure became more distinct on F and G, and in thirty-six hours afterwards all the gas was cleared away. But, what attracted my attention most, was the fact that the pressure upon the headings F and G had so diminished that it could hardly be detected, even by sitting down quietly to listen. The return was found to be in good condition and free from falls.

The mine was easily kept free from any standing gas before the fan was stopped, but after the fan started the gas could not be swept away and the pressure became very distinct upon the stoppings in the headings. After the gas was cleared away, no pressure could be observed on the closed headings. Has such a case been met with before, and what explanation is there for it?

Yours, etc.,
PRACTICAL FACT.

Plains, Luz. Co., Pa., Feb. 1st.

Pumping.

Editor Colliery Engineer:

SIR:—I notice that there have been several different answers to "S. W.'s" pump question, which was only to be expected, because certain assumptions have to be made before an answer was given. These assumptions being different in each case, the answers do not agree. Each anwer under the mentioned assumption is correct, and pumps of dimensions given under these conditions would, no doubt, do the work.

Some one wrote "More Light is the Soul of Ambition," and no doubt many of your readers are desirous of "more light," and are seeking it diligently in the correspondent's column of your valuable paper, and on this same pump question many may be a little confused, owing to the several results.

A careful study will make the matter clear, and in order to help a little farther I will reason the question out on my supposition, using Mr. Percy's rule given on page 165 of The Colliery Engineer Pocket-Book.

$20' \times 20' \times 10' \times 6\frac{1}{4}$ gals. = 25,000 gals. each 30 minutes, or 50,000 gals. per hour; 50,000 gals. $\times$ 276 = 13,800,000 cubic inches $\div$ 60 = 230,000 cubic inches per minute $\div$ 70 total height of delivery = 2,875 cubic inches per foot of pump $\div$ 12″ = 240 sq. inches nearly; to this add 10% for slip of pump, and we have 266·66 square inches; and 266·66 $\div$ ·7854 = $\sqrt{339 \cdot 5}$ = 18·4″ diam. of water cylinder.

Now let us consider the power required to move this resistance. The area of 18·4″ diam. is 266·66 sq. inches, then what is the pressure per sq. inch of 70 feet vertical water column?

$$70 \times 15 = 1{,}050 \div 34 = 30 \cdot 9 \times 266 \cdot 66 = 8239 \cdot 8 \text{ lbs.}$$

total pressure on pump. Effective steam pressure taken at 60 lbs. per sq. inch. Therefore 8239·8 $\div$ 60 = 137·33 sq. inches as area of cylinder.

We have already made one assumption, viz.: that effective steam pressure is 60 lbs. per sq. inch; now that we have found the theoretic area of cylinder required to raise the water, we must make another assumption, viz.: the amount of power required to overcome inertia of water in pipes, and overcome friction of pump and give extra power, etc., etc. Mr. Percy adds 50% and others follow his rule (it is a safe one) but would it not be extravagant in this case with only 70 feet of a discharge column? I think it would, but, at the same time, the addition of 50% in this case would make the pump available for a heavier duty if required at another place, and in this light it would be commendable, but the question only desires to know the power for the present duty. A margin of 10% I think would be sufficient even with the discharge column 9″ diam. as the increased head equal to the amount of friction generated by water traveling 300 feet per minute in 9″ diam. pipe would be less than one foot, making the whole resistance equal to weight of water in 71 feet of water column.

$$137 \cdot 33 + 10\% = 152 \cdot 6. \quad \text{And,}$$
$$152 \cdot 6 \div \cdot 7854 = 194 \cdot 3$$
$$\sqrt[2]{194 \cdot 3} = 14''$$

nearly as diameter of steam cylinder.

Mr. Percy, on page 165 of The Colliery Engineer Pocket-Book, says: "*Pipes should be at least as large as the pump.*" This does not agree with American builder's practice, as an examination of any catalogue will show.

Yours, etc.,
H. L. D. W.

Bon Air Mines, White Co., Tenn., Jan. 18th.

A Strong Endorsement of "The Colliery Engineer" as an Educator in the Theory of Mining and Kindred Subjects.

Editor Colliery Engineer:

SIR:—You are aware that the examinations for candidates for mine managers are now in progress in this state. As I am largely, if not wholly, indebted to THE COLLIERY ENGINEER for my theoretical knowledge relating to mining, and it has enabled me to pass a creditable examination, I deem it my duty to render an acknowledgement of the benefits received through a careful study of its pages.

I venture to say that nearly all, if not all, of the candidates who passed the examination in this district (including five counties) were subscribers to THE COLLIERY ENGINEER. A great many expressed themselves as being glad that they had subscribed for the journal a year or two before the law was passed, thus taking time by the forelock; others were free to admit that they were sorry that they had not heeded the warning given them by friends to prepare for the inevitable.

I also wish to say by way of encouragement to others who may be seeking to qualify themselves to pass the examinations for mine managers that some of those who passed this examination had little or no education until a few years ago, when they were induced to read THE COLLIERY ENGINEER. They commenced at the foot of the ladder. Beginning at addition they have kept on improving themselves until they have mastered arithmetic as far as is necessary to work out the formulæ used in ventilation and mine mechanics and, to their credit, some of these same parties obtained the highest grades at the examination.

I take pleasure in commending THE COLLIERY ENGINEER to all who wish to inform themselves in mining; especially those who have not had the advantages of early education. I freely concur in the opinion on the "Intelligent Miner," from Allegheny Co., Pa., who stated "if miners remain ignorant on subjects relating to mining when they have such opportunities as your journal presents it is their own fault."

Yours, etc.,
PETER JEFFREY.

Carterville, Ill., Jan. 25th.

Ventilation.

Editor Colliery Engineer:

SIR:—I submit the following in reply to question (1) by "J. W. S.," of Westville, N. S., in your last issue.

(1). An air-way 10′ $\times$ 10′ and 2,000′ long is passing 60,000 cu. ft. of air per minute, what would be the required area of an air-way to pass 15,000 cu. ft. per minute its length being 1,800′ the pressure remaining the same?

Since air-ways will pass quantities of air in proportion to their areas, the area will be in proportion to the quantity, other things being equal. As the length differs in this case, so will the rubbing surface in the proportion 9 : 10. Then, we have the following compound proportion:

$$\begin{matrix} 4 : 1 \\ 9 : 10 \end{matrix} :: 100 : x, \text{ or } 27 \cdot 7 \text{ sq. ft. area.}$$

The volume passing is as 4 : 1, and the length as 9 : 10.

Yours, etc.,
L. P. H.

Avoca, Pa., Jan. 13th.

Pumping.

Editor Colliery Engineer:

SIR:—I would say relative to the question asked by "Beginner," in the August issue, as to whether more or less power is needed if the suction be 5′ or 20′ and the discharge 95′ or 80′, the shaft being 100′ deep, that as the 15′ more suction needs no power to bring the water up to the pump, only the power to overcome the extra friction of the extra suction, that the weight of water being less in the discharge pipe would need less power to discharge it and would result in a shorter steam line.

Yours, etc.,
C. WALTERS.

Leisenring No. 1, Pa., Jan. 25th.

Surveying.

Editor Colliery Engineer:

SIR:—Please insert in your next issue the following question:

A main entry running 1,000′ due East has a furnace at the East end. Through carelessness the entry has been closed; desiring to get back to the furnace we go into the main entry 250′ from the West end and turn to the North 25° and run 250′, then turning 35° still further North, we run 250′ more. Now, I would like to know the degree of bearing from last given point and what the difference of travel would be from mouth of entry, *workings are level.*

Yours, etc.,
MINER.

Elk Garden, W. Va., Jan. 26th.

Miscellaneous Questions.

Editor Colliery Engineer:

SIR:—Please insert the following questions in the next issue of your journal:

(1.) What is the meaning of the following equation? Please work out fully.

$$\frac{1}{\dfrac{\sqrt{\left(\frac{1}{a}\right)^2 \times s}}{a}}$$

(2.) An inlet of a mine, 4,000′ long, with a return of the same length, shows a water-gauge of 0·5 of an inch at the entrance, what would be the pressure 2,000′ farther in? Please give the rule to find the pressure at any given distance.

(3.) What would be the limit in distance of discharge of a siphon dipping $\frac{1}{4}$ of an inch per yard, without considering friction? State fully and give rule for any angle of dip.

(4.) The main entry of a mine divides into two entries, each of which extends to the surface, if the pressure is four pounds per square foot in the single drift, what is the pressure in the two drifts? State fully.

Yours, etc.,
ALBERTO.

Wall, All'y. Co., Pa., Feb. 8th.

Ventilation.

Editor Colliery Engineer:

SIR:—I notice in the January issue an answer by "J. S. K.," of Canon City, Colo., to question (1) asked by "J. M.," of Morrisdale Mines, Pa., in which he states that the quantity of air is found by proportion, thus—

$$\sqrt{80} : \sqrt{160} :: 40{,}000 : x, \text{ or } 56{,}445\tfrac{1}{4}'.$$

This answer in my mind cannot be correct. While it is theoretically true that the quantity of air varies as the square root of the pressure; still I think there is a manifest difference between the amount of air that would be obtained from a fan increased to twice the speed, and that which would be obtained from double the pressure.

A fan making 80 revolutions per minute, and producing 40,000 cu. ft. of air, if the speed is increased to 160 revolutions per minute, will produce 80,000 cu. ft. of air, but, of course, would take eight times the power to double the speed. Hence I think the quantity would be found to vary directly as the speed of the fan, which in this case would be 80,000 cu. ft.

Yours, etc.,
PETER JEFFREY.

Centerville, Ill., Jan. 25th.

Mechanics.

Editor Colliery Engineer:

SIR:—I submit the following in reply to Thomas M. Brown, of Pinckneyville, Ill.:

If the pressure of an engine is 44 lbs. per sq. in., diameter of cylinder 1′ 8″, length 6′, and paddle-wheel make 20 revolutions per minute, what is its power?

In finding the horse power of an engine, we will let

P = pressure.
L = length of stroke.
A = area of cylinder.
N = number of revolutions per minute.

Then, we have

$$\frac{P \times L \times A \times N}{33{,}000} = 50 \cdot 26 \text{ H. P.}$$

Substituting their values we have

$$\frac{44 \times 6 \times 20'' \times 20 \times \cdot 7854 \times 20}{33} = 50 \cdot 26 \text{ H. P.}$$

Yours, etc.,
T. K.

Mt. Olive, Ill., Feb. 10th.

Relative Efficiencies of the Force and Exhaust Fans, as Suggested by the Escape of Natural Gas from Broken Mains into the Mines below.

Editor Colliery Engineer:

SIR:—I have been considerably interested in reading the review of the mining report of Mr. Henry Louttit, Inspector for the First Bituminous District, given in your January issue. Mr. Louttit refers to the laying of gas pipes or mains by the natural gas companies over certain mines in his district and speaks of the danger to the mine, arising from breaks in the pipes, and the gas finding its way into the mine below. The subsidence of the surface, incident to extraction of coal, renders a break in the gas mains liable at any time. The same cause also opens a crevice by the fracture of the overlying strata that permits of direct communication between the mine and the surface.

His views, as expressed in his report, will find very general endorsement, in regard to the possibility of the natural gas from the broken main finding its way into the mine below. But a better reason can be given than the one he suggests, viz., the increased weight of the gas due to the pressure in the main. He reasons that a cubic foot of air at a temperature of 32° and a barometric pressure of 30 inches, weighs ·080977 lbs., giving a pressure of 14·72 pounds per square inch, due to weight of the atmosphere. Also, under the same conditions, a cubic foot of natural gas will weigh ·04421 pounds. But under the pressure of 60 pounds per square inch or the pipe pressure, he figures the gas will weigh ·1768 lbs. per cubic foot. This is true. He continues: "This weight is for the gas at the moment of exit from the pipes, and this will be maintained for quite a distance after leaving them owing to the great velocity with which the gas travels."

It is quite evident this last assumption, that the weight of the gas is the same for even a second of time after leaving the pipe is wrong; because such a condition could only exist when the covering of clay and earth over-laying the pipes is practicably air-tight. And again assuming the pipes to be laid at a depth of four feet below the surface, this clay and earth covering would have to weigh 2160 pounds, or more than a ton, per cubic foot to hold the pressure of 60 pounds per square inch.

Mr. Louttit means to say that the velocity of the gas is great at the pressure of the pipes. But it could not be greater than the tension of the gas under the same pressure. It is in point of fact equal to it, for it is the tension of the gas which produces such velocity, or which measures it when produced. The instant the gas issues from the broken pipe the tension and the velocity react against each other equally, and this takes place practically at the opening of the pipe. The gas under 60 pounds pressure has been compressed so that its atomic particles are practically ¼ as far apart as they were under the ordinary atmospheric pressure. When the pipe pressure is relieved, these particles spring back to their original relative, position, and their velocity in so doing is equal to the velocity of the escaping gas; because, they react against each other. But the space through which each particle can move is infinitesimally small, and hence the gas has assumed its original volume and weight practically at the opening of the pipe.

Nevertheless this does not destroy the tendency of the gas downward through the crevice and into the mine in particular cases, viz., where the "vacuum" system of ventilating is being used in the mine. If, on the other hand, the "plenum" system is used, the gas will be forced upward and out through the escape pipes he mentions as connected with the trench.

This brings us to a discussion which I have long wanted to see brought up, viz.: The relative merits of the force and exhaust fans. The former is the representative of the "plenum" system of ventilation and the latter represents the so-called "vacuum" system. Formerly the expression of opinion was almost wholly in favor of an exhaust fan as compared with the force fan, no adequate reasonable such choice being given. An old miner once explained his preference for the exhaust method by laying a piece of hemp rope on the ground and taking it by one end said: "Boys, I can pull that rope all right, but I cannot push it." The arguments seem to be principally in favor of the force fan as far as our experience teaches us. But perhaps some of the readers of THE COLLIERY ENGINEER can enlighten us as to the merits of the exhaust fan. If so, we shall be glad to hear from them.

Let us compare the two methods by supposing them to be applied successively to the ventilation of the same mine, under like conditions of temperature and barometric pressure.

Let Fig. 1 represent the "plenum" system or ventilation by a force fan; and Fig. 2 the "vacuum" system or ventilation of same mine by an exhaust fan. Let

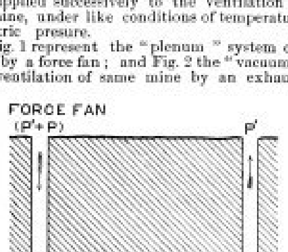


FIG. 1.

Actual pressure $= (P^1 + P)$.
Effective pressure $= (P^1 + P) - P^1 = P$.

p = unit of ventilating pressure.
p^1 = like unit of atmosphere pressure.

It is evident that in Fig. 1 the actual unit of pressure in the down-cast must be $(p^1 + p)$, while the actual unit of pressure in the up-cast is p^1 due to the atmosphere. And the difference of these two pressures or p will be the unit of ventilating pressure. Now the total resistance of the mine $K S V^2$ or $\frac{K S Q^2}{a^2}$ is the same in both cases, the quantity Q being the same. Hence the ventilating pressure $P = p\,a$, necessary to overcome the resistance, must be the same in both systems; and the unit of ventilating pressure p is the same in each case. By referring to Fig. 2 we see the unit of pressure at the down-cast is p^1 or the unit of atmospheric pressure. Hence since the unit of ventilating pressure p is the difference between the units of actual pressure at the two shafts, the unit of actual pressure at the up-cast

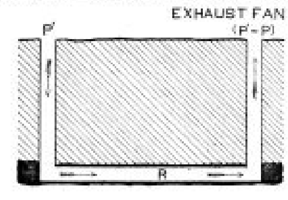


FIG. 2.

Actual pressure $= P^1$.
Effective pressure $= P^1 - (P^1 - P) = P$.

must be $p^1 - p$. That is to say, an exhaust fan of like efficiency as a force fan must be capable of reducing the atmospheric pressure in a shaft as much as the force fan increases it. The expression $(p^1 + p)$ denotes the efficiency of the force fan; while $(p^1 - p)$ denotes the same for the exhaust fan. The first of these expressions is a positive value and shows the efficiency of the fan to be limited only by the power of the engine and the strength of the fan. The expression $(p^1 - p)$ becomes zero when $p = p^1$. Hence the power or efficiency of the exhaust fan can never exceed the atmospheric pressure. This limit however to the efficiency of the exhaust fan is so high as to meet all of the demands made upon it for mining purposes, especially as the velocity of the ventilating current is necessarily limited.

But there is a very important advantage that the force fan has over the other, viz., the maintaining of a higher actual pressure, in distinction from the effective pressure of the pit. The effective pressure is the surplus or ventilating pressure p, and is the same in both systems of ventilation. The actual pressure per square foot, at any point in the mine is, in either system, equal to the resistance still ahead of the current, divided by the sectional area of the air-way, plus the actual pressure per square foot in the up-cast shaft. In the plenum system, the actual pressure per square foot in the pit is always greater than the pressure of the atmosphere per square foot. The practical effect of this is to convert every crevice or fissure, reaching to the surface, into an outlet for the air of the mine, driving out whatever gas is present in such fissure. Also, to drive back the gases which would otherwise issue from old works, by establishing a small leakage of air through such old works to find vent in the open air. In the vacuum system, on the other hand, the actual pressure per square foot in the pit is always less than the outside pressure, for the same unit of surface, and hence the above beneficial results are reversed; and every crevice and fissure pours its gas into the pit. If such fissure communicates with the atmosphere, the outside air will be drawn or pressed into the mine through it. Every crevice or fissure becomes an inlet to the mine when the exhaust fan is used, but an outlet when force fan is employed.

This we would suggest is the case where the gas from broken mains finds entrance into a mine. These gases would not enter were the force fan used. If the experiment mentioned by Mr. Louttit, which is a good one, should be applied to a mine ventilated by a force fan, we venture the assertion that the gas would not have been found to have entered the pipe at all.

Respectfully
J. T. BEARD.

Ottumwa, Ia., Jan. 23d.

TRANSMISSION OF POWER BY ELECTRICITY.

How It Is Done at the Edison Works, at Schenectady, N. Y.

The transmission of power in mills by means of costly belting, pulleys, and shafting, and, in hundreds of cases, by steam pipes radiating from a boiler house to scattered auxiliary engines, has long been considered a costly and more or less unsatisfactory method. This consideration is becoming stronger and more widespread as the adaptation of electricity for the transmission of power progresses towards further development and becomes better known. Mill owners, iron masters, spinners, carpet weavers, and others engaged in manufacturing, who are now obliged to depend upon engines, with their accompanying evils of loss of power, dust, oil, strong smells, dangers from fire, etc., are asking themselves if it is not possible to adopt some other method of power generation and transmission which will do away with the various disadvantages inseparably connected with this system. Various minor attempts at the utilization of electricity to operate mill and mine machinery at a distance, have been made within the past few months, but no experiment on a really grand and extensive scale has been undertaken until quite recently. The Edison General Electric Company seems to have the honor of being the first to solve this problem in a comprehensive manner. The transmission of power from one central power house, containing all the boilers and engines, to the forty or more different buildings which go to make up the Schenectady works of the Edison Company, has attracted attention from all sides. A New York publication, *Power*, chiefly devoted to mechanical interests, considers the matter of so great importance, that, in its February issue, it gives a full and graphic description of the manner in which the elimination of the various defects, mentioned above, is effected.

The power house, is situated almost in the middle of a piece of land twelve acres in extent, and is surrounded on all sides by the different buildings to which it supplies the necessary power. This house contains a battery of boilers of over 2,000 H. P. capacity, the engines necessary to drive the electric generators and the generators themselves. Radiating in all directions run the conductors through special Edison underground tubes to the different buildings where they are connected to Edison motors, which in turn are connected by belts to the shafting serving to operate the machinery. By the adoption of this method, the general aspect of the interior of the buildings is entirely changed. Formerly, there stood in a corner of each building a small independent engine connected by steam piping to the boiler house, giving off its superfluous steam, smelling of lubricating oil and raising the temperature, occasionally, to an unbearable degree. Now, in the place of the engine, and occupying, perhaps, less than a quarter of the space, is a small motor, a switchboard, and a regulator. One throw of a small switch lever, the motor is running noiselessly, and the whole machinery in the building is in motion. There is no trouble, no engine on center, no steam, no smell, and no dirt. The attention required by the motor is very slight, and one of the workmen looks after it without allowing it to interfere with his ordinary occupation to any appreciable degree. The machinery in the forty odd buildings, operated by the motors, drawing their motive force, electricity, from the central power house, gives employment to over 3,500 men. Electricity is also conveyed along the wires to the different testing rooms where all kinds of electrical power apparatus is continually under delicate test. In addition, the two largest machine shops, properly so called, where the big Edison dynamos and their smaller brothers are assembled, and the foundry, are each equipped with traveling cranes, which are operated exclusively by means of electrical motors. These are so constructed that they respond immediately to the slightest desire of the motor man, and are capable of raising and transferring immense weights with ease and rapidity. Here also are to be found the huge shears for cutting iron, and the large and small trip-hammers, all owing their working ability to electricity generated at a point many hundreds of yards distant.

In addition, *Power*, gives the following facts in figures: The power plant comprises an Armington & Sims 10 x 12 engine of 150 H. P., driving on 100 Kilowatt Railroad Generator and two 100 Kilowatt Standard Generator, and another Armington & Sims engine of same proportions, in reserve, coupled to one 50 Kilowatt and one 100 Kilowatt Generator. A small engine of same make of 25 H. P. drives three 8·5 Kilowatt generators. There are also two 300 H. P. Edison Triple Automatic Engines, each driving two of the new Edison 100 Kilowatt Multipolar Dynamos, and a 150 H. P. Triple Automatic engine driving two 60 Kilowatt Generators of former standard Edison type. The boiler battery consists of three boilers of 500 H. P. each, and three of 250 H. P. each, making a total of 2,250; this will eventually be raised to 3,000 H. P., when the three additional 250 H. P. boilers are put up. The present generator or dynamo capacity is about 1,000 Kilowatts. This will be increased to 1,400 Kilowatts as soon as possible and the normal capacity of the power station will then be 1,900 H. P. The normal output is about 950 H. P., at the present moment, but this is increasing as the new shops go up. The present floor area of the Schenectady Works is 11·84 acres. Current is distributed to 43 motors of standard Edison type, which would represent a capacity of 1,324 Kilowatts if run to their full capacity. About 20,000 feet of single conductor wire is used to convey the power from the central house to the motors and this does not include the wiring of the buildings or the conductors laid in Edison underground tubes. The voltage of the motor circuit is 250 volts, the lights running on 125 volt circuits. The loss of power in transmission is small when compared with the enormous loss when steam was conveyed to the small independent engines in the scattered buildings.

Thus it will be seen from the foregoing that from the points of view of both economy and expediency the days of the universal use of steam alone in power transmission, are numbered. The impetus has been given to a new departure, and the progressive Nineteenth Century ideas will effect the rest.

PERSONALS.

MR. JOHN WEAR, Ex-Superintendent of the Coleraine colliery of W. T. Carter & Co., died at his home at Beaver Meadow, Pa., on the 29th inst. Mr. Wear was well and favorably known in the Schuylkill region, where he had resided for a long time. The Hazleton *Sentinel* recently published a sketch of his life.

MR. MORGAN D. ROSSER, who has been superintendent of the four collieries of the Kingston Coal Co. for the past twenty-five years has resigned.

MR. E. B. LEISENRING, the well-known coal operator, and one of the most prominent citizens of Mauch Chunk, Pa., was married to Miss Annie May Wickham, of New York, on the 16th instant.

Mr. W. L. Bellis of Cleveland, Ohio, writes us that his patent mine collar is rapidly winning its way into still greater popularity, and all mines that once use them become regular customers.

MINING THIN COAL SEAMS IN MISSOURI AND KANSAS.

BY ARTHUR WINSLOW, STATE GEOLOGIST, AND LEO GLUCK, ASSISTANT, MISSOURI GEOLOGICAL SURVEY.

[From a Preliminary Report of the Coal Deposits of Missouri.]

The fact of the prevalence of thin coal beds in some parts of the State has already been referred to in the preceding chapter on the coal industry of the State. Some of the reasons why such beds can be worked with profit were there given. It is here proposed to describe the processes by which these beds are mined, in order that their entire availability may be appreciated and understood.

The data from which the following article is prepared are derived chiefly from a study of the mines in Lafayette County, Missouri, where the coal bed is about 20 inches thick, and from an inspection of such at Leavenworth, where the coal is 22 inches thick, and at Osage City, Kansas, where it is only 14 inches thick; these three localities being in the districts in which such thin beds are most extensively operated.

The general system of mining adopted is the Longwall method. The prominent recommendation of this method is that it admits of all the coal in the mine being excavated, none being lost in pillars, as in the pillar and room method. Hence the amount of coal taken out in the former case, from any given area is greater than in the latter case.

In the past the belief was general that a tough and somewhat flexible roof was an essential condition for the successful use of the Longwall method. The conditions in Missouri and adjoining States necessitated, however, a removal of this restriction and, as mining progressed, a system of Longwall working has developed by which the coal is taken out from under comparatively weak and unstable roofs. We hence recognize a division of the process of mining these thin beds into the following two parts:

First, where the roof is strong and flexible.

Second, where the roof is comparatively weak and brittle.

The former condition is, of course, the preferable one and, under the latter conditions, work cannot be prosecuted when the roof is extremely soft and weak, and it is always more expensive and somewhat more dangerous than with the first. An essential condition, with either method, is that there be enough material available, either from the roof or floor, to supply the packing necessary for partially supporting the roof. This will be better understood after the following description of the methods of work is read.

The ideal location in these flat beds, where the question of drainage is not the preponderating one, and when the system of mining alone is considered, is at the center of the property, or, more properly, in the center of the coal area.

METHOD OF MINING WITH A STRONG AND FLEXIBLE ROOF.

With the most approved practice, when the roof is strong and flexible, the following is the general line of procedure when the mine is operated by a shaft:

From the bottom of the shaft four entries are driven in the coal at right angles to each other for a distance of from 20 to 50 feet, this distance depending on the character and strength of the roof, the depth of the coal beneath the surface, upon the nature of the underlying clay and also upon the anticipated period of operation of the shaft. From the ends of these rudimentary entries cross-cuts are then driven connecting the former with each other, as is illustrated in Fig. 1. From the exterior sides of these cross-cuts the coal is next mined radially from the shaft, the main entries advancing with the face and being kept open by gob walls and packing. This process continues until the face has advanced some 800 feet, and until the distance between the ends of each two adjacent entries is about 1200 feet. When this stage is reached the face is still pushed forward in the same direction as before, but instead of one entry being open and left packed, two are now left, which radiate from the main entry, one on the right-hand side, one on the left-hand side, each at an angle of 45° with the original direction of this main-entry. In the angle between these two new entries a triangular gob wall is built as a permanent pillar, and beyond it the mining of the coal continues as before. When this has proceeded to such a distance that the haul along the face of the coal to the entries again becomes excessive, bifurcation of the entries is again resorted to, although the angle at which the new entries separate from the original direction will be different from what it was in the first case.

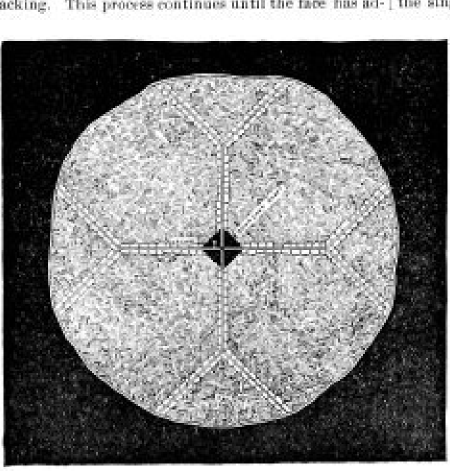


FIG. 1.

Plan of mine operated by Longwall method in strong and flexible roof.

The process continues until the limits of the property are reached, unless the coal be at such a shallow depth that it is more economical to sink a new shaft than to have a very long underground haul.

In illustration of the general process of mining above directed the preceding outline sketch of the map of a mine operated by this method is presented in Fig. 1. The position of the shaft and of the adjacent pillars will be readily recognized, the packing of gob is indicated by the irregular shading, while the face of the coal is plainly shown by the black band surrounding the whole.

METHOD OF MINING WITH A WEAK AND BRITTLE ROOF.

When the roof is comparatively weak, and brittle, a method of mining is pursued which differs from the last described in that less space is left between the advancing face and the packing which follows it. Thus, while in the former case, a track is laid along the face between the entries, over which the coal is pushed in boxes, in the latter case no track is laid along the face, but the coal is removed directly along numerous subordinate entries. By this means much less open space need be left at any one time between the packing and the face, with consequent less strain upon the roof.

The general mode of proceeding is as follows: From the foot of the shaft entries are driven in opposite directions for a short distance in the coal. As soon as a sufficient length of face is exposed for mining operations to proceed, the coal is attacked on both sides of the entry along the whole length. As the face advances the waste material or gob is thrown behind and, at the same time, ways are left with packed walls on both sides at intervals of about 40 feet. With the best practice these passage-ways are run at right angles to the main entry. Between two passage-ways, along the main entry, walls of packing are carefully built. The interval between two such is known as a room, and is generally operated by one miner.

The general plan of thus starting such work is shown in Fig. 2.

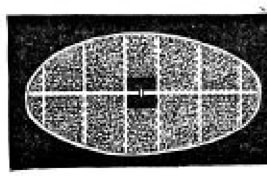


FIG. 2.

At a distance from the shaft of about 100 feet cross-entries parallel with the room-ways, are started, on each side of the main entry, which are kept open by packed walls continuously to the limits of the workings.

Between these cross-entries the rooms are continued in a direction at right angles to the main entry, while, beyond these cross-entries, rooms are now started parallel to the main entry. Each room is made about 200 feet long and beyond this cross-entries are opened from which new rooms are started. This method is more difficult to describe than the last. A study, however, of Fig. 3 will make the method of work plain. The double broken lines there shown are entries, whereas the single solid lines are room-ways. Between these are the packing and gob. The heavy black band around the margin is the face of the coal. The object in having the various entries and in not running the rooms to an indefinite length, is manifestly to limit the distance which the miner has to push his boxes of coal, and to gather the various boxes into entries at frequent intervals.

The two methods of work above outlined are both with shafts. With drift mines the method of working is the same, only the length of face subtends a smaller angle than with the shaft mining.

DETAILS OF LONGWALL MINING.

Having now given a description of the general principles of mining in these thin coal beds, we will proceed to a discussion of the details.

Methods of driving entries.—The method of entry-driving in these coal beds, varies with local conditions.

As the coal bed itself is not sufficiently thick for a traveling way to be confined to it, it is generally necessary to cut down the roof, or to take up the floor in order to acquire the requisite height. The section of such an entry is illustrated in Fig. 4. In the larger mines a height of about 6 feet is usually desired in the main-entries. In the mines at Osage City, however, the entry is cut only 4 feet high and 4 feet wide, but here the roof is a soft shale and generally falls down so that a height of 6 to 8 feet prevails. The entry is driven narrow here so as to prevent heavy roof falls. In the Leavenworth Mines the dimensions of the entry are 5 feet wide at the base, 4 feet at the top, and 6 feet high. In Lafayette County the height of the entry is about 5 feet and the width varies up to 12 feet with the double track entry; the roof here is self-supporting and there are not the same restrictions to the width of the entry that prevail in mines with weaker roofs. In minor entries and room-ways, and also in very small mines where mules are not used, very little roof or bottom is taken out and the height in many cases is only about 3 or 4 feet.

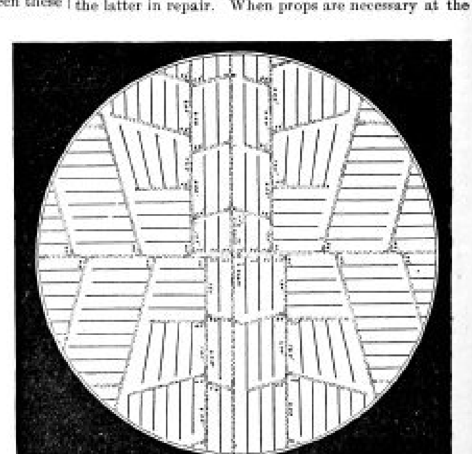


FIG. 3.

Entry driving in the solid coal is only done at the beginning of the work, through the pillar at the foot of the shaft. Beyond this the entry work consists in packing the walls on each side, brushing down the roof or taking up the floor and laying the track. The method of doing this and the attendant cost vary with different conditions. In the vicinity of Lexington the entry is driven through the pillar by first undercutting the coal to a distance of 18 or 24 inches and then shearing the coal on each side of the entry to a corresponding depth. The rib of coal thus left is then wedged down and removed. The coal bed here is less than 2 feet thick and, between it and the overlying limestone roof rock, there are only a few inches of shale. Hence, in order to acquire the requisite height for hauling in the entries, the clay underlying the coal is lifted to a depth of 2½ feet. In places, where there is more shale between the cap rock and the coal, less of the underlying clay is taken up, and the roof shale is brushed down. Elsewhere, as in the Leavenworth Mines, where there is no roof rock, but a large body of shale immediately overlying the coal, the requisite height of entry is obtained entirely by brushing the roof. Under conditions such as sometimes obtain near Corder, in Lafayette County, where the overlying shale and the underlying clay are both thin, the roof rock is shot down in part. This lifting of the bottom clay, or brushing and shooting of the roof is necessary both in the entry beyond the solid pillar as well as in the latter.

The cost of thus driving an entry varies with the different conditions. In the vicinity of Lexington the removal of the coal in the entry through the pillar costs about $5.00 a running yard. The lifting of the tough, hard bottom clay to a depth of 3 feet in entries cost about $2.50 per running yard. In the vicinities of Corder and Higginsville, where the roof rock is shot down to a height of about 3 feet, the cost is about $2.00 a running yard.

At Leavenworth and about Osage City, where fissile shale overlies the coal, $1.25 a yard is paid for brushing down the roof, in the main entries, to a height of about 4 feet above the coal. In the short room-ways, in these mines, the miner brushes down the roof to a height sufficient for man haulage, without extra pay. Track-laying is done by the companies in the main-entries; and such props as are necessary there are also furnished by the company. In the room ways the miner lays the temporary track there used, and the company furnishes the necessary material.

Method of Mining Coal.—The method of mining the coal is essentially the same in both of the systems previously defined. The coal is undercut along the whole face, to a depth of about 18 or 24 inches, and is wedged down, or falls from the weight of the superincumbent strata. These general conditions are illustrated in Fig. 5. The practice is for a certain length of face to be assigned to each miner and he is paid at a fixed rate for the amount of coal which he gets out. The under-cutting is done, in almost all cases, by hand, no machine cutter having been successfully used in such mining in the districts examined.

In addition to the work of undercutting and wedging the miner has, further, to load the coal and sometimes to push it to the entries; to pack the gob, to keep his room-way open, and to lay the track in these room-ways, and to move it along as the face advance. He, further furnishes his lamp oil and all tools, and keeps the latter in repair. When props are necessary at the face he puts these in place, but they are furnished him by the company ready for setting. The undercutting is generally done in the clay under the coal and is about 4 inches high at the face, tapering towards the end. Where the underlying material is excessively hard, however, or where there is little or no clay the cutting is done directly in the lower bench of coal. This is, of course, objectionable in that it causes waste of coal. The length of face worked by one miner varies from 20 to 60 feet, and the length of cut per shift varies 10 to 40 feet, according to the character of the underlying material, the thickness of the coal, and other minor conditions. A cut of about 20 feet is perhaps a fair average. With the strong roof, where a track is layed along the face, the distance between the face of the coal and the gob packing is generally about seven feet, and this must be kept clear by the miner.

With the weak roof, where no track is layed along

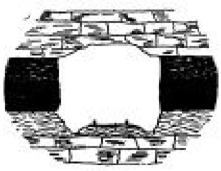


FIG. 4.

the face, the space is generally not more than three feet. In Lafayette Co., and in the Leavenworth Mines, the miner is paid at the rate of about 4c. per bushel ($1.00 per net ton) for the clean coal which he mines. In the Osage district about a cent more per bushel is paid in consideration of the thinness of the bed and the consequent increased difficulty of mining.

Methods of building pillars and packing gob. The method of supporting the roof is different in the two systems described in the preceding pages. Where the roof is a strong one a heavy and well packed wall is carried along by the miner on each side of the entries. Between these, continuous pillars, less carefully packed, are carried along at right angles to the face, as the work advances. These pillars are built of the heavier and larger blocks of waste material, and in between them the smaller and loose material is shoveled.

The plan of work above described is well illustrated in Fig. 6.

The distance between each pillar is generally about 6 feet, the wall itself is usually about two feet thick and it is tightly wedged with the roof at the top. The miner who works adjacent to the entry builds the entry wall, generally without extra pay. The difference between this wall and the others is that it is made of the larger blocks, is more carefully, packed and is built with a smooth face towards the entry. The proximity of the miner to the road head is thought to be a compensating consideration for the extra work of building this wall; in some cases, however, a small extra allowance of pay is made for this work.

In mines with weak roofs pillars are carried only along the entries and in the room-ways between these, props are placed in rows running vertically to the face. In the Osage district, of Kansas, each prop in such a roof is 18 in. apart, and each row is 2½ to 3 feet from the adjoining one. As the work proceeds the entry walls are built of the larger material and the loose material is thrown in around these rows of props. In Fig. 7 this plan of work is illustrated.

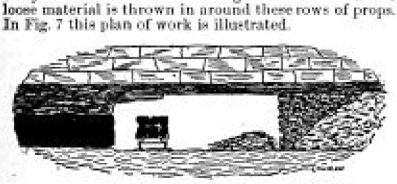


FIG. 5.

Cross section illustrating the method of mining coal.

The method of hauling. In the larger mines hauling in the entries is generally done with mules. They haul the coal in trips of several cars, the number being dependent upon the grades encountered in the entries. In some large mines, where the grades are very slight, or the coal dips towards the outlet, the cars are run out singly by the miner, and this is generally the case in small mines. The capacity of the cars is generally about one-half a ton or less, they being small and low on account of the limited working space. The track in the entries is generally a light T-rail, spiked to wooden ties. Where the track runs along the face, the rails are the same, but they are tied together by iron bars. As the face advances the whole track is moved forward by the miners. This track between two entries is not connected at the middle, but has loose ends. As it advances with the face, the distances between the diverging entries necessarily increases, and to allow for this additional lengths of track are added from time to time. The entry track and face track are connected by a flat iron plate on which the cars can be readily transferred from the one to the other. In some mines, where the entry is wide, a switch is laid at each road-head, where empty cars or boxes are stored and full cars can pass each other. Further, in mines with soft roofs, where the cars come from a large number of different points, turn-outs are provided in the entries, where empty trips coming in can pass the full ones going out. The transfer plate at the road-head is not advanced with each moving of the face track, but, generally, remains in the same place for two or three days, the face track being curved back to meet it. Along the room-ways, in mines with weak roofs, only temporary tracking is laid of wooden strips 1½″ x 3″ in section.

In mines with strong roofs the empty cars are all run in along the face track, to the various places of work, by the "pusher," and are then filled by the miner. After the cars are filled they are removed successively from the face track to the entry track by the "pusher," beginning with the car nearest the entry. As each full car is removed an empty one to replace it is brought in and is temporarily turned up off of the track so as to allow the full ones beyond to pass by, as they are pushed out.

In mines with weak roofs the car is run to the end of each roadway and is then loaded by the miner, who either shoves each block of coal separately to the face of the roadway, or slides it in on small sled-like buggies to such roadways, and there loads it on to the cars.

Methods of ventilating and draining. The system of ventilation in these mines is extremely simple; in fact it is one of the points recommending these methods of Longwall work that, when properly prosecuted, the mines are so easily ventilated.

In some cases the entire fresh air current is carried from the downcast shaft out one of the entries to the face, it is then split to the right and left and carried around the whole face to the end of the opposite entry, along which it returns to the upcast shaft. In other cases the air current is split at the beginning, at the foot of the downcast shaft, and is then carried in opposite directions to the face, where each current is again split to the right and left. These currents then pass along the face around a quadrant of a circle, where two from opposite directions unite and pass back along one entry to the upcast shaft. The entries which are off the line of the main currents are generally cut off from these currents by brattices or doors, and are generally ventilated by the occasional opening of the doors or by the leakages through the brattices. In some cases small side-currents are kept up constantly along side entries which are much used.

The draining of many of the mines, in which this system of work is carried on, is a very simple matter, inasmuch as little or no water accumulates in them. Where water exists it is drained towards a sump located at a low point, and is thence pumped to the surface. For drawing the water to these sumps, small ditches or drains are dug along the entries, and, in some cases, small drain tile is used. A large amount of water in connection with such mining is an especially

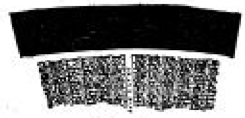


FIG. 6.

Plan illustrating pillar work and gob packing with a strong roof.

serious objection, inas-much as it tends to weaken the roof, to soften the underlying clay, and to produce excessive settling and squeezing throughout the mine.

Concluding remarks. The fact that, with the methods of mining which have been described, all of the coal can be removed from the ground, has already been referred to as the chief recommendation. The ease of ventilation has also been referred to and the simplicity of the plan of work further recommends it to use. It is desirable, however, in order that the best results may be reached, that the work be prosecuted regularly and uniformly, so that the face advance equally in all directions and preserve approximately the shape of a circle. If this is not done the coal will not split off freely at some points along the face, while elsewhere it will split off before a sufficiently deep undercut has been made. Further, unequal settling resulting from this irregular work will produce inequalities in the floor and roof, which become obstructions in hauling the coal along the face. A greater fracturing of the roof is also liable to result, accompanied by all of the attendant difficulties. All of such Longwall mining, however, causes a greater or less fracturing of the roof. On this account, it is not generally practicable to carry it on when the mining is near the surface, and when the surface is a wet one. An excessive amount of water is admitted to the mine in such cases. It can also not be practiced at a shallow depth when the overlying property is of great value, for the reason that the effects of the settling may be transmitted to the surface and cause serious damage.

A number of suggestions might be made in the nature of improvements upon the methods of mining these beds, both in this state and in Kansas. Among these are the introduction of rope and power haulage, and the use of machine cutters. In the direction of rope haulage nothing has yet been done. The reasons generally given, are that the properties worked are too small and the amount of coal available too little to

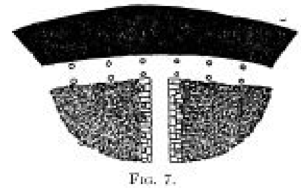


FIG. 7.

Plan illustrating pillar work and gob packing with a weak roof.

warrant the introduction of an expensive plant. Further, the shallow depths at which the coal is found in many places, make it cheaper to have frequent openings from the surface than to haul the coal far underground, by power or otherwise. In the future, as the industry develops, and as the demand becomes greater and more regular, some of the conditions will change, and improvements in these and other directions will probably be made which will lessen the cost of production. At the Mendota Mine in the northern part of the state, where the coal bed is nearly 3 feet thick, rope haulage is already successfully used, but here both the pillar and room as well as the Longwall method are practiced.

Machine cutters have been experimented with to a limited extent in Lafayette County, but not with success. The Harrison machine was used. The chief reasons given for the failure of the experiment are the lack of competent and willing labor, and the excessive amount of refuse which the cutters made. The coal bed here was only about 18 in. thick, however, and the cutter took out nearly a foot of clay. This together with the overlying shale which came down with the coal was more than could be disposed of in the mine, and hence had to be hauled to the surface at excessive cost. At the same Mendota Mine in the northern part of the state, in which rope haulage is practiced, machine cutters have also been introduced and are successfully used. We do not feel, at present, at all convinced that with some form of machine especially adapted to these thin beds, machine cutting may not be in near future successfully prosecuted.

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ALEX. DICK, MINING ENGINEER, ASSISTANT EDITOR.
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IT IS NECESSARY AND WILL BE BENEFICIAL.

Since the close of the war the Anthracite coal trade has been in an anomalous condition. The production has increased from ten million to forty million tons, but for nearly the whole period the mines have been in condition to produce more coal than could be profitably marketed, and prices have fallen from $10 per ton, the retail price in Philadelphia in 1866, to $5 per ton, the retail price at present. The wages paid for mining have been reduced one-half and because it is necessary to restrict production to obtain even $5.00 per ton at retail in Philadelphia, the collieries are only worked from three-fourths to one-half time. All classes interested in the production of coal are suffering because of this unnatural condition. The capital invested in the collieries is not profitable; the mine officers are not paid as well for their services as the same class in other branches of industry not requiring as great technical knowledge and executive ability, and the Anthracite miner earns less than other workmen who perform the same amount of work and run the same risk of injury or death from accident.

The causes of this peculiar condition are, First: Too much capital has been invested in the production and transportation of coal. More railroads than can be operated profitably have been built to distribute the product of the mines and more mines than are necessary have been opened to supply these roads with tonnage. Second: With the object of cheapening the cost of production in order to realize profits on the low prices for coal which have prevailed for many years, the operators have largely increased their output. Many new collieries have been opened and the capacity of those already opened has been largely increased. The result is that the capacity to produce is far ahead of the demand for consumption, and for years it has been impossible to obtain prices for coal that will pay the operators reasonable interest upon their investments and the miners fair wages for their labor.

An association was first formed to prevent the ruinous effects of over-production and to secure a remunerative price for coal in 1872. This association was dissolved the first of September, 1876, because one of the companies was shipping more than its proportion. The history of the trade in 1877 and 1879 (when unrestricted competition prevailed) shows how far in advance of the requirements for consumption the development of colliery property is maintained. It also proved that without restriction of production and regulation of prices both mining and transportation interest must be ruined. At the New York auction sale of the D. L. & W. Co. in November, 1877, prices fell to the lowest point as yet reached. The average price obtained, that year by the P. & R. C. & I. Co., for lump coal at Philadelphia was $2.40 per ton. In 1878 there was a new association formed which expired by limitation at the end of the year and 1879 was another season of unlimited production. The losses suffered that year by the coal producing interests have been estimated at thirty million dollars. Coal was sold on board vessels at Philadelphia at $2.00 per ton. At the September auction sale in New York the price realized for broken coal was only $1.97½ per ton. These prices are less than cost in the cars at the mines.

This lesson was a severe one and it has not been necessary to repeat it. Since 1879 the Anthracite interests have acted with sufficient harmony to prevent the ocurrence of another such disastrous experience, but there has been a great deal of friction because of the failure of the parties interested to act in good faith, and it has been found impossible to advance prices to a remunerative point, when there is no penalty for violating the mutual agreement as to the amount of coal to be mined and the price at which it is to be sold.

The pooling of interests by the owners of the Philadelphia & Reading R. R. Co.; the Lehigh Valley R. R. Co., and the New Jersey Central R. R. Co., and the purchase by the capitalists interested in them of a large interest in the D. L. & W. R. R. Co. is a movement to control the Anthracite coal trade and by introducing economies and regulating production to make the business of mining Anthracite coal remunerative. It will be better if the leasing of the Lehigh Valley and New Jersey Central properties by the Reading Company shall not prove unconstitutional since if the three roads can be placed under one management great economies in the administration of the properties can be effected. The more economical the management of these large companies the greater will be their earnings and the more liberal they can afford to be to the individual operators and to the employes of their mining departments, and the less it will be necessary to advance prices to make the business pay. If the leases are declared unconstitutional plans will be devised to accomplish the end aimed at. It is not necessary to discuss what action will be taken should such a contingency arise, but if the owners of the four largest companies interested in the Anthracite coal trade wish to do away with the ruinous competition that has so long ruled they can do so. A saving of 25 cents per ton in the cost of mining, transporting, and marketing the Anthracite coal product of forty million tons (or an advance in prices of that much) will add ten millions of dollars per annum to the earnings of the companies to be divided between the capital invested in transporting and mining the coal and the labor engaged in producing it. The proportion of this which will fall to the operators and to labor will be so considerable as to largely benefit the whole population of the Anthracite coal counties.

That the effect of this agreement by the owners of the coal carrying companies to act together will be to raise the price of Anthracite to exorbitant figures, as is so freely predicted by the New York and other journals, is ridiculous. As we have shown, Anthracite coal has been sold at prices so low that there has been no profit in mining, and both operators and miners have suffered. Hereafter it will not be mined if it cannot be sold at a profit, and the operator and miner will be benefited. Exorbitant prices will not be asked for it. Bituminous coal is plentiful and cheap and if the price of Anthracite is placed too high the public will use soft coal.

The attitude of certain men, high in position in labor organizations, in opposition to this pooling of interests is something we cannot understand. It is certain that the prices obtained for coal will be higher and more regular than in the past, and as the wages of the Schuylkill miners are fixed by a sliding scale regulated by the rise and fall in the price of coal, it is also certain that their earnings will be increased. If the earnings of the Schuylkill miners are greater the wages of those in the Lehigh, Wyoming, and Lackawanna regions will also be better. For twenty-five years every effort of the miners and laborers of the Anthracite coal regions to prevent the many reductions in wages which have been rendered necessary by the decline in the prices of coal, due to over-production, or to secure advances in wages has resulted in defeat, because it has been impossible to get good pay out of an industry which could not afford to pay high wages. In plain language it has been impossible "to milk a dry cow." This movement to control the trade and advance prices is the first encouraging rift in the gloomy outlook for labor in the Anthracite coal regions for many years, and yet we find men, whose occupation it is to advocate measures to secure better pay for the workmen, antagonizing it.

THE COLLIERY ENGINEER SCHOOL OF MINES.

It is only four months since we enrolled our first student in The Colliery Engineer School of Mines, and we have now 275 in our books. The course is meeting with success beyond the most sanguine expectations, and the school has every prospect of becoming one of the largest and most popular institutes for technical education in the United States. Our students reside in every state in the Union, from Pennsylvania in the East, to Washington in the West and Alabama in the South, while Nova Scotia and British Columbia each supply a few. We also number on our roll men in all positions from the mining engineer, mine superintendent, and mine foreman, to the miner.

We believe that few have an adequate idea of the completeness of the Lesson Papers or the thoroughness of the method of instruction. We do not supply the student with a superficial text-book, and leave him to flounder through it alone. We take right hold of each scholar and stick to him until he is proficient, whether it takes weeks or months.

When we first introduced this system of study we made the fee low in order to place it favorably before the public, because as it was something new it was natural some people should doubt the success of the system. Now, however, the continued approval of our students and the rapid progress they are making are sufficient evidence of its worth, and on the 1st of June the fees will be increased to $35 for a complete mining or complete mechanical scholarship, payable in advance, or to $40 if paid by installments. The partial scholarships will be each raised to $20.

We wish to announce to our students that the Instruction Papers on Surveying will soon be ready. The first class for field practice, at Scranton, will start on June 1st, and those who intend taking advantage of it should apply for their Surveying papers, so as to have them studied previous to that date.

ILLINOIS MINING INSTITUTE.

We are pleased to record the inauguration of a State Mining Institute for Illinois. It would be to the advantage of every man interested in mining if similar associations were started in every State in the Union. There is nothing better for the perfecting of a mining engineer's or mine manager's education than periodical meetings for the reading of papers and friendly interchange of views.

The first meeting of the Institute was held at Springfield, Ill., on February 19th, when the following officers were elected: President, J. C. Simpson, of St. Louis; First Vice-President, Richard Ramsay, of Braceville; Second Vice-President, Walter Rutledge, of Alton; Third Vice-President, Hugh Murray, of Sparta; Secretary, J. S. Lord, of Springfield; Treasurer, Thos. R. Stockett, of St. Louis; Executive Council, Wm. Scaife, of Coal City; G. C. Simpson, of Springfield; J. D. Peters, of Murphysboro; Robert Lee, of Cable; R. D. Fletcher, of Streator.

The object of the organization is educational, and as all the members are in positions of responsibility as to life and property the Institute will embrace within its scope all matters relating to safety and economy in mining. The next meeting will probably be held in May.

During the meeting Prof. Joshua Lindahl, the State Geologist, drew attention to a circular he had issued to all the Illinois coal operators regarding a proposed State mining exhibit at the World's Fair. The Illinois Board of Commissioners refused to allocate any money for this purpose. Prof. Lindahl thereupon wrote to every coal operator in the State asking them to send, at their own expense, a specimen of their coal to be exhibited, along with an analysis. The person to do the sampling for the analysis was, however, not to be of the operators, but of Prof. Lindahl's selecting, and we are not surprised to hear that out of eighty operators who troubled to reply to the invitation only five of them showed any inclination to respond. We should say these five happy mortals must have gems of coal seams. The guilelessness of Prof. Lindahl's circular is highly typical of a true student of nature—not human nature.

THE NEW CAMBRIA LIBRARY BUILDING AT JOHNSTOWN, PA.

AMONG the many buildings which were utterly destroyed by the flood of May, 1889, few had been better appreciated than the Library Building which was erected by the Cambria Iron Co. in 1879.

A new building enlarged and improved, has now taken the place of the old erection.

It was an act, unique in the annals of ordinary human nature, that prompted Andrew Carnegie to defray the entire cost of such a restoration.

There are not many people who would, even with the means at their command, write out a check for $55,332 to pay for the re-establishment of an institute to be devoted to the educational advancement of the workmen of a business competitor. This is just what Mr. Carnegie did, however, and is another verification of the fact that his generosity recognizes neither country nor nation, sect nor creed, but is in everything thoroughly cosmopolitan. He is known alike on both sides of the Atlantic, and his fellow countrymen of the kingdom of Fife are as ready to swear by the name of Carnegie as the Moslems are by the beard of the prophet.

One of the features of the inaugural ceremony of February 19 was the speech by Mr. John Fulton, General Manager of the Cambria Iron Co. Mr. Fulton dwelt on the work which had been done in the old building towards the technical education of the young men of Johnstown. The speech was a fine *resumé* of the advantages of such a training and the worth of his advice was evidenced by the fact that of former students many had risen to high positions, one being a State Inspector of Mines, while others were now Mine Superintendents.

EDITORIAL NOTES.

THE State Board of Examiners sat at Springfield Ill., on February 15, and succeeding days, to examine applicants for certificates of competency as mine managers. Fifty-two were successful in passing the examination. Of this number thirty-three are subscribers to THE COLLIERY ENGINEER, and four of these hold scholarships in The Colliery Engineer School of Mines.

PREVIOUS to the Reading Company taking possession of the L. V. R. R., the officials and clerks in the latter corporation's Philadelphia office were furnished with their midday lunches by the company The day after the deal was made, each officer and clerk was notified that from that time forward he would have to buy his lunch himself. One of the clerks, of a poetic turn, thereupon relieved his mind in the following stanzas:

Quickly following the Reading's coup,
They cut off dessert, and then the soup,
The warming broth, the cool ice-cream,
Are things as seen in a fleeting dream;
And now they all will have to go,
(Officials high and Dinkeys low)
Without the nourishing consomme,
For which they now will have to pay;
And missed along with the loved tureen,
Are pies, puddings, baked apples, and cream;
They all must go, their weight to lend,
To help the guaranteed dividend.

Penney. isn't in'it,
Reading made the scoop,
Navi. doesn't give a pin,
And we are in the soup.

The Anthracite Trade.

The past month witnessed the most important combination of Anthracite coal interests ever consummated. The Philadelphia and Reading Railroad became the lessee of the Lehigh Valley Road; and the Port Reading Railroad, under the same management, became the lessee of the Central Railroad of New Jersey. This naturally placed the Lehigh Valley Coal Co., and the Lehigh and Wilkes-Barre Coal Co., also, under the same management. The Delaware, Lackawanna and Western Railroad, at its annual election, admitted to its directorate Messrs. Maxwell and Baker, and it is announced that it will act in complete harmony with the Reading management, and its relations will be closer than they have ever been. This practically put under one management nearly 70% of the entire Anthracite output. The balance is produced by the Delaware and Hudson Canal Co., the coal companies of the Pennsylvania Railroad Co., the Pennsylvania Coal Co., the New York, Ontario and Western R. R. Co., and the New York, Lake Erie and Western R. R., or other operators on the lines of their roads. Of the above, the Delaware and Hudson Canal Co. controls about 10% of the output. What action it would take in the matter has been under speculation for some days, and the recent activity in trade in its stock gives credence to the rumor that it will be brought into close relations with the new combination.

The Reading management will handle the output of the individual collieries on the lines of the Lehigh Valley and Jersey Central roads on the following terms: When coal sells at $4.00 per ton f. o. b. New York, or less, the operator to get 60%, and the railroad 40%. On all over $4.00 and less than $4.50 per ton, the operator to get 40%, and the railroad 60%. All over $4.50 per ton the operator to get 30%, and the railroad 70%. President McLeod, in this arrangement, virtually guarantees a minimum price for stove coal at $4.00 per ton, f. o. b. New York, such price to be based on the average monthly prices of the Wyoming coals of the Lehigh Valley R. R. Co. and Delaware Lackawanna and Western Co. An additional inducement offered the operators, is the establishment of a board of arbitration for the settlement of all possible disputes, and of a system for the inspection of coal. This arrangement of prices can be readily seen in the following table:

Selling Price.	Operator's Share.	Railroad's Share.
$4.00	$2.40	$1.60
4.10	2.44	1.66
4.25	2.50	1.75
4.35	2.54	1.79
4.50	2.60	1.90
4.60	2.63	1.97
4.75	2.67½	2.07½
4.85	2.70½	2.14½
5.00	2.75	2.25

This arrangement is considered a liberal one, and is being accepted by the operators generally.

Coxe Bros. & Co. have secured control of the three mines of Pardee Bros. & Co., at Latimer; of the mines of Pardee, Son & Co., at Mt. Pleasant, and of Calvin Pardee & Co., at Hollywood. The product of these mines will hereafter be shipped over the Reading's line from Bethlehem to Philadelphia, instead of being sent over the Belvidere Division of the Pennsylvania R. R. from Philipsburg to Philadelphia.

There is naturally considerable uncertainty in the trade regarding the future policy of the combination regarding prices, but the arrangement with the individual operators, mentioned above, makes it evident that prices are lower now than they will be when all the new plans are in operation. That the policy will be conservative is evidenced by the fact that at the meeting of the sales-agents on the 26th ult., the March output was fixed at 2,500,000 tons, and there was no change in prices.

The demand for coal is light. Stocks in retailers' hands are also light, but there seems to be no desire to increase them.

The Bituminous Trade.

The Bituminous trade is dull and featureless, and the trade is now considering the character and policy of the Seaboard Steam Coal Association, that seems to be an assured fact. It is believed that this association will be more effective this year, and rate cutting will not be so freely indulged in. It is too early in the season for new contracts to be made, and as old contracts are about filled, the trade is confined to the wants of the smaller buyers.

A rise in the Ohio enabled the Pittsburgh River operators to send nearly 5,000,000 bushels to Cincinnati and Louisville, and the Pittsburgh harbor is comparatively bare of coal. The markets usually supplied with river coal, all have an abundance of coal now. The local demand in Pittsburgh is active. The trade in Chicago is suffering from an over supply, and, as a consequence, prices suffer.

The Coke Trade.

The coke trade is a trifle duller than it was last month, and considerable coke is being stocked in the yards. The car supply is ample, and prices are well maintained at same figures as quoted last month. The future, at this writing, is uncertain, as there is at present a depression in the iron trade, and this always has a corresponding effect on the coke trade.

Anthracite Coal Statistics.

Statement of shipments of Anthracite coal for month of January, 1892, compared with the corresponding period last year. Compiled from the returns furnished by Mine Operators.

	January 1892.	January 1891.	Difference.
Wyoming Region	1,520,927 06	1,684,307 05	Dec. 163,379 19
Lehigh Region	353,347 00	499,421 12	Dec. 146,074 12
Schuylkill Region	935,592 04	955,232 07	Dec. 19,640 03
Total	2,809,866 10	3,138,961 04	Dec. 329,094 14

The stock of coal on hand at tide-water shipping points, January 31, 1892, was 790,932 tons; on December 31, 1891, 637,668 tons; increase 153,264 tons.

NEW MINING COMPANIES.

Names and Post-Office Addresses of the New Mining Companies Incorporated in the United States Since our Last Issue.

The International Mining Co.,	Pueblo, Colo.
The C. O. D. Gold Mining Co.,	Colo. Springs, Colo.
The Lou P. K. Mining Co.,	Denver, Colo.
The Condon Mining and Milling Co.,	Denver, Colo.
The Salmon River Placer Mining Co., Ltd.,	Denver, Colo.
Bessemer Iron Co.,	Duluth, Minn.
The American Turquoise Co.,	Chicago, Ill.
The Snowstorm Consolidated Gold Mining Co.,	Chicago, Ill.
Loretta Gold and Silver Mining Co.,	Milwaukee, Wis.
The Belle Vernon Coal and Coke Co.,	Belle Vernon, Pa.
The Connecticut Free Stone Quarry Co.,	Cromwell, Conn.
The Monserrat Silver Mines Co.,	New York City, N. Y.
Albion Phosphate Mining Co.,	Martinsburg, W. Va.
Dead Medicine Mining Co.,	Spokane, Wash.
New York and Middle Coal Field Railroad and Coal Co.,	Philadelphia, Pa.
East Palestine Coal Co.,	Pittsburgh, Pa.
The Crescent Coal Co.,	Wilkes Barre, Pa.
Hidden Treasure Gold Quartz Mining Co.,	San Francisco, Cal.
Virtue Mining, Milling & Development Co.,	Stockton, Cal.
Antelope Crystal Salt Co.,	Salt Lake Ranch, Cal.
Union Gold Mining Co.,	New Orleans, La.
New Jersey Iron Ore Co.,	New York City, N. Y.
Mississippi Cotton Oil Co.,	Meridian, Miss.
The Union Mining Co.,	Neihart, Montana.
Good Luck Mining Co.,	Helena, Montana.
Consolidated Silver Crown Mining Co.,	Spokane, Wash.
The Washington Consolidated Mining & Milling Co.,	Seattle, Wash.
Bliss Salt and Oil Co.,	Bliss, Wyo. Co., N. Y.
The Buffalo Stone Co.,	Buffalo, N. Y.
The Consolidated Mica Co.,	Hot Springs, S. D.
Pacific Star Coal Co.,	Chicago, Ill.
The San Luis Prospecting & Mining Co.,	San Luis, Colo.
The Gold King Mining Co.,	Colo. Springs, Colo.
The Summit Gulch Mining and Milling Co.,	Denver, Colo.
The Highland Mining & Tunneling Co.,	Aspen, Colo.
The Pueblo-Creede Mining Co.,	Pueblo, Colo.
Campfield Coal and Mining Co.,	Des Moines, Iowa.
The Clarendon Marble Co.,	Rutland, Vt.
Bertha Zinc and Mineral Co.,	Jersey City, N. J.
Jefferson Coal Co.,	Piedmont, W. Va.
Coal Harbor Coal Mining Co.,	San Francisco, Cal.
Lead Placer Mining Co.,	Lead, S. D.
The Lone Rock Marble & Mineral Co.,	Chicago, Ill.
Detroit Iron Co.,	Duluth, Minn.
Tar Springs Asphalt Co.,	Los Angeles, Cal.
The Asbestos Mining and Manufacturing Co.,	Denver, Colo.
The Della S. Consolidated Mining Co.,	Aspen, Colo.
The Bull Mountain Gold Mining Co.,	Colo. Springs, Colo.
The Black Hawk Mining Co.,	Denver, Colo.
The Menlo Park Mining Co.,	Ouray, Colo.
The Eureka Coal and Coke Co.,	Dun's Branch, W. Va.
Huntington Improvement Co.,	Huntington, Ark.
Silver Mountain Mining Co.,	Walla Walla, Wash.
The Moore & Blunton Gas Co.,	Noblesville, Ind.
Shear Oil & Asphalt Co.,	Hueneme, Cal.
San Antonio Oil Co.,	Hueneme, Cal.
Lion Oil and Asphalt Co.,	Hueneme, Cal.
29 Palms Mining and Milling Co.,	Riverside, Cal.
Consolidated Santa Rosa Mining Co.,	Riverside, Cal.
Charleston Iron Co.,	Duluth, Minn.
Phoenix Mining Co.,	Paint Creek, W. Va.
Hope Mining Co.,	Paint Creek, W. Va.
The Silver Basin Mining Co.,	Denver, Colo.
The Cripple Creek Syndicate Mining & Milling Co.,	Denver, Colo.
The Western and Eastern Investment Co.,	Denver, Colo.
El Vadelesta Mining Co.	Jersey City, N. J.
Everett Gold Mining and Milling Co.,	Tacoma, Wash.
Fulton Fire Brick and Mining Co.,	Fulton, Mo.
The Harden Placer Co.,	Colo. Springs, Colo.
The Phillips Land & Gas Co., of Alexandria,	Alexandria, Ind.
Henrietta Coal Mining Co.,	Philadelphia, Pa.
The Globe Powder Co.,	Allegheny, Pa.
Temperance Flat Mining and Milling Co.,	San Francisco, Cal.
The Scotia Mining and Milling Co.,	Colo. Springs, Colo.
The Montezuma County Development Co.,	Cortez, Colo.
The Saturn Mining Co.,	Aspen, Colo.
The Miller Creek Contract Mining Co.,	Denver, Colo.
The Mansfield Lead and Zinc Co.,	Mansfield, Ohio.
Sunset Coal Co.,	Tacoma, Wash.
Compromise Natural Gas Co.,	Windsor, Ind.
The Glen Falls Coal and Coke Co.	Clarksburg, W. Va.
Gold Eagle Mining Co.,	Cerrillos, N. M.
Columbia Building Material Co.,	Alexandria, Va.
Chicago Iron Co.,	Duluth, Minn.
Kanawha Iron Co.,	Duluth, Minn.
Liberty Mining Co.,	Great Falls, Mont.
Vulcan Mining Co.,	Elkhorn, Mont.
The Lost Creek Fire Brick and Silica Co.,	Anaconda, Mont.
Black Swan Coal & Mining Co.,	Des Moines, Iowa.
Rowena Mining Co.,	Keokuk, Iowa.
J. P. Pierce Co.,	Santa Clara, Cal.
The Idaho Mining Co.,	Salina, Kan.
The Bompy's Hook Stone Co.,	Bompy's Hook, near Alpine, Bergen Co., N. J.
Enterprise Mining, Milling and Smelting Co.,	Seattle, Wash.
The Acoparra Mining Co.,	Colo. Springs, Colo.
Big Kanawha Coal Co.,	Chicago, Ill.
The Augusta Gas & Oil Co.,	Augusta, Ill.
Sunset Mining Co.,	New Orleans, La.
Black Hills Mining and Developing Co.,	Hill City, S. D.
Consolidated Quarry Co.,	Alexandria, Va.
Washington Marble Co.,	Alexandria, Va.
Pink Granite Co.,	Alexandria, Va.
United States Contract Co.,	Norfolk, Va.

Orkney Springs Hotel and Improvement Co.,	Alexandria, Va.
The U. S. A. Tunnel Mining and Milling Co.,	Denver, Colo.
The Cleopatra Mining Co.,	Colo. Springs, Colo.
The Omaha and Grant Smelting Co.,	Denver, Colo.
Hardin Baker Gold Mining Co.,	Milwaukee, Wis.
The Robinson Mining Co.,	Baker City, Oregon.
The Lemhi Placer Gold Mining Co.,	Salmon City, Idaho.
Dubuque Ore Concentrating Co.,	Dubuque, Ia.
The John Young Silver Refining Co.,	Chicago, Ill.
Patton Vitrified Brick Co.,	Chicago, Ill.
The Minnesota & New Mexico Reduction Co.,	Gold Hill, Grant Co., New Mexico.
The Creede Prospecting and Mining Co.,	Denver, Colo.
The Mountain Side Mining and Milling Co.,	Great Falls, Mont.
Frisco Mining Co.,	Great Falls, Mont.
Tomasso Hill Mining Co.,	San Francisco, Cal.
Missabe Mountain Iron Co.,	Duluth, Minn.
Centralia Mining and Improvement Co.,	Centralia, Wash.
The Argent Mining Co., of Idaho,	Chicago, Ill.
The Bethlehem Natural Gas, Oil & Mining Co.,	Noblesville, Ind.
Cynthiana Natural Gas, Oil & Water Co.,	Cynthiana, Ind.
The Golden Star Mining Co.,	Chicago, Ill.
The Ohio Land & Coal Co.,	East Palestine, Ohio.
The Weurich Lead & Zinc Co.,	Mansfield, Ohio.
The Magnetic Ore Milling Co.,	New York City, N. Y.
The Rapid River Mining Co.,	Spokane, Wash.
Arctic Placer Mining Co.,	San Francisco, Cal.
Long Creek Co.,	Richmond, Va.
The Maid of Erin Silver Mines, Ltd., London, Eng.,	Leadville, Colo.
The Antlers Mining & Milling Co.,	Colo. Springs, Colo.
The Jessie Gold Mining & Milling Co.,	Breckenridge, Colo.
The National Ore Reduction Co.,	Pueblo, Colo.
Helena Mining Co.,	Great Falls, Mont.
The Silver Pass Mining Co.,	Olden, Tex.
Rowland and Lacy Petroleum and Land Co.,	Los Angeles, Cal.
Farview Natural Gas and Oil Co., Ind., Howard Co., Ind.,	Kokomo, Ind.
Silver Belt Mining Co.,	Albuquerque, N. M.
Manhattan Gold Mining & Milling Co.,	Silver City, N. M.
Odgen Electric Power Co.,	New York City, N. Y.
The Greiner Economical Cupola Co.,	Chicago, Ill.
Porter Creek Consolidated Mining Co.,	Porter, Wash.
Mammoth-Garfield Gold Mining Co.,	San Francisco, Cal.
Bush Gold and Silver Mining Co.,	Marietta, Wis.
Carpenter Bar Gold Mining Co.,	St. Croix Falls, Wis.
The Creede Mining and Milling Co.,	Denver, Colo.
Harrison Gas Coal Co.,	Greensburg, Pa.
The Avondale Lime and Stone Co.,	Philadelphia, Pa.
The Valley Coal and Mining Co.,	Kittanning, Pa.
Belington Coal and Coke Co.,	Belington, W. Va.
The Silver Prince Mining Co.,	Spokane Wash.
Cleveland Iron Co.,	Duluth, Minn.
The Horton Mining Co.,	Duluth, Minn.
Woodward Mining and Milling Co., Consolidated.,	San Francisco, Cal.
Isle Royale Mining Co.,	New York City, N. Y.
The Enterprise Mining and Smelting Co.,	Butte, Mont.
Magnet Mining Co.,	New Chicago, Mont.
Quartz Gulch Reduction and Concentrating Co.,	St. Paul, Minn.
Bowling Green Phosphate Co.,	Jacksonville, Fla.
Atlas Clay Material Co.,	Chicago, Ill.
The Gertrude G. Placer Mining Co.,	Chicago, Ill.
The International Chemical Gas Co.,	Chicago, Ill.
Burlington Investment Co.,	Burlington, Ia.
Monarch Zinc and Lead Co.,	Chicago, Ill.
The Sunday Creek Oil & Gas Co.,	Corning, Ohio.
The Glen Coal Co.,	Glencoe, Ohio.
The Louis & Talbot Stone Co.,	Dayton, Ohio.
Everett Development Co.,	Everett, Wash.
The Keystone Brick and Terra Cotta Co.,	Rochester, Pa.
Madison Fuel and Light Co.,	Madison, Kan.
Plummer Quartz Mining Co.,	Nevada City, Cal.
The Silver Galena Mining Co.,	Missoula, Mont.
The Colorado Mining Bureau Corporation,	Denver, Colo.
The Treasure Mining and Milling Co.,	Breckenridge, Colo.
The Rico-Aspen Consolidated Mining Co.,	Denver, Colo.
The Mint Mining Co.,	Denver, Colo.
Cooper Coal and Commercial Co., of Santa Rosa,	Santa Rosa, Cal.
Lake County Kaolin Co.,	Leesburg, Fla.
The Omaha Mining Co.,	Neihart, Mont.
Santa Rosa Oil Co.,	San Luis Obispo, Cal.
Crossbow Gold Mining Co.,	San Francisco, Cal.
Ohio Mining Co.,	Duluth, Minn.
Acme Coal and Coke Co.,	Seattle, Wash.
The St. Louis and Argenta Mining Co.,	East St. Louis, Ill.
Western Stone Co.,	Albuquerque, N. M.
The Clifton Mining and Milling Co.,	Colo. Springs, Colo.
The Fiorella Mining and Milling Co.,	Denver, Colo.
The Virginia M. Consolidated Mining Co.,	Colo. Springs, Colo.
The Gold Mint Co.,	Denver, Colo.
The Rio Grande Valley Prospecting and Mining Co.,	Denver, Colo.
The Colorado Gas and Fuel Co.,	Colo. Springs, Colo.
The Hoyt Gold and Silver Amalgamating Co.,	Chicago, Ill.
The Chicago and Columbia River Coal Co.,	Chicago, Ill.
The Bonanza Mining Co.,	Boston, Mass.
Big Missouri Mining Co.,	Chicago, Ill.
Custer & Maud Mining Co.,	Chicago, Ill.
Minneapolis Iron Co.,	Minneapolis, Minn.
The United States Mineral Paint Co.,	Chicago, Ill.
San Carlos Oil Co.,	San Francisco, Cal.
The Apple Mining Development Co.,	Broken Bow, Neb.
Coeur d'Alene Nellie Mining Co.,	St. Paul, Minn.
Peerless Coal and Coke Co.,	Elkhorn, W. Va.
The New England Soapstone Co.,	Hartford, Conn.
The Linden Coal Co.,	Cleveland, Ohio.
Pawnee Coal Co.,	Chicago, Ill.
The San Francisco De-Borneo Mining Co.,	Oshkosh, Wis.
The Lawrence Land & Mining Co.,	Denver, Colo.
The Chanchamayo Gold Placer Co.,	New York City, N. Y.
The Puno Silver Mining Co.,	New York City, N. Y.
The Dominion Lumber Co.,	New York City, N. Y.
Columbia Loan and Investment Co.,	Columbia Falls, Mont.
Pittsburgh Gold Co.,	Pittsburgh, Pa.
The Ruth Mining Co.,	Leadville, Colo.
The Tenderfoot Consolidated Mining Co.,	Aspen, Colo.
The Creede and Cripple Creek Land and Mining Co.,	Denver, Colo.
Florida Iron Mining and Manufacturing Co.,	Orlando, Fla.
Marienville Gas Co.,	Marienville, Pa.
The Summit Coal & Coke Co.,	Clearfield, Pa.
The Greenbriar Oil, Gas and Mineral Co.,	Graysville, Ohio.
Rock Run Coal Co.,	Brazil, Ind.
Freeman Reduction Co.,	Chicago, Ill.
Anchor Coal and Development Co.,	Chronicle Bldg., San Francisco, Cal.
Sierra Mining and Milling Co.,	Mullan, Idaho.
Greenhorn Creek Mining and Lumber Co.,	Oakland, Cal.
The Free Coinage Mining Co.,	Las Vegas, N. M.
The West Bedford Stone Co.,	Bedford, Ind.
Acme Mining Co.,	Chicago, Ill.
Gold Nugget Mining Co.,	Port Townsend, Wash.
The Park Regent Consolidated Mining Co.,	Denver, Colo.
The Jupiter-Belmont Mining Co.,	Denver, Colo.
The Big Four Consolidated Mining and Milling Co.,	Aspen, Colo.
The Franklin Land and Mining Co.,	Denver, Colo.
The Enterprise Mining and Land Co.,	Colo. Springs, Colo.
The Chief Mining Corporation,	Pueblo, Colo.
Vulcan Iron Co.,	Duluth, Minn.
Dayton Iron Mining Co.,	Duluth, Minn.

STRIPPING ANTHRACITE SEAMS.

Methods of Procedure to Secure Best Results, and Accurate Estimates of Material Removed.

BY H. W. ALTHOUSE,
Asst. Mining Engineer, Consolidated Coal Co., of St. Louis.

Stripping, whether applied to coal measures, ore bodies, or phosphate beds, literally means the removal of the covering, earth, rock, etc., from the material sought after, and often brings to mind the idea of cheap work. This is true in many instances; such as where earth alone overlies the seam, and it can be removed by dredge, figuring as low as six cents a yard. Under certain adverse circumstances where power shovels cannot be used, the cost is double or treble that amount. The latter is the cost of stripping Anthracite, when the topography of the country and nature of the material are such as to prevent the use of power shovels. When the crops of the seams are low in the valley, on the hillside, and on the mountain top, as in the cross section, Fig. 1, they indicate erosion in addition to upheaval. It will be noticed that much of the coal measures have been lost by the former agency, which is the case throughout the entire coal region, more especially prominent in the mountain country where the strata frequently is "turned on end." The wash met with usually, is inconsiderable compared with that found in the lower elevations, where it is so great as not to warrant removing. At times, where the seam conforms to the surface, and has not too much rock overhead, stripping is employed. Generally the crop is sought, which in most places is well defined by benches and ridges, and also by crop falls, shaftings, and borings. The engineering data at hand being so complete, as a rule, to determine the exact location.

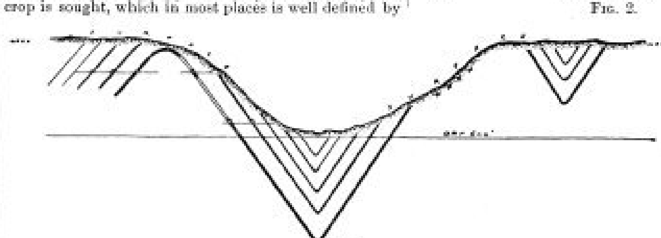


Fig. 1.

The preliminary survey connected with the stripping depends upon the knowledge of the engineer. The question of location is a study; and practice and experience demonstrate the fact that even without classifying the materials removed it would be exceedingly difficult to estimate the amounts removed, unless a system is adopted.

In laying out the confines of the work, the crop being known, a base line, the foundation from which the work is planned, should be located in the field. This base line should be straight if possible, parallel to the strike of the seam, and 100 ft. away from the excavation. Having driven a stake every fifty feet and numbering them from 0, 0 + 50 and so on, call this base, line 0; from it lay off, parallel to it, a line of stakes one hundred feet distant, number as above and mark this, line 1. Then stake off the remaining portion in fifty ft. squares or as judgment dictates. The *lines* run with the crop, those crosswise are called sections as is shown in plan, Fig. 2.

Let all the work be based on one common meridian and datum, agreeing with those of the mine workings,

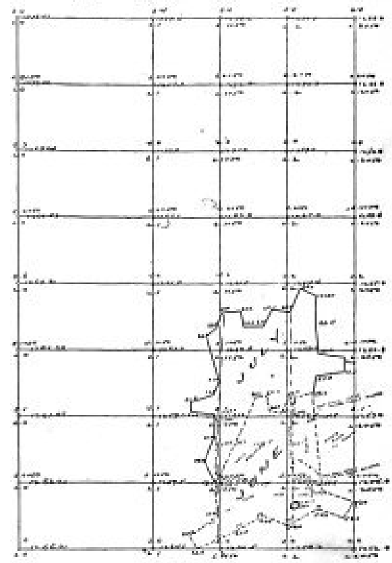


Fig. 2.

if known. Establish levels along the base line at each stake on plugs driven flush with the surface and take elevations of the natural ground at all other stakes. It is also advisable to have a few good bench marks throughout the work. By means of this method of laying out strippings, the engineer, between estimates, is enabled to watch the progress of the work in detail, not only on the ground but in the office as well. The mapping should be on good heavy paper as there will be considerable pencil erasure.

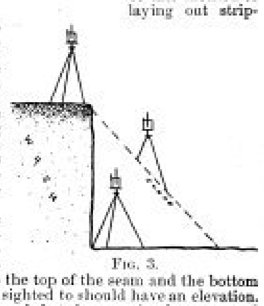


Fig. 3.

In surveying the work, use the vernier, accurately locate the top and bottom of the cut, also the top of the seam and the bottom slate. Every point sighted to should have an elevation. Occasionally it is found that the seam has been grooved deeply by glacial action.

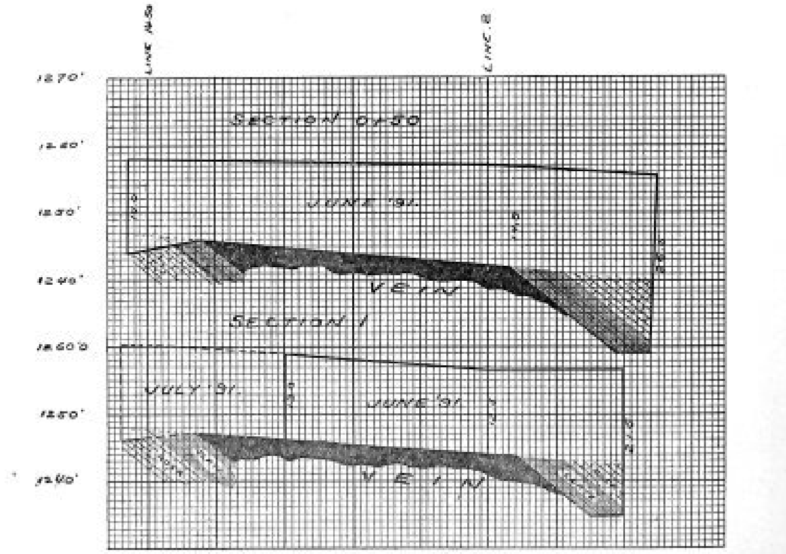


Fig. 4.

On the working plan, mark all surface elevations in black, those at the bottom of the excavation in red, which in the drawing, Fig. 2, are heavy and light respectively. Different months work should be represented by colors. (In the figure June and July, for example, are in dotted and solid lines.)

The excavation should continue, if possible, in one direction. This is of advantage to the contractor as well as the engineer, especially where there are four classifications. Much the engineer will become acquainted with. He may have to notice when, where, and why the method of "plunging" the cut is adopted, which nationalities work better together, how many shovels should be worked to a pick, and how many barrows, carts, etc., for each group of men. He also learns why under force account there are so many men hired as foremen, blacksmiths, repair men, and last, but not least, water boys, and why the poor labor and small shovels are used; and why on a haul for barrows, carts are employed, and he must remedy expensive practices whenever possible. Where possible steam shovels, ditchers, plows and scrapers are used, but when owing to the grades and material to be removed these are impracticable cars and carts should be used.

The estimate connected with different classification is interesting. Rarely is the method of double areas by traversing employed, on account of the nature of the cut. It being impossible in such excavations, where the cuttings are perpendicular, to obtain the area unless the perimeter is run or by lengthening certain sights. On light slopes the perimeters could be obtained, and also by running an average line on the slopes, (Fig. 3) it might be done, but to determine such point would require so much labor and detailed calculations as to condemn it. This method could be employed by taking a final estimate, but then it would not be thorough unless the principle of Graphostatics to a certain extent is used, and in no case would it be exact for any other estimate but the final one without such additional employment.

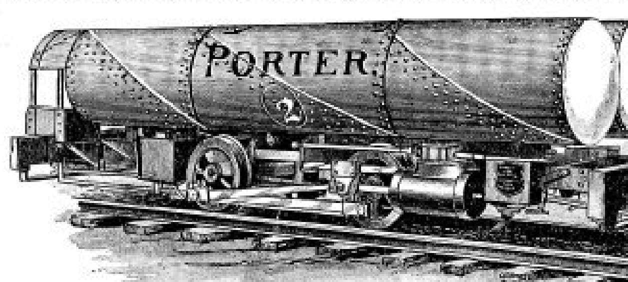
In the sectional method of estimating excavations, the survey should be platted as in plan (Fig. 2), all elevations marked, and the depth of wash and height of rock known. Then on prepared cross section paper in tenths, construct the sections, showing the classifications, etc. In Fig. 4, 0 + 50 and 1 are cross sectioned in detail. These cross sections should be kept on file and completed as the work advances.

By this system of planning, etc., stripping estimates are complete at the last excavation, no final estimate being necessary unless requested. It will be found that after the adoption of the foregoing method, the work will be pleasing, as nearly correct as is possible, and entirely satisfactory to all concerned.

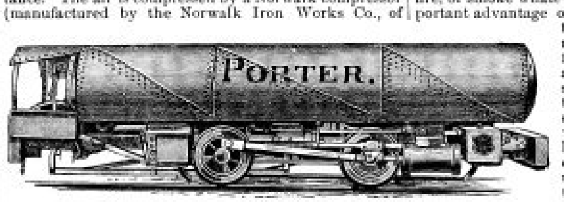
COMPRESSED AIR MINE LOCOMOTIVE.

Its Advantages over Steam or Electric Locomotives for Mine Use.

H. K. Porter & Co., of Pittsburgh, Pa., builders of light locomotives, have constructed a locomotive operated by compressed air, for use inside coal mines. This locomotive has been in use some months very satisfactorily, and is fully as powerful as a steam locomotive of the same size cylinders. The general construction is the same as a steam locomotive, with the boiler and water tank omitted, and two large cylindrical tanks added, for holding compressed air. These tanks are 33″ diameter and 16′ long. By means of a very simple method of connecting the air reservoirs with the engine cylinders no difficulty whatever is experienced from freezing either in summer or winter. The locomotive is constructed to carry air at 500 to 600 lbs. pressure, but thus far the output of the mine, 15,000 bushels per day, has not been large enough to tax the locomotive to anywhere near its full power, and usual charges of air are 250 to 450 lbs. This locomotive makes alternate trips on different cross-entries. One entry is 1,925 ft. long, with a number of curves 25 ft. radius, and the longest up-grade for loaded cars 1,200 ft., averaging 1½% grade, but very irregular, so that for short distances the grade runs as steep as 5%. The other entry is 1,550 ft. long, with grades of 1% for loads to be hauled up, and very crooked, many curves being 25 ft. radius, and one curve only 17 ft. 3 in. radius; curves being measured to centre of track. An ordinary day's work, not developing more than about half of the full power of the locomotive, is 31 round trips, or about 20·5 miles total daily mileage. Over the longer entry, up maximum short grades of 5%, from 8 to 11 cars are hauled each trip; weight of car 1,250 lbs., and of load 3,360 lbs. The average charge of air doing this work



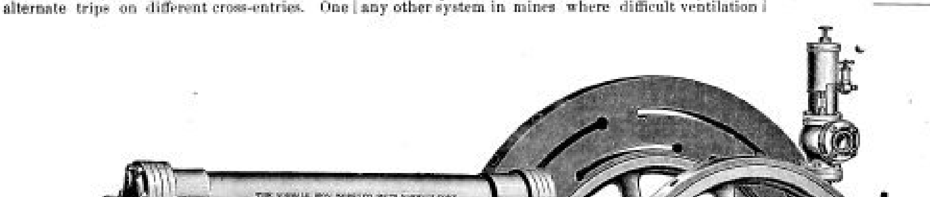
was 334 lbs., running the pressure down 193 lbs. and having 141 lbs. pressure left at the end of each trip—equivalent to a distance run of about 20 ft. for every pound of pressure used up. Over the shorter entry from 14 to 18 loaded cars are hauled up 1% grades, the average charge being 314 lbs., using up 146 lbs. and having 167 lbs. pressure left at end of each round trip, making distance run per pound of pressure exhausted about 21 ft. Of course on easier grades and curves one charge of air would run the engine a much longer distance. The air is compressed by a Norwalk compressor (manufactured by the Norwalk Iron Works Co., of



South Norwalk, Conn.) situated for convenience 2,400 ft. from the point where the locomotive is charged, and no loss of pressure is noticeable, conveying the air this distance through 3 in. pipes. The locomotive is charged inside of one minute. If charged to 500 lbs. it can make two round trips, a distance of about 1½ miles, hauling longer trains, than can at present be taken care of at the sidings or on the tracks at the tipple, and have considerable air to spare. It is entirely practicably to build an air locomotive with capacity to run 4 miles or more with one charge of air, doing heavy work. So little time is required to charge the engine, the compressor is usually run to a light pressure and the engine charged oftener. The locomotive can be charged Saturday night and left standing till Monday morning and not show perceptible loss of air by leakage, and there would be nothing to prevent its starting off at a mere touch of the lever after a rest of weeks, or even months.

The compressed air locomotive has advantages over any other system in mines where difficult ventilation or danger from gas makes steam locomotives undesirable. The cost of an air locomotive is nearly the same as of a steam locomotive of the same size, and the cost of a compressor plant large enough to operate two locomotives is usually a little more than the cost of one locomotive. The running expenses are light, and the air is also used to good advantage for running a pump, the air being conveyed a long distance, where steam would not work satisfactorilly. Compressed air coal digging machines may also be operated by the same plant. As compared with electric systems the compressed air locomotive involves about one-third the outlay, and the operating expense is less, and the danger of naked electric wires is avioded, and also danger of electric sparks causing fire-damp explosions. As compared with rope haulage, the cost of plant and of operating is less, and it can be used without any trouble on entries too crooked to be operated by rope systems.

The air locomotive is simple and not liable to get out of order, and requires less skill to operate than a steam locomotive, and is safe and reliable. One of these air locomotives has been in use seven years with not over $50.00 cost of repairs, and without losing a trip. It improves the air in the entry, and there is no steam, gas, fire, or smoke whatever. In this respect it has an important advantage over the only cheaper system that there is—the steam locomotive. In mines where the main entry is used for the return current of foul air, any smoke or gas made by the steam mine locomotive cannot reach the working parts of the mine, and so can do no harm. In mines where the locomotive entry must be used for the intake of fresh air, or where the locomotive is to be used for gathering from cross entries and rooms, the air locomotive is the cheapest and most efficient system. These air locomotives are built of various sizes of cylinders, from 5 in. to 10 in. diameter, and to suit the dimensions of the mine entry and gauge of track. The smaller sizes will run on 16 lb. rail and in entries 4 ft. high, and are specially useful in cross entries. The larger sizes require 20 to 30 lb. rail and entries 4½ ft. or more in height. These air locomotives may be seen at work at the old Eagle Mines on the Monongahela River, near Pittsburgh. Compressed air system is also the best possible system of transportation for many places where steam or other systems are dangerous or objectionable, such as powder mills, rope and cordage works, lumber yards, saw mills, etc. Compressed air is also well adapted to street railway purposes, and many street railway companies who are looking for some cheap and satisfactory power, without smoke or steam, and without the intolerable screech of the electric motor, and free from the pole and wire nuisance, will find it in compressed air.



NORWALK AIR COMPRESSOR USED IN CONNECTION WITH PORTER LOCOMOTIVES.

(Built by Norwalk Iron Works' Co., South Norwalk, Conn.)

An Unsolicited Opinion.

Mr. Thomas Middleton, of Middleport, Ohio, writes, "I have been a subscriber to The Colliery Engineer since 1881. Of course, it had then an additional name (Mining Herald). I wouldn't part (of my own choice) with the information and pleasure received from it in that time for thrice the money it has cost me."

A Unique Calendar.

One of the most unique and neatest calendars issued this year, is that issued by The Lunkenheimer Brass Mfg. Co. of Cincinnati, Ohio, to advertise the "Handy Gate Valve." It has embossed on it a perfect representation of a "Handy Gate Valve" that opens or shuts by moving the lever.

"I have taken The Colliery Engineer for four years and was therefore enabled to pass a successful examination and gain a certificate of competency at the examination for mine managers in this state."

John Westwood,
604 Barnhart Ave.,
Streator, Ill.

A WELL MADE STEAM ENGINE,

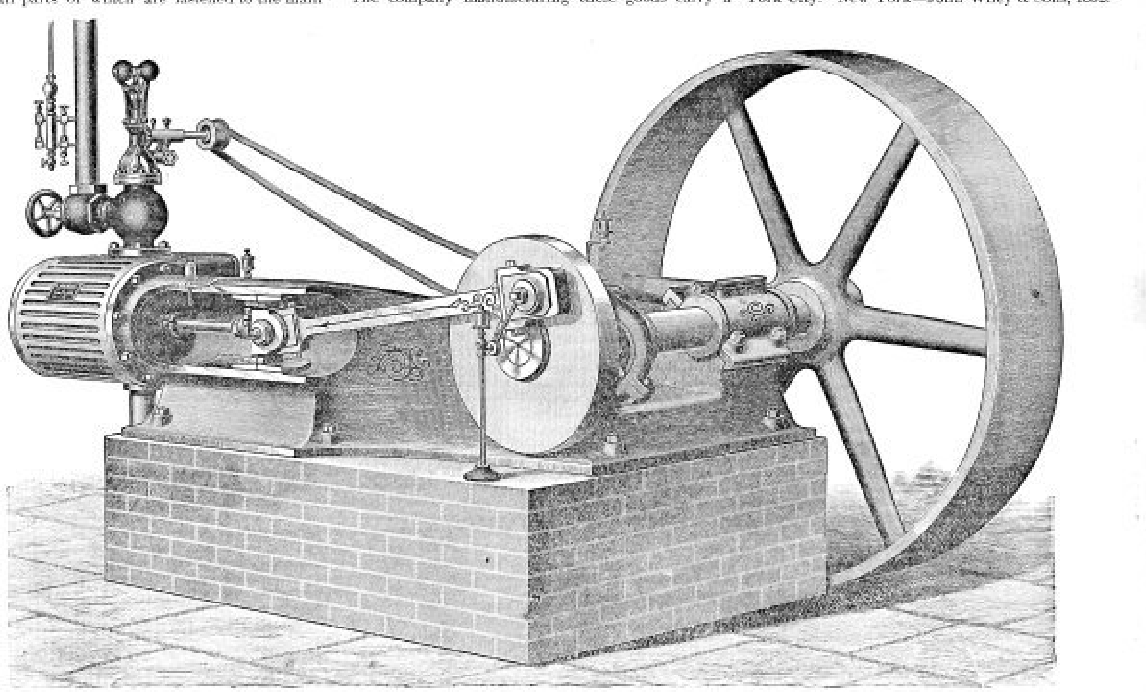
And First-Class Boilers of Guaranteed Strength.

The engine shown below is one of the most modern of steam engines. Its proportions and arrangement conform to the latest engineering practice and its neatness and adaptability of design are evident to the most casual observer.

The company building these engines claims not only these points for the engine but also strength beyond all ordinary requirements, first-class material and workmanship and construction on the interchangeable plan so that in case of breakage duplicate parts can be immediately ordered of the factory by number and the damage repaired with a minimum loss of time.

Every engine is subjected to thorough tests before shipment, under full steam pressure and brake load, by competent inspectors at the works of the makers, a certificate of which accompanies each, thus giving assurance to the purchaser not only of the capabilities of the engine but also as to the result of its individual preformance. The bed of this engine is also one of its distinguishing features. In it the metal is so distributed as to present the greatest resistance in the line of motion between the cylinder and crank shaft, and furnishing within itself both of the bearings for the crank-shaft, which brings it absolutely and permanently square with the other working parts. This point cannot fail to be appreciated by steam users generally and especially in countries which are subjected to earthquakes and other terrestrial disturbances.

The two bearings for the crank shaft being a part of the main bed of the engine, of which the guides are also a part, makes the whole a thoroughly rigid machine, all parts of which are fastened to the main



bed.

Under these conditions it is only necessary to set the main shaft of the engine parallel to the shaft which it is to drive, fasten it in position, attach the steam connections, and then the engine is ready to run.

The separate pedestal which is used on ordinary side crank engines to support the outer shaft journal is dispensed with and all chance of the engine itself getting out of line is entirely removed. Such a shock as an earthquake might, and in fact would be likely to throw the engine out of line with the shaft it drives, but never out of line with itself.

This engine, while not especially placed on the market as a high-speed engine, is nevertheless designed for quick motion and may be run at almost any desired speed as it has all the elements of endurance. Its bed frame is rigid, its ports ample, and it has large bearing and wearing surfaces, adapting it to long and continuous runs under heavy duty. It is heavy, compact, durable, and a marvel of simplicity. The self-contained feature of its bed, which sustains the crank shaft in perfect alignment commends itself to every one, its quick motion and sensitive spring governor insure close regulation, and there is no room for doubt that it will show results in power, durability, and economy rarely surpassed.

These engines are used in almost every kind of industry and in every case are rendering the utmost satisfaction.

The builders of this engine are also manufacturers of a complete line of both Stationary, Tubular, and Firebox Boilers, Circular and Muley Saw Mills, which are of the same modern designs and upon which they exert the same care in the choice of material and in the workmanship and devices for meeting the demands of the machinery buying public that they do upon their engines.

The plate used in these boilers, which are supplied in connection with the above described engine, is the best Open Hearth Homogeneous Steel, capable of being turned down double cold without fracture.

All tubes are made lap welded and of charcoal iron from a mill whose reputation is beyond question and are properly expanded in the heads and beaded over in both ends by skilled workmen.

The Burden Rivet is used exclusively. The holes in the heads for tubes are accurately drilled in all cases by means of special cutters, which not only causes no injury to the metal of the head but also produce a true hole into which the tube can be thoroughly fitted and expanded. The bracing is in excess of the requirements of modern boiler practice. All flat surfaces are strongly and substantially stayed with braces of the best refined iron properly distributed throughout the boiler.

The heads of stationary boilers are braced by bolts running from head to head with double nuts on each end.

The arrangement of the tubes is in horizontal and vertical rows, and is such as to give free and perfect circulation within the boiler as well as being easy of access for cleaning.

Before shipment each boiler is thoroughly inspected and tested to 150 lbs. hydrostatic pressure, by the authorized inspector of a reliable boiler insurance co.

This inspector renders weekly reports to his company of the inspection and test of each boiler, and upon these certificates a policy of insurance for $300.00 is issued on each boiler by said company.

This policy is assigned to the purchaser of the boiler in due form, giving a substantial guarantee that the boiler has been properly made, inspected, and tested.

The company manufacturing these goods carry a stock of them on hand at all times for immediate delivery, the only delay necessary after receiving the order being that required for thoroughly packing such machines for shipment.

Those who are interested in this subject and who desire a special descriptive catalogue can receive same by applying direct to the makers, Messrs. Chandler & Taylor Co., Indianapolis, Ind., U. S. A.

THE McALESTER EXPLOSION.

Some Additional Notes Regarding Its Cause.

BY WHITFIELD FARNHAM.

It is proper that a few words should be added to the account of the mine disaster at Krebs, near McAlester, Indian Territory, as published in the February number of The Colliery Engineer. That report was written hurriedly, soon after the accident, and some additional facts have since come to light. It was stated that no powder cans were found exploded, but it now appears that some miner had (contrary to rules) smuggled his 25-pound can of powder down the slope, and hid it in the air course, nearly opposite entry O. This can was exploded, but was afterwards surreptitiously removed from this location to the proper place and locked in a box between two other powder boxes, thus successfully hiding the fact from the "pit boss" and the committee at the first examination. This explains how the explosion gained such force in its travel up the slope.

The men who escaped safely from entry N, opposite and so near entry O, the initial point of the explosion, did not pass out to the slope at once, as might be inferred from the account, but waited for the after-damp (that filled the slope and blocked the mouth of the entry) to be cleared away, which required about one hour. They tested it frequently, and only ventured out when their lights would burn. Similar precaution saved many others.

The mine was examined and the causes of the disaster inquired into at the request of the general manager of the Osage Coal and Mining Co., by Walton Rutledge, mine inspector of the 4th district of Illinois, C. C. Woodson, State Mine Inspector of Missouri, and John T. Stewart, State Mine Inspector of Kansas, during the first week of February. Their report will probably soon be published, but it may be well to say now that they locate the start of the explosion in the same place, and ascribe the same cause (viz., blown-out shots caused by reckless mining) as given in my report, except that they think a small quantity of carbureted hydrogen gas (fire-damp) may have been liberated from the coal by one of the shots—not being willing to admit that an explosion can occur in coal dust in the entire absence of gas. They condemn in the strongest language, not only the shots in upper entry O (described last month) but also the shot fired at the same time that fatal afternoon in lower entry O and which was also a blown-out or windy shot—necessarily so from its depth and location.

BOOK REVIEW.

A Manual of Mining based on the course of lectures on mining delivered at The School of Mines of the State of Colorado. M. C. Ihlseng, C. E., E. M., Ph. D., Professor of Engineering Colorado State School of Mines, formerly of Columbia College School of Mines, New York City. New York—John Wiley & Sons, 1892.

This book of 428 pages which has just been issued is got up in an attractive form. It is liberally illustrated with cuts of a high class type. Part I., entitled *Mining Engineering* consists of sixteen chapters embracing all the subjects which come within the scope of the mining engineer. The chapter on Methods of Mining embraces not only coal and iron-ore working but includes metalliferous, gypsum, salt, and other mines.

The mechanics of mining are fully dealt with in chapters IV. to X., and ventilation is treated in chapters XI. to XVI.

The illustrations of the various types of pumps and more especially the cuts descriptive of the details such as valves, suction pipes, clacks, etc., will be found of great value to students in a mining engineering course.

Part II., entitled *Practical Mining*, gives details of the various forms of shafts, the methods of sinking, the modes of driving tunnels, adits, levels, etc. Boring is fully treated in chapter V. The illustrations on timbering under varying conditions are very clear and distinct. The new and more powerful types of explosives such as ammonite, tonite, etc., are well explained and their analyses given in Chapter VII. This is in itself a good recommendation for the book in the light of recent investigations, regarding coal-dust, which call for an explosive which will be sharp and flameless.

The various types of mining drills and machines are fully described, and a considerable amount of space is given to a discussion of the best positions for bore-holes to secure the best results.

Altogether this book will form a useful addition to the library of the expert and to the table of the student, and possesses this additional great claim to popular favor that it is the only American work treating on both coal and metal mining.

EASY LESSONS FOR BEGINNERS

IN THE STUDY OF THE

ART OF MINING

AND THE

SCIENCES RELATED TO IT.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the theory of mining and to learn how to answer the questions in ventilation, mine surveying, and mechanics which are asked at the examinations for mine manager's and mine foreman's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine manager's and mine foreman's certificates and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and the calculations are worked out at length for the benefit of those who are not familiar with figures.

PENMANSHIP.

In the study of penmanship the most important thing to be acquired is to be able to write plainly, for characters that cannot be read are of little use. After this has been accomplished rapidity in writing may be obtained by constant and long continued practice; and finally, if one would become a graceful writer, beauty of writing must also be acquired. A page plainly written is satisfactory, but one beautifully written is not only satisfactory but praiseworthy.

Continuing in the order of the alphabet, we have for consideration this month the capital letters P, Q, and R. Letter 1, Fig. 37, numbering from the left, shows the letter P written correctly. Its development consists of the capital stem, left curve, and a right curve. The capital stem begins at five-sixths of the full height of the letter; at the base line it merges into a full left curve which, with a broad turn making a right curve, crosses the stem vertically at the top and recrosses it at right angles at the middle, where it terminates. The

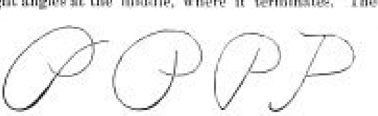


FIG. 37.

second letter, counting from the left, shows a common mistake made in writing this letter, viz., that of making the general shape of the letter round instead of oval. In letter 3, the capital stem is drawn too far to the left, giving an angular turn at the base which destroys its symmetry. The fourth and last letter shows a careless way in which this letter is often written. The oval is not completed and the loop on the right hand side of the stem is too wide.

The capital letter Q, as shown by Fig. 38, consists of the capital loop with its terminating curve drawn to the left forming a horizontal loop at the base, ending with a curve one-third of the full height of the letter. In the second letter from the left the capital loop is too angular and is a violation of the fourth law of penman-

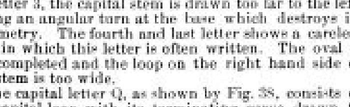


FIG. 38.

ship, namely, all curves should be elliptical. The third letter represents an easy but incomplete way of writing this letter. Letter 4 shows several causes of deformity; the curves are not elliptical, the strokes are not parallel, and in completing the letter an extra curve is made, which spoils the looks of the letter and prevents its union with the following letter in writing a word.

In Fig. 39, the first letter R conforms with the requirements of the four laws of penmanship and is pleasing to the eye. It consists of a capital P with a small loop made across the capital stem, and a curve extending to the base line, uniting there with a curve extending upwards one-third of the full height of the letter. When

FIG. 39.

R is combined with other letters this last curve changes to suit circumstances. In letter 2 the ellipse is made too circular, and although the inclination of the major axis is correct, it is imperfectly developed. The ellipse in letter 3 is too narrow and on a wrong inclination. Letter 4 is loosely constructed, and is a direct violation of the laws of penmanship.

ARITHMETIC.

In this issue we will explain the process of pointing off the decimal in numbers that are added, subtracted, and multiplied.

Pointing in the addition of decimals is of the most simple character, because it is evident that if ·5 be added to ·5 the result is 1; and if 5 is required to be added to ·5 the result is neither 10 nor 1, because ·5 cannot be added to the integral or whole figure 5; consequently the simple rule in addition is to place the figures over each other, according to their numerical values, for example, ·5 must be set over ·5;

·5
·5
1·0

and when 5 is added to ·5

5
·5
5·5

Again, if ·5 has to be added to ·05 we have

·5
·05
·55

The rule for pointing in addition can be expressed as follows: The numbers to be added, are to be set over each other in such order that the separate figures stand to each other, in the same relationship that they each bear to the decimal points, for example, add the following numbers together: 1·03, 27·84, ·005, 2002, ·001.

1·03
27·84
·005
2002
·001
2030·876

In short the, common rule might be expressed as follows: Keep the decimal points above each other, in the order of a vertical line. But a statement like this is very unsatisfactory, and it is very much better for the student to first discover the reason why the decimal points are so kept in order. The position of the points, in the subtraction of whole and fractional numbers, is precisely similar as in addition, and the explanation given for one will equally apply to the other. Now pointing off decimals in multiplication involves a little difficulty, which we will try to remove. It is clear that the half of a half must be a fourth. Therefore, ·5 × ·5 = ·25, and the principle to be understood is simply this, that if you multiply a whole number by less than a whole number the result must be less than the whole number multiplied, for example, the half of 20 is 10, and if you multiply 20 by ·5, the result must be 10·0. Now, when a cipher stands alone, on the right-hand side of the decimal point, it has no value; ciphers also on the right-hand side of a decimal number have no value, because ·5 and ·50 express the same thing. Consequently the cipher in the last case may be dispensed with. At this point we would like to warn the student against acquiring the absurd practice of speaking of ·25 as decimal twenty-five. The term twenty-five can only practically be applied to a whole number. And what is true in this example is equally true in all others. The rule for pointing off in multiplication is as follows: Add the number of decimal places in the multiplicand, to the number of decimal places in the multiplier, and the sum is the number to be pointed off in the product, for example, multiply 26 by ·6, then the product will be 15·6. In this case there was one decimal in the multiplier, and none in the multiplicand; consequently one must be pointed off in the product. Again, multiply 2·6 by ·6, the product will be 1·56, as we have one decimal place in the multiplicand, and one in the multiplier, making two places of figures to be pointed off in the product. Therefore the only difficulty that can arise in this case, is in the confusion that may exist in the mind of the student, with regard to what is meant by the term "the number of places." Multiply 345·345 by 543·002 and the product will be 187,523·025690; now observe there were three decimal places in the multiplicand, and also three in the multiplier, making in all six places to be pointed off in the product. It will be seen that the last decimal figure is a cipher, which being at the right-hand side of the decimal figures has no real value; the product can, therefore, be expressed as follows: 187,523·02569. With the aid of a few exercises out of an arithmetic, the student cannot fail to be correct in his pointing.

MISCELLANEOUS PROBLEMS SOLVED.

Q. If the area of an air-way be doubled, the velocity remaining the same, how much will the frictional resistance be increased on the total quantity, and how much will the frictional resistance be decreased per square foot of section?

A.—Friction varies directly as the rubbing surface; to explain this we will take two air-ways, one twice the area of the other. The small air-way 5′ × 5′ = 25 sq. ft. area, the large air-way 6′ 3″ by 8′ = 50 sq. ft. area, each are 3,000′ long. The perimeter of the small air-way is 5′ + 5′ + 5′ + 5′ = 20′; for the large one 6′ 3″ + 6′ 3″ + 8′ + 8′ = 28·5′. The perimeters multiplied by the length in feet gives the amount of rubbing surface for each air-way, thus: 20′ × 3,000′ = 60,000 sq. ft. of rubbing surface for small airway; 28·5′ × 3000 = 85,500 sq. ft. of rubbing surface for large air-way.

Then, 85,500 ÷ 60,000 = 1·425, or the frictional resistance in this case will be increased from 1 to 1·425. The amount of rubbing surface per sq. ft. of section may be found as follows:

60,000 ÷ 25 = 2,400 for small air-way.
85,500 ÷ 50 = 1,710 for large air-way.

Then,

1,710 ÷ 2,400 = ·7125, or the resistance per sq. ft. of section will in this case be reduced from 1 to ·7125.

Q.—The pressure per square foot producing ventilation is equal to 66·56 ounces, what is the height of the water-gauge?

A.—We will first reduce the ounces to pounds, thus,

$$\frac{66·56}{16} = 4·16$$ pounds, and 4·16 pounds pressure per sq. ft. are equal to a water-gauge of

$$\frac{4·16}{5·2} = ·8 \text{ inches.}$$

Q.—How many cubic feet of air are there in a circular shaft 1,680 feet deep and 18 feet in diameter; also what would be the rubbing surface of this shaft?

A.—To find the number of cu. ft. of air in a shaft of the above dimensions we proceed as follows:

The rule is square the diameter and multiply the result by the constant ·7854, to find the area, thus—

18 × 18 × ·7854 = 254·4696, and this multiplied by the depth in feet, 1,680; will give the cubical contents, thus—

254·4696 × 1,680 = 427,508·928 cu. ft.

The rubbing surface of the shaft is obtained by first finding the perimeter and multiplying it by the depth or length, thus—

18 × 3·1416 = 56·5488′ perimeter and 56·5488 × 1,680 = 95,001·984, rubbing surface.

Q.—The form of an air-way is that of an arch with a semi-circular top, it is 8 feet high and 8 feet wide, and begins to circle 4 feet from the bottom, what is the area of the section?

A.—Up to the point where it begins to circle we have a rectangle 8′ × 4′ which has an area of 32 sq. ft. Treating the top part as half a circle, whose radius is 4′, and diameter 8′, we find the area of the whole circle by squaring the diameter and multiplying the result by ·7854, thus—

8^2 × ·7854 = 50·2656 sq. ft.

Then half of this would be the area of the circular part of the air-way, or 50·2656 ÷ 2 = 25·1328 sq. ft., which added to the bottom gives the whole area,

32 + 25·1328 = 57·1328 sq. ft., the required area.

Q.—A circular shaft is 16 feet in diameter, and during the course of sinking from some cause the shaft feeder has flooded the shaft with water to a depth of 312 feet; how many gallons and cubic feet of water are there in the shaft?

A.—To find the cubic feet of water in this shaft we square the diameter 16, and multiply the result by ·7854, thus—

16 × 16 × ·7854 = 201·0624 the square feet in the area of the section of the shaft. Now, if the area of the section be multiplied by the depth of the shaft in feet, the result will be the volume of water in the shaft in cubic feet:

201·0624 × 312 = 62731·4688 cubic feet of water. Now, as there are 7·4805 U. S. gallons in a cubic foot, then

62731·4688 × 7·4805 = 469,262·75 + gallons the answer required.

Q.—How long would it take to pump the shaft dry in the previous question if no feeder continued to run into it, the pump being twelve inches in diameter, and having a 5 feet stroke, and making 6 strokes per minute?

A.—First, we will find the cubic feet the pump can lift per minute, as follows: The diameter being 12″ = 1′, then

1 × 1 × ·7854 × 5 × 6 = 23·562 cu. ft.

Now, if the cubic feet of water in the shaft be divided by the cubic feet of water the pump can lift per minute, the result will be the time in minutes the pump will empty the shaft.

Thus,

$$\frac{62731·4688}{23·562} = 2662·4 \text{ minutes, or } 44·37 \text{ hours}$$

This is a correct answer theoretically, but in practice there is a loss by leakage from the bucket and the valves.

POWER IN MINING.

The Elementary Principles of Mechanics—Steam—Boilers—Engines—The Machinery Employed in Mines.

1. What is a force?

It is anything that tends to change the state of a body. Either to move it or to stop it.

2. How is it measured?

Always in pounds.

3. What is velocity?

Its rate of motion.

4. What are the laws of motion?

If a body is at rest it will remain so. If in motion it will move forever uniformly in a straight line till some other force acts on it.

5. Is that perpetual motion?

Yes, but nobody ever has perpetual motion. The nearest to it is that of the stars.

6. Why does not a body go on forever?

Because of friction, or the resistance of the air or some other force.

7. What is the measure of a force?

We measure it in pounds only if it is a pressure and in its ability to move a certain weight a certain distance in one second. Thus, if a force produce a velocity of one ft. per second in a body weighing about one-half an ounce.

8. If a force moves a 20-pound weight at a rate of 40 feet per second, how much is that force?

Well 20 pounds is 320 ounces or 640 half-ounces and that multiplied by 40 feet gives 25,600 as the value of the force.

9. Will you name some of the forces?

Steam acting on a piston; air in an air drill; water moving a wheel; the falling weight of a clock; the explosion of powder; and the muscular power of a man or horse.

10. Are all of these forces measured in the same way?

Yes. In each case the force is only capable of producing a given quantity of power, no more, no less. No scheme has yet been found for increasing the value of any power. When you have multiplied the velocity by the number of half-ounces, you have the total value of which the force is capable. *Remember no kind of machine can give you any more.* For in example, question 8 above, the force can give 25,600 units of force whether it is steam or a mule that furnishes it, and whether it is in a hoister or on a canal, no more than 25,600 units can be obtained. If you increase the speed you cannot move so heavy a body or if you try to force a heavier body, it will travel slower.

11. Give me some examples.

With 25,600 units you can move a 4-pound body 200 feet a second, because if it is all used on the body, then 25,600 must equal the number of half-ounces multiplied by the velocity.

$$25{,}600 = 4 \times 2 \times 16 \times 200$$

There are two half ounces in an ounce and 16 ounces in a pound. If you want to find how fast this force will move a body weighing 20 ounces you must divide the 25,600 by 20, which gives 1,280 feet per second.

12. Do you mean that no matter what kind of a force or what kind of a body you have that this is always the rule?

Of course I mean only on this earth are these things true. On the moon it may be different. Again this does not take into account friction or the resistance of the air. Of these we will speak later.

13. Suppose all of the force were not acting on the body? You spoke as if that had something to do with it in question 11.

By that I meant simply that friction did not act. And that the forces balanced each other. When they do we call them in equilibrium. I will use the term *balance* instead of equilibrium.

14. What is a machine?

It is a piece or contrivance for producing an effect at one point by a power operating at another.

15. Name some of the simple machines?

A crowbar, a pulley, spur wheels, windlass, screw, and so on.

16. How is a crowbar a machine?

By it you can lift a weight or move a car.

17. How does it act?

One end rests on the ground and that point is called the fulcrum (pronounce the u as you would the u of tub). Then with your hand at the other end you lift the weight at some point C, Fig. 1. Have you ever tried the

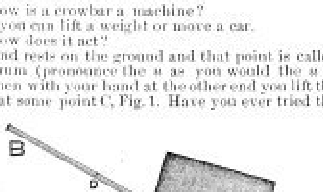


Fig. 1.

crowbar by holding it somewhere else than at the end? If so, have you noticed that it is harder to lift a weight that way than if you held it at the end? Again, where would you prefer to hold the crowbar in Fig. 2, if it rests on a stone at A? At C, nearer to A, or at B far away? At B, yes that is right. I would rather take hold at B and pry the weight up with the point C than to hold it at C and lift the weight from B. Now that suggests a rule.

18. What is the rule?

Look back to question 10. We saw there that if you increase the speed, you can not move so big a weight. Here is the same thing; a large weight can only be moved a small distance. Now the rule is this: The power multiplied by its distance from the fulcrum balances the weight multiplied by its distance from the fulcrum: Power $\times$ A B = weight $\times$ A C. Take an example I can pull 60 pounds and the crowbar (Fig. 1) is five feet long. How much of a weight can I raise if it rests on C, one foot from A? Here 60×5 = weight $\times$ 1 and the weight is 300 pounds. Suppose I held my hand on the crowbar at D, Fig. 1,3 feet from A, then I could only raise 180 pounds because 60×3 = weight $\times$ 1.

19. Do this example now: Suppose in Fig. 2 the same crowbar rests on a stone 15 inches from one end and I used 50 pounds at the other end B. What could I lift at C?

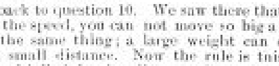


Fig. 2.

Well now A is the fulcrum. Then as the crowbar is 5 feet long, or 60 inches, the end B is 60 — 15 inches from A (= 45).

50 pounds $\times$ 45 inches balances weight $\times$ 15 inches.

Therefore,

Weight $\times$ 15 = 2,250 and the weight is 150 pounds.

20. But suppose I wanted to raise 300 pounds with this bar, how could I do it?

Your only way would be to move the stone under the crowbar until

50 pounds $\times$ A B = 300 pounds $\times$ A C.

That is, when A B is six times as long as A C. As A B + A C must equal 60 inches, then A C must be $\frac{1}{7}$ of B C = $8\frac{1}{7}$ inches.

21. Is that the only way?

Yes, unless you could put on more muscle.

22. But do not we gain power in this way?

Yes, but you will also see that you lose distance Don't forget question 10. The point B must swing further than the point C. So you do not raise the weight as far as you move the hand.

23. How can I arrange to gain distance and to gain power too?

No way whatever can be found by which you can do both. It often is claimed but it can not be done. Don't believe any one who pretends this.

24. Can I arrange so as to gain distance then?

Yes, by using more power. Look at Fig. 2 and imagine your hand at C and the weight at B. Then you can raise the weight at B fast but the point C travels slowly.

25. Suppose I want to raise a 300 pound weight nine inches high so I can put a block under it. What must I do?

To raise the point B nine inches high I must move the point C down a certain distance. If the stone at A is 15″ from the end C, then C will go down $\frac{1}{3}$ as fast as the point B, which is three times as far off from A as is C. So C goes down 3 inches while B goes up 9 inches.

300 $\times$ 9 inches balance power $\times$ 3 inches.

So the power must be 900 pounds.

26. But I can give only 50 pounds push. What then?

Well, you must get a longer crowbar or else give it up. You would need a crowbar so long that

300 $\times$ 9 inches = 50 $\times$ distance swung by your hand which is 54 inches. If then the length A B were 45 inches your crowbar would have to be 270 inches.

27. I can't get so long a crowbar. What could I do?

Then you must use some other kind of a machine. For example a jack-screw or a block and tackle, or windlass.

28. Is a windlass a machine?

Yes, it is a double machine. It has a crank-handle B on which you apply your power that goes to a shaft A then to the barrel on which the rope winds (Fig. 3).

29. How does it act?

In Fig. 4 I have drawn the end view of a windlass

Fig. 3.

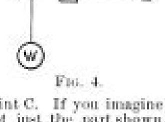


Fig. 4.

The rope hangs from the point C. If you imagine the barrel to be cut away except just the part shown, we have a crowbar like Fig. 2. Power at B, fulcrum at A, and weight hanging at (instead of resting on) at C.

Then the weight multiplied by the distance A C (the radius of the barrel) is balanced by the power multiplied by the distance A B (the length of the crank arm).

30. But does not the round barrel of the windlass have anything to do with it?

No, it makes only this difference: Instead of having a large number of arms alike, A C (Fig. 4) close together, they are put solidly together and the barrel as it turns always has the rope hanging from an imaginary arm.

31. Let the barrel be 9 inches across and the crank 15 inches long, how much can I move with the windlass?

Your power being, say, 50 pounds, we have 50 times 15 balancing weight multiplied by the half distance across the barrel

$$50 \times 15 = \text{W times } 4\tfrac{1}{2},$$

so the weight is nearly 167 pounds.

32. Is the principle the same with the crank arm of a direct-acting hoister?

Yes, the drum of the hoisting engine winds rope on it just as the barrel of the windlass does. Instead of a crank-arm for the hand to take hold, the piston of the steam engine is connected by a "pitman" to the crank arm on the same shaft as the drum. (See p. 153, of February, 1892, number of The Colliery Engineer.)

33. Let a drum be 10′ in diameter and a crank on the side be 10″ long, how would you calculate it?

The weight of the cage, car, ore, and rope is hanging from the drum. So if these all weigh 9,000 pounds then 9,000 times 5 feet must be balanced by the steam pressure acting on the crank pin times its crank arm.

So 9,000 $\times$ 60 inches = P $\times$ 10″.

Whence the rotary power on the crank pin must be 45,000 pounds.

34. Suppose the arm was at a dead point, what then?

There is no force to turn the pin.

35. Then the engine could not start from a dead point?

That is why two cylinders, one on each side of the drum, are used, the pistons of which are connected to the cranks which are so set, that both cranks can never be at dead points. They are usually set at quarters. Later I will discuss the effect of the pitman and crank combination.

[to be continued.]

GEOLOGY

In Its Relation to Coal, Iron, Oil, Gas, and Ores.

1. What is coal?

Any mineral substance containing sufficient carbon to supply its own fuel and be capable of burning. The line between the various fuels is not easily drawn. There are all grades of coal with vegetable matter at one end of the series and graphite at the other, including peat, lignite, soft bituminous hard coal, and graphite. (See p. 18, August, 1891, number of The Colliery Engineer.)

2. What is the difference between these varieties?

If you read the lectures on chemistry you will notice that every piece of organic matter, leaf, wood, flesh, etc., has carbon, hydrogen, and oxygen in it in different proportions. According as these elements (See p. 18, August, 1891, number) differ in quantity, so they produce wood, grass, or flesh. For example, wood is made of minute particles of carbon, of hydrogen, and oxygen. The same is true of the coals, of which here is a table to show their composition. For simplicity we put C. for carbon, H. for hydrogen, and O. for oxygen.

	C.	H.	O.
Vegetable matter has about	·49	·06	·45
Flesh has about			
Peat has about	·56	·07	·37
Lignite has about	·70	·06	·24
Block coal has about	·75	·10	·15
Soft coal has about	·88	·06	·06
Hard coal has about	·95	·03	·02
Graphite has about	1·00	·00	·00

3. Why are they so different?

Because these coals were made at different times.

4. How do you know that?

Because they never occur near each other and they look so very much unlike one another.

5. Please explain what you mean?

Graphite is a pure carbon just like the diamond, and has a fine grain, is smooth and shiny, like steel. It leaves no ash after burning.

Anthracite is a hard stone coal, with a very little ash, and burns without smoke.

The bituminous coal is soft, blazes up with a flame, swells, and finally bakes into a spongy mass called coke. There are many varieties called cannel, coking, cherry, splint, or block.

Lignite is a poorer quality of coal that leaves behind a great deal of ash, and is brown in color showing often the fibres of wood in it.

Peat is a matted mass of rotting vegetation.

6. Where are these varieties found?

Graphite is not very common, and occurs in thin seams.

Anthracite is found in Pennsylvania and Colorado, where the rocks have been disturbed, or broken up.

Bituminous coals are found all over the world, as a wise provision of nature for the comforts of man.

Lignite, or brown coal, is mined in the Western States.

7. Is there any theory to account for them?

Yes, it is one which the geologists have formed from their observations and knowledge of the behavior of the forces of nature.

8. What is it?

Have you ever noticed the marshes and bogs, how they are the rotting masses of vegetable and organic matter? If they are not disturbed for a number of years the marsh becomes deep and large. In the swamps of Louisiana, Arkansas, and Mississippi are very deep bogs, in which also grow large trees, close together. When these die, fall, and rot, a thick bottom of carbonaceous matter is deposited. When the water is absorbed, or if the bog becomes dry, a peat is formed, which can be cut and burned. Throughout Ireland, and in many countries are thick, rich bogs of the peat, some quite compact and dry. In any swamp we can find a depth of this black, half decayed wood. Then the land sinks, or the sea rises, and covers the peat with sand and mud, just as we have seen off the shores of Guernsey and off Devonshire. The peat becomes buried, pressed together by the materials above it, and in time it assumes the shape like lignite, light, and having one-tenth of its weight in water. A further change, as time wears on, produces the forms of bituminous coal. With greater time, pressure and heat anthracite is formed. If it is still longer heated graphite or plumbago is formed.

9. How long has this change been going on?

Geologists cannot tell but it must have taken ages. The amount of coal that supplies U. S. inhabitants alone, is 150,000,000 tons every year, and men tell us that there is sufficient under ground to keep up the supply for an indefinite period. The time required to make all this coal out of wood is very great.

10. What evidences have you of this theory?

First, the microscope shows coal is full of leaves, fibres, and bark of trees. Then near Richmond we see a bituminous bed of coal that has been changed in place to anthracite where a thin sheet of lava has touched it. And we can make coal by putting sawdust under heat and great pressure.

11. Have those "coal pipes" that occur in the roof any connection with coal formation?

Those are called "sigillaria." They are tree trunks that were standing when the mud formed around them. You will notice them in the roof as saucer-shaped. As they are the base of trees near the roots and taper thinner upward they are liable to drop down, so always stand from under and prop them at once. In looking for coal (prospecting that is called) the finding of sigillaria is a sign of being above the coal. Here is a picture of them, Fig. 1. The scars are where leaves once grew.

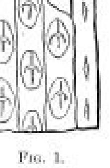


Fig. 1.

12. There must have been immense forests to furnish so much timber and vegetation?

There were. If you have seen the large and dense swamps of the Southern States that hid so many negroes during the Rebellion; or the illustrations of Brazilian and African woods you will readily see that the illustration, Fig. 2, (on next page) is simple in comparison. It shows what the geologists believe to have been the forests of the coal period.

13. Now there are three things troubling me. First, how does this theory come to have been formed? Second, what do you mean by coal period? Third, I do not understand what you say about the mud forming around the "pipes?"

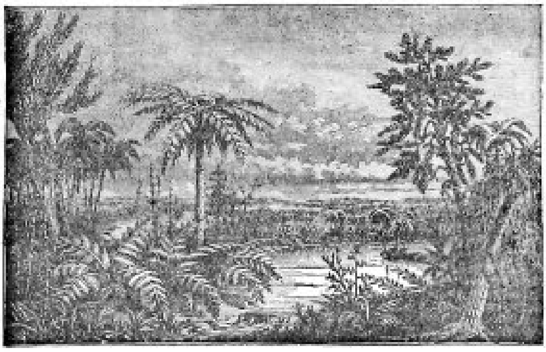


FIG. 2.

That is a long story, but I will answer your second first. Have you noticed that coal contains different kinds of leaves, roots, etc.? Well they indicate to us that these plants existed at the time that the trees were growing. We call that the coal period.

14. How was the theory formed?

It followed the same ideas as are now going on. A leaf falls into the stream and becomes imbedded in its mud. A twig falls on the ground and is covered by sand. An animal dies on the plains, its bones are bleached. A rain washes them into a creek, and they are covered with sand. If in time these are buried under the soil, they give form to the sand that packs around them and a "fossil" is produced. That explains the coal pipes that had been growing in a marsh and stood many hundreds of years after the marsh had been covered by a stream that had deposited mud around the tree. We know that old forest trees live perhaps a thousand years.

15. Did animals live during that time?

Yes; there were beetles, spiders, and other insects. There were some air-breathing, back-boned animals, like our water dogs. There were no birds, no serpents, no fruits, no flowers. Fishes were plenty.

16. Are there any of these in the coal?

Occasionally they are found, to give life to the dead waste, but they are generally found in the slates and clays above and below the coal.

17. Is that the reason that certain rocks are called carboniferous, or of coal period?

We always know how and where to look for coal. The finding of fossils is our guide. For example if I find in a certain rock, remains of the five-fingered leaves, like that shown in Fig. 3, I know I am too high to look for coal and must go down. And if a rock is found with the lower forms of life, like those of Fig. 4, I am too low down in the rocks. Carboniferous rocks will have shells like those shown in Fig. 5.

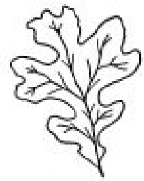


FIG. 3.

18. What do you mean by saying "too low down?"

The question involves the whole history of the earth's formation. All the rocks are in layers which occur in the same order wherever you go. Some

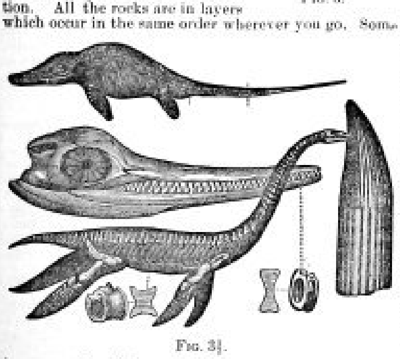


FIG. 3½.

layers may be missing or very thin, and in other places they will be thick. The order is, however, the same.

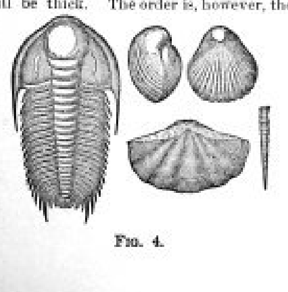


FIG. 4.

Granite is always at the bottom and is called the basement of the earth. Then come a variety of sandstones, slates, clays, and limestones, of different colors and natures.

Some of the bottom layers of these have fossils like those in Fig. 4, and are called *Silurian*. Above them will come layers having fishes, called *Devonian*; corals were also numerous. On top of these, never below them, came again series of slates, limestone, etc., (carboniferous) that are full of plants, fossils, or shells like Fig. 5. Above them came layers and layers of these same rocks carrying corals *in sizes, not in forms* as were those of the *Devonian*, and *equally split* tailed fishes, and above all reptiles like those in Fig. 3½.

These layers included the *Jurassic*, *Triassic*, and *Cretaceous* periods. During the last-named there also existed great forests to produce the coals of the Western States. After the *Cretaceous* we had birds appearing in the *Tertiary* rocks, and finally mammals.

So you see there is perfectly uniform order which can always be identified by the kind of fossils the rocks contain. The more nearly the animal or plant resembles those of our day the higher up the rock is.

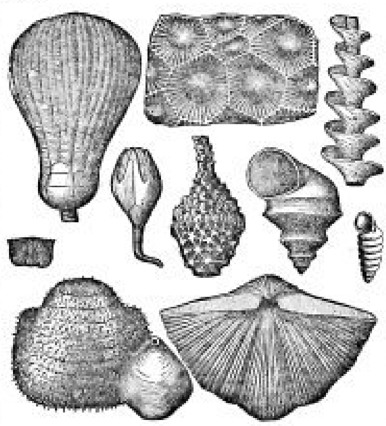


FIG. 5.

19. Are these rocks always of same thickness?

No, for they were made under different conditions of the earth and may be one foot thick in Pennsylvania and 50 feet thick in Germany. The carboniferous does not exist at all in Colorado.

Again the rocks were formed like the peat as mud deposits of a creek, or lake, or ocean, so they will be thin near the banks and thick in the deep water.

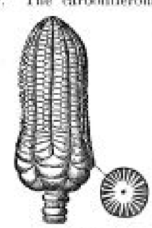


FIG. 6.

20. What are strata?

That is a term for several layers. One is called a stratum. Two or more are strata.

21. Is that where "stratified rocks" comes from?

As the rocks like limestone and slate are flat layers we call them stratified. (See p. 286, July, 1891, number of THE COLLIERY ENGINEER.)

22. Is granite stratified?

No it is a massive rock.

23. Then it was not produced by seas or creeks?

No, granite is the foundation rock of the earth and when as the Bible says, this earth assumed form, it began to be worn away by frost and water. The coarse heavy material was washed to the bottom of the hill and there it was left while the sand and mud were carried further on. Soon the current became too slow and the sand accumulated while the lime grains were carried along with the clay mud. Afterwards the lime settled out and the mud formed a bottom way out in deep water. If the operation continued long we had

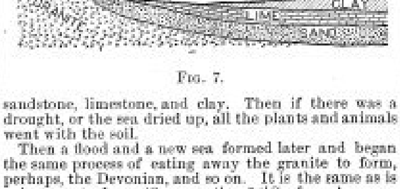


FIG. 7.

sandstone, limestone, and clay. Then if there was a drought, or the sea dried up, all the plants and animals went with the soil.

Then a flood and a new sea formed later and began the same process of eating away the granite to form, perhaps, the Devonian, and so on. It is the same as is going on to-day. (See question 8 "Surface Arrangements.")

24. What are the slates made of?

They are the same as clay but they have been hardened more than the clays. (See page 287, July, 1891, number.)

25. Then, the coal must have been formed in very quiet water, a pool or ocean?

Yes, how did you come to see that?

26. Because usually our coal seams have clay or slate roof and floor. Then in years to come will we be fossils for future geologists?

Yes, drowned sailors lying in their wet graves are being slowly buried with whales and corals in the ever-settling sediment. The whole history of the earth has been one ceaseless action of rain and sea that carries everything to the ocean the bottom of which is and has been a cemetery in which lie the dead from the three kingdoms of nature—the earth, air and water.

27. How long has this been going on?

We can not tell, certainly a long time.

(TO BE CONTINUED.)

METHODS OF MINING.

Shaft Sinking—Tunnelling—Systems of Working Coal and Metals—Timbering in Mines.

1. What are the methods of reaching veins or seams?

By shaft, slope, tunnel, or adit.

2. What is a shaft?

It is a vertical opening sunk from the surface.

3. What is a slope?

It is a passage that is inclined. Some call it *incline*, others a *plane*.

4. What are the other two?

These are horizontal openings. A tunnel, properly speaking, is a passage driven *through* a mountain, or from daylight to daylight. In mining this term means a passage from daylight through the country rock *to* the vein. An adit is a horizontal opening on the vein from daylight in.

5. Then only slopes and adits are on the vein?

Yes. The first follows the dip of the vein and the other follows the strike of the vein.

6. Which is the best method of opening a vein?

That depends upon the surface features. If the vein crops out to daylight, one may have the choice of all four methods. Undoubtedly it is cheaper and more advised to follow the vein by slope or adit, for then you know what your vein looks like. With coal this is not of so much consequence, because the coal is so even in quality and the bed of uniform thickness. With lead or silver it is different, the vein changes in direction and in thickness. The vein is rarely ore-bearing throughout, but only has streaks of ore that must be followed. Generally speaking, "stick by the ore" and follow it. If on a hillside the vein crops out, running up and down, then surely you have the best and cheapest method—by adits. These are driven every 100′ apart in height and offer the simplest mode of transportation.

7. How about slopes; are they not cheap?

Slopes are good for following the vein down and thus give you an idea of its value, but they are expensive to keep up. The wear and tear of hoisting is great, and the timbering is more expensive than for the same style in shafts. But there is another objection. If the vein should "knuckle back" hoisting would be dangerous. For example, veins in the lead and silver districts are not regular in their pitch, as you will see later, under geology of this department. Sometimes they double back. You may imagine what danger and trouble there is in hoisting up a shaft like that in Fig. 1. I could name several. But when the company started out on the slope, they did not know what to do when they reached the point A. I believe there are a dozen such shafts in Colorado. Their owners sooner or later must change. They can not hoist fast through them. And you know the speed of hoisting and the amount of the load fixes the output of the mine; no matter how much ore is broken down, only a small amount can be pulled out.

FIG. 1.

8. Do you prefer a vertical shaft?

By all means. It is safer, you can hoist quicker, the timbering is better preserved and watched, and even the hoisting rope lasts longer.

9. How would you sink it?

I'd prefer to put it on the side shown in Fig. 2, so as to cut the vein. I would drive across to cut the vein every 100 feet or so in height.

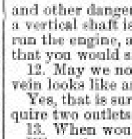


FIG. 2.

10. Are not these cross-cuts expensive?

I grant you they are.

11. Would this plan not cost too much?

This must be determined by the owner. It is dearer than a slope at first. But when you figure up the first cost of slope and then add to it the slowness of hoisting, the extra cost of repairs, the danger of knuckling, and other dangers, you will find that before five years a vertical shaft is cheaper, for it will require less coal to run the engine, and the rope will last so much longer that you would save money.

12. May we not first sink a slope to see what the vein looks like and then after sink a shaft?

Yes, that is surely the best plan, for you would require two outlets sometime anyhow.

13. When would a tunnel be better?

When the country is wet and you know enough about the vein and its ore to know where to find it and what it contains. A tunnel is cheap to operate. It requires no hoisting machinery and the cars and ore can be brought out through it without trouble or great cost. Transportation is the most important, and, in ore mines, the least considered of all branches of mining.

14. Is a tunnel expensive to drive?

Yes, though the cost will depend more upon the difficulties encountered, like water and soft rock. Hard rock is no longer any objection. With machine drills and electric firing the cost of driving tunnels is not so serious an item as it was.

15. Are machine drills and electric firing cheaper than by hand?

Yes, the work is done more rapidly and cheaper.

16. What is the method of using air drills in tunnels?

There are two systems. The "center cut" and the "radial." In the center cut system, known as the American method, the holes are drilled 12 to 14 feet deep and in vertical rows of four each and looking toward each other. The two rows 1, 1, in Fig. 3, the center cross and are fired first. This breaks out a wedge of rock. The others are fired in volleys, marked 2, 3, afterwards. Then the sides are trimmed to shape. For this method, there are two machines at A and B. The advance of the tunnel is 10 feet when the tunnel is 9×16 feet, 20 holes are drilled. The "radial" system is for drifts where the machine is placed at one side of the drift and drills the holes about 4 feet deep, such as in Fig. 4.

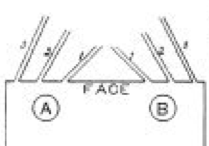


FIG. 3.

In the consumption of powder they are a little higher than in hand work, but the progress is very much faster. It does not pay to arrange the holes in the last way, as a miner would, for the time lost in moving the machine is too great.

FIG. 4.

17. Are tunnels timbered?

Usually not, unless the ground is soft.

18. How are they timbered?

Like galleries and drifts—in sets of four pieces. Sill, cap, and two posts.

19. How are they joined?

If the pressure is only from the top, then the cap may rest on the posts, as in Fig. 5. If there is any side pressure the joint should be cut, as in Fig. 6.

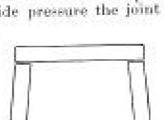


FIG. 5.

FIG. 6.

Never hollow out the post to rest the cap on for the post will soon split. Always dress off the ends to a flat face. Some miners dress and hew off the cap and the posts like Fig. 7, but I do not find this a good plan. I have known of cases where the cap fell through when the posts were forced back. This was on account of poor backing.

FIG. 7.

20. What is that?

The timbers and frames should never be allowed to stand long without being well packed behind with waste rock stowed away between the rock and the lagging.

21. What is lagging?

That is close slabs of flat boards, cord-wood, or half round slabs from the saw-mill, which are placed close along-side of one another, like in Fig. 8.

22. What are they for?

To hold back the waste packing and to prevent any movement. Remember this one principle in timbering and mining generally—that timbering is not for a bad roof merely. *It is intended to prevent a good roof, so called, from becoming bad.* A stick of timber will hold a heavy load or stand a very heavy pressure *so long as it is quiet*, but the moment that movement begins, there is no timbering on earth strong enough to prevent disaster. So always close up spaces in the waste and pack them as tight as you can to prevent movement. The talk about "rock of ages" is all well enough but it is cracked, some will soften on exposure to the air and little of the rock of the earth is so solid as to stand the jars of blasting without loosening up and falling. The man who will not timber up because the roof looks good, will be fooled some day, and be brought home on a stretcher. Therefore, I pray you, be over-cautious in your timbering. Think of it! One man out of every four hundred miners is killed every year by falling roof.

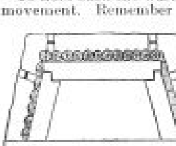


FIG. 8.

23. Is there no remedy against this?

No. Men who live with the constant threatening dangers of mining all around them, become hardened and careless. They say that "I am more lucky," or "more careful." But to-morrow is their day. I have picked men out of mines crushed by rock, and yet they had to crawl over loose timbers supplied to them, to reach their working faces. They are anxious for a big turn-in, and do not want to lose the time necessary to prop the timbers. The use of machines for drilling and coal cutting will remedy this somewhat. For then certain men will do nothing but attend to the machines; others will only put up timbers, still others will do the blasting, and so on. This is a big improvement, and is much safer for everybody.

24. How far apart are the sets you mentioned in 18?

Three feet, ordinarily, but they may be farther apart or nearer together, according to the greatness of the pressure.

25. How are the sets held together?

Nails or spikes should never be used. Straps are sometimes used. But I advise you to get along without any iron, all the pressure is inward toward the gallery or drift and if the joints are carefully made the pressure will hold the pieces of frame together without any fastenings. Often wedges and wedge-blocks are placed at the caps and heads, as in Fig. 8, but a tight backing of waste rock will be sufficient.

26. Will this do if the ground is soft or crumbles?

No. The lagging may help, but generally, soft ground requires heavy sets. The lagging, by the way, should *always be weaker than the timbers* of the sets, so that when crumbling takes place and anything must give away, the lagging will do so first and relieve the sets. The lagging can be so easily replaced when quiet is restored.

(TO BE CONTINUED.)

SURFACE ARRANGEMENTS.

The Preparation of Coal and Ores for Market.

1. Why need ores be prepared?

Because minerals and ores as they come from a mine are never pure. They are found mixed with material of no value. Often, also, there occur with the valuable portion of the ore, material which is injurious to the ore, while in use. Of this we will speak later.

2. How about coal?

The same is true there. No matter what may be the uses to which coals are to be put, there are impurities that injure the coal. Iron pyrites and slate, besides clay, are the most common. The first occurs all through the coal in fine grains and sometimes in balls that break up in the hewing or shooting. The slate and clay come from the partings, roof or floor. In loading the cars these cannot be picked out quickly in the dark so when they arrive up at the surface they must be separated.

3. What are the objections to pyrites?

Pyrites contain sulphur which increases the percentage of ash for whatever purpose it may be used.

4. Does not coking in the ovens destroy the sulphur and carry it off?

Burning does take off some of the sulphur from the coke but the iron remains in the ash. Pyrites, as you may know, is over one-half sulphur and nearly one-half iron.

5. Is the sulphur injurious?

Yes indeed. A coal with much pyrites in it cannot be used raw in iron manufacture because the sulphur spoils the pig iron. Nor is impure coal fit for burning under steam boilers. It makes a poor heating coal and clinkers badly. The blacksmith cannot use a coal with pyrites, nor one with slate, because of injury to the tools he is forging.

6. How are the pyrites and slate removed from the coal?

Until recently the only means adopted for separating them was by picking. The broken coal was caused to slide down screens made of bars through which the fine material and culm or slack passed and over which the larger coal sizes were carried. Boys, on convenient seats, watched for the lumps of slate or clay, and picked them out as they flew by. This method was crude and not entirely satisfactory. In ore mines, the method is the same except that the ore is dumped on tables. The sorters have less ore to pick over than the boys have of coal.

7. What is done now?

Methods called washing are used. For coal and for ore, the principle is the same.

8. What is the principle?

Watch a creek and you have the plan. When a creek is falling fast and flowing with great speed it can wash away anything smaller than quite large pebbles. When it has emptied into a large river, it moves slower and now the pebbles settle down, but the heavy sand, fine sand, and clay go on. Wherever the river widens the speed of the river is less and now sand will settle. The mud remains and is carried away out to sea before it settles down. Every change in the speed of the river alters the bottom; finer material will settle if the speed is slower and only the coarse stuff will stay on the bottom if the river is faster. So with the washing machines. (See Q. 23, Geology.)

9. Must the coal and the ore be fine for this work?

Yes, and that is the only objection, at least with coal. There is one reason why the material must be broken, besides the one mentioned. Usually the impurities are mixed all through the coal and ore, and unless you break it up, you can not separate them.

10. Is there an objection to making small coal?

Yes, the waste is large and you can not break up coal for screening without losing a great deal. The breaking wastes nearly a tenth; screening loses some and the lip-screens waste a little. It is found that the breaker waste from mines delivering to furnaces is less than that from mines which supply domestic sizes which are all small. This waste is always very large. Later we will discuss means of preventing so much waste.

11. But is not sized coal better for the consumers?

Yes, the consumers prefer sized coal. Grates are planned for the burning of a certain size of coal, and so the screening is all right for the consumer. So, for coke making, small coal is preferred. But the breaking of coal produces so much culm which with the fine coal hoisted up to surface is screened out and lost. At present there is little chance of using the fine coal. Usually, too, it has more impurities than the raw coal. If this slack were washed it would sell better than it does now. It could then be used for coke making. If the dry coals of the Mississippi Valley could be coked there would be more washing of the coal and slack.

12. Is coke better to burn than coal, that you should lay so much stress on it?

For certain purposes, yes. Furnaces for melting iron and lead find coke better than raw coal.

13. Is any coal so good and pure as not to require washing?

I hardly think so. I believe all coals have sulphur, and most of them have slate. But even if it was not necessary to wash the impurities out of the coal, screening would separate the coal into sizes and give cleaner products. So I believe that every coal should be washed for one purpose or another.

14. Is it not expensive?

Oh yes. I grant you it is simply a question of cost as to whether it would pay. As the consumers prefer coal which is clean, and demand it to be screened and sized, it is a question whether a colliery wants to continue to supply trade by putting up a cleaning works, or if it would rather run the risk of losing business. Breakers were found to be necessary and to improve trade years ago. So it will be equally important to build washing-houses for the coal.

15. Is there only one method of washing coal?

No, for air will accomplish just what water does. The farmer of the olden time separated the chaff from the wheat by letting a current of air sweep across the barn and blow away the chaff. Still the air method is not a success, for you have to use a strong blower fan or a suction fan to make the current.

16. Then water is the only means?

Yes. Dr. T. Drown has tried to obtain some other liquid, but, like others, has concluded that water is the cheapest.

17. What is the plan of washing?

You have seen how water can separate lighter particles from heavier? Well, coal is lighter than the slate and pyrites. So a current of water is caused to flow in such a manner and with such speed as to just carry off the coal and leave the heavy impurities behind.

18. Is it the same plan as that of dressing ores?

No, not quite the same. An ore of iron, lead, silver, or gold is heavier than the impurities that are found with ores. So there, the plan is to wash away the lighter materials.

19. Is there any other difference?

Not essentially. In principle there is no difference. But in quantity to be treated there is. You see, with metallic ores, we have to deal with small quantities of rich material, and hence can afford to be more careful with the operation. A *large* ore-washing mill is one that treats 100 tons a day. This is a very small turn-out for a coal mine. A coal washing plant must deal with enormous quantities of a very cheap substance, and one on which the margin for profit is so small that we must use machines that act very quickly and simply.

20. A coal-washer, therefore, is a very large mill of simple and self-acting machines, while an ore-washer is not. Is that so?

Not exactly. The first part of the statement is correct, but the latter part is not. First, a mill for washing ore is called a concentrator, and the process is called concentration. But the mill may be just as simple as the coal washer. All I intended to imply was this, the coal must be washed fast and the ore may be concentrated slowly or even several times before the operation is complete. Ores are, therefore, repeatedly washed in many mills.

(TO BE CONTINUED.)

A Pirate.

THE COLLIERY ENGINEER's estimate of the annual supplies required for an 100-oven coke plant is printed in the *New York Engineering and Mining Journal* and credited to the *American Manufacturer*. The *Journal* acted in good faith. The *Manufacturer* acted piratically.—*Connellsville Courier.*

No More Trouble From Boiler Corrosion and Boiler Scale.

Last month we published an article on the merits of the boiler compound manufactured by the Pittsburgh Boiler Scale Resolvent Co. In our advertising pages of this issue will be found a page of testimonials from those who have used it longest. If it will successfully meet the requirements of all these parties it naturally follows that it will meet yours, and you cannot afford to pass it by without investigating it.

A neat reminder of the Lidgerwood Manufacturing Company, comes to our desk in the shape of a delicately tinted bevelled-edge card, $7 \times 8\frac{3}{4}$ in., upon which is mounted a photograph of a new six-spool Lidgerwood hoisting engine for bridge erectors. There is a brief description of the engine below the photograph. The card is designed to be hung upon a nail.

The Lidgerwood six-spool hoisting engine is portable, serviceable, and thoroughly reliable, and is designed for use in bridge erection and in the construction of iron buildings. It can also be profitably used for hoisting heavy loads generally. It has six spools, independent in action and each having a clutch, lever, ratchet, and pawl. The absolute independence of the spools enables the engine to be operated to great advantage in bridge erection as several members of a truss or girder can be hoisted and held in position while they are being bolted or riveted. The engine has many other attractive features and the Lidgerwood Manufacturing Company will gladly reply to all inquiries concerning it, addressed to the New York office of the Company, 96 Liberty Street.

HOW TO LIVE

Use Hot Water.

The human body, says a writer in *Hall's Journal of Health*, is constantly undergoing tissue changes. Water has the power of increasing these tissue changes, which multiply the waste products, but at the same time they are renewed by its agency, giving rise to increased appetite, which in turn provides fresh nutriment. Persons but little accustomed to drink water are liable to have the waste products formed faster than they are removed. Any obstruction to the free working of natural laws at once produces disease. People accustomed to rise in the morning weak and languid will find the cause in the imperfect secretion of wastes, which many times may be remedied by drinking a full tumbler of water before retiring. This very materially assists in the process during the night, and leaves the tissues fresh and strong, ready for the active work of the day. Hot water is one of our best remedial agents. A hot bath on going to bed, even in the hot nights of summer, is a better reliever of insomnia than many drugs. Inflated parts will subside under the continued poulticing of real hot water. Very hot water, as we all know, is a prompt checker of bleeding, and besides, if it is clean, as it should be, it aids in sterilizing our wound. A riotous stomach will nearly always gratefully receive a glass or more of hot water.

Consequences of Error.

Take care what thou sowest, as if thou wert taking care for eternity. That sowing, of which the Scripture speaketh, what is it? Yesterday, perhaps, some evil temptation came upon you—the opportunity of unrighteous gain, or of unhallowed indulgence, came, either in the sphere of business, or of pleasure, of society, or of solitude. If you yielded to it, then and there did you plant a seed of bitterness and sorrow. To-morrow, it may be, will threaten discovery; and agitated and alarmed, you will cover the sin, bury it deeper in falsehood and hypocrisy. In the hiding bosom, in the fruitful soil of kindred vices, that sin dies not, but thrives and grows; and other and still other germs of evil gather around the accursed root, till from that single seed of corruption, there springs up in the soul all that is horrible in habitual lying, knavery, or vice. The evil deed may be done, alas! in a moment—in one fatal moment; but conscience never dies; memory never sleeps; guilt never can become innocence; and remorse can never, never whisper peace.—*New York Ledger*.

A Paper on the Hidden Causes of Disease, by the Late Sir Morell Mackenzie.

At the solicitation of the editor of *Youth's Companion*, Sir Morell Mackenzie, M. D., a short time before his death, wrote the following article on the "Hidden Causes of Disease."

Age is not always to be measured by years. It has been truly said that "a man is as old as his arteries;" as long as these living conduits retain their soundness and elasticity, the parts which they supply with blood will resist decay.

Overwork, "hard living," prolonged privation and exposure to cold, and generally speaking, whatever makes the fire of life either burn too fast or get low for lack of fuel, will add very largely to the natural wear and tear of the tissues.

Dryden speaks of a man whose restless spirit

> Fretted the pigmy body to decay
> And o'er informed the tenement of clay.

Anxiety and distress of mind also contribute powerfully to hasten the advent of old age. A great sorrow will whiten the hair and make a man look old and worn; adding, in very truth, years to his life in the physiological calendar.

Probably there is no more potent cause of disease than long-continued mental suffering; and the greater part of its effect in this way is due to the fact that it brings on premature old age.

Old age causes disease by setting up changes in the tissues which make them liable to perverted action, as in the transformation of harmless warts into cancerous growths; or less capable of resisting the effects of cold and other external agencies; or more prone to wasting, which the exhausted system finds it more and more difficult to repair.

Organs like the brain and the heart—which are, as it were, banks for the storing up and distribution of vital energy—become worn out, and physiological bankruptcy results.

The special enemy of old age, inflammation of the lungs, is due to weakness of the heart, combined with loss of elasticity in the lungs. The mortification of the feet and ulcers of the legs so frequent in the aged are also consequences of deficient blood supply, associated with local degeneration of tissue.

HOW PARALYSIS COMES IN.

The arteries lose their elasticity and give way under any unwonted increase in the force of the blood current; thus a fit of anger or even a sudden movement may be followed by bleeding into the brain—popularly called "apoplexy" or "paralytic stroke"—or a large vessel may become dilated into a kind of hollow ball, called an aneurism, which causes pain and troublesome complications by pressure on the parts in its neighborhood, and may at last burst, with an immediately fatal result.

The changes wrought by old age in the structure of the brain show themselves at first in subtle alterations of disposition and intellect, such as irresolution, timidity, irritability, unreasonable suspicion, avarice,—that "good old-gentlemanly vice," as Byron calls it,—garrulity, loss of memory, confusion of thought, and all the characters of age," which literature from Homer downward has delighted to portray.

In a more advanced stage these senile changes in the brain lead to various forms of mental derangement, and in the last scene of all to "second childishness and mere oblivion."

The most fatal tendency of old age, however, is to the formation of what are called "malignant" growths. This is distinctively a "senile change," if we are to believe Mr. Jonathan Hutchinson, an English authority on the subject, who insists that cancer is merely chronic inflammation in tissues that have undergone the degeneration characteristic of old age.

PECULIARITIES OF STRUCTURE.

That there are peculiarities of structure and constitution, which predispose to certain diseases is a fact as to which there can be no possible dispute.

A good example of such a proclivity is seen in "bleeders," who suffer from what medical men call hæmophilia. The constitutional tendency to bleed on the slightest provocation is very marked in such persons. After the extraction of a tooth, or a trifling cut, they bleed so profusely and so long that surgical skill is sometimes taxed to the uttermost to keep them from bleeding to death.

The late Duke of Albany (Prince Leopold) was the subject of this peculiarity to such a degree that the lives of his physicians were made a burden by the almost incessant demand for their assistance which it entailed. It was ultimately the cause of his death; and yet the injury which indirectly proved fatal was nothing more serious than a slight twist of the knee-joint, which occurred in dancing.

Nothing has yet been discovered to account for this extraordinary peculiarity except a certain thinness of the blood vessels, which is far from being constantly present in such cases. The theory that the Duke of Albany had "one skin less than other people" is probably a grotesquely distorted version of this slight structural anomaly.

The most noteworthy instance of constitutional tendency to disease is seen in the case of consumption, and what used to be called scrofulous diseases. These are now all classed, together with consumption, under the head of tuberculous diseases.

The peculiarity of structure in these cases shows itself in this—that the real cause of the disease requires a certain condition of the tissues before it can produce its effect. They are more delicate and more easily injured in predisposed subjects than they are in other people. Wounds do not heal kindly, and are apt to fester in persons of this constitution.

HEREDITY.

That heredity is a cause of disease admits of no doubt. It is not the disease itself, but the tendency thereto, that is inherited, just as other physical peculiarities are.

Readers will remember the horseshoe vein on the forehead which was the badge of all the tribe of Redgauntlet; and there is a well-known family in the South of France which for more than three centuries has boasted a white lock of hair. The Bourbon nose, and the thick lip of the Hapsburgs, are other instances in point.

Consumption, gout, insanity, and cancer are the diseases which show the greatest tendency to run in families. Of the hereditary transmission of gout, nearly every noble family in Europe can show the most conclusive proof. With regard to cancer the case is not so clear; but statistics prove that heredity can be more or less distinctly made out in a considerable proportion of those who fall victims to the disease.

The Bonaparte family furnishes a remarkable example of the hereditary transmission of cancer. One of the parents of Napoleon the First died of cancer of the liver or stomach. He himself died of cancer of the stomach, which also proved fatal to his brother Lucien and to his sister, the beautiful Pauline Borghese.

A hereditary tendency to disease may not show itself till an advanced period of life, as Professor Huxley, in his charming autobiographical sketch has lately told us that a peculiar movement of the hands which was habitual in his mother has recently shown itself in him.

The moral to be drawn from these facts is that if a man has reason to suspect that he inherits a tendency to a particular disease, he should be careful to avoid exposing himself to the conditions which favor its development. He should also be mindful of his posterity, actual or possible.

Most people use their bodies as if they were their property in fee simple. This is hardly fair to their descendants. A man should, undoubtedly, treat his body as though it were strictly entailed, and the rights of his heirs should be, as far as possible, respected.

If the attack of the disease can by any means be kept off, it is possible that in time the family taint may be eliminated.

The Mortality of Miners.

This is an old subject of controversy, and the general idea seems to have prevailed that the mortality is above the average. In connection with the frequent mention of the subject lately, attention has been called to Dr. Ogle's views contained in a paper on "Occupational Mortality," which was issued in connection with the Registrar-General's 55th annual report. A contemporary thus summarizes the returns.

While not bearing out the assertion that miners enjoy healthier lives than agricultural laborers, they show that coal miners and the miners in the North Riding of Yorkshire, and in other ironstone districts, aged between 25 and 65 years, were liable in 1871-80 to a lower death rate than the mean rate among all males at the same ages. Taking 1,000 to represent the mortality figure of all males at the above-mentioned ages in the ten years under notice, the figure for laborers in ten agricultural counties was 701; for miners in nine counties where the mining was almost exclusively for coal it was 891; and for miners in the North Riding and other ironstone districts it was 834. Dr. Ogle wrote: "The death rates of coal miners are surprisingly low. In spite of their terrible liability to accident, and their constant exposure to an atmosphere vitiated by coal-dust, by foul air, and by an excessively high temperature, the comparative mortality figure of these laborers is considerably below that of all males." This rule holds good, not only for the aggregate of all the miners in the nine counties dealt with, but for each of the six great coal areas taken separately, excepting only South Wales and Monmouthshire, where the exceptionally high rate from accident causes the mortality to exceed the mean for all males. —*Labor Tribune (England).*

Chauncey M. Depew's Method of Preventing a Break-Down.

To the charge which has been made in connection with the Hastings disaster that Chauncey M. Depew spends too much time outside his duties as President of the Central Road, Mr. Depew makes an extended reply:

He said: "I have closed my twenty-fifth year with the Central Railroad and in that quarter of a century I have been in touch with every part of its business and every condition of its development. Though blessed with physique and health and capacity for work accorded to very few men, I early made up my mind from observing the men who had broken down around me and gone to pieces, that the only safety was in variety of occupation; that unless a man could relieve the strain by excursions into other fields, and especially such things as would keep up his cheerfulness and hopefulness, he was gone."

After citing the means of relaxation adopted by a prominent banker and by a railroad president, Mr. Depew said:

"I care nothing for cards, take no interest in games of chance, and at first used to spend my evenings late in the night in continuing the business of the day. Of course that produced sleeplessness, and in a short time led to an overstrain in one direction of the same brain fibers, which destroyed their elasticity, and resulted in bad judgment and poor work. It is for this reason that the extremely busy man can do better the next day if after his business hours he can switch his mental machinery off to some channel which gives rest and recreation. Happily for my critics, and equally fortunate for my health, my recreation is mental labor in other channels than business, which are public and widely advertised, while the railway president or banker who passes his evening at his club or with the card party in his house is free from criticism, because the public are wholly unaware, and, therefore, they don't care how he passes his evenings."

Mr. Depew spends much time in his office, but he urges that it is a misapprehension to estimate a man's value by hours.

"I know plenty of business managers," he says. "If they were not ably assisted, would ruin the properties which they control, even if they gave 18 out 24 hours to the service. I know others of such comprehensive and executive genius that, with three hours a day, they will make any business a success. Commodore Vanderbilt was the greatest business success the world has ever known. He made about a million and a half a year for every year he lived, counting from his birth. He always closed his business day at 2 o'clock, and there never was any business so important that he would give it any attention after that hour. He drove in the afternoon his fast horses and devoted the evening absolutely to recreation and pleasurable amusements. He always claimed that his judgment was very much better and his success largely due to these habits. I believe that a man of large executive endowments, who is properly educated and trained, has the faculty of selecting efficient and loyal subordinates, and the greater faculty of instantly turning his mind and concentrating all its resources upon the business in hand, can successfully manage several important business concerns and still have time for his family, his friends, and the public."

In conclusion President Depew refers to the large share of New York's traffic handled by his road and then says: "I do not claim that my speeches produced this result or any considerable portion of it, but the passenger agents both of the Central and rival lines, tell me that they notice an appreciable difference in travel by our lines, as the public appearances of the President are more or less frequent."

ELECTRICAL PROGRESS

Electrical Improvements.

Two Germans have each invented a process by which the filaments of the incandescent lights can be preserved from deterioration. One is by depositing chromium upon the filament, either chemically or by electrolysis. The claim is that the melting point of chromium is so high, as to resist the action of the electric current and increase the life of the filament. The second method is to deposit nitrides of silicon or boron upon the surface of the filaments. This is done by heating the filaments to high temperature, in an atmosphere of volatile compounds of silicon or boron, and volatile compounds of nitrogen.

A French engineer has discovered a method of repairing broken filaments economically, so that the bulbs can be used again. He makes a hole in the bulb, carefully takes out the broken filament excepting a small piece, which is left attached to the platinum supports. The bulb is then filled with a hydro-carbon liquid, and a new filament inserted, with its ends just touching the piece of old filament. An electric current is then turned on, which decomposes the liquid; the hydrogen liberated, rises through the bulb and the carbon is deposited, cementing the new and old filaments together. The bulb is then cleaned and sealed ready for use.

The reduction of aluminum from its oxide by means of the electric current, is one of the greatest results in the way of electrolysis. The metal which was only recently a comparative myth, is now produced in large quantities, and is used in the manufacture of many articles, both useful and ornamental. Experiments are being made, with reference to its use in the steel plating of vessels, a small quantity of aluminum in the steel, rendering the latter more uniform and more ductile, with a higher ultimate strength.—*Mining Industry.*

Is Electricity a Manufactured Article?

At first sight this may seem a grotesque question, but it has a very serious financial aspect and in fact more than one law suit to determine this point is at present in progress, one, indeed, in New York City. The point at issue is the taxation of central stations, for many States and cities make a wide difference between manufacturing establishments and others. If electricity is a manufactured article then it should be treated with the same consideration due to the establishment of a new industry, with as much gentleness as if it were a soap factory or a shoe shop. Then, too, the question is likely to arise from time to time whether the electric current is dutiable. It is one of the few things that the redoubtable McKinley did not specifically include in his amiable tariff bill, but it might be levied upon as an unclassed manufactured or unmanufactured article for the benefit of the governmental pocket. A question of opinion such as that involved in this inquiry is one to fill the hearts of our legal friends with unwonted joy, for there are as many sides to the subject as there are human beings to discuss it. Does a change in the form of energy constitute manufacture? Is the electric current a substance or not, and in either case is it in any sense properly manufactured in the central station? If it is a substance, has it been altered in form sufficiently to be classified as a manufacture? If it is not, can it be manufactured at all? These are a few of the pleasant questions that arise for solution before the courts, and the longer one discusses them the more hopelessly abstruse do they seem to be. As a matter of plain straightforward equity, an electric light station and gas works ought apparently to stand on precisely the same footing, but whether under our existing laws this can be permitted is another question. For example, is an establishment for the distribution and sale of power, whether transmitted by cable, steam, or compressed air, a manufactory? If it is not, should the distribution of power by electricity be classified as manufacturing? On the other hand, is not the production by the consumption of coal of an available something for human advantage manufacture, whether it is a current of gas or of electricity? It is one of the cases where appeal cannot be taken to logic, for logic is left out in the cold in such a varying series of analogies; nor can one appeal to ethics, for ethics is not always considered in adjudicating disputes; so after all it may have to be settled on a purely legal basis. If so, no man can tell what the result will be, for the laws are not universally bound by any code of either ethics or logic.—*Electrical World.*

An Electrical Mail Carrier.

A plan to carry the mails by electricity between New York and Brooklyn has been submitted by Mr. A. Bryson, Jr., of New York, to Postmaster Collins, of Brooklyn. It is the result of an act recently introduced in Congress by Mr. J. J. Clancy, which provides for the better transmission of mail matter between the two cities, by means of pneumatic tubes, electrical or other appliances, and authorizes the appropriation of $95,000 for the purpose. A similar bill has also been introduced for experimenting between New York and other cities. Mr. Bryson's system consists of a traveler, say 6 feet long and about 11 by 16 inches in breadth and height, to the back of which is attached an electric motor about 8 inches square; this is acted upon by an electric wire which runs along the bottom of an iron or steel cube, which encloses the whole arrangement. In fact it is the trolley system on a reduced scale, and the live wire which supplies the power is fed from one end or the other of the route. The rapidity with which the traveler is propelled may vary, depending on the amount of energy called for. From 70 to 100 miles an hour, or even higher speed, can be obtained. All the advantages which the pneumatic system could give would be obtained, but with much less expense for the plant and its maintenance.

First Messages by Telegraph.

The Western Union Telegraph Company is searching for the first telegram that went over a wire. It is believed that Maj. Stephen Johnston of Piqua, has it, but he has not been able to find it among his papers.

In 1844, when Morse was experimenting in Washington with a wire that extended to Annapolis, he was visited by Maj. Johnston, who was among the delegates arriving in town on their way to the Whig convention in Baltimore. The experiments were incomplete, and in the course of the explanation Morse said that he had sent to Annapolis a friend who would try to send a message in the characters that he had arranged and gave the slip to Johnston, who considering it the completest sentence ever sent by telegraph, carefully preserved it. The message expressed the pleasure of the sender in reaching the inventor by wire.

In the most trustworthy description of the development of the telegraph, it is related that among the earliest messages, while the line was in its experimental state, was one from Baltimore on May 1, 1844, announcing the nomination of Henry Clay to the Presidency by the Whig convention. On May 11 Morse sent to his assistant, Albert Vail, in Baltimore, "Everything working well," and that became historical.

The most impressive of the first messages was that sent at the public exhibition in the chamber of the United States Supreme Court in the capitol, on May 24, 1844, to which Morse had invited his friends. Miss Annie G. Ellsworth, a daughter of the commissioner of pensions, who had announced to Morse the passage of the bill granting the appropriation to build the line, selected this message from Numbers xxiii: 23: "What hath God wrought?" It was received by Vail in Baltimore and sent back. The strip of paper on which the Morse characters were printed was claimed by Gov. Seymour, of Connecticut, because Miss Ellsworth was a native of Hartford, and is now in the archives of the Hartford Athenæum.—*Chicago Journal of Commerce.*

USEFUL INFORMATION.

Cause of Thunder.

Many theories have been offered in explanation of the phenomenon of thunder. Here is Prof. Hirn's description: "The sound which is known as thunder is due simply to the fact that the air traversed by an electric spark, that is, a flash of lightning, is suddenly raised to a very high temperature and has its volume, moreover, considerably increased. The column of gas thus suddenly heated and exhausted is sometimes several miles long, and as the duration of the flash is not over the millionth of a second, it follows that the noise bursts forth at once from the whole column, though for an observer at any one place, it commences where the lightning flash is at the least distance. In precise terms the beginning of the thunder clap gives the minimum distance of the lightning, and the duration of the rolling of the thunder the length of the column of heated air. Professor Hirn also remarks that when a flash of lightning strikes the ground, it is not necessarily from the place struck that the first noise is heard. Again, he points out that a bullet whistles in traversing the air, so that we can, to a certain extent follow its flight. The same thing also happens with a falling meteorite just before striking the earth. The noise actually heard has been compared to the sound produced when one tears linen; it is due, really, to the fact that the air rapidly pushed on one side of the projectile in front, whether bullet or meteorite, quickly rushes back to fill the gap left in the rear."—*American Meteorological Journal.*

Fecundity of Sea-Fish.

Doctor Wemyss Fulton contributes a paper on this subject to the "Annual Report of the Fishery Board for Scotland" of 1890, wherein he states that the fecundity of over a hundred specimens of fish, comprising thirty-nine species, has been determined. The degree of fertility varies to an extraordinary extent among certain fishes, and according to the sizes of the individual. The ling produces a greater number of eggs than any other fish—twenty to thirty millions being an ordinary average among medium-sized and large specimens. On the other hand, the pipe-fish brings forth each season only a few hundreds, the eggs being taken charge of by the male, which carries them about in a compartment situated on its under surface. The cod produces from two or three to seven or eight millions of eggs; the haddock from two or three hundred thousand to nearly a million; the saithe from four or five to seven or eight millions; the torsk, or tusk, from about one to two or three millions. In the herring the number ranges from about twenty to about fifty thousand, the average for sixteen specimens examined being over thirty thousand, showing a considerably greater fecundity than has been generally supposed. Among flat-fish the most fertile is the turbot, with from three or four to nine or ten million eggs, and the least so, the long, rough dab, which produces from about thirty to sixty thousand. In proportion to its size, the flounder produces more eggs than any other fish, the number ranging from over five hundred thousand to about one and a-half million eggs. The common, or English sole, is also very fertile.

Facts About Our Railroads.

To gather the statistics from the corporations which operate the American railways is not a simple work of a day or so, but takes time. It is only just now that we know, from the government reports, what the railway business amounted to for the year ending June 30, 1890. The mileage at that time was 163,597, an increase during the year of 5838 miles. This increase, it is of interest to note, was greatest in that group of States formed by Kentucky, Tennessee, Mississippi, Alabama, Georgia, and Florida, where were built during the year 1370 miles, or 23 per cent. of the whole increase. In the State of Georgia the increase was 438 miles, and this was more than in any other State in the Union.

These roads are owned and operated by 1797 companies, but about one-half of the mileage is operated by forty companies. The gross revenue of these roads for the year mentioned was $1,051,877,632, but 80 per cent. of this revenue was divided among seventy-five roads. Large roads must do cheaper work than smaller ones, as these seventy-five roads carried 83½ per cent. of the passengers, and 85¼ per cent. of the freight. To operate the railways required the services of 749,301 men. This was an increase of 44,558 men over the previous year, and added an average of twenty men to the operating force on every 100 miles of road in the country.

In arriving at the capitalization of these great properties accurate statistics have been obtained on only 156,404 miles. The capitalization for this mileage is $9,437,333,372, or $60,340 per mile. At the same rate the capitalization of all the mileage would bring the total up to about ten thousand millions. This is certainly a great amount of money; but dividends were not paid during the year on 63·76 per cent. of the capital stock. The surplus from operating these roads was $12,070,383, a decrease of $7,387,155 from that of the year before. The passengers carried were 492,430,865, an increase of 20,250,322 and the average journey of each passenger was 24·06.—*Harper's Weekly.*

Financial Training for Children.

In this, as in all other respects, a child's individuality must be considered. One child requires a different training from another; but generally speaking there are only two wrong natural tendencies to be overcome by such training. These are the two opposite extremes of thoughtless extravagance and selfish hoarding.

Probably the vast majority of parents have the first difficulty rather than the second to contend with. Children are more apt to be thoughtless about money than to overvalue it. How, avoiding each great error, can they be taught its wise use? The school savings bank idea is helping to check the great waste of pennies and nickels which is constantly going on among the children; but parents have a duty and an important one in this connection. Few grown people seem to realize that right habits of both saving and expenditure do not come by nature but must be acquired, and that to assist a child in forming such habits is the truest kindness both to the present child and to the future man. A vast amount of unhappiness and of positive trouble might be prevented if parents would take careful thought about the training of their children in practical finance. There are questions of morals as well as of expediency concerned in it.

In what way can the thoughtless, extravagant little one be trained to prudence? In the first place do not give spending money irregularly, regulated only by the child's demands. Think over the matter and decide on a fair allowance, even if the plan is more trouble than to give according to the impulse of the moment. The amount once settled and stated to the child, on no account exceed it. Thus he may know what to expect and get out of the way of letting the pennies slip and continually teasing for more.

Require an account kept of his expenditures, and look it over each week before giving the next installment of the allowance. Here is an opportunity to give suggestions, but avoid severe criticism. A child will necessarily make some foolish purchases. Counsel rather than carp.

Arrange if possible for a larger allowance as the child grows older, with the understanding that certain personal expenses shall be met from it. These will vary with the age and ability of the boy or girl. One might be required to provide handkerchiefs, ribbons and gloves, another shoes and stockings or school supplies, books, pencils, papers, etc. Most young people would enjoy this responsibility; and the practical understanding of the value and purchasing power of money that comes of such training can scarcely be overestimated. Some instruction will be needed at first with regard to the quality of goods and the fair market price; but young heads are quick to learn. And they see, as they never would otherwise, the necessity of caring for their clothes when they buy them from their own private purse.

Teach the boy to weigh one purchase against another that he may learn to judge of relative importance. Show him that his candy and peanuts for the month would buy the fish-line or ball he wanted; both are merely for pleasure, but good things to eat last only a moment and are worth least of all pleasures. Weigh the expenditures for games with that for books, lectures, and scientific pursuits and show that instruction and amusement are worth more than amusement alone. Make him understand that a dollar may buy one of a dozen different dollars worth, but only one. To select one, excludes all the rest.

We are responsible for what we do not as well as for what we do buy. A good place to enforce this is in connection with the church and charity-giving. If such items are small, it is because others are too large.

Such training as this presupposes thought and time devoted to the matter; and thought and time are the very things parents are least willing to give their children. Yet to rear them to wise and noble man and womanhood, if they would but realize the mighty fact, not money nor luxuries nor even parental fondness is worth a thousandth part as much.

With regard to the selfish, stingy child, the same plan of an allowance, accounts and their inspection should be pursued, but with the different end in view of fostering liberality. Strive to make the child forget his mere personal wants, and draw out his sympathies for those around him and for all noble objects. Show him in conversation, and perhaps in extreme cases by a severe object lesson, how the close selfish theory of life would work toward him were it put in practice in the home. Be what you would have the child become. Surrounded by wide and noble sympathies it is scarcely possible for a child to grow up narrow and selfish.—*Amelia H. Botsford, in Christian Union.*

Scientific Advancement

Mortar Batteries and Long Range Rifles for the Defence of New York.

In addition to the modernizing of the existing forts in New York Harbor a new element of defence will be introduced in the shape of mortar batteries. As is well known, the mortar, or "bombard," was one of the earliest forms of cannon, and dates almost as far back as gunpowder itself. Not only so, but very large mortars were cast, and as long ago as 1857 a mortar was made in England carrying a shell 36 inches in diameter, and weighing with its bursting-charge, 3,000 pounds. A little later Armstrong introduced the *rifled* mortar, which has recently come so prominently into notice on account of its great range and accuracy.

The method of using mortars in sea-coast defence is to mount a large number of them in deep pits where they will be safe from direct fire, and after having obtained with one mortar the range of one or more of the enemy's ships, to fire a volley from the entire battery with the same charge and in the same direction so as to cover several thousand square yards of space, and thus multiply the chances of sinking the ships. This is something on the shot-gun principle, but as the shells weigh over 600 pounds, and fall from a height of from 1000 to 4000 yards, the penetrating effect is very great. As the decks of the heaviest iron clads are only about 4½ inches thick, and have an area of nearly *half an acre* each, the probability of sinking as well as striking a ship with a battery of mortars is excellent, while the mortars themselves and the gunners who serve them are comparatively safe. This is *not* magnificent, but it *is* war.

It is proposed to have mortar batteries so located as to command not only the channels of approach to our harbors, but also the positions likely to be occupied by an enemy's fleet in bombarding our forts or cities.

Another important element of offensive power to be added to our forts is the modern high-power rifle of from 8 to 12 inches calibre, and perhaps larger, these guns being very long, and using slow-burning powder, so as to give a very high initial velocity and a correspondingly long range, without overstraining the gun itself. Some idea of the enormous increase in range obtained with modern guns may be had from the "jubilee shot," so called, because it was fired in July, 1887, at Shoeburyness, during the Queen's Jubilee. This shot was fired from a 9·2-inch rifle, and attained a range of 21,800 yards, or more than 12 miles, and at its highest point was over 4 miles above the earth. This is the longest range on record, and would, of course, be of no practical use except in bombarding a city or some other extensive target. The chances of hitting a ship or a fort at that distance would be very slim; but it is desirable to have at least a few long-range guns to prevent a ship which carries such guns from taking up a position beyond reach of our guns and annoying us from a safe distance. It is to be noted that with guns of equal power a fort would have the advantage of a ship in both range and accuracy of fire. The range would be greater, because guns on ships are seldom so mounted as to allow firing at high angles of elevation, while the accuracy of fire would be greater on account of the more stable platform in the fort. The rolling motion of a ship has been known to cause such inaccuracy of fire that a broadside at close range would do no damage whatever to the enemy, the shot passing harmlessly over, or into the water beneath him.

One of the greatest dangers heretofore has been that an enemy in swift armor-clad ships would disregard the forts, and rush past them into our harbors. But this is now provided against by the use of fixed torpedoes, whose mission it is to hold the enemy in check until the guns or movable torpedoes can get in their work. The torpedoes must be planted, if possible, under the guns of the forts, so that their removal by the enemy would require him to come within the effective range of our batteries. The exact location of the torpedoes would, of course, be unknown to the enemy, and the mere suspicion of their existence would inspire due caution on his part. It is pretty well settled by the best naval as well as military authorities that no commander of a ship or fleet would be justified in disregarding a torpedo-blockade, or in attempting to remove such obstructions as long as their shore connections are held by the defence.—*Harper's Weekly.*

Electricity's Rival.

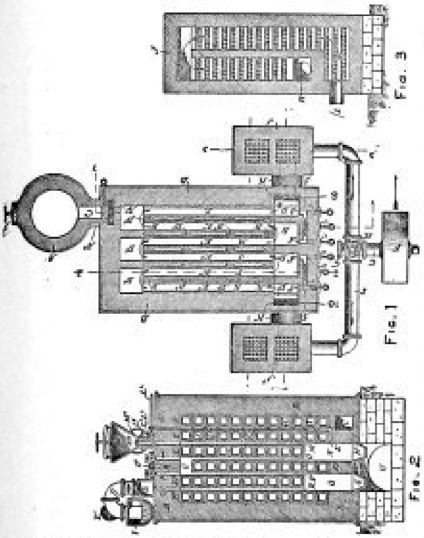
Progress in the development of electricity has been so rapid during the last few years that the public has come to regard it as the motive power of the future, but it appears that electricity is to have a rival in the shape of compressed air. Robert Gillham, an engineer of New York, has recently returned from an extended sojourn in Paris, where he made a thorough study of the compressed air system of the metropolis. The new dynamic agent according to his report, has within an almost incredibly short time fairly revolutionized many lines of industry at the gay French capital. It is at this time propelling surface cars with unequalled ease, furnishing motive power for elevators, and a multiplicity of uses, manufacturing ice and preserving meats of all kind. The air is compressed at a large central station and conducted through mains in the streets to all parts of the city, as are water and gas.

The method of using the compressed air in engines as described by the engineer, is interesting. The air is admitted from the main through a pressure reducing valve by means of which the pressure can be adjusted to any number of atmospheres desired. From the reduction valve the air is conducted to a small coke radiating device in the shape of a hollow cylinder having vertical divisions where the air is heated. The coke is burned in the central space and the air passes up and down the other vertical divisions in succession until it has reached a high temperature. The air is then conducted to the engine, where it operates exactly as steam. Once in the engine it is made to do all sorts of labor, not the least of which is the generation of electricty for lighting and other purposes.

One fact of importance noted by Mr. Gillham on his visit was the preparation Paris engineers are making by means of compressed air with a view to averting the terrors of another siege such as was experienced in 1871. Refrigerator stations can in an emergency to be made to contain enough food to last Paris for over a year. Mr. Gillham thinks that both the smoke and steam nuisances will be obliterated by the encroachment of the compressed air system in every line of dynamic application.—*Chicago Journal of Commerce.*

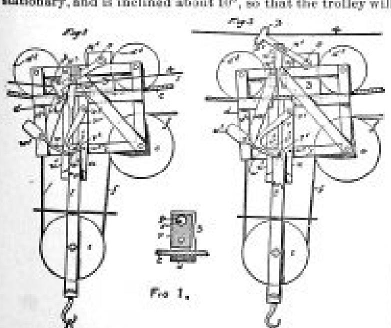
GAS APPARATUS.

No. 463,139. JOSEPH H. COLLINS AND ISAAC N. KNAPP, PHILADELPHIA, PENNA. *Patented Nov. 17, 1891.* This apparatus is designed to make gas for metallurgical purposes from powdered carbonaceous material. A horizontal section near the middle of the height is shown in Fig. 1. Fig. 2 is a vertical cross section near the middle, and Fig. 3 is a vertical section of the regenerator J along the line 3, 3. Ordinary producer gas is supplied by the producer A, through the flue C, Fig. 2, which runs to the front end of the furnace B. Here the gas rises through a vertical flue 8, and runs horizontally along the flues E to the chamber D^4, and back toward the front again, as shown by the arrows—until it finally escapes from the chamber D^3, through the pipe K to the regenerator J^1. To burn this gas, air is let in through the front by the stoppers d, d^1, d^2 d^3 as required to maintain uniform combustion in all the flues. The air comes in by the vertical flues shown in the front in Fig. 1, and through the regenerator J, which heats it to a high temperature. The course of the air is shown in Fig. 3, by the arrows. The flues E are made of hollow square tiles as shown in Fig. 2, which are laid so as to leave narrow vertical spaces or retorts L, M, O, P, R, extending from top to bottom of the furnace. Powdered coal or other fuel is fed from the hopper M^1 into the top of the space or retort M, and as it works downward it becomes highly heated, the gas is liberated and the remainder reaches the chamber N in a state of incandescence. At L^1 it is met by a current of steam blown in from the pipe L^2 down through the space or retort L, which highly superheats it. The steam is decomposed by the glowing fuel at N, and water gas composed of carbon monoxide and hydrogen is rapidly formed and mixed with the coal gas liberated in the retort M. The mixed gases pass upwards through retort O to the chamber C^1, where oil is injected by the pipe O^1. The oil is quickly gasified by the intense heat, and mingles with the other gases, which pass down the retort P to the chamber Q, where they drop any dust carried over from chamber N, into the dust-pan Q^1. In passing through the retorts P and R the gases are practically united and fixed, and they pass out of the furnace by the siphons S^1 and hydraulic main T. The exhausting fan F serves to draw the products of combustion of the firing gas through the regenerator J^1 while the fresh air is drawn in through J. As soon as J^1 is thoroughly heated and J is cooled as far as allowable, the four way valve H is reversed and the air and gas currents are reversed. Another valve not shown changes the current of firing gas from the producer A from the flue 8 to flue 10, and reverses the path of the flame in the flues E. The gas made by this process is without nitrogen and possesses great heating power.



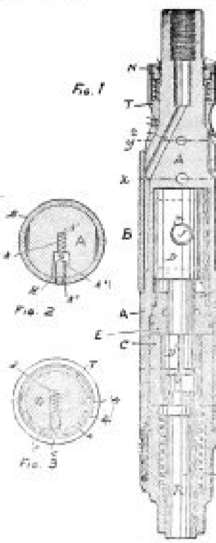
TROLLEY FOR AERIAL ROPEWAY.

No. 466,279. CHARLES M. NORTH, MONTCLAIR, N. J. *Patented Dec. 29, 1891.* In this ropeway the main cable is stationary, and is inclined about 10°, so that the trolley will run one way by gravity. The trolley is hauled back by the fall rope f, and it is locked in any position by gripping the cable. This is done by a hand line 4 which extends from tower to tower over the main cable. When the line is slack as in Fig. 2, the arm s^1 lays down, but when it is tightened as in Fig. 3, the arm is raised. The shaft v has an eccentric inside the box 3, as shown in Fig. 1, and as it is turned it moves the block r downward and grips the cable between r and s. When the line is slackened the weight of the arm opens the grip. The block i is locked to the trolley by raising it nearly to the top of its lift, so that the pin t^1 shoves the curved end r^2 of the hook r aside and passes above it. The hook drops back by gravity and catches the pin as the fall rope is eased off. By hauling in or paying out the fall rope the trolley may be moved along the cable, as desired. To unhook the block the trolley is gripped to the cable, and the fall rope hauled in. As the block rises the pin t^1 strikes the body of the hook and crowds it back so far that the catch w catches the notch on its lower end and holds it out of the way of the pin. As the block lowers the pin t^1 trips the catch w, as shown in Fig. 3, and lets the hook drop back into place for future operations.



PNEUMATIC TOOL.

No. 461,706. FRANK H. MARSH, NEWARK, N. J. *Patented Oct. 20, 1891.* This tool is designed to strike with great rapidity on the head of a rod R to which a chisel or other tool is attached. The blows are comparatively light, but their great number per minute make them very effective. The piston D is propelled by compressed air which enters by the duct 2, and escapes by the duct 3. The necessary ports are formed by grooves in the outside of the cylinder A, which are covered by the sleeve B. This sleeve is forced on tightly and pinned in place. A small piston valve J moves crossways of the piston D in a seat drilled through the piston, and admits air alternately to the top and lower ends of the cylinder, and also exhausts the spent air into duct 3. The top end of the cylinder is made conical as shown, and is covered by a cap or throttle T. This is provided with several holes 4, of varying size. By turning this cap the duct 3 can be throttled to any desired extent to regulate the rapidity of the strokes, or closed, to stop. The lower head of the cylinder E has a projecting collar 5 which enters the cupped end of the piston D and cushions the blow on the entrapped air, when for any reason the rod R does not come up far enough to receive the blow, the striking head D^1 is renewable. Fig. 2 is a a cross section at the line x, and Fig. 3 is a cross section on the line y, showing the graduated exhaust openings 4, and the spring pin used to hold the cap in place when adjusted.



HYDRAULIC VARIABLE SPEED GEAR.

No. 466,661. LOUIS DUNCAN, BALTIMORE, MD. *Patented January 5, 1892.* In this device a rotary pump is driven by any suitable power, and the liquid discharged by it, preferably oil, is driven through a rotary motor or pump which is attached to the shaft to be driven. To vary the speed of this shaft, the motor is so constructed that the eccentricity of the hub, or of the casing, can be varied at will, thus varying the effective radius of the paddles, and the quantity of liquid used. In Fig. 2, the pump is shown mounted on a loose sleeve B on the driven shaft C^1, and is driven by power applied to the wheel A. D is the casing and G G are the paddles. The motor is of similar general construction, having a fixed casing F, paddles G^1, and a central hub H^1 having a center hole much larger than the shaft. The central hub has a tubular neck H^2 which is encircled by a collar N. A screw L^1 is operated by a crank or wheel on its top end, and serves to move the collar and the center H^1 from the position shown in Fig. 3, to that shown in Fig. 4, thus giving the paddles on the top side of the shaft greater leverage than those on the lower side, and requiring more liquid to fill the spaces between them. As the supply forced in by the pump is steady, the motor runs slower, but with proportionally greater force, thus adapting itself to the heavy strains of stopping and starting cars and other machinery. The ports P, P^1 of the motor are directly connected to the ports of the pump, forming a closed liquid circuit. The pump may be situated anywhere, at any distance from the motor, and the ports may be connected by suitable pipes. A yielding connection is made between the hub H^1 and the shaft C^1, by four springs k, as shown, which allows H^1 to be shifted without losing its hold on the shaft.

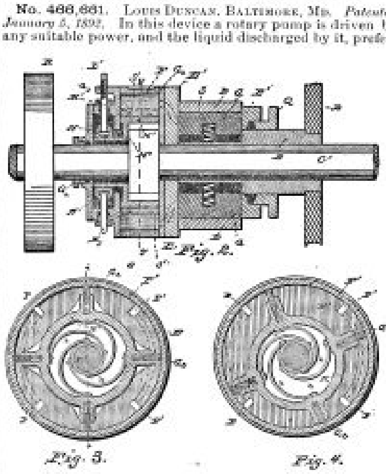
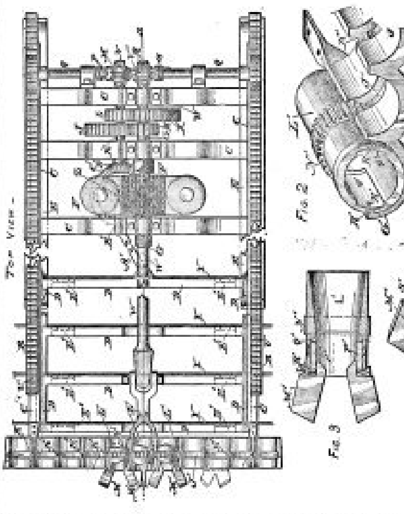


Fig. 3. Fig. 4.

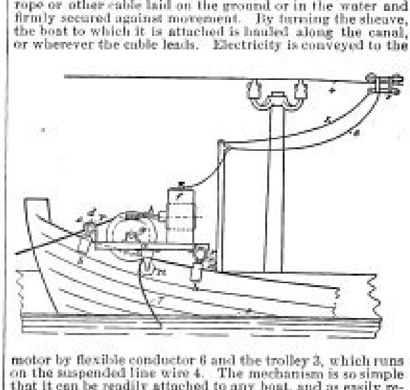
MINING MACHINE.

No. 465,197. JAMES PASSMORE AND PETER A. ARP, PHILIPSBURG, PENNA. *Patented Dec. 15, 1891.* The cutter blades M^1 are each provided with a shank P^8 shaped to fit in a socket Q^8 in the front end of the sleeve L^2. A series of these cutter sleeves are supported in a long cross-head at the front of the machine. The cross head is made in halves, and clamped together the top half being readily removable. Each sleeve has a thrust collar on its front end, and a cog wheel N^1 in the middle. The sleeves lay so close together that the cog wheels mesh and turn each other. The middle sleeve is turned by the shaft W which is below the motor shown, and is connected to it by gears X and L. The cross-head is attached to two racks U which slide in ways on the main frame and serve as guides. The cutters are fed up to their work by pinions on the shaft Q at the rear of the machine. This shaft is driven by clutches P and S, which are moved by a hand lever (not shown), and which engage the worm wheels N and R which turn loosely on the shaft. These worm wheels are driven in opposite directions by worms M and V on the shafts K and W. Four scrapers Y are employed to remove the chips. They are flat plates hinged at E^1 to a sliding frame D, in such a way that they can swing upward to pass over the dirt in moving forward, but stand vertically while moving backward. The frame D is reciprocated by a pitman A^1 and crank B^1 on the lower end of the vertical shaft Z, which is rotated by the bevel gears C^1 D^1 as shown.



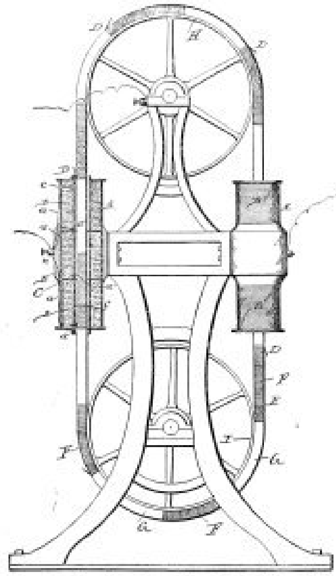
TOWING BOATS BY ELECTRICITY.

No. 464,955. OTTO BUSSE, ODERBERG, GERMANY. *Patented Dec. 15, 1891.* An electric motor f, drives a worm wheel g, and a sheave wheel h. This sheave engages a wire rope or other cable laid on the ground or in the water and firmly secured against movement. By turning the sheave, the boat to which it is attached is hauled along the canal, or wherever the cable leads. Electricity is conveyed to the motor by flexible conductor 6 and the trolley 3, which runs on the suspended line wire 4. The mechanism is so simple that it can be readily attached to any boat, and as easily removed therefrom. A similar apparatus could be fixed to a common dirt car or even a road wagon, and be used for haulage on common roads, for quarries and similar uses, with great advantage.



ELECTRIC MOTOR.

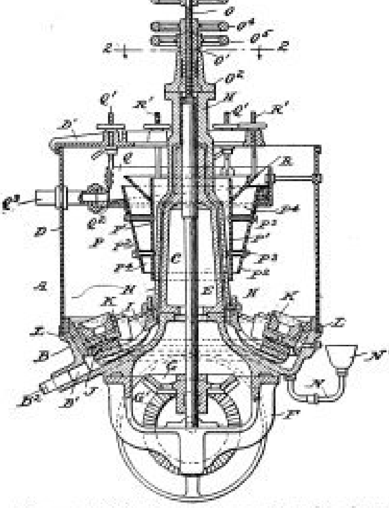
No. 464,063. MARTIN H. COLLOM, DENVER, COLORADO. *Patented December 1, 1891.* This motor consists of a pair of solenoids or open coils A fixed to the sides of the frame shown, and an endless core composed of alternate magnetic and non-magnetic portions. The endless core runs over sheaves I and H. Sheave H is electrically connected to one pole of the battery or dynamo, and the other is connected to the driving solenoids A. The magnetic sections F are electrically connected together by conductors in the non-magnetic sections G. Brushes D project from



the front end of each section F, which rub against contact strips *a* on the inside of the solenoids, and complete the circuit. As a magnetic section F touches the end of the solenoid and establishes a current in it, a powerful attraction is instantly exerted by the solenoid to draw F to the center of the coil. Before it arrives at that point the current is interrupted, and the opposite solenoid is excited and continues the motion of the core until another magnetic section arrives at the first solenoid and excites it. Any number of solenoids may be employed to increase the power of the motor.

GRINDING AND AMALGAMATING MILL.

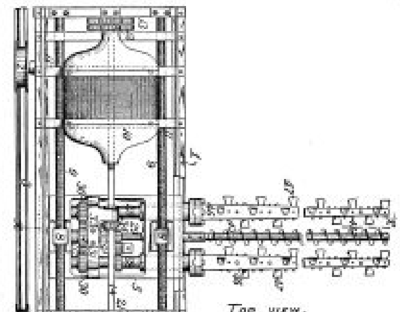
No. 461,162. GEORGE FRASER, AUCKLAND, NEW ZEALAND. *Patented December 29, 1891.* The pan B is stationary, and is provided with a ring die L. The muller H is turned by the shaft E, and carries a spider I at its lower end, which supports a ring J. A series of conical rollers K lay on top of the ring J, with their peripheries against the ring die L. When the spider revolves, the rollers are crowded by centrifugal force against the die L, and they rub against each other, thus thoroughly grinding the crushed ore in the tub D to pulp. Mercury is introduced by the pipe N and cup N^1, which is set above the bottom of the pan. The amalgam is drawn off by the outlet B^1 and the plug B^2. The tailings pass up between the circular shells P^1 and P^2



which are attached to the overflow pan P^4, and to the top by suitable bolts. The inner shell is straight and is fitted with a movable collar R which can be adjusted by the hand wheels R^1 to control the outflow of water and tailings which pass away by the spout Q^1. These two shells serve to protect the tailings at the point of overflow from the whirling water and commotion in the tub, thus giving them a chance to separate by gravity. A muller of five feet diameter grinds from 500 to 800 lbs. per hour, at about 70 revolutions per minute, of stuff passing a half-inch sieve. The machine dispenses with the use of gratings or screens, copper-plate tables, riffles, blanks, and berdans. The machine further reduces the loss of quicksilver to a minimum, and also permits of reducing low-grade ore at a profit.

MINING MACHINE.

No. 465,150. JOHN C. WERNER, BALDWIN, PENNA. *Patented Dec. 15, 1891.* Two cutter bars 46, are employed in this machine, with a worm or conveyor 43 between them to carry away the chips. The cutter bars are bolted by flanged joints to the ends of the shafts 28, each of which has a pinion 30 meshing with wheel 32. This wheel is driven by the pinion 31 above it and the bevel gears 33 and 34. Motion is given to 34 by a square shaft 14 which is driven by gearing at the motor end of the machine from the motor 10, as shown. The cutter spindles 28 and their attachments are



TOP VIEW.

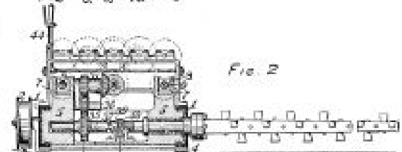


FIG. 2

mounted on a carriage 5, which slides on ways on the main frame 1. The carriage is fed either way by the screws 9 and nuts 8. The screws are turned by the gearing shown at the right hand end of the machine in the top view and by dotted lines in Fig. 2. Friction clutches 16 and 18 are employed to change the speed of the screws. 16 is attached to small pinion 22, and 18 carries a larger pinion 21. Another clutch 37, Fig. 2, is employed to disconnect the driving gears on the carriage from the cutter spindles. The front side of the machine slides on a shoe bar 4, and the rear is supported by truck wheels 2, designed to run on a rail 3.

HOISTING DRUM.

No. 466,158. WILLIAM C. DAVIS, DENVER, COLO. *Patented Dec. 29, 1891.* The friction disc 4 is driven by the bevel gearing shown in Fig. 1. The drum carries a ring X, having a V-edge adapted to the groove in the friction disc. The drum is pressed endways against the friction disc by a screw 2, which is turned by the arm O, which is attached by the link Z to the hand lever y. The brake employed is the well known "differential" brake, consisting of the strap F which is fastened at one end to the long arm A of a lever, and at the other end to the short end C, of the same lever. As the lever moves one end of the strap is slacked off and the other end is drawn up, and the strap is tightened by an amount equal to the difference between the movement of the pins at A and C. When the drum moves with the arrow K for

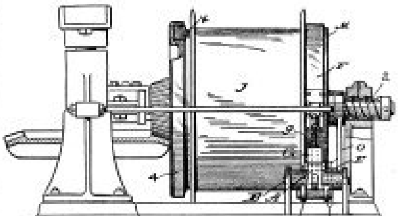
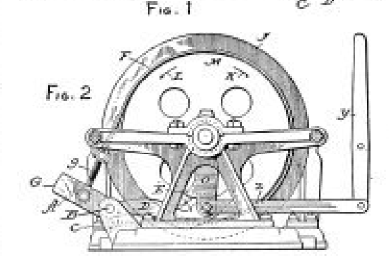


FIG. 1

FIG. 2



hoisting the brake lets go automatically, because the arm A slacks off the strap faster than arm C takes it up. When the drum moves with the arrow L, for lowering, the brake tightens itself. To prevent the closing of the brake when not desired, the bent arm D is added to the brake lever A C. When the lever O is moved to the left the drum is forced against the friction disc for hoisting, and the brake is free to slacken itself, and when O is in middle position, as shown in the end view, the drum is released and the brake is free to catch it and hold the load. But when it is moved to the right it depresses the arm D of the brake lever, and slacks the brake suitably for lowering.

TRAVELING GRATE.

No. 465,295. ROBERT J. SHOEMAKER, PHILADELPHIA, PA. *Patented Dec. 15, 1891.* This grate is composed of a series of grate bars 9, of any ordinary construction, which are provided at each end with jaws 12, Fig. 2, on one side, and lugs 13 on the other, which are adapted to pass between the jaws 12 of the next bar. Bolts 14 are used to connect the sections together. The ends of each bar are shaped as at 10, to suit the teeth of the sprocket wheels 7, one of which is located at each end of the fire-box. The fire-box is constructed with flanges or ribs A which project

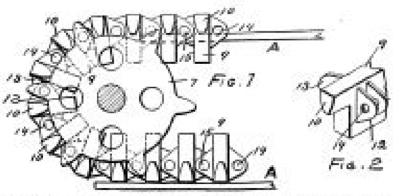
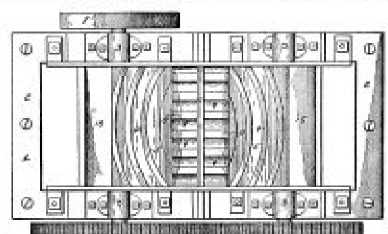


FIG. 1 FIG. 2

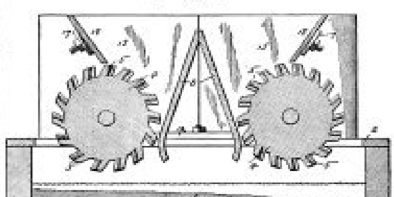
under the ends of the grate bars and support them when moving. the grate may be inclined to any desired angle, and the bars may be designed to suit any variety of fuel. The sprocket-wheels may be driven by power for continuous firing, or they may be moved by hand for occasional removal of the ashes.

COAL BREAKER.

No. 466,185. PHILIP RICHARDS, PLYMOUTH, PENNA. *Patented Dec. 29, 1891.* The novelties in this breaker, are the inclined crushing plates 8 between the rolls, and the curved ribs or teeth 5 on the body of the rolls. The plates 8 are made with deep V grooves 9 running vertically on their faces, and the ribs on the rolls are curved in such a manner



TOP VIEW.



CROSS SECTION

that the coal is crowded toward the middle of the rolls and away from the side housings. The groves 9 serve to guide the coal past the rolls. Thus each roll is independent of its mate and crushes the coal against the plate 8, instead of the teeth of the opposite roll, as in the common type of breaker.

The Weather at Girardville, Schuylkill Co., Pa.

From the records of Mr. E. C. Wagner, of Girardville, Pa., Superintendent of the Girard Water Co., and voluntary observer United States Signal Service, it appears that the chief features of the climate at that point, in 1891, was as follows:

Highest reading of Barometer, December 31st	30·531 inches.
Lowest reading of Barometer, January 23d	29·429 inches.
Highest reading of Thermometer, June 15th and 16th	92°.
Lowest reading of Thermometer, March 2d	7°.
Range of Thermometer during the year	85°.
Total snow fall for the year	42·75 inches.
Total precipitation for the year	62·44 inches.
Average monthly precipitation	5·203 inches.
Greatest monthly precipitation, July	9·64 inches.
Least monthly precipitation, May	1·80 inches.
Greatest daily rainfall August 23d	3·50 inches.
Precipitation 1887	48·73 inches.
Precipitation 1888	62·62 inches.
Precipitation 1889	70·27 inches.
Precipitation 1890	64·65 inches.
Precipitation 1891	62·44 inches.

PERSONALS

MR. JOHN FULTON has resigned from the arduous duties of General Manager of the Cambria Iron Co., and has been succeeded by Mr Chas. S. Price. Mr. Fulton has been reappointed to his former position of General Mining Engineer of the company. In his resumption of his old position he will be relieved of a great many duties that have been particularly arduous, since the great flood of May, 1889. He went through all the horrors of the disaster and keenly felt the loss of townsmen, acquaintances, and intimate friends, and in addition witnessed the destruction wrought in the magnificent plant of which he was the directing head. He has ably filled the position in which he was placed, and under his direction the restored plant of the Cambria Iron Co. has been made more perfect than ever, and he no doubt will enjoy the relief that will come to him in resuming his old and less laborious office.

The Colliery Engineer.

AN ILLUSTRATED JOURNAL OF

Coal and Metal Mining and Kindred Interests.

VOL. XII.—NO. 9. SCRANTON, PA., APRIL, 1892. WITH WHICH IS COMBINED THE MINING HERALD

THE ECONOMIC GEOLOGY OF ZINC.

The Mineralogy, Mode of Occurrence, and Production of Zinc.

BY H. A. WHEELER, E. M., OF ST. LOUIS.

The number of minerals that contain zinc is not large, and there are only three which are found in sufficient quantities as to be of importance as ores, except at a peculiar local occurrence in Northern New Jersey. These three common ores of zinc are the sulphide, carbonate, and hydrous silicate, and the two latter are due to the alteration by the atmospheric agencies of the sulphide, and hence change into it as depth or the permanent water-level is attained. They have the following characteristics:

Sphalerite, or *Zinc Blende*, is a sulphide of zinc containing about 67% of zinc when pure, and has a non-metallic luster, a yellow to brownish streak, is rather soft, and only moderately heavy (specific gravity is 4·0). It varies in color from white to yellow, red, brown, and black, and is known by the miners under the names of "rosin-jack," "ruby-jack," and "black-jack," according to the color. It is the principal ore of zinc from which by far the larger portion of the world's production of "spelter" is obtained, the latter name being the one under which zinc is sold in the metal market.

Smithsonite, or "dry bone," or "white-jack," is a carbonate of zinc containing about 52% of zinc, when pure; it has a non-metallic luster, usually a yellow to brown color, is quite hard and rather heavy (specific gravity is 4·2). It is generally earthy or massive, usually lacks any decided individuality, and is nearly always stained yellow or brown by iron, though white or colorless when pure.

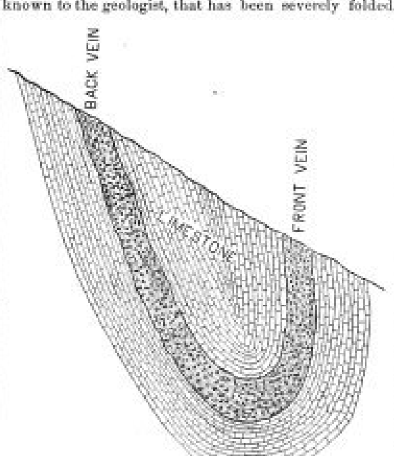
Calamine, or "silicate," is a hydrous silicate of zinc that contains about 54%, when pure; it has a vitreous or glass-like luster, is usually white or brown-colored, rather hard, and moderately heavy (specific gravity is 3·5). It nearly always occurs in crystalline, radiating masses or as small thin-bladed crystals.

In Sussex County, in Northern New Jersey, there occurs, in the vicinity of Franklin Furnace, a peculiar group of zinc minerals that have never been found elsewhere in workable quantities. They occur intimately associated together, are remarkable for their purity, and have thus far proved to be very persistent and reliable in their occurrence. These zinc ores are:

Zincite, or oxide of zinc, containing 80% of zinc, when pure; it has a red color, an orange colored streak, is quite hard, heavy (specific gravity 5·0), and has a non-metallic luster.

Willemite is an anhydrous silicate of zinc containing 58% of the metal; it has a brown to greenish color, a non-metallic luster, is hard, quite heavy (specific gravity 4·0), and generally occurs in granules.

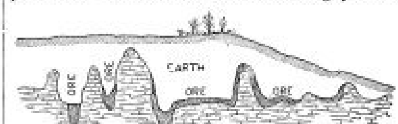
Franklinite is a black mineral with a metallic luster that is very hard, heavy (specific gravity 5·0), and usually occurs in granular masses. It consists of a variable mixture of oxides of iron, manganese, and zinc, and contains from 8 to 20% of metallic zinc. It is too low grade to be used by itself for making spelter, but is quite largely used for making oxide of zinc or "zinc white" that is so extensively used as a paint. These last three zinc minerals are not only unique in their composition and association, but their mode of occurrence is equally as interesting. They are found more or less intermixed in a highly disturbed belt of white crystalline or metamorphosed limestone that is of Archæn age, or amongst the very oldest rocks known to the geologist, that has been severely folded.



SKETCH A.—CROSS-SECTION OF THE STIRLING-HILL VEIN.

This folding has been so sharp as to cause the vein that carries the zinc minerals to double on itself and to again crop out close to and nearly parallel with the original outcrop. This doubling of the vein on itself was not at first suspected by the miners, though predicted by Dr. Cook, the geologist, and they were worked as two independent veins, known respectively as the "front" and "back" veins, each having a different pitch and somewhat different strike; when the workings were extended deeper, the two veins were found to be approaching each other, until finally at the South end of Stirling Hill, they united as one simple folded vein, as shown in sketch A. The vein conforms in strike and pitch with the enclosing crystalline limestone, and has been traced for a distance of four miles, though a large gap occurs in the central portion where the vein *seems* to be absent. The vein varies from five to forty feet in width, and while the general tendency is for these three valuable zinc minerals to occur intermixed, there is frequently and at times a quite persistent segregation of the zincite and franklinite into separate distinct sheets or "veins." Prolonged and costly litigation has largely curtailed the working of the several mines located along the vein, so that the deepest is less than 400 feet; but now that the titles have at last been cleared, the output from this small but important district ranges from 50,000 to 60,000 tons of ore a year, which goes to Newark, and Jersey City, New Jersey, and Bethlehem, Pa., to be smelted.

In the Saucon Valley, near the town of Friedensville, Pa. (four miles from Bethlehem), occur deposits of zinc that have become famous on account of the purity of the spelter made therefrom. The zinc occurs as very irregular deposits in a hard, compact, bluish limestone that vary from mere seams to bodies forty feet in thickness, which is now blende, since the water-level has been reached, while in the upper workings the ore was oxidized to the silicate and carbonate. The blende has a very unusual compact structure with a dark-gray to bluish color, and so closely resembles the limestone in which it occurs as to be distinguished from it with difficulty. No other minerals occur with the blende, except iron pyrites, so that an exceptionally pure grade of spelter is obtained on smelting this odd ore. Some of the mines were so wet as to necessitate their partial abandonment, on account of the excessive quantity of water that had to be pumped, and at one of them is located the famous pumping engine "President," long known as the largest pumping engine in this country. This engine was designed to operate three pairs of 30-inch pumps, and one pair of 22-inch pumps, all of ten feet stroke, by means of a steam cylinder 110 inches diameter by 10 feet stroke, making six to seven strokes per minute. This district has not been a large producer



SKETCH B.—SECTION OF THE BERTHA ZINC MINE, VA.

for some time, on account of the trouble with water, and all the ore now goes to Bergenport, N. J., to be smelted.

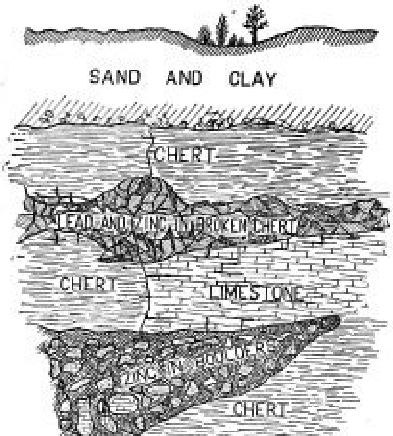
A very interesting deposit of zinc occurs at Bertha, Wythe County, Va., where under a cover of earth that varies from 10 to 100 feet in thickness, an irregular residual deposit of the carbonate and silicate of zinc is found resting on limestone, or flanking pinnacles of limestone that rise well up into the overlying earth, or filling up pockets at the base of the pinnacles and hummocks of the limestone, as shown in sketch B, after McDowell. The ore sheet, or rather accumulation of ore, is usually from one to three feet in thickness, though some of the pockets carry quite large bodies of ore, while in other places the limestone is quite bare of ore. The ore is very free from lead, yielding a high quality of spelter, and it is mined by stripping off the heavy over-burden of earth.

The Bertha mines belong to a series of deposits of zinc and lead-bearing limestones that are said to extend for over 100 miles West of Roanoke in South-Western Virginia, which are oxidized ores or either the carbonate or silicate, as far as they have been worked, but which in depth will undoubtedly run into the sulphide or blende. While this series of deposits have not thus far been extensively worked, except at Bertha and Roanoke, they seem to be quite promising, and probably will become important producers in the future.

The Upper Mississippi Valley lead district contains more or less zinc in association with the lead, and while the zinc was thrown away in the early history of this region by the miners in their search for lead, the zinc has caused the re-opening of old abandoned mines, and infused new life into mines that formerly marketed only the "mineral," as the miners term the galena or lead ore. As this district was described in the article on lead in THE COLLIERY ENGINEER of December, 1891, a description of it will not be repeated here, though it was the joint proximity of coal, and the quite large production of zinc ore by this region that caused the erection of the zinc smelters at Peru, and La Salle, Illinois, of which the latter is by far the largest zinc smelter in this country.

The Central Missouri lead region has also produced some zinc in connection with its lead ores, but no large amounts of zinc have been found, and it has been regarded as a by-product in mining the lead ore. The South-East Missouri lead region, where the galena occurs disseminated in the limestone, does not carry any zinc.

The South-West Missouri lead region was originally opened and formerly exclusively worked for lead, and what zinc (either as "white-jack" or as "rosin-jack") was obtained with the lead, was thrown away on the dump. To-day this same region has become the heaviest zinc-producer in the United States, while the lead is now saved as a by-product in working the mines for the zinc. For, since we have begun to smelt our own zinc-ores and cease to depend on the foreign producers, the price of zinc ore has so risen that it is now more profitable to work them than to seek after the associated galena



SKETCH C.—SECTION OF A JOPLIN ZINC DEPOSIT.

This region may be said to have its center at Joplin, in Jasper County, which is one of the oldest mining camps of the district, and to extend as far West as Cherokee County, Kansas.

The ore is almost exclusively blende, which is usually yellow colored, and is most appropriately called "rosin-jack" by the miners, as it strongly resembles common rosin. Some carbonate (or smithsonite) and silicate (or calamine) has been found near the surface, but except at Granby, in Newton County, Mo., the amount obtained of these oxidized ores has never been large. Variable amounts of galena or sulphide of lead occurs with the zinc, which at times is quite important, especially in the upper part of the ore-bearing stratum, but in most cases the amount is rather too small to be of great commercial importance, though there is always enough to injure the quality of the spelter obtained therefrom, so that it rates as a second quality when compared with the purer ores of the Franklin District, New Jersey, or the Friedensville Mines, of Pennsylvania.

The ore occurs in irregular bodies and caves in a cherty limestone formation of sub-carboniferous age, or just below the coal measures. In the ore-bearing limestone occur "bars" or strata of chert that are usually highly shattered and broken, and the ore is found filling the numerous cracks and fissures in the chert as shown in sketch C. The ore-bearing horizon has not been worked to a greater depth than 200 feet, and most of the mines are very shallow, or less than 100 feet deep. More or less tough yellow to brown residual or "tallow" clay occurs with the zinc, besides iron-pyrites, calc or lime spar, dolomite, and galena. A local custom largely prevails in this district of leasing out the mineral-bearing lands in small lots that are usually 200 feet square, on a royalty of 10% to 25%. A so-called land company will sink a central shaft by which the adjacent territory is drained, and will then lease out the adjoining lots to any miner or prospector who is capable of sinking a small working shaft and can carry on the crudest kind of mining and ore-dressing. The outlay involved on the part of the miner in equipping his lot with a kit of hand-mining tools and a hand-windlass or horse-whip or whim for raising the ore, is so small, that almost no one is debarred from lack of capital, with the result that most of the ore is produced by a large army of small independent leasers. The ore requires concentration before it is salable, as it will only run from 10 to 30% as mined, so that a hand-jigging outfit is the usual accompaniment of the lot leasers, though a few large power or steam concentration mills have been erected by some of the larger companies. The dressed or cleaned ore will run from 50 to 62% in zinc, which is sold on the ground to traveling buyers that are kept constantly in the field by the numerous smelters in Missouri, Kansas, and Illinois, that depend on this district for their ore supply. The price of the dressed ore fluctuates considerably, dependent on the quality and usual market conditions, and first-class ore is liable to fluctuate from $20 to $28 a ton. Recently some sales have been made to English smelters, who in spite of the heavy charges that the ore will have to bear in being shipped to Swansea, still regard it as more profitable to buy than their own lower grade home ores.

Associated with the argentiferous lead-ores of Leadville and Central City, Colorado, are quite large quantities of zinc-blende which generally contain so much iron as to be black or dark-brown in color. The blende does not usually contain sufficient silver to permit being profitably worked as a silver-ore (or from 5 to 15 ounces per ton), while it is too intimately associated with the lead and iron ores to permit the zinc to be profitably extracted in the attempts that have thus far been made to work them. Large quantities of this impure blende is being stocked as tailings by some of the concentrating mills of Leadville, which in time will probably be profitably worked when the local market has enlarged and the cost of working will have been cheapened. Many other of the Rocky Mountain silver-lead mining camps produce similar argentiferous blende, which is too low grade to work for its silver contents by the present processes, and is too far away from cheap facilities for smelting and marketing the zinc to be of value for spelter. Recently a mine having a large body of zinc ore near Socorro, New Mexico, has been able to profitably ship its ore to the La Salle smelter, at La Salle, Ill., and in time this will undoubtedly be followed by others of the numerous scattered zinc producing mines of the Far West when the conditions improve as regards cheaper labor and more reasonable railroad freights.

Some of the silver veins in Maine carry considerable blende which is too low grade in silver to pay as a silver ore, and which is too impure with lead and occurs in insufficient quantity to permit being profitably worked as mere zinc mines, and this same remark can be extended to similar deposits that occur in the Southern States, especially in the Carolinas. Small amounts of zinc ore have been mined and shipped to the New York Bay smelters from Tennessee, but the quantity has thus far been small and the shipments are quite irregular.

Arkansas contains some zinc in the form of blende in association with the sulphides of lead, iron, and copper, in the central part of the state in fissure veins, but the veins have not thus far proved profitable. Close to the Missouri border, in Marion County, occur a very different class of zinc deposits in limestone and chert that are likely to become quite productive when the district enjoys favorable railroad facilities from which it is now debarred. The ore, as blende and carbonate, occurs in flats or sheets so intermixed with the chert as to require concentration, before it can be shipped during the high water season by flat-boats down the White River to the Iron Mountain R. R., and thence to St. Louis for a market. The region is so inaccessible that most of the land is free, and the claims are located according to the U. S. mineral statutes, or in parallelograms 1,500 by 600 feet.

The production of spelter (or metallic zinc) in the United States for the year 1891 is estimated by the *Engineering and Mining Journal* at 76,500 short tons (2,000 lbs.) Of this amount, the Eastern Zinc Works, located at Bertha and Roanoke, Virginia; at Lehigh, Pa.; at Bergenport, Newark, and Jersey City, N. J., furnished about 12,000 tons. The balance came mostly from the South Western Missouri district, which sent its ores to five works adjacent to this region in Kansas that produced about 20,000 tons; to four works in Missouri that produced about 16,000 tons; and to three works in Illinois that are credited with a production of over 28,000 tons, the larger portion of which came from the huge establishment of Mathieson & Hegeler, at La Salle.

In the world's production of zinc the United States is decidedly eclipsed by the enormous output of the mines in Belgium and the adjacent Rhine provinces, which, as a group, stand conspicuously in the lead. Silesia ranks second, and before we were able to supply our own markets, this was one of the most important of the foreign brands in our market, on account of its purity. Our production ranks third, as may be seen from the following figures of the world's production for the year 1890, in gross-tons (of 2,240 lbs.)

WORLD'S PRODUCTION OF ZINC IN 1890, IN GROSS TONS.

	Tons.		Percentage.
Belgium and Rhineland	137,630	or	40%
Silesia	87,175	or	25%
United States	60,020	or	17%
Great Britain	29,145	or	9%
France and Spain	18,240	or	6%
Austria	7,835	or	2%
Poland	5,030	or	1%
Total	343,265	tons, or	100%

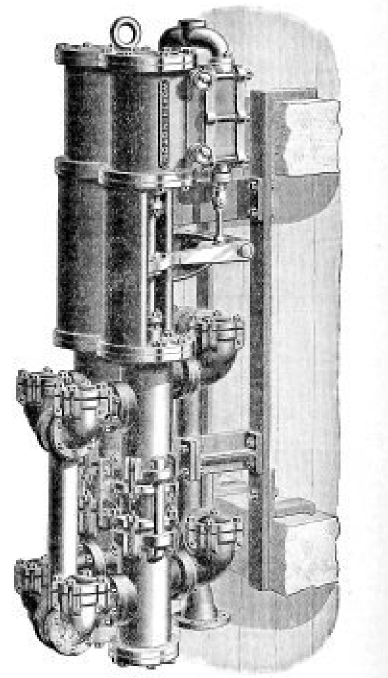
The Worthington Sinking Pump.

Of all the situations in which steam pumps are required to work, none are, in all probability, so exacting as where they are used in sinking mine shafts and recovering flooded mines.

The work is rough, severe, and continuous, calling for great care in the selection of the materials of its construction and a design combining great strength with simplicity and compactness, and what is also very important, employing the least possible amount of shaft space.

The necessity for an efficient steam pump embodying the above requirements which should be positive in operation and quiet in its action, has long been felt, and the sinking pump shown has been designed in order to meet all the conditions mentioned, and possesses some additional features which are new and cannot fail to be appreciated by mine men and others who use pumping machinery of this class.

In the first place, the pump is duplex, and being fitted with the well known Worthington Valve Motion, its operation is positive, therefore, it is always ready to start and when running there is an entire absence of the concussive action which results from the use of



single sinking pumps and often causes serious trouble and annoyance by bursting the column pipe. Being self-contained and working with perfect smoothness, the strain on supports and hanging irons is naturally reduced to a minimum.

The use of the Worthington valve motion obviates any possibility of the pump refusing to start from the action of condensation water in the steam pipe, or from the formation of ice, where compressed air is used. The steam cylinders are fitted with dash relief valves, for regulating the stroke; the two water plungers are double acting, working through exterior stuffing boxes and adjustable packing. Experience having proven that the outside packed plunger is much superior to any other form for sinking work. The water valves are enclosed in heavy pots and are made accessible for examination or repairs by means of swing bolt covers to the valve pots.

The suction opening is at the lower end of the pump, the most convenient place for attaching the suction hose. The discharge connection to the column pipe is on the side; the discharge steam and exhaust pipes are placed inside next the shaft; the valve motion, which is very simple, is also inside next the shaft and is protected by the heavy cradles as shown.

Means are provided for either suspending the machine at the link at the ends of the steam cylinders or of hanging it on suitable timbers on the side of the shaft, by means of hanging irons.

These machines are made in several sizes and are manufactured by Henry R. Worthington, No. 86 and 88 Liberty Street, New York City, and No. 607 Arch Street, Philadelphia, who will be pleased to furnish further particulars on application.

METHOD OF WORKING THE PITTSBURGH SEAM.

A Plan of Working to Economically and Safely Remove all the Coal.

BY JOS. W. BLOWER, COLUMBUS, OHIO.

It will be generally admitted by those financially and officially interested in working the Pittsburgh seam, that a larger percentage of the coal in the seam should be taken out, and that, owing to the limited supply of timber and its great cost, other means must soon be adopted to secure the roof.

The present systems of mining are, (1) As shown on the accompanying plan on No. 1 entry, with 21 ft. rooms and 12 to 13 ft. pillars, and (2) As shown on No. 3 entry with 27 ft. rooms and 6 to 7 ft. pillars, which are left permanently.

The method shown on No. 1 entry is favorable only when the cover is light so that the falls can be controlled easily when the ribs or pillars are drawn. The coal, when worked by this plan, should have well defined facing and end joints, so that no powder is used in its extraction. Under such conditions, from 90 to 95 per cent. of the coal has frequently been taken out. Such conditions, however, are the exception now and not the rule. Conditions quite the reverse are found after No. 2 Pool on the Monongahela River is passed. Then the system shown on No. 3 entry is almost universally adopted, because greater losses of coal were experienced when the other method was tried. The 12 ft. pillars being crushed to slack by falls and squeezes, and frequently lost altogether. The squeeze extending over a large area when it had once set in and occasionally closed the entry also. The method shown on No. 3 entry is therefore preferable under the existing conditions.

The rooms in both systems are laid off to run only 75 yds. and break-throughs are made every 35 yds., or less if necessary, and about $1.00 per 1000 bushels of coal mined is required for timber. (Posts, caps, etc). Break-throughs cost 50 cts. per yard and are very unsatisfactory for ventilating purposes. In nine cases out of ten they are the direct cause of the rooms closing and burying large quantities of coal, even when the system as shown on No. 1 entry is worked fairly successfully. Break-throughs are not usually paid for when the rib or pillar is only six feet thick, for, when the room has advanced nearly far enough to need a break-through, the miner commences "gripping" out in order to thin the rib, and finally a hole is put through, which the gob partly fills up again. These break-throughs are generally made in a straight line, parallel with the entry. Sometimes 20 or 30 rooms are working together, with a few at the beginning of the entry finished which begin to "cave." This "cave" having free access by way of the break-throughs to the other rooms, often affects a number of them also. As some of these have only been worked two-thirds of their intended length when this occurs, the officials say "we can get this coal from the other entry." But the same conditions are met there and the coal is often irretrievably lost. Of course the owner does not know this, generally for two reasons: First, because he does not often personally go in the mine, and second, because, owing to a false idea of economy, the entries only are surveyed, the rooms being placed on the map approximately. The excuse given is "the business is not profitable enough to give the surveyor any more work than what is actually necessary to comply with the letter of the law and to prevent working in land outside of the lease or mine property." Acres of coal are thus lost, the room pillars alone representing about 20% of the coal in the seam, and frequently the entry pillars are also left in.

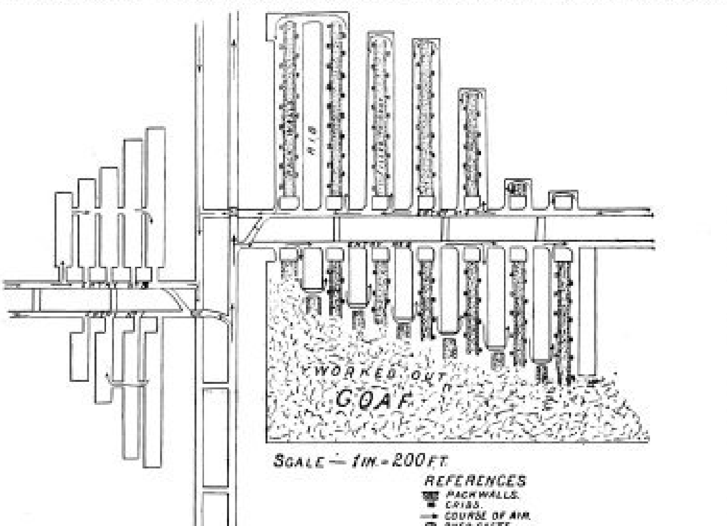
The disadvantages of the present methods, will, I think, be very generally admitted, and they may be summed up as follows:

(1.) Only 70 to 75 per cent. of the coal is extracted, while the expense necessary to extract the whole has been incurred.

(2.) The cost of timber is too great, and owing to its limited supply new methods must eventually be adopted.

(3.) Break-throughs are expensive (when paid for), and inefficient sources of ventilation, and they are the direct cause of rooms caving prematurely.

To remedy these, the plan of working, as shown on entries 2 and 4 is suggested. I think it will be found very satisfactory for the Pittsburgh seam, and especially for it as found on the Third Pool of the Monongahela, and in fact at any place where it is possible to post the roof, providing there is sufficient *debris* to build the necessary pack-walls. No change is made in the entries or in the laying off of the rooms. Two rooms are connected, leaving the same amount of entry stump as under the old methods. The track is run alongside each rib making the room 39 ft. wide, and a pillar 27 to 29 ft. wide, with a track on each side of it. The refuse, which amounts to one third of the seam, will be packed to the roof between the tracks, filling up about 20 ft. of the width of the room forming an artificial brattice, by which the air can be circulated around the face of the rooms, and which also forms the support for the roof. If not sufficient *debris* is found in the rooms, the slate from entries and rooms being turned can be taken in and gobbed. It will be seen that the ribs will be left intact, and posts are not used, except temporarily for slate; cribs take their place. These cribs are placed every ten yards apart, beginning at 5 yds. from the entry stump on the side of the room whose rib will be drawn first. The cribs on the other side beginning ten yards from the entry stump. The advantage of this arrangement is apparent on inspection of the plan. If the pack-walls are built properly, these cribs will not be necessary until the rib is drawn back, but the best plan is to set them as the room is being driven. They may be built of old posts, ties, wooden rails, etc., with a foundation of say 9 to 12 inches of slack, and wedged up tight to the roof. The necessity for the slack will be best shown on their removal, as they can then be undermined easily. It also allows them to give a little as the weight upon them is increased.



It is generally known that these rooms will not "cave" when 39 ft. wide, but the roof coal will "sag" sufficiently to make the packed gob air-tight.

In bringing back the rib, small cribs made from wooden rails about 2½ ft. long, set on a base of slack, can be used. A few posts may also be necessary.

Another pack-wall may be brought down with the rib, as shown on plan, which will prevent any fall taking place, and a gradual subsidence will only occur, and no large reservoir for the accumulation of gas, will be formed.

Ribs brought back in this way will be "Longwall retreating" on a small scale, and in case it is found that a roadway can be carried along the face of these ribs, every two alternate rooms could be left, and the coal worked back in this way, making a face length of 94 feet, more or less, as circumstances may allow. Or the room may be made wider, and the car taken along the face of the room. The tracks would be safe, having one solid rib side, and pack-walls and cribs on the other. Conditions existing would soon prove what modifications of the general plan could be made. It will be seen that rooms can be driven an indefinite distance without fear of caving, and it will pay to drive them a minimum distance of 100 yds. or longer, if it will pay to haul one car further. Besides five pairs of entries will only be needed where six pairs are required by present methods.

The proposed system will be found applicable where "soot seams" affect the roof and coal.

I have found by experience, that double rooms were safer and required less timber in proportion to width than narrow rooms, and that while entries and narrow rooms would cave until the roof had arched itself, the wide rooms allowed sufficient sag to relieve the pent-up gas, or they may be allowed to break in the center.

For machine mining, the plan suggested, has a longer face length to work upon with no unnecessary moving of the machine. The machine can be set down on one side of the room and work its way across. The truck in the meantime being changed to the other side, ready to transfer the machine elsewhere.

Another advantage will be that the miners will work double, and in this way reduce the length of time the room will be in operation. Fewer tight shots will be needed, some of the labor of bearing in will be reduced, and better coal will be secured.

In my opinion many accidents occur when miners work singly, which would not occur if the men worked together. Men are often hurt and unable to report the accident, which becomes more serious on account of lack of timely assistance.

It will, no doubt, be said that the system proposed is impracticable, and that the rooms will cave, but this will not be found true if, the pack-walls are properly built, and anyone acquainted with Longwall work, will substantiate me.

But, suppose the rooms did cave. The ribs or pillars are large enough to allow a skip, say 12 or 15 ft. wide, to be taken, and thus the face of the room can be reached and finished, or the remaining portion of the rib may be brought back and no coal will be lost.

The advantages claimed for this system, are:

(1.) The extraction of all the coal.

(2.) A reduction in cost of timber.

(3.) The ventilation of the working faces without incurring the cost of the ruinous and inefficient break-throughs.

(4.) It requires fewer entries, and as a consequence less rubbing surface, thereby producing better ventilation with the same expenditure of power.

(5.) Large accumulations of fire-damp will be avoided, if the *debris* is properly utilized.

(5.) The miners will have a wider room, better ventilation, and will use less powder.

(7.) The system is better adapted for machine mining.

(8.) The mine foreman or his assistants, when making the required visits to working places will have only half as great a distance to travel.

I hope those interested will give the subject a careful investigation, and if in their opinion the system is practicable, try it in one entry at least. I do not claim the idea is perfect in detail. Some modifications due to local conditions, may be necessary, but these will soon suggest themselves to the practical official.

Can the Pittsburgh seam be worked by Longwall? is a question often asked. If this system is tried the answer will come, and it will not entail the risks of Longwall advancing. It certainly can be worked by Longwall retreating, but no one is prepared to go to the first expense.

Safety Signals for Mine Shafts.

A mining contemporary gives an account of an electrical apparatus designed for the prevention of accidents to miners while riding on the cages in the shaft, and which will also, it is said, tend to lessen the number of accidents occasioned by cages coming in contact with the chairs. The invention has been in successful operation during the past two years at the Drum Lummon Mine, Montana, and it was devised by an ingenious employe of the company owning the mine. The arrangement consists of an electrical connection between the cage and the chairs on the different levels of the mine, and also between the cage and the engine room. An ordinary battery is placed in the bottom of the cage, and wire attached to it run through a contact piece to the side of the shaft, something on the same principle as the trolley on an electric street car. An ordinary push-button is placed in such a position on the cage that the station tender can readily reach it. Wires running down the shaft connect with the trolley on the cage, and at the other end are attached to a dial in the engine-room. Another wire connects with the chair in the mine, and as the dial is in full view of the engineer, he can tell at a glance whether the chairs are set or not. Should an accident happen to anyone on the cage between two levels, by pressing the push-button, the cage can be brought to a stop in a moment. In the ordinary way, with a bell-rope attachment, if the cage is going at even a slow speed it is dangerous to attempt to grasp the bell line, on account of the liability of getting an arm caught between the sets.

The Western Pennsylvania Mining Institute.

At the February meeting of the Western Pennsylvania Mining Institute, held at Monongahela City, Pa., Mr. W. J. McMasters, of Munhall, presided in the absence of the President. Mr. Wm. Seddon read a paper on the objects of the Institute, which was discussed by a number of the members. That portion relating to gases was particularly discussed, and as some of the members present stated that they had encountered a strange inflammable gas, the Secretary was instructed to procure samples of it, and have it analyzed by some capable chemist, and report at the next meeting. Mr. W. J. McMasters exhibited a model of a self-closing door to be used in main entries, or any other part of the mine where doors are necessary. Its advantages and disadvantages were fully discussed, and several suggestions as a means of further improvement in the invention were offered. Mr. McMasters also exhibited an improved Chirry lamp, which met with general commendation on account of its economical features.

As the next meeting (July 9th) will be the fifth anniversary of the formation of the Institute, Messrs. Henry Louttit, Adam Kyle, and Robert C. Campbell were appointed a committee to arrange a programme, and they were directed to report to the Secretary not later than April 1st.

THE PROGRESS IN MINING.

Reviews of Important Papers Relating to Mining in the Proceedings of the Mining and Scientific Societies, and in the Mining Journals of Europe, United States and Canada.

The Gas Enclosed in Coal and Coal Dust. A paper on this subject was recently read before the members of The North of England Institute of Mining and Mechanical Engineers. This paper was the result of experiments made by Messrs. Bedson and McConnell with Bituminous coal taken from the Hutton seam at Ryhope Colliery. A known weight of coal in small lumps was heated for several hours at 212° Fahrenheit *in vacuo*. The gases produced were drawn off, measured and analyzed. The analysis showed a mixture of carbonic acid gas, oxygen, nitrogen and marsh gas ($C H_4$). After the coal had ceased giving off gas it was pounded into a fine powder and this dust was again heated *in vacuo* for several hours at the same temperature (212° Fahrenheit). The result was to obtain another volume of gas from this dust. This gas was similar in composition to that given off by the coal while in lumps except that instead of marsh gas there was a quantity of heavier hydro-carbon. These experiments are interesting as a proof that all the gas in coal will not escape, even when the coal is reduced to a dust, unless subjected to heat. The natural conclusion therefore is that Bituminous coal dust holds a certain volume of combustible gas ready to escape when heated.

Safety Explosives. In further reference to the paper recently read before The Colliery Managers' Association of Great Britain, by Mr. Foggin, and which was reproduced in THE COLLIERY ENGINEER for February last, we are indebted to *The Colliery Manager*, of London, for the following letter written by Mr. H. Bigg-Wither, General Manager of the Roburite Explosive Co., Ltd., of Wigan, England.

Mr. Bigg-Wither says: "I wish to point out that in discussing a subject of this kind writers should carefully discriminate as to the particular words they use. For instance, there is an absolute difference in the meaning of the words "percussion" and "concussion;" and the term "explosion" can be very easily misapplied unintentionally, inasmuch as it may have several distinct meanings when applied to explosives. Thus, the explosion of gunpowder is the result of combustion; that of high explosives generally is the result of detonation, while in the case of some high explosives it is the result of detonation and combustion combined.

"With this preface I will now call attention to the results of percussion tests detailed by Mr. Foggin. We have a percussion apparatus at our works similar to the one described. The falling weight is 50 lbs., and we can get a fall of 40 feet. This year we have made a great number of tests with explosives of various classes, and we have found that with explosives of the Sprengel type, consisting of a dual mixture of nitrate of ammonia and a hydro carbon, a blow of sufficient weight simply produces decomposition of the portion struck, and that the surrounding mass of explosive is not affected by this so-called explosion, the result being merely a sharp crack or report. Moreover, we have obtained this same result with substances which are not classed or used as explosives.

"Mr. Foggin's statement that this so-called explosion was not produced by "ammonite" at different heights from 5 to 25 feet is quite unaccountable, except on the supposition that there was some accidental mechanical difference in the carrying out of the various experiments, for, out of seven experiments made on one day with ammonite, we got the following results: Two experiments at 5 feet drop, one sharp report; two experiments at 4 feet drop, both gave sharp reports; three experiments at 3 feet drop, one gave sharp report. I may say that on the same day we got a more resonant report from dynamite, carbonite, and tonite with a drop of only 6 inches at the first experiment with each.

"Having previously remarked the difference in the report produced by "roburite" and "dynamite" under percussion, we thought that it would be interesting to study this difference, and see whether other experiments would not assist us in demonstrating that the report produced by the Sprengel class of explosives was no true explosion, inasmuch as no detonating wave was set up, but that, on the other hand, the report from dynamite, for instance, was a true explosion, and that a detonating wave was set up. We have made a series of elaborate experiments in this direction which have thoroughly convinced us that our theory is absolutely correct."

How Anthracite was Formed. *The Colliery Guardian*, of England, publishes in a recent issue, a paper by a Canadian correspondent on the coal fields of Nova Scotia. We give the following summary of the paper as likely to be of interest to our readers: It is interesting to inquire whether the Mammoth seam of Pennsylvania is co-existent with the coal measures of Canada.

There is a 40 ft. seam of Bituminous coal in Pictou County, Nova Scotia, which enters one of the basins from the southwest, and therein trends north several degrees east. This Bituminous seam which is heavily charged with hydro-carbons and sulphurous gases although now being worked has stood in abeyance for many years. It is stated that this seam is a continuation of the Anthracite Mammoth seam of Pennsylvania and the alteration in its nature from Anthracite to Bituminous has caused much conjecture. The writer of the article goes on to submit the following theory:

He first briefly refers to petroleum and natural gas and states that springing from one source these two owe their existence to the conditions under which coal was formed, namely, the decomposition of animal and vegetable life.

Pennsylvania petroleum is a mixture of hydro-carbons (which may be classed under the marsh gas series) with paraffins and olefines. Pittsburgh natural gas contains 67% of marsh gas, 22% of hydrogen, 3% of nitrogen, 5% of the heavy hydrocarbons and the remainder of oxygen and the carbon-oxides.

The writer goes on to say that assuming these two bodies possessed an origin identical with coal and noting their present order of deposit in the earth, their ingredients must have been originally removed from the great Pennsylvania Anthracite measures, thus assigning to these measures their unique nature.

Any Bituminous coal subjected to distillation in a closed vessel would precipitate (1) watery liquor, (2) aetherial or volatile oil, (3) volatile alkali, (4) thick greasy oil. The closed vessel in this case is nature's distillation in the crust of the earth. Internal heat, which has torn the country of the Eastern Alleghanies into such great contortions, acting on carboniferous deposits would gradually distil these liquids above mentioned and the whole would be driven through the cracks in the earth's crust out of the country of the Eastern Alleghanies into the region they are now found.

Good Surveying. We are indebted to the proceedings of The Mining Institute of Scotland for a short description of "Shaft Surveying at the Przibram Mines," taken from a recent volume of the Transactions of the Institution of Civil Engineers, England. Two shafts—the Adalbert and Maria—had been sunk in 1879 to the thirtieth level at a depth of 3200 feet and it was proposed to deepen the Kaiser Franz Josef shaft from the seventeenth level to the level of the other two, a depth of 1864 feet. To hasten the work the sinking of the shaft was begun simultaneously at four different points. While one set of sinkers was sinking from the seventeenth level another set were rising from the twenty-third level to meet them. Another starting down from the twenty-third was being met by a rising set from the twenty fifth. Similar operations were being conducted between the twenty-fifth and twenty-eighth, and between the twenty-eighth and thirtieth.

It will thus be seen that eight points of work were in full force at one time. The relative positions of the three shafts were first determined by a survey at the twelfth level with a mining theodolite with two verniers reading to one minute. The total length of the survey was 3673 feet with forty-four stations, and the traverse gave the sides and angles of the triangle formed by the three shafts at

Side of Triangle.	Distance in Metres.	Angles Opposite.
a. Maria—Adelbert	= 564·091	A at Franz 90° 34' 58"
b. Maria—Franz	= 546·091	B at Adelbert 37° 18' 28"
c. Adelbert—Franz	= 442·828	C at Maria 52° 6' 34"

The survey was repeated after a connection had been effected in each of the sections, the total distance surveyed being eleven miles with 684 stations. The operation was completely successful, as the shaft was formed full size (19$\frac{1}{2}$ feet $\times$ 6$\frac{1}{2}$ feet) and no alteration was found necessary in timbering or masonry in any section when a holing was made.

The Capell Fan in Westphalia. From the Transactions of The Mining Institute of Scotland we give the following extract regarding some tests made at the Prosper I mine at Berge Borbeck. There was originally a Guibal fan at the colliery, 39 ft. diameter, with a maximum capacity of 76,000 cubic feet per minute with a 3·2 inch water gauge. As this was inadequate a Capell fan 12·3 feet diameter and 6·9 feet broad was substituted. This fan after a few months' working shows what are quite justly described as "astonishing results." The fan engines are coupled, and the cylinders are 20$\frac{1}{2}$ in. diameter with 31$\frac{1}{2}$ in. stroke. The fan is driven by a camel hair belt 23·6 inches broad and makes four revolutions to one of the engines. Special trials were made with the fan running at 228 revolutions per minute. With a water gauge of 7·3 inches 105,000 cubic feet per minute were obtained. This was an efficiency of 52·039 per cent. or 5 per cent. greater than the best of the fans reported on by the recent Prussian Fire-damp Commission. At a speed of 350 revolutions of the fan per minute the effective work was calculated at 53 per cent. Lubrication of the fan axles is effected by kidney fat broken up into small lumps in the oil boxes with a continuous stream of water falling on it. With this lubricant no heating of the journals was observable, whereas experiences with oil and tallow were not nearly so satisfactory.

The use of Roburite and Tonite in Mines. A series of experiments to test whether the fumes from these explosives are more dangerous to the health of the miner than gunpowder smoke was recently carried out by a committee of The North of England Institute of Mining and Mechanical Engineers. The decision arrived at is that the products of combustion are not more deleterious with one explosive than with another. As both roburite and tonite are safer and more powerful than gunpowder, their use should be extended now that the main objection to their adoption has been groundless. The committee are very emphatic in their declaration on this point, they say: "It has been ascertained in the examinations made by Professor Bedson that the amount of carbon monoxide resulting from the explosion of roburite or tonite is not practically, and on an average, greater than that produced by gunpowder. Moreover, it has been shown that, after a very short interval, this and other gases are entirely carried out of the place by the air current. We are, therefore, unable to assign the ailments complained of by the men to any poisonous or specially hurtful influence of the explosives."

Coal Dust Explosion. In an article on "Explosions of Coal Dust in Artificial Fuel Factories" (*Dingl. Poly.*), two accidents due to the explosion of coal dust are described in the *Jahresbericht d. K. preuss. Gewerberathe für* 1888. At the Reichenwald works an explosion of coal dust took place in the dried coal store-room whilst the operations were in full progress, with the result that the front of the drying-house was violently blown out and a considerable conflagration occurred in the factory. At Furstenberg on the Oder, where the works are entirely built of stone and iron, a similar explosion occasioned no damage, either to the workmen or to the buildings. The ignition of the coal dust appears to have commenced in the lowest feeding screw belonging to the drying room elevator, and to have spread forwards to the store-room and backwards to the two drying-houses. Five explosions followed in quick succession in different parts of the works, the detonation being strongest in the store-room, and in a few minutes all the chambers containing dry coal dust were on fire. These accidents show that coal dust is itself a dangerous explosive, the presence of which must be guarded against in factories, mines, &c., by thorough ventilation and other protective measures.

The Value of Bore-Hole Records. When a mining company puts down a bore-hole they do so with the main object of proving the existence of some particular seam or vein. Sometimes the bore is successful in its search, sometimes it is not. In the latter event no value is placed upon the records of the boring and they are often allowed to disappear or are at least carelessly kept. In some instances where the mineral looked for is expected to be found at a shallow depth from the surface no written records are kept at all and bore-holes are put down with as little system of geological knowledge as if the cost of each was little more than of shoving a walking cane into the ground. Little thought is taken of the fact that the usefulness of these bore holes does not end with the attainment of the present object or that perhaps in a few years their records may save a lot of money in proving the existence of say a valuable clay where previously the search was perhaps only for a good house coal.

The State Geologist of Missouri, in his preliminary report on the Coal Deposits of that State appreciates the value of all these local records as a means of assisting him in formulating a reliable State Geological map and we cannot do better than present his own words on this point. He says:

Of especial value in this report are the records of the various deep shafts and drill holes which are included. These were furnished by many different individuals, and, in each case where the results are quoted, recognition of this assistance is expressed. With a few exceptions, the individuals and corporations of the State have generously contributed such results in a free, public-spirited manner. The importance of furnishing such records to the survey, where they may be kept on file for ready reference, cannot be too strongly emphasized. Hundreds of such holes have been put down in the State for various purposes, and from comparatively few of such are reliable results now available. Such holes are generally sunk for a definite purpose and when that end is reached it occurs to few that the results may still be valuable for other purposes. But this is almost always the case. Whether a thick coal bed be encountered or not a good record establishes a series of facts concerning the geology of the locality and is, hence, valuable. For instance, the record though *apparently* barren of results of economic value, may show that the drilling stopped in a certain limestone, which, by comparison with a record obtained elsewhere, we know is 20 or 50 feet, as the case may be, above a certain valuable coal bed. Hence from the study and comparison of these two records we are able to predict the probable existence of workable coal within a short distance of the bottom of the hole. Again, the hole may have penetrated rocks which we recognize as below any coal in the State; in this case the result is of general value in preventing further exploration below this depth. Only from the results of such deep drilling can the area of available coal in the State be exactly determined and the limits of the individual beds be defined, especially in those parts of the State where the coal beds are deep beneath the surface.

The reason why records of value are not always attainable is, however, not only because of negligence on the part of those immediately interested to preserve them, nor yet because of refusal to contribute them. It is unfortunately the case that many holes have been put down by incompetent men, or by men who know merely how to handle a drill without having sufficient knowledge of lithology or geology to be able to accurately describe and record the descriptions of the rocks they encounter, nor to interpret the meaning of all they pass through. In cases it is even worse than this, and the history of many a deep and expensive drill hole in the State shows evidence of trickery and bad faith on the part of the driller towards those in whose service he was supposed to be working. The uncertainty attending such work has thus brought disfavor in many localities upon deep drilling as a public enterprise; many having acquired the impression that only indefinite results of small practical value could be reached. This impression is wrong and unfortunate, for such work can and should be prosecuted by every progressive community in the coal regions which is anxious to determine the existence of coal beds and to have them developed. In view of these facts the survey suggests a possible plan of co-operation which if adopted, would ensure a well conducted drill hole, a reliable record and an official report on the same, and would, at the same time, secure for the State complete results of the drilling in such condition that they can be unhesitatingly used and will be entirely comparable. To any private individual or community desiring to have a *deep* drill hole sunk, the survey could arrange to recommend reliable men whom the individual or community can employ to do the work of drilling; second, it could supervise this work, and last, it could furnish an official statement of the results of this drilling. In return for this service, it would be required that the survey be allowed full and free use of the results for the benefit of the State. That this would be, in every way, a liberal offer, cannot be disputed. In addition to securing reliable results, the individual would, by this means, be put in possession of a report, which would be, as it were, negotiable. Being of an official nature, from an impartial source, others will place faith in it and will invest money on its authority, for purposes of actual development, where they would not do so, were the report of a private nature, emanating from an interested source. If such a plan of co-operation were generally adopted, the State would soon have accumulated an invaluable mass of material from which it would be possible to outline, with a high degree of accuracy, the general limits of each and every coal bed in the State. From this the prospects of finding coal at any one point could be predicted, as well as its probable depth and thickness when found. Surely the attainment of such a condition of exact knowledge is worthy of our serious efforts.

Draining in Mines.

We are indebted to the *Iron and Coal Trades' Review*, of London, Eng., for the following extract from a paper on the above subject recently read by Mr. Henry Davey, M. I. C. E., before the Cleveland Institute, of Engineers.

The author dealt with some of the leading general principles involved in methods of draining mines under the most important conditions of both coal and metalliferous mining. In treating of draining during sinking operations, he said the conditions vary greatly in sinking for coal or for ore. In the former case the shaft or pit is usually completed before the coal is worked; in the latter the shaft is generally deepened during the working of the mine, and is, therefore, never in a permanent condition. Temporary steam pumps might be used to advantage for small quantities of water from moderate depths, but for any important work a surface engine with bucket pumps having proper lower appliances should be adopted. Pumping water was not a costly operation if proper and sufficient pumping plant was employed for the work, but if this plant is insufficient, the loss often is very serious. Even with proper plant sinking through water-bearing strata is slow and costly, because of the delay occasioned by the sinkers having to work in water. Heavy pumping under such conditions could be expedited by the use of jet pumps and other auxiliary appliances, by means of which it was unnecessary to lower the main pumps so frequently. Hydraulic pumps might be used to great advantage. Many special appliances of this nature might be employed if they could be procured when wanted, but no one kept special appliances. Makeshift plant was procured, and the sinking in consequence became very slow and costly. The author said that for many years he had been convinced that a sound investment would be found in the establishment of a depot where the best sinking appliances might be obtained on hire or purchase. In sinking shafts and wells through water bearing strata, great cost was usually incurred and much time taken up. The subject was of considerable local importance because of its bearing on the sinking of mining shafts. The problem was simply that of keeping down the water in water bearing-strata in advance of the sinking operations, so that the excavation of the shaft should be done in dry ground. The ordinary method was to sling a pump or pumps in the shaft and to lower the pumps from time to time as the sinking progressed; obviously the excavation had to be performed in water, and if the quantity of water was great, a large portion of the work had to be done by the men working in 2 or 3 feet of water. To facilitate the work, and reduce the water in which the men had to work, a sump was made under the suction pipe of the pump, and it was the keeping this sump excavated in advance of the other work which was most difficult and tedious.

In the plan proposed by the author the pump would be placed in a borehole made before the commencement of the sinking of the shaft. It was necessary that *debris* should not go down the borehole in quantity sufficient to choke it up. That is provided against by means of a heavy taper shield of cast steel surrounding the pump, and resting on the edge of the borehole. This shield is perforated with holes inclined upwards towards the pump to allow water to get into the borehole, but to exclude *debris*. The shield is made very heavy, and by its own weight follows the excavation around the pump, and also protects it from injury through the blasting of the rock. The pump is made without a foot valve, the rod of the bucket working through the seating of the valve which rests on the top of the working barrel. By this arrangement the drawing of the bucket also draws the valve, and should the bottom of the borehole be filled up with sand, it can be removed by lowering a sand pump. The boreholes should be made to a greater depth than that required for the pump to provide space for sand and *debris*. The application of this pump would be varied to suit the local circumstances and the geological formation of the strata to be passed through. In some situations the shaft might be drained by means of boreholes outside the diameter of the shaft altogether. It was usual and necessary to have duplicate pumping engines, and where two engines were made to pump from the same well, the well must be very large to accommodate two sets of pumps. Such wells were usually from 12 to 14 feet in diameter. A simple borehole could be made cheaply and expeditiously. Four 30-inch boreholes could be put down in a small fraction of the time required to sink a 12-foot well in the ordinary way. Instead of making a large well, the author puts down four boreholes to accommodate the pumps for duplicate pumping engines. The boreholes being completed, the pumps are lowered into them, and coupled up to the permanent engines. The author held that it was true economy to have a pumping engine large enough to do the work at half or even one-third its full speed, or what might be called two or three times too big. He was at present putting down large pumping plant at great cost to recover a colliery drowned because it was formerly drained by means of underground steam pumps. The practice had been to put down a new pump for every new feeder, but one day a big feeder broke in, and the pumps were soon under water and the colliery also.

Underground pumping engines had been largely employed of late years, but the author thought it a mistake to take steam underground. It was not possible to get dry steam to underground engines through pipes carried down the shaft, and with wet steam the engine would give a low duty. He had found the engines on the surface could be made to work with one-half the steam required by the best underground engines for the same work. In some places underground pumping engines were more suitable than surface engines, but in most of such cases the pumping was better and more economically done by means of hydraulic pumps from an engine on the surface. He instanced the installation of Messrs. John Denton & Co., at the Grimesthorpe Colliery, Sheffield. The work was previously done by means of steam pumps, but the steam was such a nuisance underground, the mine was made so hot, and the steam pipes and plant gave so much trouble, that Messrs. Denton resolved to try another plan. The shaft is an inclined one. There are three hydraulic pumps placed in different parts of the mine. The first lifts 150 gallons per minute 300 feet high; the second 137 gallons 300 feet high; and the third 30 gallons 300 feet high. The power is supplied from the surface through pressure pipes 4 inches, 3 inches, and 2½ inches in diameter at 700 lbs. per square inch. The pumping plant cost $7,425 and the pipes $2,481.

The author stated that he had devoted considerable attention to the system of applying hydraulic power to underground machinery, and he gave particulars of the hauling and pumping engines at Altham Colliery, the New Russia Company's Collieries, and the Quebrada Copper Mines. He expressed his conviction that for vertical shafts, where considerable quantities of water had to be dealt with, the pumping could be more safely and economically performed by means of surface engines and pump rods than by any other means. Where, however, their use is inadmissible, the system of hydraulic transmission is the most economical, convenient and practicable, not only for pumping, but also in many cases for hauling purposes. Conveying steam underground for pumping purposes was to be avoided, if possible, except under very special circumstances. The author mentioned that several installations had been put down for pumping by electrical power. He also cited a colliery near Marseilles where three hydraulic pumps were placed in different parts of the mine, which is 1,100 feet deep.

Dimension Stone Quarrying.

Mr. W. L. Saunders, M. Am. Soc. C. E., recently read an interesting paper on this subject before the American Society of Civil Engineers. We append the following excerpt of the paper:

With beds of solid and valuable building stone it is a point of importance to secure as large a percentage of marketable rock as possible. One of the oldest methods of obtaining this is to drill deep holes. Quarrymen have often observed that holes drilled by hand are never really round, but are somewhat triangular in shape and when a blast is fired in one of these holes the rock usually breaks in three directions radiating from the points of the triangle. This is very extravagant on the rock as the pieces are irregular in shape and a large percentage of stock is wasted in trimming off the stone into a cubical shape.

One of the first devices for overcoming this waste was to insert the charge into the hole encased in a canister of peculiar shape. The hole was drilled from 10 to 12 inches in diameter. The drill used was shaped like a broad axe and was worked by being raised up a certain height and then dropped; the weight of the drill in falling being the force which struck the blow. The canister containing the charge was made of two curved pieces of sheet tin with soldered edges. When this canister was placed in position in the hole, there was a space on each side shaped like a crescent moon. This space was filled in with sand or earth and as the canister was placed so that its section lay lengthways in the desired direction of fracture, the effect was the same as if the hole had been drilled in the shape of the canister. If it had been possible to drill the hole exactly in the shape of the canister a good deal of work would have been saved.

Another system was what is termed Lewising. A Lewis hole is made by drilling two or three small holes close together and parallel with each other. The partitions between the holes was then broken down leaving one hole of a long narrow shape of section. This form of hole is used in granite. Sometimes a series of Lewis holes are drilled in a straight line and at equal distances apart (sometimes 10 to 25 feet) and fired simultaneously by electricity.

Mr. Saunders describes the following new system developed by Mr. Knox which possesses advantages over the two aforementioned. A round hole is first put down, preferably by machine to secure a perfectly round section. After this has been done a V-shaped groove is cut out on each side of the walls of the hole in the direction of the desired line of cleavage. These grooves are cut with a "reamer" by hand, and the greatest care must be taken to preserve a uniform direction with the V-shaped grooves or in other words the "reamer" must not be allowed to twist, or otherwise a bad fracture will result.

If a bed of rock in a quarry has to be moved and a natural seam divides the bed at each end of the walls of the quarry then there will only be one face, the back to set free.

Knox holes are put in at equal distances apart along the line of desired cleavage and these are fired electrically.

The explosive recommended is one of a low grade. Dynamite is not suitable, and black powder, or Judson powder, or other explosives which act slowly are preferable. No definite rule can be laid down as to the amount of powder to be used to secure equal results in every case. A hard, fine-grained stone requires less powder than soft stone. As a matter of fact very little powder is required for most rocks. If too much powder is put in each hole, the rock, especially if it be soft like sandstone, is shattered. It is preferable, therefore, to put a smaller charge in and to place the holes closer together. In this improved form of hole the tamping should not be put down directly on the powder. An air space should be left between the powder and the tamping. The tamping can be sustained at the top of the hole by first inserting a wad of hay, grass, oakum, or other material. When a series of these holes have been blasted it is found that a clear fracture along the line of holes is obtained and a solid cubical mass of rock is thereby set loose. The theory of this action in these V-shaped holes is that the gases formed by the explosion finding no sharp angle as a starting point for a fracture at any point in the circumference of the hole until they come to the Vs, they rush to these two points and concentrate all their energies on them acting like two wedges driven from the center by a force equally prompt and energetic.

Similar holes to cut in two directions, one at right angles to the other, are made by cutting one additional pair of V shaped grooves on the opposite sides of the hole.

Mr. Saunders in his paper also deals with the merits of the Knox system adapted to the details of rock cutting.

An Electric Safety-Lamp.

The members of The Mining Institute of Scotland recently had an opportunity to inspect Bristol's Patent Electric Safety-Lamp. The following is a short description of it: The battery consists of 3 cells of accumulators. Its action is that if a current is sent through it for a certain period it will afterwards when switched on a lamp give off a corresponding current for a corresponding time.

The lamp can be charged to give a light for 10 hours.

The cost of these lamps in England is $8.40 and for an installation of 500 lamps at a colliery including a two-horsepower dynamo and all connections the first cost will be $4,500. The first cost for a similar outfit of Evan Thomas, Marsaut, or similar good-class oil safety-lamps will probably be $2250 including a Howat's Patent Lamp locking and cleaning machine or just half the cost of the electrical plant and lamps.

The cost of running and keeping 500 Bristol Electric Safety-Lamps to burn 8 hours a day will be 8 cents per lamp per week.

Taking attendants' wages, deterioration of plant and 5% on capital outlay, into account the anual cost will be $2,760 or $5.52 per lamp per annum.

Electricity applied to Mining.

Mr. D. S. Bigge discussed "Theory" and "Practice" in the application of electricity to mining in a paper read before The North of England Institute of Mining and Mechanical Engineers, at Newcastle, Feb. 13th, of which the following is an abstract:

The question of power transmission by means of electricity is by no means a new or untried one, and though, perhaps, little is known of the details as yet by the mining world in general, results have been obtained in actual practice which merit serious attention. Electricity has now been applied, and with great success, in mining work for haulage, pumping, drilling, coal-cutting, and other minor uses, and as in the cases of electric lighting, electric power may now fairly be said to have passed out of its experimental stage, and to have become an accomplished fact. It is chiefly as a means for transmitting power to great distances with small loss along the line that electricity will be found to predominate over any other known form of power transmission, and as distance is usually a most important factor in mining operations underground, electricity in a large number of cases will be found to adapt itself admirably to the work required to be done.

The advantages claimed may be tabulated as follows: 1. A very large increase in working efficiency over any other known form of power transmission. 2. Considerable reduction in capital expenditure, when compared with other systems, a reduction which becomes more and more apparent as the distance for the power to be transmitted increases. 3. Increased facility in running the cables when compared with the laying of air or hydraulic mains. 4. Very small loss in the cables through resistance or leakage to earth when compared with the waste on a compressed air system. 5. Smallness in size of the machinery, thus proving itself to be of a portable nature and easily manipulated. 6. Absence of heat from the machinery underground. 7. Great simplicity in working. 8. Small cost of maintenance. 9. Finally, the ease and speed with which the whole plant can be erected and set to work.

The principal objections raised against the employment of electric power are the following, viz.: 1. Danger arising from sparking at the motor brushes and main switch underground. 2. The idea that electrical machinery is of too delicate a nature for use in mines. 3. Risk of fire from breaking of the main cables by falls of stone, derailed tubs, or other causes. Having dealt with the three objections raised the author proceeded to consider the general question of power by electricity. When one power is transmitted from one place to another by means of steam, air, or water, through pipes, the difficulty of pre-determining the exact loss of power from friction in these pipes is very great; in fact it varies so much under different circumstances that the author believed that exact determination may be said to be impossible. So also the loss of power in the motors driven by fluids is equally undeterminable with any degree of accuracy, on account of the variations in efficiency caused by slight alterations in load or speed, or by leakage through the valves or packings. These difficulties in calculation do not present themselves with electrical transmission of power. The loss of power in the cables depends solely on the electrical resistance, which is a practically constant quantity, and the current passing through the cables, which can be estimated with great accuracy. Nor is the loss of power in the motors more difficult to estimate; first, with a given motor the losses can be calculated with almost any degree of accuracy, from its known resistance and electrical or magnetic qualities; and secondly, since the experimental determination of the efficiency of dynamos and motors is so readily carried out, a very great number of actual efficiency tests have been taken from which the efficiency of a given size of machine of any particular type or construction can be easily foretold. The calculation therefore of the power wasted in transmitting power by means of electricity is extremely simple, and the efficiencies of a plant can be readily foretold, and the results to be obtained guaranteed with perfect confidence.

Where there are two or more collieries under the same management within a comparatively short distance of one another, at which power is required, one central station should be established where plants should be installed of sufficient power to serve the several collieries. The advantages of this plan are clear. (*a*) Inasmuch as all the machinery will not be working to its full capacity at each of the collieries simultaneously, the actual power at the one central station will be less than the sum of the powers which would have to be installed at each separate position, and in addition to this the plant would be cheaper, because the price of machinery does not vary directly as its output. (*b*) The cost of maintenance of a few large dynamos and engines will be less than that of a greater number of small ones. (*c*) Greater efficiency is obtained by running the machinery more nearly at its full load, the percentage variations of power required being smaller, when a large number of motors are taking power from the one plant. (*d*) The cost of attendance on the generating plant will be enormously reduced, the same number of men being able to attend the one central station as would attend to each of the separate plants. The great saving in all these directions had been fully proved by actual practice in the large central stations supplying light and power in London and other large towns.

COAL IN WEST VIRGINIA.

Reports of the Inspectors of Mines for the Year ending June 30, 1891.

Annual reports of the State Mine Inspectors of West Virginia have just been made to the Governor and contain valuable information and interesting statistics. The reports show that during the year ending June 30, 1891, the total coal production in the State was 7,281,430 tons of 2,240 pounds each, and the coke production in the same time was 1,238,418 tons. In 1880 the coal production of the State was 1,568,000 short tons. In 1889 the production of coal was 4,726,047 long tons, and of coke 665,193 long tons. The reports for the last year also show that there were 179 mines in operation in which there were employed 14,178 men. There were 4,117 coke ovens in operation and 777 more building.

Inspector Harr, of the First District, reports 14 fatal and 24 non-fatal accidents during the year. He says: "Upon making careful inquiry into the cause of these accidents, I find that a majority of them resulted from the carelessness of the workmen themselves. A careless miner is the worst enemy to his fellow-workmen. I can not see how best to remedy this evil, but would suggest that the mine boss in charge, exercise more strenuously his authority in this matter. In no case should he allow men to work in danger, no matter what their experience may be. There has been but one explosion of gas during the year, from which four men lost their lives. This happened May 7, 1891, in Harrison County, at the Ocean mine."

There were six mines opened in the First District during the year and eight are now being opened. There are 1207 coke ovens in blast and 235 are being erected.

Inspector Spruce, of the Second District, reports 25 fatalities. He says: "The fatalities in the counties of Mason, Putnam, Kanawha and Fayette are one in 748 miners employed, while in the counties of Mercer, and McDowell they are one in 180 miners. According to these figures about four times as many men get killed in the mines of Mercer and McDowell as in the other counties just named, in proportion to the number employed. This is due, he expiains, more to the fact that inexperienced men are employed there than that the mines are dangerous; and also that the miners are not required by the companies to set posts in their own rooms or working places. He recommends that the miners be paid for setting their own posts instead of its being done by men employed for that purpose."

There were 35 new mines opened during the year and a large number of coke ovens built.

NUMBER OF MONTHS WORKED AND AVERAGE EARNINGS OF THE MINERS OF THE SECOND DISTRICT OF WEST VIRGINIA, FOR THE YEAR ENDING JUNE 30, 1891.

County.	Number months worked.	Average earnings of miners per month.
Mason	11	$37.29
Putnam	9	41.17
Kanawha	10¾	39.11
Fayette	11	36.60
Mercer	10½	38.25
McDowell	10¾	42.75
Average	10½	39.26⅔

A FOREMAN FOR EACH MINE.

The Pennsylvania Bituminous Mine Law Defined to Mean That Operators Must Employ a Certificated Foreman for Each Important Opening.

We are indebted to the *Scottdale Herald* for the follow important decision of Judge Doty, of Westmoreland Co., Pa.:

By the Court: On 30th June, 1885, the Legislature of this Commonwealth passed an Act entitled, "An Act relating to Bituminous coal mines and providing for the lives, health, safety, and welfare of persons employed therein." It was intended to be a complete system. Everything is required that was thought to be for the welfare of the miners, and everything prohibited that was likely to prove detrimental to the lives, health, or safety of those employed in such mines.

Among other provisions, the Act provides for the appointment of Inspectors, and prescribes minutely the duties to be performed by such inspectors. It is one of the duties of an inspector "to examine the mines in his district as often as possible, which shall be not less than once in three months, to see that the provisions of this Act are observed and strictly carried out."

In pursuance of his duty, William Jenkins, an Inspector of the Second District, on the 30th of April, 1890, gave notice to John P. Brennen, Superintendent of the McClure Coke Co., that but one mine boss was employed for two mines, known as Bessemer and Rising Sun, contrary to the provision of the fifth section of the said Act of Assembly, and requested an additional mine boss to be employed by said company. From this decision of the Inspector an appeal was taken to the Court of Quarter Sessions, under the fourteenth section of the Act. Again, it was decided by the Inspector that the McClure Company was violating the fifth section in employing only one mining boss for the mines known as Donnelly No. 1, Donnelly No. 2, and Mayfield; and also in employing one mining boss for Hazlett Shaft, and Hazlett Slope.

From the latter decision appeals were also taken.

On the 4th October, 1890, the Court appointed three practical, reputable, competent, and disinterested persons to forthwith examine such mines, and report, under oath, the facts as they exist, together with their opinions. For some unexplained reason such report was not filed in Court until 22d September, 1891. There is a difference in opinion among the viewers, but an agreement as to the facts as they exist.

The fifth section of the Act provides as follows: "In order to better secure the proper ventilation of every coal mine, and promote the health and safety of the persons employed therein, the owner or agent shall employ a competent and practical inside overseer, to be called mining boss * * * ." We think there is no difficulty in arriving at the meaning of this section. From the language of the section the expressed purpose of the Act and the many and exacting duties imposed on the inside overseer, it seems plain that the section requires a mining boss to be employed for every coal mine. The plain requirement is that to secure the proper ventilation of every coal mine a proper mining boss shall be employed.

What then is a coal mine in the sense in which it is employed in this statute?

A coal mine is defined as, "a mine or pit containing mineral coal;" and a mine is, "a pit or excavation in the earth from which ores are taken by digging." The number of men employed is immaterial, as it is provided in a subsequent section that the Act shall apply to every mine employing more than ten men. The extent of the mine does not seem to be a consideration in the mind of the Legislature, nor the amount of territory embraced in one mine. It seems equally clear that it is not the intention to require a mining boss for each separate working drift in the same mine. Nor is it necessary to inquire as to the quantity of coal mined, or whether the output from a mine goes to one or different places. It is not intended that but one mining boss should be employed by each coal company, or the Legislature would have so said in unmistakable terms. A single company may, and frequently does, control many mines extending over a great extent of territory.

Underground communication is an element not to be lost sight of, but these ramifications under ground may connect many different coal mines. "Every coal mine," then, evidently means every separate and distinct mining operation; mine disconnected with any other mine; an excavation from which coal is taken by digging, having a system and operation distinct and disconnected from any other mine. We have seen the definition of Webster, and, as commonly understood, a coal mine is also a pit where coals are taken out by digging in a distinct and separate operation. Every coal mine has its machinery and equipment for taking out the coal; its shaft, or slope, and system of ventilation; its mules and tracks and the men who work especially in that mine. And in and of itself contains every element of the definition, and so far as its operations are concerned, is independent of and disconnected from any other mine.

Now, what are the facts in these cases? The Hazlett mines are known as the Hazlett Shaft and Hazlett Slope. The two are connected by an entry for the purpose of drainage, but the entry is not sufficient for the purpose of travel. Each mine has its tipple and its system of ventilation, and apparently all the appliance for mining. Seventy-three men are employed in the one and thirty-one men in the other. The only other things in common are, that they are operated by the same company, have substantially the same name, and one mining boss has supervision over both. In other respects, so far as we are advised of the facts, each is independent of each other. We have no doubt that one mining boss could supervise both these mines. The territory is not large and not many men are employed: but we are also persuaded that each is a distinct coal mine, and under the Act it will be necessary to employ another certificated mining boss, one for Hazlett Shaft and one for Hazlett Slope. It might be a more reasonable requirement to give a mining boss supervision of a certain amount of territory, or over a certain number of men, but if such change is desirable it is for the Legislature and not for the court.

When we look at Bessemer and Rising Sun Mines the situation is somewhat different. These are connected by underground traveling ways. Both are of small area and confined within a limited space and only about eighty-four miners are employed in the two mines. Each mine has its own tipple and its own system of ventilation, and one mining boss has supervision of the two. Each seems to be complete in itself and independent of any other. Bessemer has all the machinery and equipment necessary for mining coal, and the operations there would go on if the other had no existence. What is true of Bessemer is also true of Rising Sun. The two mines are not one. The two have underground connection. One mining boss, in our opinion, could easily superintend both mines. But we have no discretion in the matter, and our duty is simply to construe the law, and, as we understand it, the law requires a mining boss for every coal mine.

It is very evident that East Donnelly, West Donnelly, and Mayfield are three distinct mines. Each has its own tipple. Each its system of ventilaton, and all the machinery and equipment necessary for mining coal. One mining boss has supervision over East Donnelly, and West Donnelly and one mining boss over Mayfield. Between East and West Donnelly there seems to be no connection underground. And yet in these three mines only 103 miners are employed. It seems an unnecessary burden to impose upon the company the duty of employing three mine bosses, but under the facts found, such seems to be the law. The concluding paragraph of the minority opinion is as follows:

I am also of the opinion that one mine boss can properly attend to two or three or more small mines, where the outlets are convenient of access to each other, and within close proximity to each other, where the number of men aggregate within reason, say 200 men. There are many mines in the Bituminous region, having one mine boss, where there are employed from 250 to 500 men, and the area of such mines being of far greater extent than is the area of any of these mines in dispute, namely, "The Hazlett," "Bessemer," and "Rising Sun," and "Donnellys 1, 2," and "Mayfield."

And now, January 30, 1892, it is therefore ordered and directed that one certificated mining boss be employed for each of the following mines: Hazlett Shaft, Hazlett Slope, East Donnelly, West Donnelly, Rising Sun, Mayfield, and Bessemer. And it is further ordered that the appellant pay the costs of this proceeding, including a reasonable compensation to the viewers, which compensation shall be agreed upon by the counsel for the parties, or, on failure to agree, hereafter to be fixed by the court.

The Origin of the Name "Tram" Road.

Webster's Dictionary tells us that the origin of the word tram is *probably* Scandinavian. This is an instance in which the Dictionary is mistaken. Before the days of the railroad, the canal was, in England, as elsewhere the most convenient means of transit for heavy loads and the owners of these many water-ways stood much in the position of the railroad kings of to-day.

Among the most successful canals in England was the one stretching from Derby to Birmingham and Staffordshire. One end of it extended to the north of Derby about four miles to a place called Little Eaton and its terminus there formed a convenient connection with the extensive house-coal, iron and pottery fields of the Alfreton and Ripley districts. The land from Little Eaton to Alfreton has a considerable rise and it was thought unremunerative to build so many locks as would be required if the canal were extended to the latter town. A road was laid therefore through a tract of land purchased for the occasion by the Canal Co., and this road is in active operation in connection with the canal to the present day. The designer of the road was James Outram, of Little Eaton. It consisted of flat cast-iron flanged plates each 3 feet long with a gauge about equal to an ordinary cart. The rails were laid at each end on stone blocks and fastened to them by spikes driven into a lead plug run in a hole in the stone. The road was called, after its inventor an Outram road afterwards contracted into 'tram road.

The cars run on the road are made with removable bodies that can be hoisted bodily with their loads of two tons each into the canal boats. When these boats arrive at their ultimate destination the car bodies are then hoisted out and laid with their load on cart frames and the soft high class coal of the Kilburn Valley is thus transported direct from the coal pit to the very cellars of the consumers without being once transshipped.

This explanation of the origin of the word tram is given in Dr. Smile's Life of George Stephenson.

Removal.

Mr. H. A. Kingsbury, dealer in mine, mill, and railway supplies and manufacturers' agent, 435 Spruce St., this city, announces his removal on April 1st, to Temple Court Building, 313 Spruce St. The well known high standing of the manufacturers he represents and his close connection with them, together with the undisputed superiority of their goods enables him to offer the best material at the lowest prices. His reputation as an honorable business man insures perfect satisfaction to his customers. He has demonstrated the fact that careful attention to his business, truthful representations as to his goods and honorable treatment of his competitors, are a means of success. In his new quarters he will be prepared to estimate on machinery and supplies for any part of the continent. We wish him continued success in his new and better location

THE USE OF THE UPPER TELESCOPE.

A Practical Example Illustrating its Use and the Calculations Required to Obtain the Correct Vertical Angle.

BY H. W. ALTHOUSE,

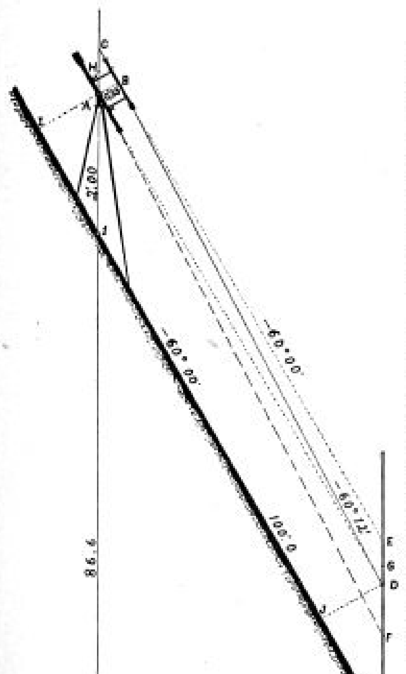
Assistant Engineer Consolidated Coal Company, of St. Louis.

This necessary adjunct to the mining transit is designed especially for use on heavy pitches where the lower telescope proves of no effect, either as to taking the course or for obtaining the vertical angle.

Perhaps to no other part of the transit is given such little attention as this same telescope, which, being a separate article, seldom receives the care to which it is entitled, and at times it is looked upon as rather an evil. However, its employment is necessary in that portion of the Anthracite coal fields where heavy dips are of frequent occurrence.

The upper telescope should be in adjustment with that of the lower, for level, plus the height between the center of each, which by construction in most transits is 0·35 ft., and under no circumstances is it advisable to remove the telescope until after having completed the heavy angles, as the adjustment would likely change. A good policy always is to test it before using.

Other devices for taking vertical angles on steep inclines are in use, but ineffective where most needed;



such as in lining slopes and repeating the vertical angles, which should always be done, and the angles averaged, care being taken that the rear and fore rods are vertical and that the heights to the lower telescope on both correspond.

For determining the vertical heights by means of the upper telescope many different methods, though at variance with each other, and also incorrect, are commonly employed. Thus, as in annexed sketch, the pitch of slope being 60° 00′, the height of transit (1 H), two feet and the rod 2 G the same. Now in sighting, the angle B to G is thus made less than it should be and the height changing from 1 H to nearly 1 B, it does not follow that by simply deducting the distance (A B), 0·35 ft. from the apparent vertical height that the latter is correctly attained.

Another method used to considerable extent, is to take the angles to G and 2, and give the heights of instruments 1 B and whatever other it will make by sighting to 2. This may not appear incorrect, but a glance at the sketch will show its inaccuracy.

Still another plan, and as with the rest, above mentioned, at fault, is occasionally used. By placing the height A C to the vertical height obtained by sighting B D. This mode on heavier pitches requires plumbing, etc., in order to find the point of intersection at C which can not be done without assistance, and is dangerous, in fact, almost an impossibility.

If anything the engineer desires to complete his work quickly, as on a slope there is no time and it is no place to be reaching unnecessarily about on pitches of 60° to 80°, and even as great as 83°, an instance of which I know, nor is it pleasant to be grasping a rope or rail on such dips in winter, the mercury near zero and ice continually falling, making the work dangerous and difficult.

After thoroughly considering the foregoing methods I evolved a plan to obtain the true vertical angle which worked successfully requiring less labor at the instrument, and also being simple and accurate. An explanation of which is as follows:

Noting the sketch D on the rod marks the "elevation" or height 1 A of the transit, invariably to be taken to the lower telescope because most easily accomplished. Then as the distance 1 2 is 100·0 ft. which I J also equals, and the line B D found to read minus 60° 12′, giving the right angle triangle, A B D with the angle B 90° 00′, perpendicular (A B) 0·35 and the base B D, 100·0 ft. to find the angle at D.

$$\frac{A\ B}{B\ D} = \text{Tang. angle D.}$$

$$A\ B = 9{\cdot}544068$$
$$B\ D = 2{\cdot}000000$$

Tang. angle Corres. 7.544068 = 0° 12′ angle D.

The line B D being—60° 12′ and since this line D is found to be 0° 12′ in excess, of B E the true vertical angle would read—60° 00′, which for 100·0 ft. on the pitch gives the vertical and horizontal distances as 86·6 ft. and 50·0 ft. respectively.

In the other methods of using the "top" telescope, the distance on the same pitch decreases and the angle increasing, the error becomes greater, and on very heavy dips, is considerable.

Therefore, in determining elevations with the upper telescope, great care should be taken, and the plan I have given will be found convenient and accurate.

The Pennsylvania as a Disburser.

The speech of President Roberts at the annual meeting of the Pennsylvania Railroad was interesting in giving a novel and striking idea of the importance to the business interests of the community of a great corporation. The public, except that portion of it employed by the railroads, is apt to regard them as a tremendous concern which simply moves freight and carries passengers and as a great absorber of money. They do not know, or they forget, that the railroad company pays back to the community in cash promptly the larger portion of its earnings in wages, and that it is, besides, a large purchaser of manufactures and a patron of every department of trade. A purchasing agent in this city recently bought for his company some sewing needles and an anchor on the same day. It would be difficult to mention any article of commerce in which a railroad company in its capacity as a consumer does not deal.

In his speech, Mr. Roberts pointed out the extent of the Pennsylvania Railroad's operations as a purchasing and consuming portion of the community. He showed that during the last decade that corporation had absorbed the productions of Philadelphia alone to the extent of \$15,800,000, or at the rate of \$1,500,000 per year. The man or corporation which adds \$5000 per day to the business of his city, and does it for ten years, ought to be cultivated. This sum, it is understood, includes only the money spent in actual improvements—in terminals, wharves, warehouses, shops in the city, &c., which indirectly tend to make further increases in commerce and trade in many directions.

The total expenditures of the Pennsylvania Railroad are, of course, much larger, and, after showing what the road had done for the city, President Roberts took up those figures. In the single year of 1891 the Pennsylvania Railroad expended in this Commonwealth the enormous sum of \$52,000,000, or at the rate of \$1,000,000 per week. There are not three railroads in the United States whose gross earnings are equal to this sum, a fact which, after all, gives but a small idea of the immensity of the Pennsylvania's disbursing capacity, as we believe forty other millions were spent on portions of the line outside the State. The figures do not need elaboration. They demonstrate at once how much and how important a part of the community the Pennsylvania Railroad is, and point out its intimate relations to all matters pertaining to business in a most striking way.

The ultimate effects of these large, constant, and timely expenditures cannot be contemporaneously known or pointed out. We of this generation can only see that they have added largely to the convenience of the public, that they have made the city more accessible to freight shippers, that they have increased our coastwise and foreign trade, that they have added to our manufacturers, and in a hundred ways built up and promoted the stability of the city and Commonwealth. President Roberts and his able lieutenants are to be congratulated on having done so much towards the development of commerce and the promotion of all that tends to a broader and more beneficent civilization.—*Editorial in Philadelphia Press March 10, 1892.*

To Pump Users.

Imitation, it has been well said, is the sincerest flattery, and the makers of the Pulsometer Steam Pump, now known the world over, have therefore much upon which to congratulate themselves. Imitations of the Pulsometer have, within the past half-dozen years, been turned out in growing numbers, but, without exception, they have failed to secure that degree of economy, convenience, and general adaptability to a wide variety of uses for which the genuine Pulsometer has become so justly famed.

Years of practical work with the Pulsometer, under all kinds of conditions and for the most varied uses, have demonstrated the merits claimed for it in the most striking manner, and leave little more to be said in its favor. Carefully conducted expert tests, moreover, made within the past year at Stevens Institute of Technology, one of the foremost engineering schools, have given figures for economy of performance of the Pulsometer which firmly establish it in its high rank of excellence among that class of water raising machinery with which it was designed to compete, and have entirely wiped out the erroneous impression, held by some, that it is an uneconomical machine in point of steam consumption.

The test figures show that the performance of the Pulsometer ranges considerably above the performances of the average of the direct-acting steam pump, and its efficiency further is maintained steadily and uninterruptedly, and will not, after a comparatively short period of use, come down to a low notch, as is the case with most direct-acting pumps.

There is nothing to wear out in the Pulsometer that cannot in a few minutes, at an insignificant cost, and without removing the pump from its postion, be replaced; no leakage of valves, plungers, pistons, staffing boxes, and the like—and hence its unique position in point of excellence of performance and durability.

As regards cost, the Pulsometer defies the competition of other pumps of the same rated capacities. Its cheapness and freedom from complicated mechanism at once commend themselves, even to the most inexperienced, and to those desiring simple pumping machinery capable of handling large quantities of water or other liquid, with the least trouble and expense.

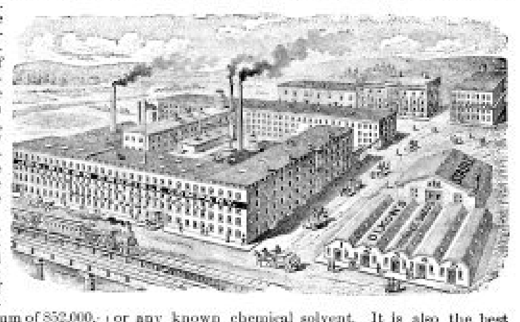
The Graphite Industry.

The graphite industry is fittingly represented by the company whose founder first gave it birth.

The Joseph Dixon Crucible Co., Jersey City, N. J., was founded by Joseph Dixon in 1827, who, at that time began the manufacture of black lead crucibles and completely revolutionized the crucible business. All crucibles used at the present day for melting brass, steel, copper, gold, silver, nickel, etc., are made of blacklead (the common name for graphite), and by the Dixon process.

The Dixon company have not only been progressive, but they have been aggressive, and have pushed their goods into all parts of the civilized world. During the past year they made extensive changes in their factories, and we take pleasure in showing by the illustration below the main works and offices located in Jersey City. Their graphite mines are at Ticonderoga, N. Y., and their cedar mills are at Crystal River, Fla.

The nature of graphite, sometimes called plumbago, or blacklead, is not generally understood; and therefore its great value in the mechanical arts has not been fully appreciated. Graphite is one of the forms of carbon. It is not affected by heat, cold, acids, alkalies



or any known chemical solvent. It is also the best solid lubricant known to science, a remarkable conductor of heat and electricity. The peculiar qualities of graphite have given it a wide range of usefulness. It is used in the manufacture of lubricants for all purposes, crucibles, stove polish, lead pencils, foundry facings, electrotyping, graphite, graphite paint, etc.

The Dixon Co. are miners as well as importers of graphite in all its forms, and use no graphite that they do not mine or prepare. Their mines are located in Ticonderoga, N. Y., and they have every facility in the way of chemists and expensive machinery, etc., necessary for completely freeing the graphite from the silica, sulphur, and other impurities which it contains when it comes from the mines.

The company's illustrated catalogue of graphite productions is an interesting pamphlet and well worth reading. It is sent free on application.

Rope Haulage and Rope Transfer.

It may be interesting to know what the Trenton Iron Company are doing in the wire rope tramway business, in addition to the line which they have just so successfully built for the Holy Moses Mine in the New Creede district. They have received the following contracts: One line for the Amethyst Mining Company in the Creede Camp, having a length of 8,250 feet, and a capacity of 200 tons per day; another line of 5,150 feet for the Smuggler Union Mining Company in Ouray, Colo., with a capacity of 200 tons per day, and another line for one of the Haggin Mines in Guanacevi, Mexico, having a capacity of 100 tons per day, and a length of 5,900 feet. They are also under contract for one of their large cable hoists for the Avondale Stone Company, of Pennsylvania, and have just completed a duplicate one for the Passaic Quarry Company, of Paterson. They are about to duplicate the big cable transfer over the Susquehanna at Williamsport; and are now constructing an additional 800 tons per day tramway for the Pennsylvania and West Virginia Coal Company, in West Virginia, and another for the transportation of colm for the St. Bernard Coal Company, of Kentucky, and also a large haulage plant for the Croton Falls Magnetic Iron Ore Company, near Brewsters, N. Y.

Correspondence

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ *Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.*

Mensuration.

Editor Colliery Engineer:

SIR:—Will some of your readers kindly answer the following question:

One evening I chanced with a tinman to sit,
Whose tongue ran a great deal too fast for his wit;
He talked of his art with abundance of mettle,
So I asked him to make me a flat-bottomed kettle;
Let the top and the bottom diameters be,
In just such proportion as five is to three;
Twelve inches the depth I propose and no more,
And to hold in ale-gallons* seven less than a score.
He promised to do it and straight to work went,
But when he had done it he found it too scant;
He altered it then but too big he now made it,
For though it held right the diameters failed it;
Thus making it often too big and too little,
The tinman at last quite spoiled his kettle;
But he vows he will bring his said promise to pass,
Or he'll utterly spoil every ounce of his brass.
Now, to save him from ruin, I pray find him out
The diameter's length, for he'll never do it, I doubt.

*Ale-gallon = 282 cubic inches.

Yours, etc.,
L. P. H.

Avoca, Pa., Feb. 11th.

The Siphon.

Editor Colliery Engineer:

SIR:—In answer to "S. U. P.," in the January issue, I would say that the quantity of water delivered per minute is about 30 gallons (U. S.). See THE COLLIERY ENGINEER Pocket-Book for table; for 2″ pipe look on page 110, in upper right hand column. Then

$$30 \times 60 \times 4 = 7200 \text{ gallons in four hours;}$$

this being 75% of the total quantity we have 7,200 + 2,300 = 9,500 U. S. gallons made in 24 hours.

If "S. U. P." wishes to make the calculation, I know of no better formula than Hawsley's, viz.:

$$\text{Imperial Galls.} = \sqrt{\frac{(15\ d)^5 \times H}{L}}$$

Where
d = diameter in inches.
H = head of water in feet.
L = length of pipe in yards.
Galls. = gallons per hour.

This only leaves 100 U. S. gallons in the 24 hours difference between the two formulæ.

Yours, etc.,
J. V.

Punxsutawney, Pa., Feb. 15th.

Speed of Fans.

Editor Colliery Engineer:

SIR:—The barometer reads 29·5° where a fan is making 40 revolutions per minute, if the barometer suddenly falls to 28·5° would the fan travel faster (owing to diminished density) or otherwise, the power remaining the same?

Would some of your able correspondents kindly answer the above question?

Yours, etc.,
C. A.

Broadford, Pa., Feb. 3d.

Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following in reply to "Carbon," of Lemont Furnace, Pa., in the January issue:

The quantity will be in proportion to area, thus—

$$6{,}250 : 22{,}500 :: 25 : x, \text{ or } 58 \text{ sq. ft. area.}$$

Yours, etc.,
T. K.

Mt. Olive, Ill., Feb. 10th.

Gas in Siphon Pipe.

Editor Colliery Engineer:

SIR:—Will you please publish the following, that some of your able correspondents may express their views:

A siphon is laid in a mine, and it is found that after running several hours it "cuts off." There is little or no leak in the pipe, which on being uncoupled at or near the summit, and a lamp held near the pipe to see if there is any obstruction, a gas is fired, and the pump being on the inner or feed end is started. The gas burns at end of pipe until water forces the gas all out. Now, what kind of gas is it, and how can the difficulty be avoided; or, in other words how can the gas be removed from pipe while still running so as to prevent stoppage of siphon?

It has been claimed by some that an air chamber at summit and two valves, one below chamber and one above, so as to have a space above pipe for the gas and air to accumulate in, and then, by closing the lower valve and opening the upper one it would escape. Would this be effective? State reasons *pro* and *con.*

Yours, etc.,
S. U. P.

Lawsonham, Pa., Feb. 16th.

Mechanics.

Editor Colliery Engineer:

SIR:—I submit the following in answer to Thomas M. Brown, of Pinckneyville, Ill., in your last issue:

Let,
A = area of cylinder in sq. inches.
D = diameter of piston in inches.
P = average pressure of steam in lbs. per sq. in. in cylinder.
S = length of stroke in feet.
R = number of revolutions per minute.

Then, we have the following formula:

$$\frac{2\,A\,P\,R\,S}{33{,}000}, \text{ or } \frac{A\,P\,S\,2\,R}{33{,}000} = \text{H. P.}$$

Substituting values, we have

$$\frac{2 \times 20^2 \times {}^{\cdot}7854 \times 44 \times 6' \times 20}{33{,}000} = \frac{3{,}317{,}529{\cdot}6}{33{,}000} =$$

100·5, the horse power of the engine.

Yours, etc.,
L. P. H.

Avoca, Pa., Feb. 11th.

Mathematics.

Editor Colliery Engineer:

SIR:—Please publish the following in reply to question by "F. W.," of Duncan P. O., Pa., in your last issue:

A shaft 12′ in diameter was measured by a rod the exact depth of the shaft, and on leaning it over against the other side, thereby forming the hypothenuse of a right-angled triangle, it lacked one inch of reaching the top, what is the depth of the shaft? Please explain fully.

Let x = the depth of the shaft in feet, it will also equal the hypothenuse of the right-angled triangle formed; $(x - \frac{1}{12})$ will equal the perpendicular of the triangle, and as the square of the hypothenuse equals the sum of the squares of the other two sides, we have

$$x^2 = (x - \tfrac{1}{12})^2 + 12^2, \text{ or}$$

$$x^2 = x^2 - \tfrac{1}{6}\,x + \tfrac{1}{144} + 12^2,$$

transposing

$$x^2 - x^2 + \frac{x}{6} = 144 + \tfrac{1}{144},$$

collecting and solving

$$x = 6\,(144 + \tfrac{1}{144}) = 864'\ 5'',$$

depth of shaft.

Yours, etc.,
W. J.

South Fork, Pa., Feb. 16th.

Ventilation.

Editor Colliery Engineer:

SIR:—In THE COLLIERY ENGINEER of June, 1891, there is published the following question: "A fan running at 40 revolutions per minute, produces 60,000 cu. ft. of air per minute, what will the quantity be if the revolutions be increased to 60?" The formula used in solving was:

$$40 : 60 :: 60{,}000 : 90{,}000 \text{ cu. ft.}$$

In January, 1892, this question was given, "A fan making 80 revolutions per minute produces 40,000 cu. ft. of air, how much more would it produce if the revolutions were doubled?" It is worked out by the use of this formula:

$$\sqrt{80} : \sqrt{160} :: 40{,}000 : x, \text{ or } 56{,}445\tfrac{1}{2} \text{ cu. ft.}$$

Now, as the questions are similar, I would like to know which of the two formulæ is the right one to use for such examples? Please explain fully.

Yours, etc.
J. E. J.

Duryea, Pa., Feb. 15th.

Mensuration.

Editor Colliery Engineer:

SIR:—I submit the following in answer to second part of "Trackman's" question, which appeared in the October issue; the first part having been answered by others: A tree 80′ long, 6′ diameter at butt end, tapers to 1′ diameter, how long a rope will it take to coil around it, the coils to be close together, also how long will the rope have to be, allowing 12″ between coils?

We may liken the circumference of the tree to a series of right-angled triangles, with bases decreasing from 18·8496′ to 3·1416′ with an altitude of 1′. The length of rope required to go around one section will be the hypothenuse of the triangle, and for the tree it will be the sum of the hypothenuse of the 80 sections.

From the end diameters the mean diameter is found to be 3½′. Then,

$$3\tfrac{1}{2}' \times 3{\cdot}1416' = 10{\cdot}9956, \text{ the mean circumference;}$$

and by using the following formula we find the required length:

$$\sqrt{10{\cdot}9956^2 + 1^2} \times 80 = 833{\cdot}27832'.$$

Yours, etc.,
J. E. M.

Duncan, Pa., Feb. 15th.

A Suggestion.

Editor Colliery Engineer:

SIR:—I notice in the Inspectors' report for 1890, that Ex-Inspector Austin King has not corrected the error he made in 1889, but assumes that some parties holding first grade certificates are not qualified according to law. This is, no doubt, correct; yet, there are others whom he failed to mention who have labored for years in gaseous mines. I would suggest that Mr. King publish the names of all the first and second class certificated men, and let the public see who the impostors are. The Board appointed by the proper authorities granted the certificates. If there are men who obtained first grade certificates under false pretenses the law will deal with them. If Mr. King has not the names Mr. D. H. Thomas, his successor, can furnish them.

Yours, etc.,
FAIR PLAY.

Rimersburg, Pa., Feb. 9th.

Siphon.

Editor Colliery Engineer:

SIR:—Please insert the following in reply to "S. U. P.," of Lawsonham, Pa., whose question appeared in the February number:

"A siphon 550′ long and 2″ in diameter has a lift of 8′ from sump to summit, and 25′ fall from summit to discharge. What will be the volume of water discharged per minute? The water is allowed to accumulate 14 hours, and the siphon will run off this head, in addition to the water made while running, in 4 hours. Now, what is total amount of water conveyed in 18 hours. This being 75% of water made, what will be the total amount for 24 hours?"

Now, using Eytelwene's formula,

$$W = \sqrt{\frac{D^5 \times H}{L}} \times 4{\cdot}71.$$

When
D = diameter of pipe in inches.
H = head of water in feet.
L = length of pipe in feet.
W = cubic feet of water discharged per minute.

To those who do not understand what is meant by "head of water," as used in this formula, I would say it is the vertical difference between the lift and discharge. Now, in this question, we have a lift from sump to summit of 8′, and from summit to discharge a fall of 25′.

Then

$$25' - 8' = 17' = \text{H}.$$

$$W = \sqrt{\frac{2^5 \times 17}{550}} \times 4{\cdot}71 = \sqrt{\frac{32 \times 17}{550}} \times 4{\cdot}71 =$$

$$32 \times 17 = 544,\ 544 \div 550 = {}^{\cdot}9890909090.$$

$$\sqrt{{}^{\cdot}9890909090} = {}^{\cdot}99448.$$

$\cdot99448 \times 4{\cdot}71 = 4{\cdot}684 +$ = the number of cubic feet of water discharged per minute, and

$4{\cdot}684 \times 60 = 281{\cdot}04$ cubic feet of water discharged per hour.

Judging from the nature of the question, the siphon runs 4 hours out of every 18. In one hour it discharges 281·04 cubic feet of water, in 4 hours it will discharge 281·04 × 4 = 1124·16 cubic feet, being the amount of water conveyed in 18 hours, this being 75% of water made in 18 hours, to find total amount made we will solve it thus: 75% : 100% :: 1124·16 : 1498·88. This is the total amount of water made in 18 hours. To find the total amount made in 24 hours, we use the same rule.

$$18 : 24 :: 1498{\cdot}88 : 1998{\cdot}5.$$

Yours, etc.,
J. N. K.

Mansfield Valley, Pa., Feb. 14th.

Ventilation.

Editor Colliery Engineer:

SIR:—Please publish the following in answer to "S. U. P.," of Lawsonham, Pa.:

It is not the raise and dip of a mine that will make so large a difference in the ventilation as friction resistances. The velocity of the large mine is 4·08 times that of the small mine, and the frictional resistance increases as the square of the velocity.

For the first mine, we have 6′ × 9′ = 54 sq. ft., area at inlet; area of furnace = 8 × 6 × ·7854 ÷ 2 = 18·84 sq. ft.; and 10,000 + 15,000 ÷ 2 = 12,500 cu. ft., the average amount of air passing through the large mine. Then, $q \div a = v$, or 231·4′ at inlet, leaving a velocity of 663·4′ per minute at furnace.

The area of inlet of second mine = 5′ × 7′ = 35 sq. ft., and 2,500 + 4,000 ÷ 2 = 3,250 cu. ft. of air, the average amount of air passing through small mine. Then $q \div a = v$, or 92·8′ at inlet, with a velocity of 162·5′ per minute at furnace. Now, $v \div v = D$, or 663·4 ÷ 162·5 = 4·08 times greater velocity at large furnace than at small one; also, $v \div v = D$, or 231·4 ÷ 92·8 = 2·5 times greater velocity at inlet at large mine than at small one.

Yours, etc.,
RICHARD LEWIS.

Gosford, Armstrong Co., Pa., Feb. 15th.

Thin-Coal Mining in Missouri and Kansas.

Editor Colliery Engineer:

SIR:—With reference to Messrs. Winslow & Gluck's very interesting paper on the above subject, in March COLLIERY ENGINEER, I should like, with your permission, to ask the authors for a little further information on one or two points that bear directly upon the practical mining of these thin coal seams:

FIRST. It would be useful to know the *details of the sections of the seams*, together with a description of the *cleat* or "*face and butt*", if any; and what effect this cleat has upon the digging of the coal: the all-round or "circle system" of working indicating, as I consider it does, that there is no well-defined system of joints in these coals.

SECOND. Fig. 3 shows that all the coal has been removed from around the foot of the hoisting shaft—that no shaft-pillar has been left. The air shaft-also, is upon the gob. Will the authors please inform us what the practical effect was upon the shafts owing to no pillars being left; *i. e.*, how much did they subside; were they pulled out of plumb; how long did it take for them to become quite settled after coal was mined out around them; were the gobs packed or filled up solid from the start; was the coal got out around them from them outwards, or towards them from a short distance away?

THIRD. To what scale is plan Fig. 2 drawn?

FOURTH. Does the $5.00 a running yard said to be paid for removing coal in entrywork in pillars, mean for *coal only*, the floor-lifting being extra?

FIFTH. What is about the *average thickness of brushing* in the "short room ways"?

SIXTH. Please give the *dimensions of screens* used at Leavenworth Mines.

SEVENTH. A description of the "sled-like buggies" used where roofs are weak, would be of interest; and are they run upon the bare floor of the working-place, or upon boards, or what?

EIGHTH. Should like to be informed as to *nature and extent of surface settlement* due to mining these thin seams, to which authors make reference.

Yours, etc.,
W. S. GRESLEY.

Erie, Pa., March 23d.

Mensuration.

Editor Colliery Engineer:

SIR:—In answer to "Beginner," of Riverton, Ill., would say I think answer given by me in December issue is correct.

I stated the formula precisely as given by Haswell, but in order to make it plainer for "Beginner," I herewith give answer and process of finding same:

$1 + 6 = 7 + 2 = 3·5 \times 3·1416 = 10·9946 \times 80 = 879·57$, and

$879·57 \times 879·57 = 773643·3849 + (80 \times 80)$, or $6400 = 773707·3849$ and $\sqrt{773707·3849} = 879·65$ feet.

The following formula, perhaps, would be plainer than one given in December:

$$\sqrt{(6 + 1 + 2 \times 3·1416 \times 80)^2 + 80^2} = 879·65'.$$

James Payne, of Adger, Ala., solves the question in January issue, giving same answer.

Yours, etc.,
H. L. D. W.

Cincinnati, Ohio, February 16th.

The Siphon.

Editor Colliery Engineer:

SIR:—Will you please insert the following reply to the question regarding the siphon, in your February issue, by "S. U. P.":

The flow of water disregarding friction is due to the difference of level between the ends of siphon which in this case is 17 ft., and now according to the laws of falling bodies—square root of twice the product of the gravity and space fallen through is equal to the velocity in feet per second;

$\sqrt{2 \times 32 \times 17} = 32·241$ ft. per second, and the amount of water flowing is equal to the area of the pipe times the velocity per second

$2^2 \times ·7854 = 3·1416$ area of pipe.

Then, $3·1416 \times 32·241 \times 12 = 1215·196$ cu. in. per second—which converted to gallons of water per hour equals

$$\frac{1215·196 \times 60 \times 60}{276} = 15850·382 \text{ gallons per hour.}$$

And as the siphon ran off all the water made in 18 hours in 4 hours, the total amount of water made in 18 hours $= 15850·382 \times 4 = 63200·152$ galls. of water ran off in 4 hours and made in 18 hours. This being 75% of what was made in 24 hours, therefore, $63200·152 \div ·75 = 84266·869$ gallons made every 24 hours. The above is theoretically, the quantity made and ran off by siphon. But taking friction the quantity is considerably reduced. Considering friction we have the following formula to compute the flow of water through pipes:

$$48\sqrt{\frac{D \times H}{L + 54\ D}}$$

Let D = diameter, H = head, and L = length of pipe; placing the value in the above formula we have

$$48\sqrt{\frac{\frac{1}{6} \times 17}{55 + 54 \times \frac{1}{6}}} = 48\sqrt{\frac{\frac{17}{6}}{559}} =$$

$$48\sqrt{\frac{17}{6} \div \frac{559}{1}}, \text{ or } 48\sqrt{\frac{17}{6} \times \frac{1}{559}} =$$

$\frac{197·9088}{57·913} = 3·417 \times 12 = 41·004$ ins. = velocity per second.

As stated in the first solution the quantity of water is equal to the area of the pipes times the velocity of second, which is

$3·1416 \times 41·004 = 128·8181664$ cubic inches per second, and taking 276 cubic inches to the gallon we have

$$\frac{128·8181664 \times 3,600}{276} = 1680·2369 \text{ gallons,}$$

per hour and $1680·2369 \times 4 = 6720·9476$ gallons ran off in four hours, which is the whole water made in 18 hours and 75% of water made in 24 hours which will be

$$\frac{6720·9476}{·75} = 8961·2635$$

gallons made in 24 hours.

Yours, etc.,
M. D. R.

Kingston, Pa., February 20th.

The Utilization of Electricity.

Editor Colliery Engineer:

SIR:—The object of your valuable journal being "the education of your readers in everything relating to mining," and as electricity is likely to become a great power in the near future in mining, as in almost every other branch of industry, information as to generating, accumulating, and storing electricity would be quite "*apropos*."

Being an old miner myself (but not at present employed in the mines), and although but a new subscriber, still I am greatly interested in your journal, and would like to ask through your columns, if some of your numerous and able correspondents, many of whom are, no doubt, *au fait* in the *modus operandi*, would advise me as to the following idea:

I am running a plant here with a Westinghouse compound engine, the main driving belt, 24'' wide, has a velocity of nearly 5,000' per minute, generating in the immediate vicinity of the pulleys, a great amount of electricity. My idea (Quixotic perhaps) is that this electricity could be utilized in illuminating the engine and boiler rooms, if it were possible to accumulate and store it. As I have no knowledge, theoretical or practical, of the application of electricity to practical purposes, I would be glad if some of your readers would inform me, if, in their opinion, there is sufficient electricity developed, under the above conditions, to run one or more lights, arc or incandescent, and if so, how it could be accumulated and stored and what appliances I would require.

Yours, etc.,
EDWARD HALPIN.

Allegheny City, Pa., February 18th.

Mechanics.

Editor Colliery Engineer:

SIR:—I submit the following answer to the question asked by "F. W.," in your February issue: "A shaft 12' in diameter was measured by a rod the exact depth of the shaft, and on leaning it over against the other side, thereby forming the hypothenuse of a right angle triangle, it lacked one inch of reaching the top, what is the depth of shaft?"

Let x represent the depth of shaft from the point where the rod came in contact with the other side.

Now $x^2 + 144^2$ is equal to $(x + 1)^2$,

Or $x^2 + 144^2 = x^2 + 2x + 1$.

Or by cancelling the x^2 on both sides we find

$144^2 = 2x + 1$.

Transposing we have $144^2 - 1 = 2x$,

Then

$$x = \frac{144^2 - 1}{2},$$

or 10367·5 inches = perpendicular.

To prove the above solution we will find the depth of the shaft from the above data, the base of the shaft is given as 144 inches, and we have found that the perpendicular or the side of shaft from the point where the rod came in contact with it, to be 10367·5 inches.

Now,

$\sqrt{10367·5^2 + 144^2} = 10368·5$ inches equal to length of rod and depth of shaft. Trusting that it is fully explained, I remain

Yours, etc.,
M. D. R.

Kingston, Pa., Feb. 20th.

Mensuration.

Editor Colliery Engineer:

SIR:—Would some of your able correspondents kindly inform me how to change the rise per yard measured on pitch to degrees and *vice versa*. For instance.

(1.) An incline pitches 8°, what is the rise per yard of incline?

(2.) An incline is 33 yards long, and rises 9'' to the yard, what is the degree of divergence?

Please give rule without having to use tables of sines, etc.

Yours, etc.,
J. V.

Punxsutawney, Pa., February 21st.

Ventilation.

Editor Colliery Engineer:

SIR:—In "L. P. H.'s" answer to "Carbon's" question, in the January issue, I beg to state that he makes the area too small, it should be about 124 sq. ft. "L. P. H." is all right as far as he goes, but he should also take the rubbing surface of the 90' area, and the rubbing surface of the 25' area and proportion them thus:

$$\sqrt{20} : \sqrt{38} :: 90 : 124.$$

If "L. P. H." will work out the formula

$$\frac{k\,s\,v^2}{a}\ g = u,$$

he will find u to be larger for the 90' area than for the 25' area, but for 124' area, supposing them all square, he will find that for the quantities mentioned, that u is about the same. Taking the length as 1,000', u = nearly 6,800.

Yours, etc.,
J. V.

Punxsutawney, Pa., February 21st.

Mathematics.

Editor Colliery Engineer:

SIR:—In answer to "F. W.," of Duncan P. O., Pa., would say that if the rod on measuring the shaft, was placed close to the side, then leaned over to the other side, as described, the shaft would be $864\frac{1}{24}'$ deep.

The 12' diameter would equal the semi chord, the inch short on the rod would equal the rise, and the depth of shaft the radius. The rule for working out such a problem is to square the semi-chord, divide by the rise, to quotient add the rise, and, then, dividing by 2 gives the radius. (See The Colliery Engineer Pocket Book, page 9, and 9th rule on page.)

Then,

$12^2 = 144$, and $144 \div \frac{1}{12} = 1728' + 1'' = 1728\frac{1}{12}'$ and $1728\frac{1}{12}' \div 2 = 864\frac{1}{24}'$ = depth of shaft.

Yours, etc.,
J. V.

Punxsutawney, Pa., February 21st.

The Siphon.

Editor Colliery Engineer:

SIR:—I offer the following solution to question by "S. U. P.," in the February issue:

A siphon 550' long and 2'' in diameter has a lift of 8' from sump to summit, and 25' fall from summit to discharge, what will be the volume of water discharged per minute?

Using Eytelwein's formula:

D = diameter of pipe in inches.
H = head of water in feet.
L = length of pipe in feet.
W = cubic feet of water discharged per minute.

$$4·71 \times \sqrt{\frac{D^5 \times H}{L}},\quad \sqrt{\frac{32 \times 17}{560}} \times 4·71 = 4·71$$

cu. ft. discharged per minute, and

$$\frac{4·71 \times 7·48}{231} = 35·23$$

gallons per minute.

The water is allowed to accumulate 14 hours and the siphon will run off this head in addition to the water made while running in 4 hours, thus making 18 hours water run off in 4 hours, what is total amount of water conveyed in eighteen hours?

If the siphon discharges 35·23 gallons of water per minute, it will discharge $35·23 \times 60 \times 4 = 8455·2$ gallons in four hours which is the amount of water conveyed to sump in 18 hours?

This being 75% of water made what will be the total amount for 24 hours.

$$\frac{8455·2 \times 100}{75} = 11274 \text{ gallons nearly,}$$

$$\text{and } \frac{24}{18} \times 11274 = 15028·24 \text{ gallons in 24 hours.}$$

Yours, etc.
A. B.

Oakwood, Vermillion Co., Ill., March 5th.

Ventilation.

Editor Colliery Engineer:

SIR:—I submit the following in reply to "Alberto," Wall, All'y Co., Pa.,—question No. 2: He wants to know, if the pressure at entrance of air-way 4000' long with 4000' return is indicated by W. G. to be 0·5, what it will be if taken 2000' farther in, he also wants a rule to find the pressure at any given distance. In the first place the difference indicated by W. G. is caused by the air rubbing against the surface exposed in its travel from the time it enters the mine until its exit, and the pressure is increased or decreased in proportion to the surface exposed, the velocity remaining the same. We therefore have in this case an example in the following proportion, $4000' \times 2 - 2000' = 6000'$. Therefore as $8 : 6 :: 0·5 : x$, or $0·375$ = pressure 2000' farther in. For rule explaining fully the friction of air in mines, I would refer Alberto to THE COLLIERY ENGINEER pocket book, page 74.

Yours, etc.,
T. K.

Mt. Olive, Ill., March 16th.

Specific Gravity of Gases.

Editor Colliery Engineer:

SIR:—Will some of your readers kindly give rule for finding the specific gravity of the different gases? Please explain fully.

Yours, etc.,
MINER.

Uniontown, Pa., March 16th.

Safety-Lamps.

Editor Colliery Engineer:

SIR:—Please insert the following question in your next issue:

What effect will it have on a safety-lamp to increase the size of the wire in the gauze three times?

Yours, etc.,
MINER.

Uniontown, Pa., March, 16th.

Ventilation.

Editor Colliery Engineer:

SIR:—Will you please insert the two following diagrams, that some of your correspondents may make

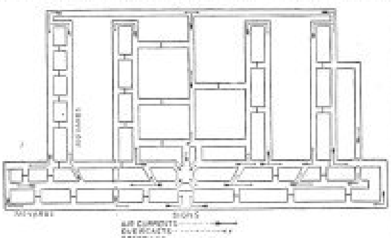


FIG. 1.

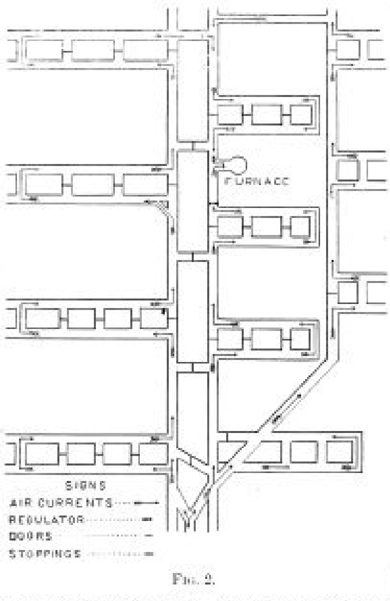


FIG. 2.

any suggestions whereby the system of ventilation can be bettered, and point out any faults?

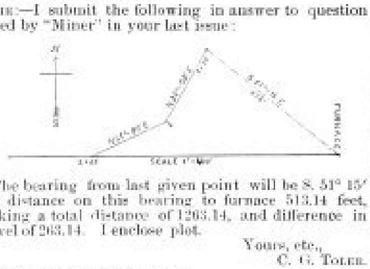
Yours, etc.,
C. D. R.

Hope Church, All'y. Co., Pa., March 5th.

Surveying.

Editor Colliery Engineer:

SIR:—I submit the following in answer to question asked by "Miner" in your last issue:



The bearing from last given point will be S. 51° 15′ E.; distance on this bearing to furnace 513.14 feet, making a total distance of 1263.14, and difference in travel of 263.14. I enclose plot.

Yours, etc.,
C. G. TOLER.

Coalburg, Ala., March 18th.

Miscellaneous Questions.

Editor Colliery Engineer:

SIR:—It will interest me very much to read answers to the following questions:

1. How would you timber a drift through quicksand?
2. Where would you leave the strongest pillars in synclinals or on anticlinals?
3. What size would you dig a mine drain to convey 300 gallons per minute with a fall of 2″ to 100′?
4. When a miner asks you for work at the mines, by what are you guided in deciding upon his qualifications for the position applied for?
5. In opening up a new coal field, by what are you guided in locating the shaft, slope, or drift?
6. Make the necessary calculations on the following mine survey:

1. Main Heading.
   1. N. 16° 9′ E. 203′ to 1st Right. 2. N. 25° 3′ E. 300′ to 2d Right. 3. N. 18° 13′ E. 275′ to 3d Right. 4. N. 20° 38′ E. 300′ to 4th Right.
2. First Right Entry.
   1. S. 80° 10′ E. 604′. 2. S. 84° 25′ E. 900′.
3. Second Right Entry.
   1. S. 84′ E. 700′. 2. S. 80° 1′ E. 750′.
4. Third Right Entry.
   1. S. 75° 10′ E. 1100′ S. 81° 52′ E. 400′.
5. Fourth Right Entry.
   1. S. 85° 55′ E. 1300′.

It is desired to drive a heading from a point which is 1400′ due east from the pit mouth or starting point of the survey to a point which is 10′ back from end of 4th Right, thus crossing the intervening entries. Give points in each and direction by angle both ways, that workmen may work both ways in each entry and have the work all in a straight line.

Yours, etc.,
WILLIAM HIBBS.

Scio, Ohio, Feb. 29th.

Ventilation.

Editor Colliery Engineer:

SIR:—In your March issue Peter Jeffrey is right in regard to his criticism of the comparative amount of air we obtain when we double the speed of the fan. This question was answered in January issue as follows:

$$\sqrt{80} : \sqrt{160} :: 40{,}000 : x, \text{ or } 56{,}445\tfrac{1}{2}$$

or if we double the number of revolutions of the fan we would only obtain an increase of air from 40,000 to 56,445½ cu. ft. This is worked out from the equation

$$Q = \sqrt{\frac{a^3 p}{k s}},$$

showing the quantity to vary as the pressure. But the question is not, if we double the pressure, but, "If we double the speed of the fan."

Now if we refer to the equation of a straight paddle fan we find the pressure varies as

$$n^2 \times \sqrt[3]{n^2};$$

and also the quantity supplied by such a fan varies as the expression

$$n \times \sqrt[3]{n}.$$

Hence we see if we double n we would obtain

$$2\sqrt[3]{2} \text{ or } 2.52$$

times the quantity of air; and

$$4\sqrt[3]{4} \text{ or } 6.348$$

times the pressure. But this formula has yet to be corrected for the increase of resistance in the fan due to increase of speed which will bring the quantity down to about double, for double the speed. But it cannot reduce it down to the mere fractional increase shown in the January issue.

Yours, etc.,
J. T. BEARD.

Ottumwa, Ia., March 15th.

Ventilation.

Editor Colliery Engineer:

SIR:—In the February issue of THE COLLIERY ENGINEER there appears an answer to a question of "A. B.'s," of Hanna City, Ill., by "N. S.," of Dagus Mines, Pa. The question being, an air-way 8′ × 8′ × 1,000′ is passing 40,000 cu. ft. of air, what diameter should a circular air-way 1,200′ long be to pass one-half the quantity, the pressure remaining the same?

"N. S." works this question by finding the relative lengths of an equivalent air-way which are found to be 8195′ and 2430′ respectively, and concludes by saying, "Therefore, a = 37·5 and o = 21·7 for the circular air-way, the diameter of which is 6′ 11″." I would like to have "N. S." show more plainly where he gets the 37·5′ area and the 21·7′ perimeter as it is not clear enough for myself and a number of your readers.

I feel much gratified for the several answers to this question that have appeared in your paper by your correspondents, as I was inclined to think there was not sufficient data given by which to work it, and now find it can be worked by several methods.

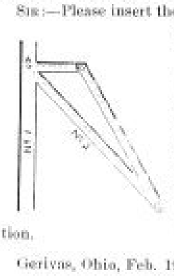
Yours, etc.,
T. S. CUMMING.

Gardner, Ill., March 5.

Mensuration.

Editor Colliery Engineer:

SIR:—Please insert the following in your journal that some of your correspondents may answer:



In the sketch, No. 1, represents the main gangway of a mine, a breast A B is opened off from it at right angles and is 25 yards long. From B it runs to C a distance of 75 yards and at an angle of 60°. At C it intersects gangway No. 2, now what is the length of No. 2, or from A to C, and what is the angle? Please give a plain and simple solution.

Yours, etc.,
JOHN CATAR.

Gerivas, Ohio, Feb. 19th.

Fans in Mining.

Editor Colliery Engineer:

SIR:—Will "T. S. C.," of Gardner, Ills., who answers so ably the questions of "E. R.," of Hopwood, Pa., relative to the above subject in the February issue of THE COLLIERY ENGINEER tell us farther what water-gauge he will have in the mine in question into which he furnishes 40,000 cu. ft. of air per min. by a fan 11·13 ft. diameter.

And also, assuming the area of the entry or air-way to be 50 sq. ft. or its size 6′ × 8⅓′ giving a perimeter of 28⅔ ft., what would the length of the air-way be, allowing for the purpose of discussion that the shaft offers no resistance to the current?

And, also why does he mention no breadth of blades or temperature, or barometric pressure, all of which play a certain part or enter as factors into the problem.

This is not asked as a catch question, but to lead to a legitimate discussion of the use of the "Equivalent Orifice" as a basis of comparison of different Mines. We believe it is wholly dependent upon a variable quantity and is therefore unreliable as a base of comparison unless the temperature and barometric pressure are mentioned.

Yours, etc.,
J. T. BEARD.

Ottumwa, Ia., March 15th.

A Problem in the Development of Coal Lands.

Editor Colliery Engineer:

SIR:—I would be pleased to have some of your able correspondents consider the following questions: There are two bodies of soft coal, each containing 500 acres of the same coal seam. The first body of coal is 500 feet vertical above railroad grade, and can be developed for working by drift, with incline 1500 feet long which would cost $1500.00 to grade. The second body of coal at the point for opening, is 60 feet below the surface or "water level," and 70 feet below railroad grade, and would have to be developed by shaft or slope through overlying strata. This 60 feet covering is half ordinary sandstone and half hard shale or slate. The coal seam in each case is 5 feet thick, and dips 3 feet in 100 feet towards the point of opening. It is desired to select one of these bodies of coal for developing to ship 600 tons per day by rail. Assuming all other conditions to be equal, and that the cost of labor and material is the same as is usual in the coal regions of Pennsylvania, which of these bodies of coal is preferable for the purpose?

(2). What would you estimate (roughly) to be the probable difference in the cost of developing and equipping for shipping coal?

(3). Would you develop the second body of coal by shaft or slope? State your reasons for your preference please.

(4). Assuming that both of these bodies of coal were developed and properly equipped, and that the drift mine made 25,000 gallons of water per day, while the other mines would make four times that quantity, all of which could be drained to the opening, but in the latter case would have to be lifted by pump to the surface, 60 feet; what would you estimate would be the difference in the cost of operating said mines per day?

Yours, etc.,
H. J.

Charleston, W. Va., March 19th.

The McAlester Explosion.

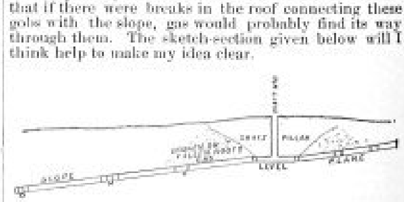
Editor Colliery Engineer:

SIR:—It seems to me, after reading Mr. Farnham's description or account of this terrible disaster and after looking at his plan of Mines No. 7 and 11 accompanying same, that we have not nearly all the evidence before us here to enable any very reliable opinion being given as to how the men, collected in the vicinity of the downcast or hoisting shaft at the moment of the explosion, came by their deaths, *i. e., what it was that exploded in this particular portion of the pit.*

We are not told the nature of the burns on the poor men's bodies; whether coked dust was or was not found adhering to the timbers or about the head of the slope or between that point and the foot of shaft; or whether the entry, "upper O", here signs of having been filled with flame after the firing of the shots therein at 5.04 P. M.; neither does the report say anything about how clean or how imperfectly the coal was worked out in this—the slope—section of the pit, especially in the neighborhood of the "knuckle". No gas having been found that day is no proof that the mine contained none, by the *mine* I mean the old workings or fallen-in places towards the upper parts of the lifts I and K or immediately to the dip of "main west" gangway.

Now, Sir, it seems to me a not altogether unlikely or improbable thing that the concussion produced by the firing of shots in "upper O" brought out fire-damp from the gobs of old workings near the top of the slope, which exploded at the men's lamps in the main intake within a hundred yards of the shaft.

I don't of course know how the coal was worked in the rooms off I and K entries, but merely beg to suggest that gas possibly lurked in the broken roof of some of these places, which, being the (?) highest point in the slope-district of the mine would not be unlikely to have collected there and ready to be driven or sucked out from any heavy concussion in the air-current. I think that if there were breaks in the roof connecting these gobs with the slope, gas would probably find its way through them. The sketch-section given below will I think help to make my idea clear.



I venture to think that if gas did exist about the point marked "GAS", it was this that blew up and killed the men, rather than any *dust* on the roads, because dampness, wet and mud seem to have been the prevailing condition in the part of the pit affected.

If this letter draw forth any comment or bring out any new facts of this case, the space I hope you will give it in your April issue will not have been occupied to no good purpose.

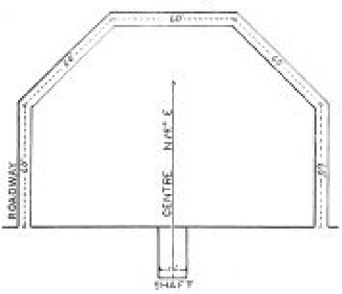
Yours, etc.,
W. S. GRESLEY.

Erie, Pa., March 14.

Surveying.

Editor Colliery Engineer:

SIR:—I desire to drive a roadway from one side to the other of a shaft, in five sections in the form and dimensions of the following diagram:



The shaft is 14′ wide, and each section of roadway is 60′ long and 12′ wide, what would be the distance from center of shaft to center of roadway, and what would be the bearing of each section? The center of shaft is N. 19° East. The roadway to be on North side of shaft.

Yours, etc.,
D.

Wilkes-Barre, Pa., March 2d.

Mathematics.

Editor Colliery Engineer:

SIR:—Please insert the following solution to question by "F. W.," in the February issue:

We have given in the question the chord of an arc of a circle and the height of arc of segment to find radius of the circle.

Then, we can ascertain the depth of shaft thus, the diameter 12′, is half the chord, and the inch equals the height of arc of segment, therefore

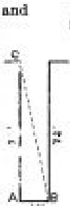
$$12^2 + 1'' = 144 + \tfrac{1}{12} = 1728''$$

and

$$1728'' + 1'' = 1729 \div 2 = 864{\cdot}5'',$$

and

$$864{\cdot}5'' \div 12'' = 72\tfrac{1}{24}', \text{ depth of shaft.}$$



To prove the correctness of the above, I enclose a sketch to represent the shaft. To get rid of decimals we will omit the fraction and call the depth 72′. Then by trigonometry

$\sqrt{AC^2 + AB^2} = BC = 73'$ nearly, and $AB \div BC =$ sine of $C = {\cdot}1642$, or an angle of $9°\ 27'$. Then,

$$90° - 9°\ 27' = 80°\ 33', B;$$

the sine of B is ·9864, and as sine A or 90° : C B :: sine B : C A, or 1 : 73′ :: ·9864 : 72′ depth of shaft.

Yours, etc.,
JOSEPH QUIGLEY.

Westville, N. S., Feb. 16th.

PERSONALS

MR. A. N. HUMPHREYS, of Irwin, Pa., formerly of Wilkes-Barre, Pa., has been appointed General Superintendent of the Westmoreland Coal Company's collieries, shops, etc. Mr. Humphreys was, a good many years ago, a mining engineer in Schuylkill County, and later in Luzerne. For some years past he has been the Westmoreland Company's Chief Engineer.

He has had a great deal of experience in mining and mechanical engineering work, and has erected some fine colliery structures, and designed a great deal of excellent machinery. We do not hesitate in saying that in his present position Mr. Humphreys will manage affairs with much ability as well as profit to the Company.

The Westmoreland is the largest gas coal mining company in this country, shipping coal all along the Atlantic sea board from Maine to Florida, also to Cuba and South America, and exporting it to Europe. The Company owns and has in regular service several thousands of the largest and best railroad cars, and uses besides cars belonging to many railroad companies. The coal is taken off the laterals at the collieries by the Pennsylvania Railroad Company's locomotives and distributed to all other railroads, and it may often be seen passing northward through this city.

The directory of this Company is a most able one, and the executive is very progressive and advanced in ideas and business methods.

MR. THOS. LYNCH, the General Manager of the H. C. Frick Coke Co., (the largest coke company in the world) is a comparatively young man, being considerably on the sunny side of fifty. In stature he is about medium height, squarely built, and has bright blue eyes that flash intelligence and kindliness combined into the faces of those with whom he converses. His hair is dark brown mixed with gray, as is also his full beard which he wears closely trimmed. He resides in a pleasant home in the beautiful town of Greensburgh, at the junction of the Penna. R. R. main line, and the Southwest division.

DR. JOHN C. BRANNER, for several years in charge of the Geological Survey of Arkansas is now connected with Stanford University, Menlo Park, Cal. Dr. Branner is a geologist and engineer of more than usual ability, and withal is a pleasant, cultured gentleman. His contributions to scientific literature, both as an official of the Pennsylvania and Arkansas geological surveys, and as a private writer, rank very high.

MR. ARIO PARDEE, one of the pioneer coal operators of the Lehigh region, died at Rock Ledge, Florida, on Saturday morning March 26th. Mr. Pardee was almost eighty-two years of age and was blessed with remarkable good health throughout his long life. The funeral took place at Hazleton on Wednesday afternoon of the 30th ult., and was largely attended by coal operators from all parts of the state. A sketch of his life will appear in our May issue.

Lunkenheimer's Regrinding Globe Valve.

We present with this a sectional view of a valve that possesses some features of special merit. Instead of the hub being threaded direct to the body of the valve, it is merely fitted into it plain, and rests upon a flange which fits upon the upper edge of the opening, as shown. The hub is then secured by a nut which fits over the flange, and is threaded to the outside of the body of the valve, as shown.

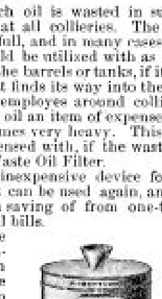
REGRINDING GLOBE VALVE.

The result of this arrangement is that the valve can be reground at any time with the greatest facility, because all that is necessary is to loosen the nut, remove the hub, place a little sand and soap under the disk, and then replace the hub, leaving the nut loose, so that the hub is free to turn with the stem during the grinding. A piece of wire is passed through a hole provided for that purpose in the lower end of the stem and disk, so that the disk will turn with the stem during the grinding, which, of course, it does not necessarily do when in use. The hub being in place when the grinding is done, effectually centers the stem and holds it in proper place, so that the regrinding is done correctly. The valve can thus be readily ground while in position, and in many cases does away with the necessity for breaking connections. The disk is also, of course easily replaced when required. The valves, as a proof of their superiority, are extensively used on locomotives, steamers, and in the United States Navy on cruisers where the requirements are very severe. These valves are made only by The Lunkenheimer Brass Mfg. Co., Cincinnati, O.

Save Your Oil.

It is astonishing how much oil is wasted in supply houses and engine rooms at all collieries. The drip pans are almost constantly full, and in many cases they overflow with oil that could be utilized with as good results as that drawn from the barrels or tanks, if it was not for the dirt and grit that finds its way into the drip pans. The carelessness of employes around collieries makes the loss from wasted oil an item of expense that in the course of a year becomes very heavy. This loss, can be almost entirely dispensed with, if the waste oil is filtered in a Robertson Waste Oil Filter.

This is an ingenious and inexpensive device for reclaiming waste oil so that it can be used again, and its employment will result in a saving of from one-third to one-half in lubricating oil bills.



While exceedingly simple it is very effective. It consists of a galvanized iron tank in which are three movable trays. The top one being of finely woven brass wire gauze, and the two under ones of suitable filtering cloths. The oil being poured in at the top, a spreader on the under side of the lid scatters the oil over the first tray (separating all large refuse), and the oil then passes on down through the filtering cloths into the bottom chamber, thoroughly cleaned of all foreign matter and in a condition to use again. This process can be repeated indefinitely, and the original oil used many times. A siphon is arranged in the filter to automatically carry off water poured in with waste oil, which if not needed can be closed with a plug. The trays being loose, the entire filter can be cleaned in a few minutes. Suitable gauge glass and valves with cock to draw off the oil are arranged in proper portions. Very strongly made it will last many years, and being handsomely japanned and striped is an ornament. It is manufactured and is for sale by Messrs. Hine & Robertson, of 45 Cortlandt Street, New York, who will be pleased to furnish inquirers with testimonials as to its efficiency and economy.

Messrs. Thos. Carlins' Sons, of Allegheny, have just moved their foundry and boiler shop into their new buildings on River Avenue, and have now increased facilities for turning out first class work at reasonable prices. The foundry is 60 ft. × 110 ft., and the boiler shop is 42 ft. × 110 ft. Both built almost entirely of iron, and so arranged with improved traveling and swinging cranes, trolleys, etc., as to ensure most convenient handling of materials. The largest being a 40 ton traveling crane in the foundry. The boiler shop is thoroughly equipped with steam riveter, bending rolls, and numerous punches and shears. The new machine shop is in course of construction, and will be ready for occupancy in the course of a few weeks. The old machine shop, 66 ft. × 88 ft., will be used for warehouse purposes in addition to the present warehouse, which is 24 ft. × 100 ft. This will enable the firm to have such a stock on hand as to ensure immediate delivery. Their railroad facilities are excellent for shipping to all parts of the continent—either by Pennsylvania or Baltimore and Ohio systems.

COLLIERY IMPROVEMENTS.

Colliery Owners, Superintendents, Mining Engineers, Contractors, and others are respectfully requested to inform us as early as possible of all improvements contemplated at their mines. We desire to make this department as complete as possible.—*Editor.*

*** The Sterrick Creek Coal Company, of Peckville, Lackawanna County, Pa., has awarded the contract for sinking the No. 1 or "Old Shaft," from its present depth, 100 ft. deeper to the Clark seam, to Ward & Griffith, of Scranton, Pa. They are also enlarging the area of the old shaft from 22 ft. x 10 ft. to 28 ft. x 12 ft.

They have also started on extensive repairs in the breaker; having torn down the narrow part and the inclined trestle, which will be replaced by a wider screen room and a tower. They are also strengthening the screen room, and altering the jackets on the screens.

In addition to the old machinery, the remodelled breaker will contain a new breaker engine, a new pair of main rolls, two new mud screens, one new center screen, two new main screens, and two new buckwheat screens.

This company was formerly known as The Grassy Island Coal Company. A charter was recently taken out in the name of The Sterrick Creek Coal Company. Mr. James Archbald, Jr., is the superintendent.

*** The Springside Coal Company, of Pana, Ill., contemplates substituting either Rope Haulage, Electric Haulage, or Compressed Air Locomotive for mule haulage in the course of a few months.

*** The Tennessee Coal, Iron and Railroad Company, of Pratt Mines, Ala., has recently contracted the operation of a certain field of coal, situated within a mile of Pratt Mines, to Mr. Charles A. Nolan, which will be known as Slope No. 6. Mr. Nolan is now putting up the necessary machinery, buildings, etc. This slope is really a part of shaft No. 1 and was driven from that place a distance of 6,000 ft. to the outcrop in order to furnish another opening to that part of the mine known as Rock Slope. This is the first instance in the State of Alabama where the entire length of slope has been driven before any side headings were driven off. The drainage from this place will flow through to shaft No. 1 and will be pumped to the surface at the drainage shaft two miles distant.

The company has also contracted the operation of a field of coal near the Blossburgh Mines of The Sloss Iron and Steel Company on the Georgia Pacific Railroad, some 20 miles west of Birmingham, Ala., to Mr. James C. Patterson, who was formerly mine boss of its slope No. 4. The coal can be worked by drift. He is at present opening two drifts, building tenement houses, tipples, etc. The railroad connections are being put in.

A tunnel driven at Slope No. 2 to a drainage shaft, which, when completed, will cause all the water in the mine to flow to the shaft where it will be pumped direct to the surface. At present the drainage of the mine is accomplished by means of 7 pumps operated by compressed air and scattered over the mine. The above arrangement will dispense with all these air pumps.

These improvements are under the supervision of Erskine Ramsay, Esq., Mining Engineer for the T. C. I. & R. Co.

*** The Centralia Mining and Manufacturing Co., of Centralia, Ill., having completed its new shaft 886 feet in depth is about to erect a new headgear and Litchfield engines 24" x 36" with 10 foot drum and sheaves. Plans are also being prepared for the ventilation and haulage plants. Mr. P. Forsythe is Superintendent of this company.

*** The Southern Land Improvement Co., of Pineville, Ky., Mr. J. D. Blake, Gen. Manager, is mining a 36 inch vein of fine gas and coking coal. They are at present considering the installation of an electrical plant for lighting, hauling, and mining. The erection of a disintegrator for crushing and disintegrating the coal before coking is also under contemplation.

*** The Rock Springs Coal Co., of Rock Springs, Wyo., Mr. F. J. Quealy, Manager, contemplates improvements which will double their output at No. 2 Mine, Rock Springs, These include a new hoisting engine and fan, also a re-screener and elevator with storage bins. Another chute will be added to the dump. These improvements will raise the output to 800 tons of lump per day. This mine is especially arranged for the production of commercial coal, and is one of the most completely equipped of the district.

*** The Redstone Oil, Coal, and Coke Co., of Grindstone, Pa., is about to erect a small haulage arrangement for manipulating the mine cars on the surface. The machinery and plant are on the ground and the work is being pushed forward under the supervision of Mr. I. F. Cook, the Superintendent of the company.

*** The H. C. Frick Coke Co. is to the front with a new steel headgear at the Leisenring No. 2 shaft. This is a valuable addition to the plant and is the first girder derrick erected in this district. It was designed by I. H. Paddock, Esq., chief engineer to the Company, and was erected by the Keystone Bridge Co. The shaft is fitted with the Ramsay shifting truck and steam rams for pushing loaded and empty wagons on and off the cages. No. 2 Mine is one of best equipped mines in the neighborhood and is fitted with an underground haulage which although working under the great disadvantage of crooked roads, is still giving excellent results. Two haulage engines are erected at top of the air shaft one in each side, and if anything should happen to either of the engines the other is capable of maintaining the output. One of the haulages is very crooked for over 1700 feet, and gave a great amount of trouble at first but, as is invariably the case where the management is determined and intelligent, these difficulties have now been overcome.

*** The Bell, Lewis & Yates Co., of Buffalo, N. Y., is putting in operation one of the largest mines in the country at Big Soldier Run, near Reynoldsville, Pa. The vein is over six feet thick and the mine is already a large producer. The company are preparing to put in a rope haulage plant and arrangements have been made for a new iron tipple. When these arrangements are completed, which will be within a year, they will be able to turn out six thousand tons of coal per day, making the largest output of any one mine in the country, if not in the world.

The Colliery Engineer.

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THE CO-EFFICIENT OF FRICTION.

If we draw a piece of cotton-waste across a smooth table it seems to travel pretty easily. If we draw the same piece of cotton-waste across an unplaned plank it does not go so easily. It requires a certain power to overcome the resistance or the friction of the rough plank. The extra power thus required is called the co-efficient, or the equivalent of the frictional resistance.

If it requires ¼ of a pound of pressure to pass this cotton-waste over a square foot of plank, it will require ½ a pound of pressure to overcome the resistance of two square feet.

This is the principle which governs the friction of air in mines. *As the extent of the rubbing surface increases or decreases, so does the pressure required to overcome it increase or decrease.*

Every mining student knows the formula evolved by Atkinson, the pioneer of the theory of mine ventilation—$p = \frac{k \quad s \quad v^2}{a}$—but just what is, or ought to be, the exact value of k nobody seems to be able to say.

Atkinson suggests that k = ·0217 lbs., the pressure required to overcome the resistance of one square foot of rubbing surface at a velocity of 1,000 feet per minute. Other writers have differed from this so much, and presented so many varied co-efficients, that

"By their own perplexities involved
They ravel more."

The following is a table of the co-efficients proposed by the various authorities:

TABLE OF VARIOUS CO-EFFICIENTS OF FRICTION OF AIR IN MINES.

	Pressure per sq. ft. in decimals of a lb. for each foot of rubbing surface and a velocity of 1,000 feet per minute.
Atkinson's Treatise	·0217
A. Devillez, in *Ventilation des Mines.*	
Forchies	·008211
Crachet-Picquery	·008928
Grand Buisson	·008611
Average of 2, 3, and 4	·008585
Used in *Ventilation des Mines*	·008511
Arched Tunnels	·002113
Along a working face of coal	·001266
G. G. Andre, *Atmosphere of Coal Mines*	·022424
Peclet, *Chemineé* (Devillez, p. 112)	·008697
D. K. Clark	·002272
According to Goupilliere's *Cours d'Exploitation des Mines*, vol. ii., p. 389.	
D'Aubuisson	·000955
Narier	·001872
W. Fairley	·010000
J. Stanley James	·000290

Here are fifteen various co-efficients used by various authors. The highest but one is that used by Atkinson and the lowest is that of D'Aubuisson.

The question naturally rises to one's mind; "What difference would these two extremes make in the total power required for the ventilation of a colliery.

If by Atkinson a force of 79 horse power is required to ventilate a certain colliery, then by D'Aubuisson the energy required would be only 7·1 horse power; a ratio of 11 to 1! Here is a diversity of opinion. If Atkinson is right then D'Aubuisson must be incompetent, while if D'Aubuisson is correct Atkinson is most extravagant. Fairley, in his "Theory and Practice of Ventilating Coal Mines," suggests ·01 as being a sufficient value for k. This figure he arrives at by striking a medium between Atkinson and Clark, but his figure is only an assumption.

Such diversity as is here shown tends to make a student wary in estimating the value of the co efficient of friction, and, as it is better to have too much power at a colliery than too little, the result has been to cause most people to cling to Atkinson's figures.

We do not intend here to formulate a new co-efficient, their name is legion already, and it will require a thorough and exhaustive series of experiments to find out a reliable figure. We think that until this is done something like Atkinson's co-efficient should be used As it stands, however, his figure entails considerable calculation and to avoid this we would suggest that the co-efficient ·02 be used instead of ·0217. The difference would be exceedingly small and the labor of calculation reduced to a minimum. According to the case previously cited the energy required would be 73 horse power, as against 79 horse power with Atkinson's figure.

The importance of the general use of some figure as a co-efficient cannot be over-estimated.

Text-books on mine ventilation are now becoming numerous. Several authors formulate their own co-efficient, and every book has its own advocates. If any one of these authors gave definite proof of the correctness of his co-efficient the matter could be easily settled, but each one founds his figures upon experiments which have been too restricted.

This being so, a mining student entering an examination for a mine foreman's or mining manager's certificate is probably at a loss to know which co-efficient finds most favor with the examiners in his district and he runs a risk of being thrown out.

This difficulty arose before us in preparing the Instruction Papers in connection with The Colliery Engineer School of Mines. After careful deliberation we found we were coerced into using Atkinson's figure because it is the one in common use, at present, at examinations in this country. Nevertheless, we are still inclined to advocate the advisability of such a compromise as is offered by the use of ·02.

DANGEROUS OCCUPATIONS.

Whenever one of those large colliery disasters, which from time to time send a thrill of horror through the community takes place, the daily press, as a rule, speaks of the occupation of the miner as being more dangerous than any other.

We have just received an advance copy of the third annual report of the Inter-state Commerce Commission containing the Statistics of Railways of the United States for the year ending June 30, 1890.

From certain tables contained in this report we find that there are proportionately many more fatal and non-fatal accidents amongst railway employes than amongst miners.

We have selected a few figures from these tables and present them in a tabulated form alongside similar statistics relating to the mining industry of Pennsylvania.

	Number of Persons Employed.	Number of Fatal Accidents.	Deaths per 1,000 Employes.	Number of Non-Fatal Accidents.	No. of Accidents per 1,000 Employes.
Railways of United States,	530,999	2,451	4·615	22,396	42·177
Anthracite and Bituminous Mines of Pennsylvania,	183,604	524	2·854	1,388	7·559

These figures speak very strongly. They tell us that a man employed about a railroad has twice as much chance of being killed as a man about a Pennsylvania colliery, and the collieries of Pennsylvania are as fiery as any in the world. They also show that if a man is liable to be injured in a mine once a year, his brother working on the railroad system of America is equally liable to accident once every seventy-five days.

There is no doubt that the mistaken idea which exists regarding the risk incurred by the miner is due in a great measure to sentimentality. There is something peculiarly revolting in the idea of many men being forever immured in the bowels of the earth, without a moment's warning, by a single disaster. There is some meagre consolation to the widow and fatherless to be able to secure a last look at their dead.

It is this touch of excusable sentiment which detracts from the horror of the daylight accident on the railroads, and adds to the already exaggerated notion of the danger of a miner's life.

We do not write this article for the purpose of deprecating the risks of mining. We know what these risks are, and we continue to advocate with all our might for more careful management and better display of judgment on the part of the miner himself to reduce these risks.

We consider, however, that it is our duty to point out this mistaken idea in defence of a large army of officials who are striving to the best of their ability to combat these dangers.

Many bosses are much in the position of the philosopher who said when he was dying that his knowledge was as meagre and his conceit as great as that of the man who picked up the shell on the seashore and thought by studying it he could learn all about the mysteries of the great ocean. What they don't know would fill a big book. But there are hundreds of others, however, who are trying their best to master all the many subjects allied to the theory of their calling and in face of the newly discovered danger of coal-dust (before unsuspected) they have a big job on hand.

We repeat, it is in defense of these officials, as well as of the increased intelligence exhibited by the miners themselves, as shown by the decrease of the number of accidents in mines in recent years, that we present these figures.

MINING INSTITUTES.

We have the authority of the old proverb for believing that "in a multitude of counsellors there is wisdom," and we think it safe to say that there is no business in which this is more true than in mining. There are often several ways of remedying a difficulty, but there is always one which is best suited to the particular circumstances. If a man can hear the opinions and experiences of others who have met similar difficulties, he will be able to piece out his own judgment with their experience, for a wise man often receives valuable ideas from men of much less ability than himself.

There has been, in times past, some feeling that if a man told what he knew to others he was giving away his knowledge and getting no return for it, but now the most intelligent men are not only willing but anxious to exchange experiences with one another, whenever there is a proper opportunity, knowing that both will be benefited.

There are a few organizations in the United States and Canada to enable practical mining men to get together and discuss matters pertaining to their business, and great good comes from them, but there is room for many more. Recently a representative of THE COLLIERY ENGINEER has been traveling through the mining districts of Elk, Jefferson, and Clearfield Counties of this State, and in conversation with some of the leading superintendents and mine bosses, the wish was often expressed to him that an Institute might be organized in that region. Many successful practical men said that they would take great interest in such an organization if formed, but no one seemed to know how to proceed to form it.

We have always taken great interest in all such movements and believe that there is no way in which a man of experience can derive more benefit, than from such discussions as naturally come before these societies. We shall be very glad to give all the assistance possible to those wishing to form such organizations, and if some one in each district of the state will write a letter offering to receive communications from those interested, we will cheerfully publish it, and we think that when in this way an expression of willingness to take the matter up is obtained from a number, it will not be difficult to arrange a time and place for a meeting where a permanent organization can be formed.

It will be well if a number of institutes can be formed so that it will not be necessary to make too long journeys to the place of meeting. In this way it will be possible to have more frequent meetings and the interest will be greater as subjects of direct personal interest to those in attendance can be brought up. Who will make a beginning?

COAL IN ILLINOIS.

THE tenth annual compilation of statistics taken from the Mine Inspector's Report of the State of Illinois which ranks next to Pennsylvania in production of coal, has just been published. The total number of tons of coal mined during the year ending July 1, 1891, is 15,660,698. The average price paid per ton for mining was 71½ cents. The average number of employes for each life lost was 549 as against 461 in the Bituminous region of Pennsylvania. The state is divided into five inspection districts. The following is a table of the number of employes, the tons mined, and the number of fatal and non-fatal accidents in each district:

Districts.	Number of employes.	Number of Tons Mined.	Number of Tons per Employe.	Killed.	Employes per each man killed.	Injured.	Employes per each man injured.	Average thickness of coal seams in feet.
First	9,128	3,082,915	338	15	609	86	106	2 to 6
Second	5,089	1,440,265	283	4	1272	58	88	2 to 7
Third	6,458	2,794,004	432	9	718	41	157	2.2 to 6.6
Fourth	5,881	4,427,622	753	12	490	77	76	2 to 8.3
Fifth	6,395	3,915,402	612	20	320	105	61	1 to 9
Total	32,951	15,660,211	475	60	549	367	89	1 to 9

Several things may be noticed about this table. For instance, the number of tons mined per man in the fourth district is 753, which is much above the average; the fifth district comes next with 612 tons per man, while the second district is lowest with 283 tons. The explanation for this may be obtained by observing the average thickness of the seams in each district. It will be observed that the seams in the fourth district have a somewhat higher range of thickness than those of the first, second, and third districts. The seams of the fifth district have even a higher range than those of the fourth, but they have also a lower range than any of the other districts.

As in other states the greatest number of accidents occurs from falls of roof and sides. The average in Illinois for 1891 is 55 per cent. The average for the preceding year was 67.9 per cent.; so there is an improvement here.

From the report it seems that the value of lump coal at the mines ranges from $1.426 per ton in the second district to 75.7 cents in the fifth. The average value is exactly $1.

For the last ten years, with one exception, the value has declined. From 1882 to 1886 the decline was 41 cents per ton, and from the latter date to 1891, 10 cents per ton. The one exceptional year was 1888, when values showed a slight increase averaging 3.7 cents per ton. Since then the decline has been slight but continuous.

There are 241 mining machines in use in Illinois and these machines produced 2,423,080 tons of lump coal during the year and found occupation for 3,005 men. No particulars are given in the report as to the cost per ton by machine as compared with hand mining, but an idea may be obtained when we say that the machines mined 18.7 per cent. of the entire output with only 9.1 per cent. of the men employed, or in other words each man engaged in machine work sends out rather more than double the tonnage sent out by the hand miners.

The law recently passed by the legislature requiring mine managers to hold certificates has given an impetus to technical education which we ourselves can evidence by the fact that Illinois alone provides over 50 students to the present roll of the Colliery Engineer School of Mines.

Certificates of service are granted to managers at present holding an appointment as such but these certificates are only available for their present situation. As no man cares about being conscious of the fact that when he loses his present situation he is ineligible for another the result is that all the old bosses are dusting the cobwebs off their lesson books and competing for a certificate of competency wherewith to assert their freedom. Such action is creditable to them.

The Anthracite Trade.

The Anthracite coal trade is rather quiet at present, with the outlook encouraging for the future. March proved to be an unusually good month for the retailers. The output is being limited to the actual requirements of the market as far as possible, and in consequence a number of collieries have been shut down completely, and others during certain days of the week. With the output well restricted, the stocks of coal on hand at tidewater points will soon be reduced. The Philadelphia *Public Ledger*, of the 28th inst., in its coal trade report says:

"The outlook for a good year for the Anthracite trade is excellent, and notwithstanding the great production of coal in 1891—the largest of any year on record—it is believed by those who study the situation carefully and keep correct statistics that the production of Anthracite in 1892 will break all previous records. The actual selling price, too, it is expected, will average a better profit to the mining and carrying interests than last year's results. The Eastern coal trade is very quiet, and until after May 1st no more coal than is actually needed for immediate consumption will be shipped in that direction."

It has been agreed to restrict the production for April to 2,500,000 tons, including the output of the Pennsylvania Railroad.

The Bituminous Trade.

The Bituminous coal trade is quiet, although large amounts of coal to fill contracts are being shipped. Outside of this contract coal the business is rather dull. The Pittsburgh and Hocking Valley mine owners have made an agreement, whereby the Pennsylvania operators are to be allowed five cents a ton reduction in tolls, and it will go to the consumer. New York reports a dullness in the market for fuel of all kinds. Prices have been cut to a great extent by certain Bituminous operators, some, however, are making contracts with their regular customers at good figures, as the cut rate people cannot supply the full demand.

The Coke Trade.

The Connellsville coke trade remains in about the same condition as last month. Prices are well maintained as follows: Furnace coke $1.90; foundry coke, $2.30; crushed coke, $2.65; all per ton of 2,000 lbs. f. o. b. at ovens. The Connellsville *Courier*, in its issue of March 25th, says.

Our detailed report of the operation and output of the region for the week ending Saturday, March 19th, shows 13,259 active ovens and 3,965 idle, a change of an even hundred evens from the active to the idle list since the previous week. Production remains practically the same.

OBITUARY.

Henry Morris Luther.

Henry M. Luther, Assistant Engineer in charge of the Mahanoy District, Philadelphia and Reading Coal and Iron Co., died of Bright's disease on the 19th ult., at Atlantic City, N. J., in the thirty-seventh year of his age.

Mr. Luther was the youngest son of the late Peter D. Luther, an old time operator in the Schuylkill region, and a brother of R. C. Luther, Esq., Genl. Supt. of the Phila. & Reading Coal & Iron Co. He was born and raised at Pottsville, Pa., and in 1873 entered the engineering department of the P. & R. C. & I. Co. as a chainman in the same district of which he was engineer in charge at the time of his death. He had recently been elected Secretary of the Peerless Coal Co., of West Virginia, and was also to have been its Superintendent.

As a boy he was exceptionally bright, and his early manhood showed that each year was developing greater talents. His rise from the position of chainman to that of Assistant Engineer was gradual but regular, and at the time of his death he ranked as senior Assistant Engineer.

He began his work as chainman under his brother, who was at that time resident Engineer of the Mahanoy District, but who resigned to accept another position soon afterward. On Mr. R. C. Luther's return to the Phila. and Reading Co., he found his younger brother, the subject of this sketch, had, by his own exertions and careful work, risen to a prominent place among the company's engineers. His official position was not in any way due to favoritism, but was due solely to his own exertions. Early in 1875, the writer, who at that time was employed as a chainman by the same company, was transferred to the Mahanoy District, and first made the acquaintance of Mr. Luther, and this acquaintance developed into a friendship that lasted till it was severed by the sad and early death of Mr. Luther.

His character was one that made all acquaintances friends, and we doubt if there is a man that ever met Harry Luther, that did not express sorrow at his death.

He was a man of strong likes and dislikes, but he was always open to conviction and was easily won as a friend by any person who proved himself at all worthy of his friendship. In business transactions his integrity was unquestioned and socially he was exceedingly popular.

He was married in the early part of 1883 to Miss Ida M. Thirlwell, of Ashland, who with two young sons survive him.

Mr. Luther's health first gave signs of breaking down last fall, and he was compelled to take a rest of several weeks. Shortly before the holidays, and before he returned to work, he spent an evening with the writer, and rejoiced greatly over his recovery and prospects of future good health. But his recovery was not a complete one, and his expectations were not realized. Early last month he again became incapacitated and, with Mrs. Luther, went to Atlantic City on the 10th ult. in hopes that a few weeks rest at the sea shore would restore his health but his disease had progressed too far, and his death occurred at 2.30 a. m. on the morning of the 19th. Less than twenty-four hours before he had written his eldest son a letter in which he stated that he was some better, but not as well as he should be.

Mr. Luther was a consistent member of the Protestant Episcopal church, and was a vestryman and treasurer of St. John's Church at Ashland, Pa.

His funeral took place on the afternoon of the 22d ult., from his late home at Ashland, and was very largely attended.

A Fine Publication.

Some months ago, Mr. W. L. Saunders, of the Ingersoll-Sergeant Drill Company, showed us the illuminated cover and some proof sheets of a catalogue he was getting up, and said "I want to get out a catalogue that for size, value and beauty, will excel any ever issued by any firm or company in our line of business." It has been issued, and Mr. Saunders has accomplished his purpose. It is a handsome volume of 225 pages, printed on toned paper in the most artistic manner. It is replete with fine engravings, and while it acts as a trade catalogue, it is also full of useful information to practical men engaged in mining, tunneling, and quarrying. The illustrations are drawn with the view of showing machinery at work, and the reading matter has been arranged to the end that the whole subject divided under its different departments may be placed clearly before one who seeks this kind of information.

The volume contains so much of interest concerning rock drills, air compressors, blasting apparatus, and rock work generally, that every mining engineer, mine official and contractor should have one in his library, and they can secure one by addressing a request to the Ingersoll-Sergeant Drill Company, No. 10, Park Place, New York.

The Cassier Magazine Company, of New York, publishers of Cassier's Magazine, has issued to its advertisers a convenient and strong receptacle for duplicate advertising contracts. Twenty-eight prominent technical publication's names are alphabetically arranged on the outside of a strong 10″ x 4½″ envelope, and opposite each publication's name are spaces that give at a glance, the space of each advertisement, when it began, number of times it is to appear, and amount to be paid for it. The idea is a good one, and the Cassier Magazine Company is to be congratulated on its success in devising so convenient a holder for duplicate contracts.

ANTHRACITE COAL STATISTICS.

Statement of shipments of Anthracite coal for month of Feb., 1892, compared with the corresponding period last year. Compiled from the returns furnished by the Mine Operators.

	February, 1892.	February, 1891.	Difference.		For Year 1892.	For Year 1891.	Difference.	
From Wyoming Region,	1,625,520'18	1,235,190'11	Inc.	390,330'07	3,146,448'04	2,919,497'16	Inc.	226,950'08
From Lehigh Region,	532,232'19	374,725'18	Inc.	157,507'01	885,579'19	874,147'10	Inc.	11,432'09
From Schuylkill Region,	1,059,218'15	767,285'03	Inc.	291,933'12	1,994,810'19	1,722,517'10	Inc.	272,293'09
Total	3,216,972'12	2,377,201'12	Inc.	839,771'00	6,026,839'02	5,516,162'16	Inc.	510,676'06

The stock of coal on hand at tide-water shipping points, February 29, 1892, was 885,653 tons; on January 31, 1892, 790,932 tons; increase, 94,721 tons.

NEW MINING COMPANIES.

Names and Post-Office Addresses of the New Mining Companies Incorporated in the United States Since our Last Issue.

La Fortuna Mining Co.,	San Antonio, Texas.
The Queen City Iron Co.,	Queen City, Texas.
La Belle Mining Co.,	Dallas, Texas.
Llano Marble & Granite Co.,	Llano, Texas.
Bald Mountain Consolidated Milling Co.,	Deadwood, S. Dak.
Pennsylvania and Ohio Fuel Co.,	Chicago, Ill.
High Point Mining Co.,	Joplin, Mo.
The Sterrick Creek Coal Co.,	Scranton, Pa.
Skagit Valley Mining Co.,	Mt. Vernon, Wash.
The Idaho Aluminum Mining and Mfg. Co.,	Spokane, Wash.
The Kansas and Utah Mining Co.,	Salina, Kan.
Washington Ice Co.,	Duluth, Minn.
Putnam Iron Co.,	Duluth, Minn.
Hale Iron Co.,	Duluth, Minn.
Towanda Iron Co.,	Duluth, Minn.
Swedish American Iron Co.,	Duluth, Minn.
Security Iron Co.,	Duluth, Minn.
Iron Belt Mining Co.,	Duluth, Minn.
New York Iron Co.,	Duluth, Minn.
Twin City Iron Co.,	Duluth, Minn.
Mesaba Chief Iron Co.,	Duluth, Minn.
Boston Iron Co.,	Duluth, Minn.
The American Mining Co.,	Minneapolis, Minn.
Bradley Iron Co.,	Duluth, Minn.
Osceola Iron Mining Co.,	Duluth, Minn.
Virginia Iron Co.,	Duluth, Minn.
The Jeff Davis Mining Co.,	Colorado Springs, Colo.
Golden Gate Mining Co.,	Spartansburg, S. C.
Crescent Oil and Mining Co.,	Trenton, N. J.
The Houtzdale Coal Mining Co.,	Camden, N. J.
Peoples Pebble Phosphate Co.,	Plant City, Fla.
King Mining Co.,	Roanoke, Va.
The Central Land Improvement Co.,	New York, N. Y.
Whitlatch Union and McIntyre Gold Mining Co.,	Helena, Mont.
Eureka Mining and Reduction Co.,	Helena, Mont.
The Champion Mining Co.,	Darlington, Wis.
Athens Iron Co.,	Duluth, Minn.
Duluth Iron Mining Co.,	Duluth, Minn.
Elmira Land & Loan Co.,	Duluth, Minn.
Lackawanna Iron Co.,	Duluth, Minn.
The Star of the West Mining and Milling Co.,	Colorado Springs, Colo.
The Black Eagle Consolidated Mining Co.,	Aspen, Colo.
The Myrtle Mining Co.,	Colorado Springs, Colo.
The Harding Smelting Co.,	Aspen, Colo.
The Midland Mining and Land Investment Co.,	Denver, Colo.
The Boulder County Ore Reduction Co.,	Denver, Colo.
The Black Hawk Reduction Co.,	Denver, Colo.
Northern Land and Mining Co.,	Hancock, Mich.
American Developing and Mining Co.,	Marysville, Mont.
Queen of the Mountain Mining Co.,	Great Falls, Mont.
Jones Lumber Co.,	Parkersburg, W. Va.
The Salsbury Mining Co.,	Butte, Mont.
The Buckeye Stone Co.,	Galion, Ohio.
Keystone Iron Co.,	Duluth, Minn.
Buckeye Iron Co.,	St. Paul, Minn.
Drake Co.,	St. Paul, Minn.
American and Mexican Mining and Milling Co.,	San Francisco, Cal.
The Hurricane Hill Mining Co.,	Port Angeles, Wash.
Arizona Onyx Co.,	Paterson, N. J.
Petit Jean Oil and Mineral Co.,	Magazine, Ark.
The Miner's Dream Mining and Milling Co.,	Ward, Colo.
The Railway Conductors Mining and Milling Co.,	Colorado Springs, Colo.
The Big Pocket Mining and Milling Co.,	Colorado Springs, Colo.
The Denver City Consolidated Mining Co.,	Pueblo, Colo.
The Orphan Bell Mining and Milling Co.,	Colorado Springs, Colo.
The Plute Mining Co.,	Colorado Springs, Colo.
The Maricopa Gold and Silver Extraction Co.,	Denver, Colo.
The Yampai Gold and Silver Mining Co.,	Denver, Colo.
The Manhattan Gold Mining and Milling Co.,	Manhattan, Colo.
The Equitable Mining and Milling Co.,	Colorado Springs, Colo.
The Rocky Mountain Mining and Investment Co.,	Colorado Springs, Colo.
The Creede Gold and Silver Mining Co.,	Denver, Colo.
The Superior Jasper Co.,	Superior, Wis.
Great Western Mining Co.,	Duluth, Minn.
The Pennsylvania Iron and Steel Co.,	Duluth, Minn.
Gray Jockey Mining Co.,	Dewey's P. O., Mont.
The Saline River Point Co.,	Kansas City, Kans.
Providence Mining Co.,	San Francisco, Cal.
The Baltic Consolidated Mining Co.,	Grass Valley, Cal.
Abundancia Mining Co.,	New York, N. Y.
The Forsythe Manufacturing Co.,	Charleston, W. Va.
Marble Hill Quarry Co.,	Pittsburgh, Pa.
The Pennsylvania Hard Vein Slate Co.,	Easton, Pa.
North Star Mining and Milling Co.,	Spokane, Wash.
Crawford, Hannon, and Clayton,	Seattle, Wash.
Eureka Oil Co.,	Eureka, Cal.
Chicago Zinc Co.,	Chicago, Ill.
Clark Iron Co.,	Duluth, Minn.
The Iron Cliff Mining Co.,	Duluth, Minn.
The Martinsburg Oil, Gas, and Mineral Development Co.,	Martinsburg, W. Va.
Greenbrier Coal and Coke Co.,	McDowell, W. Va.
Roseburgh Gas Co.,	Roseburgh, Ind.
The Hollensbe Stone Co.,	Sand Creek, Ind.
The San Juan Mining and Milling Co.,	Chicago, Ill.
The Rock Glen Town and Mining Co.,	Colorado Springs, Colo.
The Cripple Creek Silver Bell Mining Co.,	Pueblo, Colo.
The Colfax Mining Co.,	Colorado City, Colo.
The Golden Reward Mining Co.,	Denver, Colo.
The Washington Mining Co.,	Colorado Springs, Colo.
Thomson Gold Mining Co.,	Spartansburg, S. C.
Shipman Gold Mining and Manufacturing Co.,	Detroit, Mich.
Elkins Gas Coal Co.,	Philadelphia, Pa.
Newell Coal Co.,	Peoria, Ill.
Ridgeville Gas Co., of Ridgeville, Ind.,	Ridgeville, Ind.
Hicks Fork Mining Co.,	Big Timber, Mont.
Florida Phosphate, Mining, Transportation, and Storage Co.,	Bartow, Fla.
Austerlitz Gold Mining Co.,	Norwich, Conn.
Everett Snohomish Mining Exchange Co.,	Everett, Wash.
Monroe Land and Improvement Co.,	Monroe, Wash.
Comstock Gold and Silver Recovery Co.,	San Francisco, Cal.
California and Nevada Gold and Silver Extraction Co.,	San Francisco, Cal.
Sitka Consolidated Mining Co.,	San Francisco, Cal.
American Onyx Co.,	Chicago, Ill.
The Foreman Silver Mines, Limited,	Cariboo, Colo.
The Dewey Hill Mining and Milling Co.,	Denver, Colo.
Carolina Sulphuric Acid Manufacturing Co.,	Blacksburg, S. C.
Cosmopolitan Iron Co.,	Duluth, Minn.
The Comstock Iron Mining Co.,	Duluth, Minn.
Laclede Mining and Milling Co.,	Horley, Idaho.
The Camaguey Mining Co.,	New York, N. Y.
The Corning Buff Stone,	Elyria, Ohio.
The Ophir Mining and Milling Co.,	Colorado Springs, Colo.
The Breckenridge Mining and Milling Co.,	Denver, Colo.
Golden Hope Mining Co.,	White Sulphur Springs, Mont.
The Confederate Placer Mining, Land, and Irrigation Co.,	Helena, Mont.
Centralia Mining Exchange,	Centralia, Wash.
Vesper Creek Mining Co.,	Everett, Wash.
Kalama Gold and Silver Mining and Milling Co.,	Kalama, Wash.
Missabe Monarch Iron Co.,	Duluth, Minn.
The Creede Mining and Investment Co.,	Denver, Colo.
The Chicago Park Mining Co.,	Gunnison, Colo.
The World Mining and Milling Co.,	Colorado Springs, Colo.
The King Solomon Mining and Milling Co.,	Denver, Colo.
The Edna Mining and Milling Co.,	Colorado Springs, Colo.
The Addie C. Mining Co.,	Denver, Colo.
The Bessie C. Mining Co.,	Denver, Colo.
Crossman Mining Co.,	Joplin, Mo.
The Columbia Mining Co.,	Alma, Wis.
Menominee Falls Quarry Co.,	Milwaukee, Wis.
Isdell Merchantile Co.,	Pony, Mont.
Black Hills Mining and Smelting Co.,	Rapid City, S. D.
The Del Monta Mining and Milling Co.,	Colorado Springs, Colo.
The Shasta Mining, Milling, and Prospecting Co.,	Colorado Springs, Colo.
Wabkootah Iron Co.,	Duluth, Minn.
Donald Grant Mining Co.,	Duluth, Minn.
Columbia Iron Co.,	Duluth, Minn.
Consolidated Missabe Iron Co.,	Duluth, Minn.
The Bessemer Ore Mining Co.,	Chicago, Ill.
The Hoyt Placer Mining, Phosphate, and Ore Concentrating Machine Co.,	Chicago, Ill.
The H. W. Flagg Real Estate, Mining, and Investment Co.,	Martinsburg, W. Va.
Waverly Mining Co.,	Menominee, Mich.
New England Iron Co.,	Duluth, Minn.
The Little Mesabi Iron Co.,	Minneapolis, Minn.
Crescent Fire Brick Co.,	Pittsburgh, Pa.
Duluth Mining Investment Co.,	Duluth, Minn.
The Cisco Mining Co.,	Cleveland, Ohio.
The Ohio Coal Mining Co.,	Akron, Ohio.
The Creede-Quintet Mining Co.,	Creede, Colo.
The Little Maid Mining and Milling Co.,	Denver, Colo.
The Aspen Mining and Reduction Co.,	Aspen, Colo.
The Western Dredging and Improvement Co.,	Lafayette, Ind.
Dovion Lead and Silver Mining Co.,	Superior, Wis.
Thetford Asbestos Cotton Co.,	54 S. Clinton St., E. Orange, N. J.
Olive Branch Mining Co.,	Helena, Mont.
Dyes Creek Placer Mining Co.,	Bannack, Mont.
Lake Superior Iron Co.,	Duluth, Minn.
The Orphan Boy Mining and Milling Co.,	Denver, Colo.
The Loyalty Mining and Milling Co.,	Denver, Colo.
The National Belle Mining, Milling, and Development Co.,	Fremont, Colo.
The Double Eagle Mining Co.,	Colorado Springs, Colo.
The Blaine Mining and Milling Co.,	Pueblo, Colo.
Riverside Iron Mining Co.,	Chicago, Ill.
Crawford County Development and Improvement Co.,	Louisville, Ky.
Wyoming Mining and Milling Co.,	Chicago, Ill.
Lincoln Iron Co.,	Duluth, Minn.
Bouchleau Iron Co.,	Duluth, Minn.
San Diego Improvement Co.,	San Diego, Cal.
Spring Garden Mining Co.,	San Francisco, Cal.
Colorado and Utah Mining and Slate Co.,	Colorado Springs, Colo.
The Ramona Mining and Milling Co.,	Colorado Springs, Colo.
The Trinidad Gold and Silver Mining Co.,	Trinidad, Colo.
The Conservative Mining and Milling Co.,	Colorado City, Colo.
The Pueblo Consolidated Gold Mining Co.,	Pueblo, Colo.
The Pike's Peak Sampling and Reduction Co.,	Colorado Springs, Colo.
The Greeley Mining and Milling Co.,	Greeley, Colo.
The Italian Mountain Mining Co.,	Aspen, Colo.
The Expert Mining Co.,	Colorado Springs, Colo.
The Cripple Creek Placer Mining Co.,	Fremont, Colo.
The Little Maud Gold Mining Co.,	Colorado Springs, Colo.
The Cascade Range Mining Co.,	Waterville, Wash.
Western Investment Co.,	Seattle, Wash.
The Mesaba Iron Syndicate,	Madison, Wis.
The Andes Gold and Silver Mining and Smelting Co.,	Chicago, Ill.
Red Mesa Stone Flagging Co.,	Albuquerque, N. Mex.
Old Abe Co.,	White Oaks, N. Mex.
White Oaks Mining Co.,	White Oaks, N. Mex.
Chatham Mining Co.,	Chatham, N. Y.
Ulster Blue Stone Co.,	Kingston, N. Y.
Snowy Creek Coal and Coke Co.,	Corinth, W. Va.
The Central Vermilion Iron Co.,	St. Paul, Minn.
Republic Iron Co.,	Duluth, Minn.
Moberly Fuel & Improvement Co.,	Omaha, Neb.
The Northwestern Mining and Agricultural Co.,	Spokane, Wash.
Pine Creek Mining Co.,	Tacoma, Wash.
Union Mining Co.,	Tacoma, Wash.
American Tripoli Co.,	Seneca, Mo.
The Ohio and Pittsburgh Coal Mining Co.,	Cleveland, Ohio.
Blue Valley Plaster Co.,	Omaha, Neb.
The Work Mining and Milling Co.,	Colorado Springs, Colo.
The Lottie Gibson Mining and Milling Co.,	Colorado Springs, Colo.
The Pueblo and Creede Mining and Milling Co.,	Pueblo, Colo.,
The Denver and Cripple Creek Mining Co.,	Denver, Colo.
The Comstock-Eldridge Gold Mining Co.,	Colorado Springs, Colo.
The Creede and Cripple Creek Mining and Milling Co.,	Colorado, Springs, Colo.
Gold Finch Mining Co.,	Seattle, Wash.
Snyder Bros. Mining and Smelting Co.,	Joplin, Mo.
Mesaba Iron Range Mining Co.,	St. Paul, Minn.
Camden Iron Co.,	Duluth, Minn.
Hock-Hocking Mining Co.,	St. Paul, Minn.
Gun Flint Lake Iron Co.,	Duluth, Minn.
The Gogebic Mining and Milling Co.,	Grand Junction, Colo.
The Headlight Mining and Milling Co.,	Colorado Springs, Colo.
The Roaring Fork Mining Co.,	Aspen, Colo.
The Taylor and Brunton Ore Sampling Co.,	Aspen, Colo.
Columbus Iron Co.,	St. Paul, Minn.
The Keystone Fire-Clay Co.,	New Lisbon, Ohio.
Black Hills Development Co.,	Deadwood, S. D.
The Rosebud Mining and Milling Co.,	Denver Colo.
Manufacturers Fuel Supply Co., of Madison Co., Ind.,	Anderson, Ind.
The Black Wonder Gold and Silver Mining Co.,	Jersey City, N. J.
Columbia Iron Milling Co.,	Chicago, Ill.
Logan County Coal and Coke Co.,	Charlottesville, Va.
Pigeon Creek Coal and Coke Co.,	Charlottesville, Va.
Allegheny Trading Co.,	Clifton Forge, Va.
The Last Chance Mining and Milling Co.,	Denver, Colo.
The Goldstone Mining Co.,	Colorado Springs, Colo.
The Bartholf Mining and Milling Co.,	Denver, Colo.
The Lone Star Mining and Milling Co.,	Fremont, Colo.
The Claude Mining and Milling Co.,	Manitou, Colo.
The Pike's Peak Placer Mining and Milling Co.,	Fremont, Colo.
The Ella C. Mining and Milling Co.,	Colorado Springs, Colo.
Shenandoah Lumber and Iron Co.,	Baltimore, Md.
Eureka Mining Co.,	Tacoma, Wash.
The Fort Scott Mining Co.,	Fort Scott, Kans.
Stockton Consolidated Mining Co.,	Stockton, Cal.
Valenzuela Consolidated Mining and Land Co.	San Francisco, Cal.

THE COMPANY STORE.

The Decision of the Supreme Court of the State of Illinois Declaring the "Truck Store Law" Passed by the last Legislature of that State Unconstitutional.

An enactment called "The Truck Store Law" was passed by the last Legislature of the State of Illinois. It contained the following clause:

"It shall be unlawful for any person, company, corporation, or association now engaged, or hereafter to be engaged, in any mining or manufacturing business in this state, to engage in or to be interested, either directly or indirectly, in the keeping of a truck store, or controlling of any store, shop, or scheme for the furnishing of supplies, tools, clothing, provisions or groceries to his, its, or their employes, while so engaged in mining or manufacturing."

A case of violation of this Act was decided against the defendants who took the matter on appeal to the Supreme Court which decided that the law was unconstitutional.

In discussing the question at issue the court says:

"The prohibition of the statute operates not directly upon the business of mining and manufacturing, but upon the individual, because of his participation in that business. It is not imposed for the purpose of rendering mining or manufacturing less perilous or laborious, nor to restrict or regulate the duties of employer and employe in respects peculiar to those industries, but for the sole purpose of imposing disabilities in contracting as to tools, clothing, and food, matters about which all laborers must contract and as to which all laborers in every other branch of industry are permitted to contract with their employers without any restriction.

"It is moreover difficult to comprehend how there can possibly be anything in the relations between employer and employe which renders it necessary to withdraw the power of contracting as to tools, clothing, food, etc., and yet allow them power to contract in all other respects. If there is capacity to contract for the payment of wages in money, why is there not capacity to contract for their payment in something else? If there is capacity to contract with reference to the sale of real estate, or of a horse or a cow, or of household furniture, why is there not capacity to contract with reference to the sale of clothing or food?"

The court furthermore says:

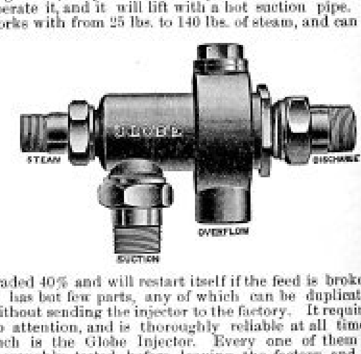
"Our constitution guarantees that no person shall be deprived of life, liberty, or property without due process of law, and the man or the class forbidden the acquisition or enjoyment of property in the manner permitted to the community at large would be deprived of liberty in particulars of primary importance to his or their pursuit of happiness.

"A person living under the protection of this government has the right to adopt and follow any lawful industrial pursuit, not injurious to the community, which he may see fit. And, as incident to this, is the right to labor and employ labor, make contracts in respect thereto upon such terms as may be agreed upon by the parties to enforce all lawful contracts, to sue and give evidence, and to inherit, purchase, lease, sell and convey property of every kind. The enjoyment or deprivation of these rights and privileges constitutes the essential destruction between freedom and slavery; between freedom and oppression."

The Globe Injector.

We herewith present an illustration of the Globe Automatic Injector, manufactured by the Eagle Lubricator Co., of Cleveland, Ohio.

Great as have been the improvements made in steam goods during the last ten years, probably no one article has advanced with such rapid strides as the steam injector. The clumsy and complicated, four and five handled injectors of a few years ago have been superseded by the automatic injector without handles, stuffing boxes, or packing. It requires but one valve to operate it, and it will lift with a hot suction pipe. It works with from 25 lbs. to 140 lbs. of steam, and can be



graded 40% and will restart itself if the feed is broken. It has but few parts, any of which can be duplicated without sending the injector to the factory. It requires no attention, and is thoroughly reliable at all times. Such is the Globe Injector. Every one of them is thoroughly tested before leaving the factory, and is fully warranted by the manufacturers, who will be pleased to send our readers descriptive circulars and price lists. As was stated before the manufacturers are the Eagle Lubricator Company, of Cleveland, Ohio. They also manufacture an improved ejector which will be illustrated in a future issue of THE COLLIERY ENGINEER.

A calamitous explosion of fire-damp occured in No. 3 pit of the Anderlues Colliery, in the province of Hainaut, Belgium, by which 152 miners lost their lives. Owing to the presence of fire in the pit the work of rescue had to be abandoned and the workings flooded.

THE WESTERN PENNSYLVANIA MINING INSTITUTE.

BY WM. SEDDON, SEC'Y.

(Transactions of Western Pennsylvania Mining Institute.)

From time to time there are rumors set afloat by certain mine officials not connected with this Institute, and who either have no intention of joining it, or are not eligible to membership on account of their general behavior and character, I deem it my duty as secretary of the organization to state that our motto is "*safety, economy, and perseverance.*"

It has always been the object of the members to first carefully consider *safety* as of the utmost importance in the working of the mines under their charge; and *not* as some people would have the public believe, the discussion of means whereby we can secure an advance of salaries. In the discussion of the best possible means of securing safety we derive benefit because we are preparing ourselves to overcome difficulties whenever they present themselves, and the miners under our charge and our employers are both benefited either directly or indirectly in proportion to our attendance at the meetings of the Institute.

Some colliery officials do not consider it necessary to study or discuss methods of mining after they have secured a certificate of competency as a mine foreman, thinking that because they are competent as far as the present mine law is concerned, that is all that is required of them. This is not the true spirit. The Board of Examiners that granted them certificates did not imagine any such line of thought, or they would not have granted the certificates to candidates of such a frame of mind. In passing an examination, we do not get a diploma guaranteeing that we are absolutely capable of managing a mine safely and successfully, and there are none that more fully understand this than the members of this Institute. Their attendance at our meetings proves to me that they feel the necessity for more extended knowledge.

For the past five years we have been holding these meetings to advance ourselves in the theory and practice of mining and its allied sciences.

I think we have a great deal to learn before we can assume to be even comparatively safe in our mines. In the matter of gases met with in mines, our theoretical knowledge is obtained from text-books which are very good in their way, but our knowledge is not as complete as it can be made by conference with our fellow officials on the practical experiences we have each had. I do not think we have, as yet, advanced far enough in our knowledge of gases to prevent serious disasters. It is only under certain conditions that we are capable of lessening fatal accidents in mines generating gas. It would appear that there is some gas present other than those we expect, or are taught to expect, and it is one with which we are not familiar, if the evidence offered from time to time after serious explosions is correct.

This evidence is to the effect that the mine was free of explosive gas shortly before the explosion. Admitting that a small percentage of gas and a highly volatile coal-dust will cause an explosion, I still think it possible that we could have gases present for which we have never searched and of whose nature we are ignorant. It is possible that there is a gas given off that owing to its affinity for the hydrogen present in fire-damp, or, the friction of its own atoms under certain conditions—such as a heavy blast, a blown-out shot, or a sudden fall of roof—will ignite with serious results. While we have gases taken from the mine and tested for their inflammable nature with certain quantities of air, we do not have them tested regarding their constituent parts and these are important factors.

All explosions do not occur in a like manner. At the time of the recent explosion at McAlester, Indian Territory, the manager ordered the speed of the fan immediately increased. This appeared at the time to be the most essential thing to do, and it proved to be the correct thing to do. I have, however, known instances where a similar action proved disastrous both to the rescuing party and the mine. This goes to prove that all explosions do not occur in the same manner, neither do they end with the same results.

Much more evidence could be offered on this subject, but as time is so limited I intend to touch on only a few of the important difficulties with which we have to contend. In ventilation the notion that one mine is as easy to ventilate as another is absurd. Though located side by side difficulties will present themselves daily in one mine which in the other mine may never be met with. The superintendent of one may not be as willing as the superintendent of the other to have the mine in a well ventilated condition. He may refuse to erect a furnace or fan where such is required, or he may insist on a furnace where a mechanical ventilator would be better. Our formulæ to find quantity, size of air-ways, power, etc., cannot be called, at all times, correct. While these formulæ may be useful, and may show the intelligence of the mining boss who is able to work them, it is only possible to arrive at approximate results by their use. I do not want to appear as condemning the works of Atkinson, Fairley, or Wilson. They are useful and have done a great deal of good, and will, I hope, continue to do so. They are undoubtedly right, if the air-ways and entries are driven as true and smooth as the entries on which these formulæ and co-efficients were based. This being the case, there is room for further study and advancement on our parts. We should arrive at some system whereby we can come nearer to what we want in calculating lengths, size, quantities, power, etc., in our crooked and usually jagged air-ways that we have in our mines at the present time.

Drainage is another important study, both theoretically and practically, for good drainage is essential for health and safety in mines. I do not hesitate to say, that a few lessons in this branch would do none of us any harm.

Timbering is a subject that I think has been neglected. We do not see many mines that can be truthfully said to be well timbered. In our River mines we stick to the old system of cross bar and post, no matter what the nature of the roof or floor may be. On the continent of Europe they have an entirely different system. I have heard professional men, who visited the mines, say that they work seams by using their method of timbering, that could not be worked at all if timbered by our method. There is no doubt, but that there is plenty of room for improvement in our manner of timbering.

Haulage is another subject that demands an important share of our attention. While we have in this vicinity some fair systems of haulage, we could improve them considerably if we visited mines where the most improved systems are in use, and discuss our experiences and the ideas gained at these meetings. Economy is one of the main requisites of successful mine management, and both operator and miner benefit by it. The one directly the other indirectly. I do not mean by economy, reductions of wages to make up deficiencies due to mismanagement. I mean economy in the use of men and material. The mine boss should look on all expenses as if they were to be paid out of his own pocket. A waste of material is no credit to an official, but on the contrary, it is injurious to his character, as well as a loss to his employer.

Where is there a better place to discuss economical methods of mining, than among the practical men composing the membership of this Institute?

The third point in our motto is "Perseverance". This is essential if a man wants to be successful in any avocation, but in none more essential than in the avocation of a mine foreman. No doubt it is disheartening to find yourself pressed on every side with difficulties over which you have no control. Your mine may not be in the shape you would wish it; You may be troubled with an excessive amount of water; your airways may need timbering or retimbering, and you cannot find time to attend to them or even give instructions as to the way you want the evils overcome because your time is all taken up by other equally important work. More coal is needed than you can produce owing to your entries striking the dip, and you have not the means to get the water out of them, or the entries have struck a rise and gas has begun to appear, and your ventilating power is insufficient. All this may happen, and considerably more. Under such circumstances the best of our mine foremen will at first become disheartened. But, by carefully considering the situation and with intelligent work and perseverance they will overcome the difficulties, and will have the mine in a fair, if not in a good condition, when the mine inspector pays him his next visit.

If I were asked the question, where could a man get better advice if placed in the position I have described, than by attending the meetings of this institute, I would be at a loss for an answer. In conclusion, I would say, there is a large field of knowledge in which we have never entered, and which we are not even acquainted with, that can be cultivated by attending our meetings, so as to bring forth fruit "an hundred fold." As we have done during the past five years, let us continue practicing our motto, and show by our actions and the transactions of our Institute, that our meetings are not to discuss the wage question, but to cultivate the acquaintance of each other and discuss the true theory and practice of mining with credit to ourselves, profit to our employers, and a deep regard for the welfare of the men under our charge.

BOOK REVIEW.

THE PHOSPHATES OF AMERICA, Where and How They Occur; How They are Mined; and What They Cost, with Practical Treatises on the Manufacture of Sulphuric Acid, Acid Phosphate, Phosphoric Acid, and Concentrated Superphosphates, and Select Methods of Chemical Analysis. By Francis Wyatt, Ph. D., Pp. 178; profusely illustrated. The Scientific Publishing Company, New York, Publishers. Price $4.

This book will undoubtedly fill a long-felt want. Until now the literature on this subject has been scattered, being mostly confined to articles published in scientific journals, and in the proceedings of societies of different nations, and in different languages. Dr. Wyatt has collected and epitomized what has already been written on the phosphates of North America and supplemented it with the result of his own large and varied experience.

Since the nature and extent of the Florida deposits were discovered there has been a "boom" in phosphates, and more attention has been attracted to the mineral than ever before. As there has been no authoritative book of reference on this subject the general ignorance concerning it is enormous, and as a consequence unscrupulous or oversanguine promoters and landowners have been able to sadly mislead the trusting investor with illusive statements. At the present time manufacturers, chemists, and farmers are all agreed that the supply is not being economically used, and this book, in showing the way to the right path, should prove a boon to all interested. It is written chiefly for the non-scientific and non-technical, explaining chemical reactions when necessary, lucidly and simply, and illustrating by plain diagrams the construction of apparatus and machinery.

A PRELIMINARY REPORT ON THE COAL DEPOSITS OF MISSOURI FROM FIELD WORK PROSECUTED DURING THE YEARS 1890 AND 1891, with 131 illustrations by Arthur Winslow, State Geologist. This book is interesting throughout its entire pages. Even the preface, an extract from which appears in another part of this journal, is an instructive essay which will be appreciated by all students of geology, and contains many valuable hints to prospectors and those in charge of the opening out of new mineral fields. Chapter III. is devoted to a description of the coal industry of the State of Missouri, and chapter IV. is a detailed systematic description of the coal-beds now operated.

HOW TO RUN ENGINES AND BOILERS. Practical Instruction for Young Engineers and Steam Users. By Egbert Pomeroy Watson, Editor and Proprietor of *The Engineer*. Published by *The Engineer*, 150 Nassau St., New York. Price $1.50 by mail.

This book of 125 pages is neatly got up and is full of valuable hints and information to those for whom it is written. It treats on all the ills that engines and boilers are heir to. It shows the young engineer how to clean boilers, and pipes of scale and describes the safety valve and other boiler fittings in a way that makes one feel more at home with these parts, than heretofore. Mr. Watson gives a good deal of space to the construction of the various parts of the steam engine, and describes the different hitches that occur in the working of machinery and how to repair the parts out of order. This book is a valuable addition to the library of technical schools and will prove of service to engine drivers &c.

FIFTH ANNUAL REPORT OF THE STATE MINE INSPECTOR OF THE STATE OF MISSOURI FOR THE YEAR ENDING JUNE 30, 1891.

Mr. C. C. Woodson, the State Mine Inspector, presents a very interesting and well prepared report. It shows an increase of production of coal of 8½ per cent. over the previous year. The lead and zinc industry has been exceedingly active the output having surpassed any previous year in the State's history. The iron product shows a decrease as compared with 1890. The report affords full information as to the general character and location of all mines, the methods of mining and of ventilation, and gives a complete list of all improvements, &c., &c. The number of tons mined is

Coal	2,650,018
Lead	16,925
Zinc	121,725
Iron	138,356

The number of fatal accidents in coal mines during the year was 30, an average of 1 for every 413 employes as compared with 1 for every 448 in 1890. There have been 12 fatal accidents in lead and zinc mines.

COAL: ITS ANTIQUITY; DISCOVERY AND EARLY DEVELOPMENT IN THE WYOMING VALLEY. A paper read before the Wyoming Historical and Geological Society, June 27, 1890, by George B. Kulp, Historiographer of the Society.

The research and industry displayed by the author in gathering together and arranging these historic facts and narrative are deserving of high commendation. Its perusal will be found instructive and interesting.

As an illustration of dispatch in supplying repairs we heard of a man who recently went to the shops of the Lidgerwood Manufacturing Company to get two cross head gibs, which were to replace worn ones from an engine made by the company ten years ago, and since became obsolete. The pattern was found, brass castings made, put into shaping machine, and finished and delivered in one hour and a half.

Another case a few days before, the Empire Construction Company, of Orange, N. J., bought a double drum hoisting engine and boiler, and upon erecting boiler on the bedplate, it fell (a rope breaking) and broke about ten or a dozen parts of the engine. A man was quickly dispatched to the Lidgerwood shops and carried away every part required in less than half an hour. The engine was running the next morning.

A WELL DESIGNED ENGINE.

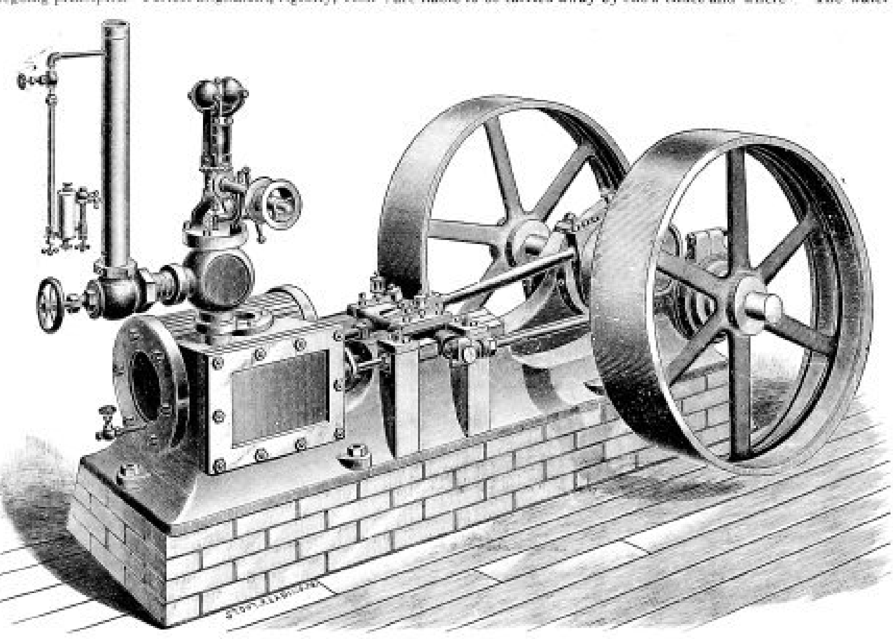
And one that is Peculiarly Adapted for Fans and Breakers.

A long felt want around collieries has been an engine combining the old principles of plain slide valve, and box bed frame, with modern taste and economy of steam. That result has been practically secured in the production of the engine illustrated in the accompanying engraving.

The cylinder is securely doweled to the bed frame and its proportions are made to comply with the best practice of steam engineering. The cylinder of twenty five years ago with its stroke three and frequently four times the bore, allowed the steam to follow almost the entire length of the stroke before cutting off. The pressure, therefore, at the end of the stroke was almost equal to the initial pressure and the benefits of the expansive qualities of the steam were thus wasted through the exhaust pipe. In the modern plain slide valve engine it is the intention of the designer to so proportion his cylinder that the steam supply shall be cut off at from one-half to two-thirds of the stroke and then utilize the expansive force of the steam to complete the stroke. The exhaust pressure is thereby reduced to about one-half of the initial pressure. To do this effectively and maintain the power, the diameter of the cylinder is increased and the stroke decreased. And in place of 10″ × 30″, 8″ × 20″, and 6″ × 15″, we find 12″ × 15″, 10″ × 12″, and 8″ × 10″, as the popular proportions of the cylinders for 40, 25, and 15 horse power, respectively.

Another leading economy in the modern cylinder is the fact that as the diameter of the cylinder is increased the percentage of friction is decreased.

The engine here shown has been designed on the foregoing principles. Perfect alignment, rigidity, economy, and durability, at the lowest possible cost, are what the makers claim for it.



The rods are all of steel, the "Brasses" of the best gun metal and the shaft of hammered iron. A critical steam test is made of every engine, at the works, before shipping, the adjustments are all carefully made and the engine is ready to run the moment it is placed in position and given steam.

They are adapted to all classes of duty and are guaranteed to give as satisfactory service as any plain slide valve engine of similar capacity and in the majority of cases will show an economy of fuel.

These engines are carried in stock and are at all times ready for immediate delivery. A full line of vertical engines from three to thirty five horse power and hoisting engines of almost any description from five to fifty horse power are also carried in stock.

A full line of vertical and horizontal tubular boilers are also kept in stock for immediate delivery. The boilers are made of steel with a tensile strength of 60,000 lbs. per inch of section. They are well braced throughout and the workmanship and material are of the best.

Any further information will be cheerfully furnished by Mr. C. B. Scott, Scranton, Pa., who will willingly furnish estimates to buyers on any part of the continent.

S. B. Stine, of Osceola Mills, Pa., reports a gratifying number of replies to his advertisement of mine cars and patent car wheels which has appeared in THE COLLIERY ENGINEER for several months past. He has received a number of orders through it, and at present is making estimates on a lot to go to New Mexico. Mr. Stine has had long experience in the business and builds many different kinds of cars. Owing to his works being situated where both lumber and iron are cheap and freight rates reasonable, he is able to furnish cars at the lowest possible prices.

A SUCCESSFUL ELECTRIC MINING PLANT.

Erected and Running Under Most Adverse Conditions.

The utilization of sources of power remote from its point of application has, during the past two years, received considerable attention from electricians in this and other countries; and repented experiments have demonstrated the practicability of utilizing power, by the adoption of electrical methods, which would otherwise be wasted, and of its utilization to such advantage that projects may be, and have been, carried out which, without the application of electricity, would have been impossible. This has been particularly the case in the mining industry. Lodes of metal are frequently found at great altitudes, where, unless some cheap power can be applied at the required spot, they can never repay working. It is not so long ago that a project to generate power for mining purposes at the foot of a mountain and utilize it economically and midway, or at the summit, would have been scoffed at as visionary; but this feat has been accomplished and with complete success.

Probably the best example of this, at the present time, is the large plant which has been installed by the Edison General Electric Company at the Virginius group of mines near Ouray, Colorado. It is one of the largest, if not the largest, purely mining plant in the world. Every difficulty likely to be met with in work of this nature was encountered in the installation. The pipe line is laid along the side of a rocky canyon; the wires from the power house to the mine, are strung partly through dense timber, where they are exposed to damage from falling trees, and partly above timber line, over rocks and snow banks, where the poles and wires are liable to be carried away by snow-slides and where lightning storms are frequent and violent. The line is nearly four miles long, the voltage of the current eight hundred volts, and the mine is wet. The relative advantages of the ground return and complete metallic circuit are illustrated, and switches are so arranged that either may be employed, the metallic circuit being used at present. The plant includes a variety of machinery, comprising two pumps, one hoist, one blower, and two motors running mills, indeed, almost everything except locomotives and drills, and these will probably be added shortly. Lastly, the enormous saving that can be effected in many places by the utilization and transmission of water power by means of electricity is strikingly manifested. Coal at the mines costs eighteen dollars per ton, and before the installation of this plant was made, the cost of the power amounted to nearly $40,000 per annum. This sum is saved by the adoption of electric power. An instance is also afforded of unprofitable mines being rendered profitable by the use of cheaper power, for while some of the mines of this group are rich enough in metal to repay working under the most adverse conditions, there are others of lower grade which would have been shut down in case the electric plant had proved a failure, but which, with the plant, will now yield a satisfactory profit.

The foregoing gives a general idea of the nature of the plant and the difficulties encountered in its installation, but an actual visit to the mine is necessary to give a correct conception of the real character of the plant, which is undoubtedly one of the most remarkable in existence. Great credit is reflected on the managers of the mine, who possessed the requisite enterprise and sagacity to expend a large amount of money on a purely speculative experiment, the success of which was regarded as uncertain by even the strongest advocates of electric transmission of power.

If a careful search of the Rocky Mountain Region had been made with a view of selecting for the first extensive experimental mining plant, a location presenting every conceivable difficulty and one which would prove a crucial test to electric power at the very outset, it is very probable that the Virginius mine would have been chosen.

The Virginius and neighboring mines, owned by the Caroline Mining Company, are situated near the summit of Mt. Sneffles, in the region of perpetual snow at an altitude of 12,700 feet above the sea, and about 5,000 feet higher than timber line. They are reached by a wagon road, open in the summer, but impassable in the winter, when the only route to the mines is by a difficult trail, the lower part of which, denominated the "zigzag," winds up a declivity so precipitous that burros with their packs, slipping from a trail frequently roll down past several branches of the zigzag before they are stopped by a tree or rock. The upper part extends over a rocky plateau above timber line, and along cliffs where the snow is frequently over 20 feet deep on the level, and where terrific wind and lightning storms are frequent. The lower half of the line from the power house to the foot of the zigzag extends up a deep canyon through a forest of dense timber. The danger of breakage and grounds from falling trees which are frequently blown down by storms and rest on the wires for some time before they can be removed, is continually present. The constructions of heavy line work over nearly four miles of such ground is an undertaking, the difficulty of which is evident, but which can be fully appreciated only by an actual examination; while the maintenance and operation of the plant under the conditions just specified present even more serious difficulties. But although these difficulties are exceptionally great, the enormous expense of transporting fuel to the mines, rendered the advantages of an electric transmission plant so very striking, that the management was induced to make the trial.

The water power utilized for the plant is in Red Cunon Creek, nearly four miles from the mines. The water power plant consists of a small dam, an iron pipe line, extending along the sides of the canon, a distance of about 4,000 feet, giving an effective head of 485 feet, and two Pelton wheels, one five feet, the other six feet in diameter, capable of developing under that head 500 H. P. and 720 H. P. respectively, or a total of 1220 H. P., the two wheels being connected to separate shafts, so that either wheel may run the entire station. The electric generating plant comprises, at present, one 100 K. W. Edison dynamo and two 60 K. W. Edison dynamos, giving a total output of 298 E. H. P. The length of the line, as previously described, is a little over 19,000 feet. The electric machinery operated at the mines consists at present of two pumps, 60 H. P. and 25 H. P. respectively; hoist one (25 H. P.), 2 Edison motors, each of 60 H. P., running concentrators and stamping mills and a 15 H. P. blower. The large pump which was erected when the plant was first installed, raises 150 gallons of water 700 feet per minute, and is of the Knowles duplex type. An Edison standard motor is geared to it by a double worm, one right hand and one left hand, working into two spur-gears that mesh into each other and operate the pump, the object of the two worms being to neutralize the longitudinal thrust. The smaller pump, which was installed a few months ago, is somewhat similar, the motor, however, being mounted over the pump, with its armature vertical, the weight of the armature counteracting the thrust of the single worm employed. Both pumps have been working steadily and smoothly for several months, and have satisfactorily filled requirements.

The hoist consists of an Edison motor of standard type, but of street car winding and controlling switch, geared to the drum through the medium of a friction clutch. By means of the controlling switch and clutch, the hoist is under more perfect control than a steam hoist.

The motors for the mills and blowers are of the standard type, and present no exceptional features.

The most serious troubles have been caused by lightning, electric storms in that section of the country being frequent and very violent. This has formed the subject matter of particular study and special lightning arresters have been devised that give excellent protection. Since their adoption little or no trouble has been experienced from this source.

That difficulties were encountered in the early operation of the plant is not surprising, and the fact that these difficulties have been overcome and the entire plant operated successfully and satisfactorily under conditions that for severity are not likely to be exceeded anywhere, demonstrates the practicability of electric power for mining, and guarantees its success in this field.

Messrs. Abendroth & Root Manufacturing Company 28 Cliff Street, New York, send to our desk an interesting and handsomely illustrated pamphlet, telling all about the manufacture and uses of their celebrated Spiral Riveted Water Pipe, also giving numerous views of situations where it is employed.

There is an admirable illustration of the St. Clair Tunnel, Port Sarnia, Canada, showing Root's Spiral Riveted Pipe as used therein for ventilating purposes.

The pamphlet is well worth obtaining and can be had upon application. Ask for "Spiral Riveted Water Pipe" pamphlet.

EASY LESSONS FOR BEGINNERS

IN THE STUDY OF THE

ART OF MINING

AND THE

SCIENCES RELATED TO IT.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the theory of mining and to learn how to answer the questions in ventilation, mine surveying, and mechanics which are asked at the examinations for mine manager's and mine foremen's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine manager's and mine foreman's certificates and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and the calculations are worked out at length for the benefit of those who are not familiar with figures.

PENMANSHIP.

To write well consists in training the hand to obey the will, so that whatever form may be fixed upon the mind, the hand will readily reproduce it. To illustrate the importance of this statement write your name with the pen in the right hand, then in the left hand, and see if the results are alike. If not, it is not that you have any less perfect knowledge of what is undertaken, but the muscles do not obey the commands of the will, because not trained. To make these muscles subject to the will requires practice and *much* of it. This can not be emphasized too strongly, as penmanship, like any other study, requires close application.

The capital letter S, Fig. 40, is written correctly in the first letter at the left. It consists of a right curve extending upwards the full height of the letter, at the top it is joined by a narrow turn to the capital stem which it crosses midway between the bottom and full height of the letter. The oval is terminated just before it reaches the intersection of the curve and stem. Letter 2, counting from the left, is a deformity arising

Fig. 40.

from the imperfect development of the lower ellipse; it is made too large and on the wrong inclination. Another error is the crossing of the stem at too great a height. In letter 3 the downward line is made too straight, producing an angular turning at the base. In this letter, as in letter 2, the lower oval is divided unequally upon left and right of first curve. In the fourth letter the upper loop is too large and the lower loop too small, which produces a manifest deformity.

The capital T is shown as it should be written in the first letter, counting from the left, of Fig. 41. It consists of a capital stem and a cap. Usually the cap is written first, but it is optional, some preferring to write the capital stem first. In studying this letter it would be well to practice upon the parts of the letter separately, observing the proportionate length and position of

Fig. 41.

the lines. In letter 2, counting from the left, the capital stem is made too nearly straight, and the cap piece is imperfectly developed. Letter 3 shows the stem and cap connected, which is a careless way of writing this letter. In letter 4, the fourth law of penmanship is violated in making the cap piece, namely: all curves should be elliptical. In the stem the oval is contracted and brought to a close by a dot.

In Fig. 42 the first letter U satisfies the requirements of the four laws of penmanship, and is pleasing to the eye. Its development consists of a capital loop, the same as is employed in making the letter V, which unites at the base with a right curve which extends upward two thirds the height of the letter, at the termination of this curve a slanting straight line is drawn to

Fig. 42.

the base and there unites with a right curve drawn upwards one-third of the full height of the letter. Letter 2 is a violation of the first law of penmanship, namely: all strokes must be parallel. Letter 3 shows an error to be guarded against in writing this letter, that of making it too much like the capital W, so that it is mistaken for it. In letter 4 the capital loop is imperfectly developed, and the straight line retraces the right curve one-half of its length.

POWER IN MINING.

The Elementary Principles of Mechanics—Steam—Boilers—Engines—The Machinery Employed in Mines.

36. But in example under Question 33 you forgot that the weight of car and so on, hung from a pulley at the top of the head gear?

That pulley, or sheave, did not alter the case. The rope pulls with 9,000 pounds whether it is straight to the drum or not.

37. Then is a pulley or sheave of no account?

All that one fast pulley does is to change the direction of the motion. The engine and drum could not be placed on top of the derrick.

38. Is that always the case, that a sheave only affects the direction not the amount of the power?

Yes, I will prove it. A power pulling on the rope at P has the same lever arm as the weight which is hanging at W. (Fig. 5), because the pulley is round.

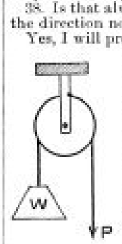


Fig. 5.

39. Suppose the pulley is not fast, what then?

If the pulley is loose and one end of the rope fast as in Fig. 6, then the power is different. The pulley revolves by climbing up the rope A B so that P has a lever arm equal to the diameter of the pulley, and the weight, which hangs from the center, has a lever arm equal to the radius. So, P $= \frac{1}{2}$ W. $P \times 2\,r = W \times r$.

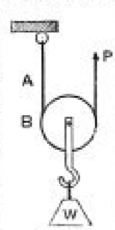


Fig. 6.

40. How is it with the block and tackle?

Similarly, only with two sets of blocks, one fixed and the other set loose, the power required to hoist any weight with the combination is as much smaller than the weight raised as the number of branches of rope. A pair of blocks with 4 pulleys above and 4 below will have 8 branches of rope (Fig. 6 has 2). So the power can, by the combination, raise a weight 8 times as great, but, of course, you must haul in 8 times as much rope as the distance through which the weight is lifted.

41. What is the strongest combination of pulleys?

What is known as the differential pulley, Fig. 7.

A large pulley, B, and a small one, A, are fastened on the same axle. An endless chain goes around them, as is shown, and also under the pulley. Now, if you pull on the chain at the arrow, you raise the weight a small distance. A power applied there will raise a weight equal in amount to the power multiplied by twice the diameter of the pulley B, and divided by the difference between the diameters of the pulleys A and B. This is a very powerful and useful arrangement for lifting great weights like pump rods, column pipe, or machinery.

Fig. 7.

42. How is it with spur wheels? Do they obey the same rule?

Yes, the rule is the same. The power multiplied by its lever arm is equal to the weight multiplied by its lever arm. Also, that the distance traveled by the power multiplied by the power equals the distance traveled by the weight times the weight.

43. Does not the number of teeth have anything to do with it?

Yes it has. Two wheels gearing into one another have their teeth the same distance apart. So the number of teeth the two wheels will have depends upon their diameters. If one wheel is 5 feet across and the other is 20 inches across, then the big wheel has 3 times as many teeth as the little wheel, because it is 3 times as broad.

44. Suppose a spur wheel 9 inches diameter engages with another star wheel 72 inches across, how much weight can I raise with it?

That depends upon how the power is applied. As for these two spur wheels, one wheel turns around once while the other turns 8 times, because the big wheel has 8 times as many teeth as the small one.

45. Then let us assume a second motion hoister with 5,000 pounds pressure on the crank pin which is 1 inch from the edge of the spur wheel?

That is a poor relation of parts but I will take that case. The crank turns once while the small spur wheel turns once. Now the crank being 1 inch from the edge, is $3\frac{1}{2}$ inches from the center. The lever arm of the power is $3\frac{1}{2}$ inches. So $5{,}000 \times 3\frac{1}{2} = 17{,}500$ foot-inches. The spur wheel turns once and could raise a weight on its teeth equal to 17,500 divided by $4\frac{1}{2}$ inches (see Fig. 5). So the weight it could raise at its teeth is 3,888 pounds which is the effort made upon the teeth of the large wheel. Now 3,888 multiplied by 36 inches the radius of the large wheel equals the effort upon the drum. If the drum is on the same shaft as the big spur wheel, it revolves as often as the spur wheel. The weight of the rope, cage, and car which is hanging from the drum with a lever arm equal to its radius, balances the 3,888 multiplied by 36 inches. So, if the drum equals 5 feet, the weight times $2\frac{1}{2}$ ft. balances 3,888 times 3 feet. The weight would then be 4,666 pounds. Fig. 8 would illustrate this case. (See page 153, of the February, 1892, number of THE COLLIERY ENGINEER.)

Fig. 8.

46. Then do all the calculations in mechanics and power depend upon the one principle of lever arms?

Yes. Whether it is a crow-bar you are using or a pulley, or any similar arrangement, the rule is to multiply the power you must use by its lever arm and that must be equal to the weight you lift multiplied by its lever arm.

47. Would it make any difference in the calculation whether the second motion engine has its two wheels spurred or only friction wheels?

No. Whether the pinion wheel A gears by teeth into the tooth wheel on the drum, or if A is a paper wheel pressing against the iron band of the drum, the result must be the same.

48. Is there no difference at all between spur wheels and friction wheels for transmitting the power?

The only difference is that the pinion wheel pays out power to the spur wheel by contact of the teeth, and each tooth must be strong enough to stand the pressure. When two friction wheels are in contact, the power paid out by A depends upon the friction, or bite, that the paper can be made to have on the iron band of the drum. To get this amount of friction you must use great force at the brake lever to throw the drum against the pinion.

49. Then what is the idea in having a small crank wheel and pinion and a large drum?

The crank arm can only be half as large as the length of one-half the stroke. The pinion wheel is on the same shaft as is the crank wheel. Now, the longer the stroke of the engine the longer is the crank arm and the greater weight the drum can hoist. Or the larger the diameter of the iron friction band on the drum, and the smaller the diameter of the drum, the larger is the weight that you can hoist.

[TO BE CONTINUED.]

METHODS OF MINING.

Shaft Sinking—Tunneling—Systems of Working Coal and Metals—Timbering in Mines.

27. What are the sills for?

With a soft floor the posts will sink unless they rest on sills. I have seen six feet galleries nearly closed by the pressure of soft floor upwards and hard roof downwards. In lead mines these "creeps" are as common as they are in coal mines. The sills should be long and strong, and always placed with bearings on the ends, and the ground hollowed out under them at the center. Then they are not so liable to break if the posts force the sills down.

28. Are not sills sometimes placed lengthwise instead of crosswise to the drifts?

Yes, the foot of each post rests on unhewn logs which are placed along the two corners of the floor. On each log several posts rest. If the pressure is also great from the sides, the sills are kept apart by wedge-braces every seven or eight feet, fitted to the sills. (Fig. 9.)

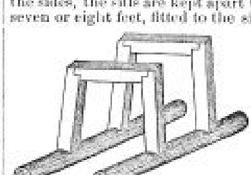


Fig. 9.

29. How far apart should the frames be?

That depends upon the nature of the ground. If the rock is firm, the sets may be three or four feet apart. If the pressure is great they must be nearer together.

30. Suppose the ground is crumbling?

Then on the outside of the sets lagging is placed, resting against the posts, and on top of the caps.

31. What is the lagging made of?

Slabs from the sawmill, or somewhat light cord wood. The lagging should always be weaker than the timbers of the sets so as to break first if the pressure comes. After the crush the lagging can be more readily replaced than could the sets if they broke.

32. Suppose the ground is very weak and soft, how would you timber?

If I were driving a gallery through very soft ground, I would use spilling. That method protects the miner while he is working and makes a permanent strong timbering. Fig. 10 is a fair drawing of it. Under the

Fig. 10.

cap of one set and over the cap of the next, I would drive spillings; that is, laths, somewhat pointed. The length of the laths is greater than the distance between two sets. As the men pick out the face they have a roof overhead, and when they have gone ahead far enough to put in a set it is done. In the meantime not only are the roof laths driven, but also those at the sides, in front of one post, and behind the next one in advance. When the roof or sides press upon the laths, they are bent so that the front end is forced down on the forward set, and the rear end upward against the cap. The cap is not raised out of place because on top of it two other laths are pressing downward. The laths are driven by mallet or hammer.

33. How large are the laths?

They may be of any size that you can drive. But not much over three inches thick.

34. What kind of ground would you use this method for?

Soft shaly ground, broken stuff, and moderately stiff clay.

35. Will it do in very soft clay?

Yes if the ground does not run like quicksand, for example, or if it does not melt after it has been opened into.

36. Suppose you strike the kind of ground that runs, what then?

For the purpose of driving through such soft ground, you would have to use some of the more elaborate methods which employ iron and masonry.

37. Are drifts, galleries, and entries all timbered alike?

Yes, unless they are so wide as to require very stout caps, or else a center prop. The center props are not desirable, because of the room they take, and also because they are the cause of so many accidents if cars are run on both sides of them. In metal mines the timbering is of a different style.

38. Why is that?

Because the veins are steep, and because the floor and roof rock is stronger than you find in coal mines. Flat beds, whether of coal or of zinc, have soft roof and floor, and require sets to be of four pieces. When the vein is tipped up steep, the floor and roof are on the sides of the gallery, and are called foot wall and hanging wall. As they are strong and firm, there would be no timbering required on the sides. The only pieces then are the cap, called a stull, and the floor sill.

39. How is the stull fastened?

A hitch is cut in the foot wall to rest one end of the stull while the other end is hammered down against hanging wall. The stull is cut much longer than the width of the vein between walls. Sometimes a wedge-block is driven at head, as shown in Fig. 11. (See page 163, February, 1892, issue.)

Fig. 11.

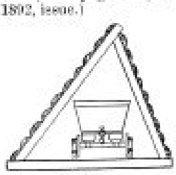


Fig. 12.

40. Suppose the walls are brittle, or soft?

Then a large head block is used beside the stull, just as the post and collar arrangement would be used in coal veins. If that will not do, the gallery is timbered by three pieces, as in Fig. 12. By the way, remember that the triangle is the strongest form you can have for frames.

41. Would this be used if one wall is loose?

Perhaps, though a common plan then is to put a post along the wall that is not strong, and have the cap rest on it at one end, and on a notch in the other wall.

42. In all of these forms of timbering I see no arrangement for carrying off the drainage water?

In the coal mines you do not want to cut the gangways or entries any higher than you have to for the car or man to get through. So a gutter is arranged for down in the lower corner of the timbering sets. In ore mines and in steep veins it makes no difference if you cut a high gallery, so then the gutter is cut under the sill and under the ties of the track. This is better than making the gangway wide, which you do not want in steep veins.

43. How are slopes or inclined shafts timbered?

Very much like the tunnels, only great care must be used in placing the sills. You must have sills in slope-timbering but you do not have to use them in tunnels. If the roof is bad you must give attention to its support. If it is not, then the frame is not strong, or else only props are used in the center with a partition nailed to them if the ladder-way is to be separated from the gangway.

44. How are shafts timbered?

Some shafts in firm rock are not timbered at all, but these are not safe. Besides, the hoisting can not be very fast in such a shaft. A bucket is the only conveyance that can be used then, and it is not safe to hoist buckets faster than 200 feet per minute. An untimbered shaft is therefore only for small mines. For large mines the shaft must be well timbered to allow of the use of a cage for hoisting, and to give a secure outlet for the men. The varieties of form for shaft timbering are numerous.

45. Which is the simplest?

The simplest and quickest to build is that composed of posts in the four corners standing upright, and five feet long. On these there rest two long wall plates and short sticks across. These pieces are about six or eight inches square or round. (See Fig. 13.) Above again come the corner posts with wall plates and crosspieces. At every thirty feet or so there are three very heavy timbers fitted into notches in the walls. These support the entire weight of the timbers. Back of the timbers the shaft is lined with two inch planks placed vertically, with the space behind them filled up with waste rock.

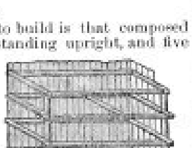


Fig. 13.

[To be continued.]

GEOLOGY

In its Relation to Coal, Iron, Oil, Gas, and Ores.

28. Is the whole crust of the earth stratified above the granite?

Yes, and all are called sometimes *sedimentary* rock as well as stratified. The first name refers to the mode of formation, the second to the manner of its occurrence.

29. How thick is the stratified series?

The crust of the earth is 50 miles thick and the stratified rock varies from a mile to ten miles.

30. Has any one ever seen the bottom granite?

Oh yes. Sometimes the stratified rocks on the granite are not deep and a bore hole has been drilled down into it. Sometimes very deep holes, nearly a mile, have failed to reach even the carboniferous. In other places there are no stratified rocks to hide the granite.

31. Why is that?

Such places may have been the original hills of the earth against which all the seas have beaten. In Canada and the Adirondack Mountains are remains of these primitive hills.

32. May they not have been thrown up through all these strata?

Not there; but the Rocky Mountain range was formed in that way.

33. Did the mountains break right through all the strata?

Yes, for all along them North and South you will see the rocks standing up on end like in Figure 8. At places the walls stand 300 feet high. It is this which makes the Garden of the Gods so famous. There, the rocks stand hundreds of feet high in walls and towers.

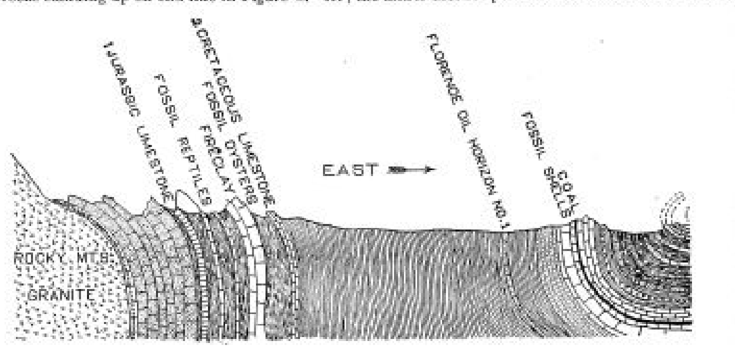


Fig. 8.

34. Is the Silurian next to the granite?

No, not here. Elsewhere it is next. The carboniferous was broken off below, but was not pushed up to the surface. You will notice to the right the rocks become flat and so they extend all the way for 2,000 miles to the Allegheny Mountains where they again stand up. Some of the Anthracite coal seams are steep instead of flat. The coal marked to the right is cretaceous. We know, too, that the Rocky Mountains were tipped up because on the other side the rocks are broken off dipping toward the West. And also a few patches were carried up on the tops.

35. I should think the strata would be broken up by this uplifting. Are they?

Yes they are. You must remember that the quiet depositing of mud as I explained was going on while the earth was cooling. As it cooled, the strata shrunk and in doing so became squeezed. The layers were bent and distorted just like a number of sheets of paper would behave under a side pressure that squeezed them.

36. What are these called?

They are called "folds" or "rolls." You must have noticed them in the mine. Fig. 9 is from an actual case. Fig 10 is also another case from on top of the Rocky Mountains a mile above sea level. The dotted lines show where it is believed the strata united. A B and C are valleys and creeks. At Tamaqua, Penn., the Mammoth coal bed, as it is called, is bent like the letter U coming out on Sharp Mountain at one end and Locust Mountain at the other.

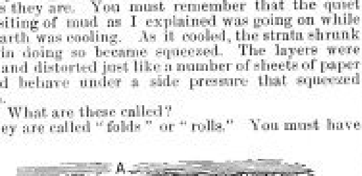


Fig. 9.

37. With these bends and rolls I should think the strata might be broken?

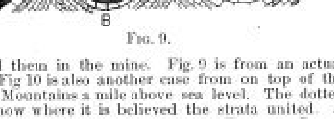


Fig. 10.

They often are broken fine or else they crack just as is shown in Fig. 11. (See page 163 and Fig. 4, p. 147, of February, 1892, number.)

38. What are the cracks called?

"Faults" is the proper name for these breaks but miners call them "thrusts," or "throws."

39. Why are they so called?

Geologists call them faults. They are breaks in the strata, across them. For example, if the rocks in Fig. 9 were to break, the fault would be along A B. But it seems that besides cracking, the strata fell and are misplaced as in Fig. 11, where A and B are coal seams. The right hand side slipped on the fault line. As these faults generally cause a settling of one side or the other, the miners have called them "throws" as if one side was thrown up or thrown down.

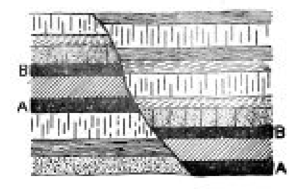


Fig. 11.

40. What do the miners mean by "rock faults" or "slate faults?"

These are not, truly, faults but they are names which the miner uses for portions of the coal beds which are thinner and have slate or sandstone where some of the coal ought to be, as S in Fig. 12. They call them "horses" in ore mining.

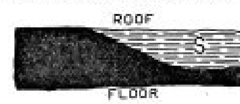


Fig. 12.

41. Faults, then, are places where the rocks have been broken and afterwards displaced? Is there ever anything in these cracks?

Oh, yes. In regions where volcanoes exist and where earthquakes are common, the faults are often filled with lava from the volcanoes or with silver and lead ores. In the coal regions, however, they rarely have anything but dirt and fine rock.

42. Are faults common?

I know of only three in Pennsylvania Bituminous region. There are several in the Anthracite districts. They are quite numerous in the Western States but not common in Virginia, Illinois, or Missouri.

43. How far do the rocks slip?

The limits are 1 foot and 20,000 ft. The average may be said to be 20 feet. But in Utah there is a throw of 10,000 feet. And in Pennsylvania and Virginia the sinking is over 30,000 feet.

44. Are they ever near together?

Look at Fig. 13 which is a good example from England.

45. How do you know but they may be separate beds which never were connected?

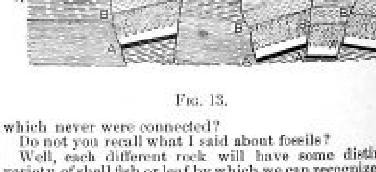


Fig. 13.

Do not you recall what I said about fossils?

Well, each different rock will have some distinct variety of shell fish or leaf by which we can recognize it. When the rocks are similar they have the same kinds of fossils.

46. Then by the fossils you know where to look for the rest of the coal seam?

Yes, if I am mining one of those coal seams and strike a fault, I go over to the other side, examine the rock and then by its fossils I can tell whether the thrust has been up, or down. And I go accordingly, Don't you see how important fossils are?

[To be continued.]

ANALYSIS OF COAL, ORES, ETC.

Instructions in Sampling and in Making Analysis to Ascertain the Quality and Value of Coal, Ores, &c., &c.

An analysis as defined by the dictionaries as the separation of a compound substance into its elements. As applied to chemical work, it is more than this. Not only are the simple substances separated from one another but they are also measured or weighed, so as to know the relative amounts. Gases are not easily weighed, so they are measured by the quart or cubic foot. Solids and liquids are weighed.

First in taking samples for analysis the attempt should be made to get as near an average of the material to be tested as possible so that the sample will give a fair idea of what the mine will ship. To get this, the rooms or stopes, which have working faces exposed, should be visited and broken down over the entire face of the exposure, up, down, and across. Each drift or tunnel should be similarly sampled so that the average of the vein is obtained. In coal seams, small partings that are likely to be removed and shipped with the coal should be included in the sample. Wherever samples may be taken, entries are made in the note-book of the appearance, size, and character of the face, partings, etc. If the partings are very large, the sample from them is not mixed with that from the vein. In sampling lead and silver veins the care taken is greater in order to take away for analysis a sample that will have a fair average of the mineral streak. The streak is separately sampled from the vein rock on the sides. Iron ores or clay are sampled in the same way. The endeavor must always be to have the sample, as far as possible, to be of *the same average as that of the ore which will be shipped*. If a shipping mine is being tested, numerous samples are taken from the cars, buckets, or out of the chutes or bins.

Samples taken from the different faces ought to be kept separate, packed up into sacks or boxes and analyzed separately, but if that is not desirable the method of quartering is adopted. The mineral to be tested is mixed thoroughly and broken up somewhat finely and carefully gathered on a canvas. The pile is then divided by a shovel into halves. One-half is rejected and the other again piled up on the canvas. The pile is then divided by a shovel into quarters and the opposite quarters A and B (Fig. 1) taken. If this is not too large an amount, the sample is boxed up in a very close box and analyzed.

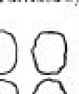


FIG. 1.

In any analysis the object to know is what there is in the mineral, how much of it is good and how much valueless; what impurities are in the specimen; and in silver ores, which part carries the silver. (See also questions under Surface Arrangements in the March issue of THE COLLIERY ENGINEER, page No. 188).

The impurities of coal which it is desirable to analyze are pyrites and ash. A coal is also analyzed to know how much fixed carbon and how much volatile matter the fuel contains. By reference to the questions 8, 59, etc., on geology you will see that in the process of coal making from peat that a great deal of marsh gas and other volatile matter was produced and liberated. It is this which gives so much trouble in the ventilation of collieries, besides being always a menace to the safety of the mine. The harder the coal, that is, the more nearly it approaches to being Anthracite, the more of this volatile matter has been driven off. In Bituminous and in lignite coals, it exists in quantity not as a gas but as a form of compound; chemists call the compound hydro-carbon. The presence of this volatile matter is not exactly deleterious but is productive of smoke and causes the coal to burn with a long flame. As the volatile and combustible matter is driven off, the coal hardens and becomes porous, and produces what is called coke. All coals having volatile matter will coke—some more readily than others. The best coke is obtained from those which cement when the gas is driven off. Some coals which do not cement, or clog up in the furnace, may also produce coke, but it is of poor quality. They burn free and may be used without coking. To ascertain, then, the amount of volatile matter and the tendency to coke, the coal must be analyzed. (See also p. 18, August, 1891, number of THE COLLIERY ENGINEER.)

Again, the amount of pyrites or sulphur must be determined, because it is very objectionable wherever the coal is to be used. Its iron melts out and fuses with the ashes to "clinker" the coal. Sulphur attacks iron, so neither the blacksmith nor the iron furnace man wants a coal of this kind.

The ash of the coal must be determined for several reasons. The quantity of ash and its character gives an index of the heating value of the fuel. The more ash there is the less carbon there remains for fuel. A red ash proves that pyrites is in the coal. The red color is made by the iron.

The amount of moisture in the coal must also be weighed. Not only does it make the coal heavier but its presence is objectionable. It takes some of the heat of the coal to drive off the water—and the amount is not insignificant, either. Many coals have 7% of water—or they have 150 pounds to every ton. Some lignite coals of the West have 450 pounds in a ton.

In analyzing a coal, the Ohio Geological Survey Bureau grinds the sample to about a ⅛ inch mesh. It is then thoroughly mixed and quartered down to a pound, which is bottled. It is further pulverized till it will go through fine bolting sieve of 100 mesh, and then 6 or 8 ounces are bottled.

(1). Of the pulverized sample, about 30 grains are weighed out carefully and placed in a small platinum crucible which has already been weighed. The whole is placed in an oven and the water boiled out of it for half an hour or so. The crucible is allow to cool and is weighed. The loss of weight is water.

(2). It is then placed over a flame and heated. The gas is driven out and burns at the top of the crucible. After five or six minutes the gas will no longer escape So the crucible is covered and again weighed. Now the loss, since the water was boiled off, is the volatile and combustible matter (or what the Chemist of the Survey, N. W. Lord, calls the volatile carbonaceous matter). It is not such an easy matter to know just when the gas ceases to escape, but one can come very close to it. It is for this reason that analysis of coal is called a proximate analysis. Quite concordant results can be obtained if the chemist is at all careful. The character of this coke that remains must be carefully examined and noted in the report. It gives a good idea of the coking quality.

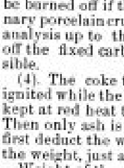


FIG. 2.

(3). The crucible still contains the "fixed" carbon and ash. The term, fixed, is used simply to distinguish the carbon that was volatile from that which resisted the moderate heat of the last test. But the carbon can be burned off if the heat is sufficiently high. An ordinary porcelain crucible would withstand the heat of the analysis up to the present time, but if one is to drive off the fixed carbon, a platinum crucible is indispensible.

(4). The coke that remains in the crucible is now ignited while the lid of the crucible is off and the whole kept at red heat till there is no trace of any carbon left. Then only ash is in the crucible. To know its amount first deduct the weight of the crucible, lid and ash from the weight, just after the volatile matter was driven off.

Weight of the platinum crucible is W.
Weight of the coal taken 20 grains.
Weight after driving out moisture is m.
Weight afrer driving out volatile matter is v.
Weight after igniting the coke is c.
Then $W + 20 - m =$ water in 20 grains of the coal.
$W + 20 - m - v =$ volatile matter in 20 grains of the coal.
$v - c =$ carbon in 20 grains of the coal.
$c - w =$ ash in 20 grains of the coal.

[TO BE CONTINUED.]

SURFACE ARRANGEMENTS.

The Preparation of Coal and Ores for Market.

21. How is this washing done?

There are three distinct methods. And there are several patented machines for each method.

The first method is to rest the coal or ore on a sieve and then forcing through it, upward, quick currents of water.

The second method is to force a constant current upward against a stream of falling ore or coal downward.

The third method is identical in behavior with that of the creek we spoke of. The material to be washed is floating in a current of water, or is carried by it, nearly horizontal. At various points are troughs for receiving the material which settles and the current of the stream is varied to assist the settling.

22. Which is the commonest plan?

The first. Perhaps nine-tenths of all the ores and three-fourths of all the coals are treated by the machines depending upon this principle. The second method treats nearly all the rest of the washed material, while the third method is quite rare in this country.

23. What is the first method called?

The machines used are called jigs because of their motion being a jigging one. (See page 162, February, 1892, number).

24. Now is the coal just as it comes from the mine washed at once by the jigs?

Oh, no. The coal and so also the ore, must be broken up and afterwards screened so as to separate the broken stuff into sizes. This process is called sizing or classifying.

25. Will you please explain what is done first?

The ore, or coal, comes up to the surface and is dumped upon a platform or into bins. From there the stuff goes to breakers. Here the coal is screened over bars, crushed, and again screened to sizes.

26. Why would not screening without crushing do?

Because there is a larger demand for the medium sizes of coal than comes from the mine. So some of the large lumps must be broken up. The screening over bars sorts out some of the mined coal into uniform sizes. The lumps that do not go through pass by men who pick out the slate and throw it away. The coal that goes through the first sets of bars is very dirty and is cleaned over mud screens which sort out the fine dust and clay from the pea and egg sizes which are sold.

27. How is the lump coal treated?

Some of the lumps go through a chute to the steamboat rolls, which crush it to small size; after which the coal passes to screens of different sizes.

28. Are Anthracite breakers the same as Bituminous breakers?

Yes, but larger and more elaborate.

29. I should think that these breakers would be expensive?

They cost more for wet coal than for dry coal and can not be built for less than $50,000.

30. Why are they so high?

Because it is better to have the mine run coal start at the very top and go down hill as it passes from rolls or bars to the different screens. Of course the hoisting engine has to raise the coal so much higher, but when once started, it hoists cheaper than the elevator belts and cups could. And if the breaker were not built so high, then the coal would reach the level of the floor before all the screening was done and the rest would have to be elevated again.

31. How are the rolls made?

They are steel barrels with movable steel teeth. As the two barrels turn, the coal is caught between the teeth and crushed. These give less waste than the old style roll- cast with iron teeth on them.

32. What are the screens?

They are simply frames of iron on which wire cloth is stretched. They are set on a shaft which is inclined so that the coal can slide down as the screens turn. They receive the coal through a hopper at the higher end and all the coal that does not go through is discharged at the lower into a chute that feeds to the next screen. Sometimes the finest screen comes first and all that does not go through it is sorted in the next which is a little coarser and so on. In other works the coarsest screen comes first, all that passes through goes to the next which is a little finer and so on. The first scheme is not so wearing on the iron and is therefore cheaper.

33. Which sizes of coal are sold?

Everything has been screened out into various sizes except the coal from the mud screens. To save this requires washing. Often, in Bituminous coals, the smaller sizes will all require washing.

34. What is the next step after screening?

Washing. You remember that the coal is in different sizes. Now if you will refer to Q. 8 of this subject and to Q. 23 of "Geology of Coal" you will see that the washing action of water depends upon the size and the lightness of the material. You will find that the current of water washes away the light fine stuff and leaves behind the heavy, coarse material. Each screen now feeds to a jig that treats one size of stuff that has been classified.

35. How does the jig work?

Look at the drawing on page 162, of February, 1892, number, and you will see that a jig is a tank full of water and in two parts. In one part a piston plays up and down; while the coal is in the other resting on a wire cloth. When the piston goes down, it forces water up through the bed of coal and lifts everything a little way. But the coal being lighter than the slate and pyrites is raised higher up to the top. Each time the piston goes down it raises the coal a little higher until all of it is soon on top. When the piston goes down, the stuff all settles down for the next stroke. The operation would now be complete, and you might stop the jig, shovel off the cleaned coal and then get the slate and pyrites at the bottom and throw them away. But that would be expensive so the jig is arranged to be automatic. A very heavy current of water is continually fed to the jigs and as it escapes over the end, it takes the cleaned coal with it. Now to keep up the supply a hopper, H, feeds from the screens continually and just as fast as the cleaned coal reaches the surface, the water washes it away into a bin. The slate and pyrites are meanwhile collecting on the bottom. A slide is raised at A, Fig. 1, and then they rush out into a trough to be thrown away.

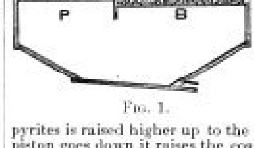


FIG. 1.

36. But does not some material get through the wire cloth in B?

Not very much for the holes are smaller than those of the screen feeding the jig.

37. What becomes of the dirt and clay that sticks to coal?

If that sort of dirty coal had been delivered to the jigs then the washing would not remove the dirt because it would wash off with the clean coal because it is lighter than pyrites. The dirt is usually washed off before the coal is crushed and screened. Jets of water from wooden troughs or iron pipes are thrown upon the coal and remove the dirt.

38. Does it make any difference whether mine water or creek water is used or not?

Yes, it does because the mine water is usually very acid. Water is water and would wash the coal all the same, but the acids, coming from the pyrites, eat iron away very rapidly. So the mine water is very destructive to the machinery and makes the repairs very costly. This makes the cost of washing dearer where mine water is used than where pure water is employed. Mine water is often so bad that it eats through an inch thick iron pipe in a couple of weeks. Many mines have to use wooden column pipes because the pumped water is so bad.

39. Which are the best jigs?

For coal, the best are the Clark and the Bradford patterns. For ore, the Collom and the Hartz jigs are most used. There are hundreds of styles patented, but the simpler the arrangement, the better, and those I have named are very simple.

40. What other ways are there of washing coal?

The cheapest, simplest and oldest scheme is one that is shown in Fig. 2. A long trough set at angle steep enough that the water will carry the coal down to D, where there is a bin for receiving it. The slate and pyrites, being heavier, settle on the bottom and are not carried off. The hopper, H, feeds the coal from the screens. Generally, however, the finer screens feed here while the coarser coal goes to the jigs.

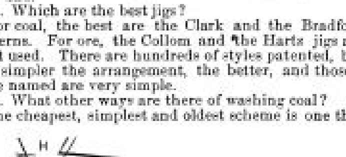


FIG. 2.

41. What prevents all the materials, pyrites, as well as the coal, from being emptied at D?

The heavy stuff settles behind the cleats B, B, and accumulates there. When these are full the lever, at right of hopper, is pulled and the water washes the slate into the car at C. Then the cleats are closed again and go on collecting pyrites and slate.

42. How is this arrangement regulated so as to give clean separation?

Easily enough. You raise the trough and the current is not swift, if you use only a little water the current can not be swift. If you lower the end or use much water you get a strong current. So you can regulate the current all right. Now, a strong current will carry away more stuff, heavier or larger, than a mild current can. So you see that it is possible to feed just the right amount of water as will wash the coal properly.

[TO BE CONTINUED.]

VENTILATION IN MINES.

Including a Description of the Gases Met With in Mines and the Atmospherical Conditions Necessary to Be Known to Understand the Laws of Ventilation.

1. What is air?

Air is the name given to the compound gas that surrounds the earth.

2. Why is it called a gas?

Because the matter of which it is composed is light, transparent, and has the property of expanding.

3. What are the kinds of matter?

Solid, liquid, and gas. All matter must be one of these three.

4. How do they differ?

A solid requires no vessel to contain it and force is necessary to separate its particles. A fluid requires a vessel to confine it. There are two varieties of fluids—gases, and liquids. These two can be poured but unless received *in* something can not be preserved. The liquids require no force to separate their particles. They pour with ease. Gases prefer to be separated while liquids are neutral, and solids, require force to accomplish it.

5. What keeps a gas in place?

You must lock it up in a tight reservoir or else it will be continually moving in order to get away.

6. What keeps the air from leaving us, or does it fill all space between us and the sun?

Air fills all space but that air is very thin; astronomers call it ether. The ether is much thinner than that we breathe.

7. How do you account for any about the earth?

The air around the earth is kept here by the attraction of the earth for it. Thin as the air seems, it contains matter in it, but very finely divided. And in just the same way that the earth attracts the falling apple so it draws the matter of the air down to it.

8. Then the air is acted on by two efforts, an internal one that naturally expands it and another, an external one, that draws it to the earth?

Yes, that is the idea. The nearer air is to the surface the more compact it is. In Colorado at Denver, the air is only four-fifths as heavy as it is in Scranton. And on top of our high peaks, it is only a little more than one-half as heavy as in Scranton. If we go down underground the air is still heavier.

9. How much heavier is it in our deepest shafts?

The deepest mines to my knowledge are about 3,900 feet. In the lowest level the air is one seventh heavier than at the surface.

10. How heavy is air?

That depends upon how hot it is. A cubic foot of air from Scranton at freezing point of water, 32° Fahrenheit, weighs 0·08073 of a pound. If the air is taken on a hot summer day when the thermometer reads 100° Fahrenheit, a cubic foot weighs 0·0703 of a pound.

11. How heavy is the air on the top of mountains?

At a height of 14,000 feet above the sea, the air we breathe weighs 0·3511 of a pound per cubic foot.

12. Does it ever become so light as to weigh nothing?

No, not absolutely nothing, but nearly so. The moon has an atmosphere about it so very light that no human beings could exist there. It weighs very nearly zero.

13. Does it weigh the same at all places on the sea level?

Yes, in Wales, in the United States, or in Australia the air weighs just the same at the sea coast.

14. Why should it weigh more at the sea level than at Denver which is 5,000 feet above the sea?

Look at Fig. 1 and imagine a high pile of cotton. The layer at the bottom has a lot of cotton pressing down on it to compress it. Half way up there is less cotton above, so the layer at B is squeezed a little only. On top there is nothing to press it down and the cotton is very puffy. A cubic foot of cotton from A would be very heavy while that from B would not weigh so much, and that from C would be very light. So it is with air on the earth. There are about 120 miles of it piled up like the cotton. At the sea level the air is like the cotton at A, Fig. 1, pressed by the 120 miles of weight above it. The air of Denver, or that on the tops of our mountains behaves like that cotton near B. It has only half the air above it and it is not so dense as that at A, and so weighs less. Points on the earth's surface above the sea level have lighter air than that at Philadelphia.

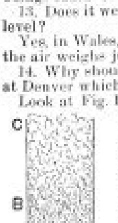


FIG. 1.

15. Then I am receiving upon my shoulders and head the pressure of all the air above me?

Yes, you are carrying the weight, not of the world, but of all of its atmosphere upon your shoulders.

16. How much does it weigh and what is the pressure?

The air above the level of the sea extending 120 miles up presses down with a weight of 14·7 pounds per square inch.

17. Is there a pressure of 14·7 pounds on every square inch of my body?

Yes. Every square inch of your body is receiving a pressure of 14·7 pounds, upward, downward and sidewise.

18. Is that the case also on a mountain?

No, instead of 14·7 pounds it is, perhaps, only ten pounds to every square inch.

19. How can you prove it?

By the barometer which indicates the amount of the pressure. Pour water into a U tube of glass or into a hose and you will find that it rises to the same level in both arms, Fig. 2. The air is pressing on A just as hard at it is on B. But imagine the top of the tube above A to have no air in it, and imagine its arm to be extended 150 miles up above the earth. Then at B the air is pressing and at A there is no air to press on it. Then the water will lower to N, Fig. 3, while the other side will rise up to M, Fig. 3, 34 feet high. At that it will stand. If mercury were used instead of water the level of M would be only 30 inches above N. The water from the level of N to that of M weighs 14·7 pounds, so also, the 30 inches of mercury will weigh 14·7 pounds. If these experiments were performed in Denver, instead of at the sea level, the water would only be 28 feet high and the mercury 24½ inches. Now these 34 feet of water or 30 inches of mercury balance the weight of the air above, or *represents the weight of the atmosphere*. That is what the barometer indicates—the weight or pressure of the atmosphere.

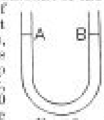


FIG. 2.

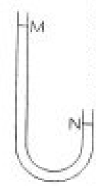


FIG. 3.

20. But a barometer is closed at one end.

Yes, so it is. Take the tube in Fig. 3, seal up the top of the tube above M and you have a barometer. There is no air above M in the 150 mile tube, so if we pump out the air from the tube after it is sealed, leaving the end N open you have on one side a column of mercury, or water, balancing at N the pressure of the air.

21. Does the barometer always stand at 30 inches of mercury?

No. When a wind is blowing, or when a storm is brewing, the barometer falls and there will be, perhaps, 29 inches of mercury. The severest storm known lowered the barometer to 28·5 inches.

22. Does the height of the barometer indicate anything besides weather?

It does in this way. If the barometer falls suddenly, it means that there is less pressure of air outside. Now, gas in a goaf, or in coal, is under a heavier pressure than the air. So, when any cause releases the outside pressure, the gas can get out readily and the amount depends upon how far the barometer lowers. For this reason the ventilation of a mine should be plentiful when the barometer is seen to fall.

Again the barometer indicates the amount of water that can balance the atmosphere or that the atmosphere can lift.

23. Is that what is meant by the suction of a vacuum?

Well, a vacuum is a space having nothing in it, not even air. If then I draw the air out of a tube I have produced a vacuum. If the lower end is under water, the vacuum of the tube is like that in the arm M of Fig. 3. "Nature abhors a vacuum," and the weight of the air outside *forces the water up* into the tube. Though the result is the same as if I "sucked" the water up, yet the real truth is that the atmosphere forced the water. No matter how long or how large the tube may be, the water is driven up into it. But the water will never rise over 34 feet under any conditions. Generally it will not be raised that high, even on account of friction and the leakage. At Denver the "suction length" is not over 28 feet. With a siphon the highest point of the bend must not be over three-fourths of the theoretical suction lift.

24. How can I know the amount of the suction lift?

By looking at the barometer and multiplying the number of inches of mercury on it by ⅞.

25. Please give me an example?

I want to know the practical height of the suction lift of a pump when the barometer reads 28½ inches.

$$28\tfrac{1}{2} \times \tfrac{7}{8} = 24{\cdot}9 \text{ feet.}$$

That is the lower clack of the lift can not work if it is more than 25 feet above the level of the water in the sump.

[TO BE CONTINUED.]

Compressed Air.

The use of compressed air for the transmission of power in mines, and for supplying motive power for mine locomotives, and all kinds of stationary machinery is gradually but surely extending in all coal fields of the continent, and it is not now a question of "will it work?" but the question is, "which is the best compressor, and can I understand the use of compressed air?" Compressed air acts practically the same as steam, except that its exhaust does not vitiate the air in the mine, or rot timbers and disintegrate the roof. On the contrary, if the exhaust is conducted into the intake air, it improves the ventilation of the mine to a certain extent. Every colliery official in the country should be posted on the use of compressed air, and compressed air machinery. The lately issued catalogue of the Norwalk Iron Works Company, of South Norwalk, Conn., will give him a large amount of information on this subject, and he can get it free by merely writing a postal card for it. It contains besides, a number of useful tables, conveniently arranged.

EXPLOSION IN A COAL BOX.

BY SAMUEL OAKLEY, SCRANTON, PA.

No question is more important, and none perhaps is receiving more attention, than that of the part which coal-dust plays in mine explosions.

Few, if any, mining engineers now deny that coal-dust may be the cause of augmenting and extending an explosion after it is once initiated, but a great many decidedly object to the theory that coal dust alone—without any small accumulation of gas—may become ignited, say by a blown-out shot, and if present in large quantities thus cause a disastrous mine explosion.

As one who believes strongly that coal dust is capable of itself, when mixed with air in sufficient quantity to cause an explosion, I hereby give a detailed and correct account of an explosion, which occurred in a coal box at the surface at the Brancepeth C. Pit, operated by Straker, Love & Co., in the County of Durham, England, and which, in my opinion, was a coal-dust explosion.

This mine is very shallow as compared with the mines near the East coast of the same county; its depth being about 120 or 130 feet, but though not deep its workings are very extensive, as somewhere near 350 miners are employed, besides the necessary number of company hands.

The seam of coal worked is known as the "jet seam" and varies from 2 to 3 feet in thickness. The top part is "jet" (the *parrot* coal of Scotland) and is from 6 to 9 inches thick. No outbursts of gas have ever occurred in the workings, naked lights exclusively being used.

The coal is loaded separate from the jet or *cannel*, and on reaching the surface, is passed from the cleaning screens, through Carr's disintegrators or coal crushers, and is crushed into powder or dust, and is then lifted by elevators to the coal box wherein the explosion occurred, so that all the coal was in a finely divided condition when placed into the box. The box was made large in order to always have a good stock of crushed coal on hand for the coke-ovens when from any cause the output might be too small to load the ovens. Dimensions of box were as follows: 24 ft. × 31 ft. × 31½ ft.

Near the top of the box windows were placed to admit light to certain parts of the elevator machinery that required oiling two or three times per day. Ladders were placed on the outside of the box for ready access to the top, and ladders were also placed on the inside so that a person could pass up the outside and down the inside whenever required.

This caused four small landings or platforms to be placed inside about equal distances apart.

A few iron tie rods passed through the box.

Now, it will readily be seen that on the upper landings and rafters of box a quantity of very fine dust would accumulate. Slides, or movable doors, were placed at the bottom of the box by which the coal was taken out of box by cars to load ovens.

Just previous to April 24, 1889, the day of the explosion, a dispute arose between the workmen and the company which ended in a strike, and the whole of the coal the box contained had been taken out by the slides at bottom except that resting on bottom corners of box, and that on the rafters and platforms referred to previously. Opportunity was therefore taken to have the box thoroughly cleaned out, and for this purpose five laborers were instructed to take shovels with them and clean all coals from the box. These five laborers entered the box at about 10 A. M. through the slides at bottom, and the "boss" or chargeman, Mr. Mills by name, entered by means of the ladders up the outside. Seeing that a large quantity of fine dust had accumulated on the upper platforms he called two of the laborers to come up and clean it down.

Four oil lamps or open torch lights had been hung upon one of the tie rods about 7 ft. from the bottom of the box.

The two men commenced throwing down the coal to those below, causing such a thick cloud of dust that those at the bottom, according to their evidence, could not see each other, and before they had been more than ten minutes in the box the explosion occurred, severely burning the six persons inside, breaking the glass in the windows, and partly dislodging the top of the box.

The report of the explosion was a low rumbling noise, not such as would be expected from a gas and air explosion and the damage was not near so great to the box. The two laborers at the top part of the box were thrown to the bottom and were rescued from the slides, but the chargeman, Mills, appears not to have been knocked down as he came out from the top by means of the ladders, as he had shortly before entered. Mills and the two laborers who were with him on the upper platform all died from the effects of burns and shock received, but the three laborers at the bottom of the box recovered; thus it seems as though the flame was not so intense near the bottom as it was further up.

One of the survivors says that he noticed the dust as it was ignited at the lamps; then there came a second larger flame, and then the whole box suddenly seemed filled with flame and he felt he was burned, and he sank on one of the slides falling through when some person opened it from below letting him out to daylight and pure air.

Another of the survivors in his evidence said that he was holding his cap over his mouth to keep out the dust, it seemed so dense, and that he noticed nothing until he felt the sharp sensation of burning behind his neck.

In my opinion this explosion is proof positive that coal-dust is of itself explosive, for the fittings of the top and windows were not sufficiently close to allow gas to accumulate, and besides, that same morning before daylight, the person who oiled the machinery had been up at the top of the box oiling the elevator machinery, previously referred to, with an ordinary oil lamp. This would have readily ignited any gas had it been present.

HOW TO LIVE

What Food to Take.

Whether the old saying that a man's heart is reached through his stomach is or is not a true one, it is a scientific fact that the stomach is a highway to the brain. The exhilarating influence of a good dinner is sometimes shown in brilliant impromptu speeches, without a doubt. The cook is responsible for many of the accidents, the failures, and successes of life. Not long ago a well known lawyer in summing up a case acquitted himself so wretchedly that the jury promptly brought in a verdict against his client. The lawyer afterward acknowledged that hot muffins at breakfast were responsible for his having lost the case. They made him irritable and insolent.

Curious to know upon what sort of food men of note do their best work, I recently interviewed some of the lights of the medical profession, law, commerce, theology, and society.

Genial Dr. George F. Shrady, President Grant's stanch friend, declares that he must vary his food in order to develop, and nourish, separately and collectively, the organs of his body.

"I have an excellent digestion and can take all kinds of food without feeling any discomfort", said he "but I believe that the brain is most nurtured by sleep and rest. If we gratify our intellectual tastes we are feeding the brain vastly better than by any sort of material food, and consequently obtain better results.

"A friend once had as a patient a young author, who had been recommended to follow a strict diet of pumpkins. On this sort of fare he wrote a novel. Well, the offspring of pumpkins—roasted, boiled, and stewed—is still looking for a publisher to launch it on an unsuspecting public!

"No one kind of food exclusively is good for the ordinary man. 'To be healthy, wealthy and wise', as the old maxim goes, study the likes and dislikes of your stomach and regulate your diet accordingly (as I do) and all will go well."

DEPEW'S ADVICE.

Chauncey M. Depew adheres religiously to simple fare—a cup of coffee and an egg for breakfast, a chop or some chicken for luncheon and a roast or other plain food for dinner. He believes that upon plain food the brain becomes most responsive to the demands made upon it.

"If men would avoid gorging, overfeeding, and otherwise abusing their system", he said, "they would find that in so far as the mind is developed so far can it be depended upon in every emergency and at all times.

"We all know that man's brain power is not in accordance with the capacity of his stomach. I know two men of wonderfully clear minds who could write a logical essay on political economy after two plates of corn beef hash which might place another man of ordinary capacity on the verge of apoplexy, and therefore every man must be a 'law unto himself'. Care of the body in the hosts of ways that we all neglect will give to its organs, one and all, a vigor and power hitherto unsuspected".

Judge Roger A. Pryor laughed heartily when told that every briefless lawyer in town was anxious to know whether his spirited speeches might be attributed to squab, lobster, or partridge.

"Tell them from me", said Judge Pryor, "that I am extremely fond of birds and dainties generally and that lobster *a la* Newburg is a toothsome dish I don't despise and that my brain works best when I'm free from indigestion. Tell these young men to follow the old Roman maxim and secure for themselves 'a sound mind in a sound body'.

"Hot breads, salads, ices, and sweets form part of my daily menu, and as they give my body strength I am able to do my allotted share of mental labor. The body must first be ministered to by food and exercise, and then the mind will soon be ripe for cultivation. The reason, memory and imagination must each be nourished with the food it requires—logic, law, mathematics, poetry or art. Upon the idiosyncracies and constitutional peculiarities of each man depend the kind of food he assimilates".

DON'T WORRY.

Dr. H. P. Loomis thinks men pay too much attention to the specific uses of certain foods.

"Look at the enormous sale of phosphates and so-called brain foods", said he. "There is nothing in them. If instead of wondering whether this, that, or the other is good for him a man would simply follow the dictates of his own appetite we would be much better off. Nature places a safeguard upon excess by creating the sensation of satiety.

"When I have eaten some rich food that causes me some annoyance I take a horseback ride or other pleasant exercise and rid myself of the ill-feeling, and in the future avoid that Welsh rarebit or venison that caused the trouble. Rest is really the best tonic for the brain. In two words I would give this prescription for happiness—'Avoid worry.'"

A prominent member of Sorosis, a really brainy woman, declares that the amount of food people require or think they require, is largely a matter of habit. Said she: "It is possible to train the stomach to do with very little or to make its requirements border on the margin of gluttony. When the hunger is satisfied, brain achievements depend upon heredity and environment, and to them must be attributed all success or failure. The gardener who only cares for the blossom of his plant instead of directing his efforts to the root, will have but sorry fruit as a reward. Let mankind look to their physical perfection, and the mental and moral are sure to follow".

MENTAL PABULUM.

The Rev. Dr. Henry Van Dyke, the author and clergyman, believes the brain to be touchingly appreciative of all kindness shown to the stomach, and sullen and unmanageable when the latter is oppressed. At the same time allowance must be made for individual tastes.

"My food", he said, "must be taken at regular intervals and be largely of the farinaceous kind, while yours, possibly, may be taken when and as you choose. A single sandwich of caviar would incapacitate me for several hours. So, I say, be kind to the machinery of the body. After all, the best diet for the brain is a constant variety in the quality and quantity of our intellectual food".

There seems to be no particular edible which holds a magic power over the realm of thought but by selecting food with a view to digestibility. In individual cases the body is aided in performing its various functions and the brain with its other organs is thus enabled to discharge its duties properly as well.

The Enervating Energy of Americans.

In thirty years time, less than half the Biblical allowance of man's life, the United States has multiplied its wealth six times, and has nearly trebled that per capita. What energy, what work, what unceasing effort has been needed to bring about this marvelous result! What can we do to retard this development of the brain and nerves at the expense of the body? Obviously it is impossible to change our surrounding, to change our food, to lessen the drive of our modern life, to relieve the strain on the mind, to make the competition less fierce. It is apparent, then, that as we cannot lessen the strain we must increase the ability to undergo it. We must, as a people, learn to understand this, that while we drive the brain we must build the body. The methods of doing this are so simple that they are apt to be overlooked; they may be summed up in two words—exercise and fresh air. As we teach our children to wash their hands and faces in the morning and continue our teaching until ablutions become a habit so fixed as to produce positive discomfort if they are omitted, so we must teach them to exercise until this, too, becomes a habit, a second nature, a something that when omitted causes real physical distress, and we must choose a form of exercise which is adapted to persons of middle age as well as to children. . . . . . Build up the body, build up the body! In our modern life this should be dinned into the ears of all until it is obeyed, for, verily, unless we build up the body, the strain on the brain will ruin the American people. The very elements in ourselves that have made us great, the push, the drive, the industry, the mental keenness, the ability and the willingness to labor—these contain in them the seeds of national death. No race may endure that has not the stamina and power of the healthy animal. The American race has run too much to brain.—*Dr. Cyrus Edson in North American Review for March.*

Indian Surgery.

It is a mistake to suppose that the Digger Indian is entirely ignorant of how to proceed in cases of broken bones. A correspondent of the *Scientific American*, who once had some experience in sawmills in California, writes that journal as follows: On one occasion, while a number of Indians were curiously watching the operations of the mill, and standing near the double-flue boiler to keep warm, one of the flues suddenly collapsed in such a manner as to fatally scald one of the owners and hurl a poor old Indian woman some 20 feet away, breaking one of her legs below the knee. In the excitement of the occasion and the necessary care of the injured owner, the injury sustained by the woman was not observed and she was taken quietly away by the other Indians. Three or four days later quite a large number of Indians appeared in a hostile attitude on a near-by elevation which overlooked the mill. After taking their station, a tall chief approached and inquired for the "sawmill man", complaining that he had "shot off his sawmill" and broke the leg of a *mahala*, and he, the chief, was ready for a fight. The foreman took in the situation at once, invited the chief into the house adjoining, and showed him the stricken owner in the agonies of death. The chief then, in his turn, took in the situation from the opposite standpoint, and immediately exclaimed: "No intendi, accidenti. Me safe, no fite, all samo". We now append the interesting and surgical part of the story as given in the *Scientific American*: In a day or so after Mr. Hoxey's burial, the surgeon went to the *campoodie*, and there sat the poor broken-legged *mahala*. The physician told me that the Diggers measured around the leg in several places, then cut a piece out of a slippery elm tree, near the size and shape of the leg, took the bark off, shaved off the outside and made as fine a splint as he ever saw, and fitted it around the broken limb, leaving the space open about one quarter of an inch on the top, and were pouring in a little water to keep down the fever heat, and that in a few weeks the squaw was limping around town again.

Typhoid Fever.

The following memorandum on typhoid fever and its proper treatment was given to Major-General Ellis by the late Sir William Gull, M. D., two years after he was in attendance on the Prince of Wales during his illness in 1872. It was suggested to Major-General Ellis recently that the publication of this memorandum might prove useful, and it appeared in the *Times*. Sir Williams Gull's suggestions with regard to the treatment of typhoid fever have been observed in the case of Prince George:—

I. Typhoid fever is a disease which runs a more or less definite course. It cannot be stopped or cured by medicines.

II. The chief thing to be done at the outset of an attack is to send the patient to bed, so as to save strength from the beginning.

III. No strong purgative medicines are desirable.

IV. As the fever develops, and the strength grows less, light food should be taken at short intervals—*i. e.*, water, toast-water, barley-water, milk and water, light broths (not made too strong, or too gelatinous).

V. If there be restlessness or much agitation of the nerves, wine (port, sherry, or claret) or brandy in moderate doses at short intervals. This must be directed medically, but in general it may be said that the amount required is that which induces repose and sleep.

VI. The bowels may be left to themselves. If unmoved for 24 or 36 hours a lavement of warm water may be necessary, but this will be directed medically.

VII. The restlessness or wakefulness in fever is best remedied by the careful giving of wine or spirit with the food, or in water. Sedatives, such as opium, are inadmissable—mostly injurious.

VIII. The bedroom to be kept at a temperature of 62 to 64 degrees.

IX. Great care necessary to keep the bed clean and sweet. This is most easily done by having a second bed in the room, to which patient can be removed for two or three hours daily, whilst the other is thoroughly aired, and the linen changed.

X. All fatigue to be sedulously avoided. No visitors admitted, and no other person but one nurse and one attendant to help her.

XI. Patient's room never to be left unattended for a moment, as in the delirium of fever patient might jump from bed and injure himself.

XII. As to medicines and the treatment of complications, the immediate medical attendant must be responsible.

XIII. As it is probable that the discharges from the bowels in typhoid fever may be a source of contagion, it is desirable that before being thrown down the closet they should be largely mixed with Condy's fluid or some other disinfectant. On the same principle, the strictest cleanliness must be observed in the sickroom.

XIV. There is no reason to believe that typhoid fever is contagious from person to person in the ordinary way. The largest experience shows that it does not extend, like an ordinary contagious disease, to nurses or others attending upon patients suffering under the disease.—*National Labor Tribune [England.]*

USEFUL INFORMATION

"In God we Trust."

The motto "In God We Trust," which is now stamped upon all gold and silver coins of the United States, was suggested by an old farmer living in Maryland. This conscientious Christian gentleman thought that our currency should indicate in some way the Christian character of our nation, which he argued, could be best done by putting a motto upon our coins expressing a national reliance on divine support in governmental affairs. It was in 1861, when S. P. Chase was secretary of the treasury, that this man wrote to Washington respecting his pet idea. His letter was referred to Mint Director Pollock, who discussed the question in his report of 1862.

Pollock and Chase were in favor of introducing the motto at once, but Congress gave the suggestion no attention whatever. In his next annual report Director Pollock again referred to the matter, this time in firm theological argument, saying, "The motto suggested, 'God Our Trust,' is taken from our national hymn, 'The Star Spangled Banner;' the sentiment is familiar to every citizen of our country; the time is propitous; 'tis an hour of national peril. Let us reverently acknowledge his sovereignty, and let our coinage declare our trust in God."

A two-cent bronze piece was authorized by Congress to be coined the following year, and on April 22, 1864, the first United States coin was stamped with the legend, "In God We Trust."—*St. Louis Republic.*

Wonders of the Grave.

The tomb of Edward I, of England, who died in 1307, was opened on January 2, 1770, after 463 years had elapsed, and his body found to be almost perfect, the face even retaining its expression. Canute the Dane, who crossed over to England in 1017, was found in 1776 by the workmen who repaired the Cathedral. His body had reposed in the grave for nearly 750 years, but was perfectly fresh and life-like. In 1569, three Roman soldiers were dug out of a peat bog in Ireland, where they had in all probabilities lain at least 1500 years, yet they were perfectly preserved even to skin, hair, eyes, and nails. In the reign of James II, of England, the big church at Warwickshire fell. In clearing away the debris it became necessary to move the tomb of Thomas Gray, at one time Marquis of Dorsetshire. When this had been done it was found that the body of the Marquis was as fresh as a corpse newly buried, the joints even being pliable. this discovery was made exactly seventy-eight years, three months and two days after the burial. Robert Braybrook, who was bishop of London in 1381, and who died in 1404, was found to look perfectly natural. When removed from the tomb after the great London fire of 1666; even the color of the eyes could be distinguished.

The "Trackless" Ocean.

That it is a mis-use of language, in these modern days, to speak of the ocean as "trackless," is ably argued by our esteemed contemporary, Goldwaite's Geographical Magazine. It proceeds to show that the routes taken by vessels, under modern conditions, even between points so distant from each other as New York and Calcutta, will coincide so nearly as scarcely to show at any point a divergence of fifty miles. A sailing vessel, taking what is called the southern route from Liverpool to New York, would sail about 4,500 miles to cover a direct distance of less than 3,000 miles, yet would in all that devious journey follow a path well understood and established in the Sailing Directions. Science has well served mankind in thus overcoming the mystery of the ocean wastes; but, even so, we cannot perceive the unfitness of the word "trackless," as customarily used in this connection. Wherever else man journeys, he beats a path or leaves a trail, and the next comer may be guided by the print of his foot or the mark of his wheels. That is a track, as commonly under-tood. But when a vessel cuts her way across the main, her course is "writ in water," and she makes no track save her fast vanishing wake. Men have sought out devices, it is true, by which her path may again be traced with exactness and certainty, and may be implicity followed. But the track is only on paper after all; and he who in mid-ocean, his eye assuring him of the fact, speaks of it as trackless, is not guilty, we submit, even of poetic license.—*Mechanical News.*

Virchow's Attack on Darwinism.

In recent years Darwinism has received some telling blows, which its over-zealous adherents affect to despise. But the latest criticism of its assumptions by Professor Virchow, in his address delivered at the Vienna Anthropological Congress, cannot be answered by a sneer.

Prof. Virchow said:

Since the Darwinian theory of the origin of man made its first victorious mark, twenty years ago, we have sought for the intermediate stages which were supposed to connect man with the apes; the proto man, the *pro anthropos*, is not yet discovered. For anthropological science the *pro anthropos* is even a subject of discussion. At that time in Innspruck the prospect was, apparently, that the course of descent from ape to man would be reconstructed all at once; but now we cannot even prove the descent of the separate races from one another. At this moment we are able to say that among the peoples of antiquity no single one was any nearer to the apes than we are. At this moment I can affirm that there is not upon earth any absolutely unknown race of men. The least known of all are the people of the central mountainous district of the Malay Peninsula, but otherwise we know the people of Terra del Fuego quite as well as the Esquimaux, Bashkirs, Polynesians and Lapps. Nay, we know more of many of these races than we do of certain European tribes; I need only mention the Albanians. Every living race is still human; no single one has yet been found that we can designate as simian or quasi-simian. Even when in certain ones phenomena appear which are characteristic of apes—*e. g.*, the peculiar ape-like projections of the skull in certain races—still we cannot say that these men are ape-like.

Of course, Darwinians retort that the absence of proof does not necessarily disprove their theory. But, if, after so many years of world-wide research, no single race "has yet been found that we can designate as simian (ape-like) or quasi-simian," the theory must be in a very sorry plight, when the verdict of its own advocates is "Not proven." —*New York Herald.*

Definition of a Cold Wave.

The Weather Bureau definition of a cold wave is a fall in temperature of 20 deg. or more in twenty-four hours, free of diurnal range, and extending over an area of at least 50,000 square miles of country, the temperature somewhere in the area going at least as low as 36 deg. Marking on a map where a cold wave has occurred by lines through the places of equal fall of temperature the areas are seen to be enclosed and something very great in extent. In one of the greatest cold waves in recent years, that of Feb. 17, 1883, the temperature at 7 a. m. was 20 deg. lower than at the same hour on the day preceding, throughout an area of 1,065,000 square miles, extending from Lake Superior and Georgian Bay on the north to the Rio Grande on the south, and from Kansas City to Cincinnati. Inside of the area of twenty-degree fall there was an area of forty-degree fall of 187,000 square miles; inside the forty-degree fall there was 31,000 square miles of fifty-degree fall, and inside of the fifty-degree fall a fall of sixty degrees at Keokuk, Iowa, the center of the cold wave, the temperature which was 60 deg. on the morning of Feb. 16, being zero the next day.

A theoretical treatment of the motions of the air involved in cold wave production is entirely out of the question in present state of the science of physics. The areas of high and low pressure that traverse the earth are probably connected in some way, as yet unknown, with the general circulation of the whole atmosphere. At the equator the air is heated more than at the pole, and, being expanded, it rises higher in the upper level in the upper layers. There is a continual flow of the upper air from the equator toward the poles, deflected to the right by the rotation of the earth.

In the northern hemisphere outside of the zone of trade winds there is a general motion of the air from west to east around the earth, resulting in a more or less permanent area of low pressure over the North Atlantic Ocean. In this region there are three centers where the low pressures are variously developed at different times: one near Davis Straits, longitude 60 deg. west; one south of Iceland 26 deg. west, and the other near the White Sea, north of Russia, 40 deg. east. The greater or less development of low-pressure area near these places in winter has an important bearing on the occurrence of cold weather in Europe. Low temperatures occur differently in Europe and the United States. In Europe the change mostly advances from the east toward the west and is slow and gradual. In the United States the change is almost always from the north and west towards the south and east.—*Engineering Magazine.*

Early Steel.

The Chinese, who in very early ages, had attained to some degree of understanding in the elementary principles of science and their applications, possessed also a comparatively advanced amount of knowledge in the manufacture and use of steel. Of its origin among them we have no account; but it is quite conceivable that its discovery preceded that of the lodestone, which under the name of Tche shih (direction stone), was in use among them fully 2,600 B. C. There is mention of steel in very ancient Chinese writings, and on account of the process of manufacture by one writer about 400 B. C.; and various descriptive illusions to it, implying a considerable amount of knowledge and power of discrimination in reference to its properties, occur at various subsequent periods down to the present day, when it is still a flourishing branch of their manufacture.

Inferentially, it is perfectly clear that the Phenicians were acquainted with the use of extremely hardened iron (properly speaking, steel), as their numerous and beautiful works in ornamental metallurgy, and the cutting and engravings of precious stones, for which they were conspicuously eminent among the nations of antiquity, necessarily involved, as also do the inscriptions which exist in the Phoenician language. Phoenicia, as represented by its famous daughter City of Tyre, was at the height of artistic celebrity in the time of David and Solomon (1050-1000 B. C.) With them, as powerful neighboring monarchs, Hiram, the ambitious young King of Tyre, found it wise to enter into a friendly alliance, and concluded an arrangement which proved to be for the mutual advantage of both communities, in the numerous works of art and value, especially in metallurgy, executed by his trained artificers for the furnishing and enrichment of the temple, capital, and palace at Jerusalem.—*Chambers' Journal.*

A Large Wire Rope.

At the Globe Works, Bankhall, Liverpool, there is in course of manufacture one of the largest steel wire cables that has been made in this country. When completed it will be three and a-half miles in one continuous length without a joint or splice, and will weigh about twenty tons. It is 3½ in. in circumference, made from the finest quality of patent crucible steel wire, and having a tensile guaranteed strain of over 40 tons. Some idea may be formed of the immense amount of labor required for the manipulation of an order of this kind, when it is mentioned that the total length of wire in the cable would measure something over 300 miles. The machinery employed by Messrs. W. B. Brown & Co., for this heavy work is of special design.—*National Labor Tribune, England.*

Evolution of Inventions.

A new departure will be made by the patent office at the World's Fair in Chicago. Hitherto it has never attempted to go beyond an exhibition of photographs and drawings. In this instance it will offer an elaborate and comprehensive display of models. The show will be designed to illustrate as completely and as vividly as possible the age of mechanical civilization. It will give in concrete form a picture of the progress of invention.

The Commissioner of Patents says that the great exhibit of the Patent Office will not be displayed. All that will be attempted in the show proper of his bureau will be to illustrate the processes through which those achievements have been perfected. For this purpose groups of models will be prepared. For example, one group will represent the progress of the steam engine beginning with the first one, which was built one hundred and fifty years before Christ, by a Greek named Hero. It had a boiler, and was able to do work by means of a shaft and belt attachment. From this primitive contrivance to the modern Corliss engine, in miniature, an interesting series will extend.

Other groups will be similarly arranged. One will represent the printing press, all the way from Guttenburg's original invention to the rotary Hoe machine, which turns out newspapers at the rate of many thousands per hour and folds them ready for delivery. In electricity wonders of all sorts will be illustrated by progressive series. There will be telephones running all the way from the primitive conception to the perfected instrument now in use. The telegraph will be introduced with the actual instrument made by Morse, by which the first experimental messages were sent over the wire from Washington to Baltimore, this line of discovery culminating with the latest devices for printing messages at any distance with type and transmitting one's own handwriting across thousands of miles of space in a fraction of a second. The growth of the locomotive will be shown in like manner; also that of the sewing machine; of the marvelous modern agricultural implements from primitive types; of clocks, from the water clock of ancient Babylon and the later hour-glass, etc.

Many of the models required for these groups are already in the possession of the Patent Office, but a large number will have to be constructed especially for the purpose. Manufacturers all over the country will be asked to supply specimens of their products for representing the latest developments of inventive art. The locomotive works will be requested to lend miniature models of their newest engines. Makers of agricultural tools and sewing machines will contribute the most improved specimens of their handiwork. Likewise with printing presses and everything else. Few, if any, of the mechanical models will be set working, however.—*Washington Star.*

Wire-Wound Guns.

The idea of making wire-wound guns first occurred to an American by the name of Dr. Woodbridge, as far back as 1850. Ever since that time a number of ordinance and artillery officers have believed that the wire gun will be the great artillery weapon of the future. Hence it is not surprising that numerous attempts have been made both in this country and in Europe to invent a system of wire gun construction which would give better results than the system of the built-up steel rifle. These attempts, however, have been unsuccessful, and not one of the wire-wound guns made up to this day has offered such advantages as to justify so great a change in gun construction.

The ideal cannon of the future, no matter whether it is a wire-wound or any other kind of gun, must be both a military and economical success. This at once shows the requirements which the cannon of the future must meet, namely: It should be able to withstand a higher powder pressure, and thus give a greater initial velocity and consequently a greater penetrating power to the missile; it should be lighter in weight, cost less money, save time in construction, while the material used should retain its commercial value after the gun is no longer serviceable. High as these requirements may seem, all of them are essential in order to justify a change in the present methods of ordinance construction.

The Brown segmental gun, the invention of John Hamilton Brown, seems to fulfill these conditions. Lieutenant G. N. Whistler's "Theoretical Discussion" of this system of gun construction has been assailed by many, including the writer of this article, but has not yet been disproved. In this meritorious paper, Whistler theoretically proved that the Brown segmental wire gun is possible, and also that it meets all the above mentioned requirements of the gun of the future. All that remained to be seen was whether the inventor and the constructor of the gun would be able to carry out practically their theoretical propositions. This has now been done, though most ordinance experts ridiculed the idea of a segmental wire-wound gun. Among the many reasons of the opposition it was claimed that, since the segmental core of a gun in itself has no circumferential strength, it was therefore a mistake at the very start to choose segments instead of a solid core. The recent successful test at Birdsborough of the powder chamber of the new 5-inch segmental gun which is now being constructed at that place for the United States Government, under the supervision of Lieutenant Whistler, settles definitely and conclusively the strength of the Brown system of wire-gun manufacture. This test was anxiously anticipated by many experts, as it was known that both the inventor and the constructor of the gun had been experimenting for more than two years in order to find the best methods of construction.

The Training of Mechanics.

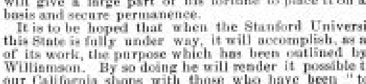
The lack of thoroughly trained artisans in the various trades is one of the greatest drawbacks on the progress of American industry. We have very few apprentices nowadays. Boys usually "pick up" trades. Not one in a hundred of our alleged "masters" of trades of American birth has had any systematic instruction. The most of our best trained mechanics are of foreign birth and learned their trades in foreign shops. The "ironclad" rules of the "Trades Unions" render it impossible for any considerable number of our American boys to learn trades in regular shops. The result of this has been to create a wide demand that the deficiency be made up by training boys in the rudiments of mechanics in the common schools; and there have sprung into existence many college annexes, where the scientific principles of physics are taught in connection with the practical application.

Every section of the country ought to encourage every movement intended to train our youth in handicraft, and every large city in the Union ought to have one or more echnological schools similar to the Sheffield annex at Yale, and the scientific and practical schools at Cambridge, that are under the control of Harvard.

A contemporary, in alluding to this matter, makes reference to the munificent bequest of Mr. I. V. Williamson, a wealthy philanthropist of Philadelphia who has determined to found a free school for the training of boys in all branches of mechanical business. He will put into the enterprise at the start $2,500,000 or $3,000,000, and if the school meets his expectations, or comes near doing so, he will liberally extend and endow it by donations in his will.

Mr. Williamson's plan is not to establish a "Manual Training School" as that term is generally understood and as it is exemplified in many of our public school systems. Such "training schools" come very short of the requirements necessary to turn out such workmen as are sought for and must be had in order to carry on in a successful manner the great workshops of the present day, which are so immensurably in advance of similar establishments as they existed fifty years ago. The intention of Mr. Williamson is to teach boys thoroughly in the mechanical trades, in order that when they enter upon life they may be able at once to secure employment. He deprecates the tendency of the day to despise hard labor, and thinks that the condition of the laboring class will be immeasurably improved if the workmen are bred up from boyhood to take pleasure and satisfaction in their work. It is with this view that he will establish his school, and the common belief is that he will give a large part of his fortune to place it on a firm basis and secure permanence.

It is to be hoped that when the Stanford University of this State is fully under way, it will accomplish, as a part of its work, the purpose which has been outlined by Mr. Williamson. By so doing he will render it possible to fill our California shops with those who have been "to the manor born," and make useful to themselves and the State thousands who would, under the present condition of things, become a burden to themselves and a possible detriment to the public.—*Mining and Scientific Press.*



The Allied Powers.

Under the above suggestive title, Mr. D. Ashworth, at the Buffalo Convention, discussed the closely interwoven relations of steam and electricity. We do not believe that our friends who have devoted themselves for years past to steam engineering, half begin to realize the actual importance of electricity as a co-worker with steam in the arts and industries of the future. Some of the more far-seeing and enterprising of them do perceive the real state of the case, and are moving to meet the growing demands of the electrical service. It is not to be supposed that the development of electricity as a motive power is as yet commensurate with that of steam, but it is rapidly becoming so, and it does not require a strong prophetic vision to anticipate the time when there will be a hundred electric motors where there is one steam engine; or, if that be an unfair basis of comparison, when nineteen-twentieths of the power plants for which steam is now utilized will be operated through electric generators and motors, and when the application of power for manufacturing purposes will be enormously extended by reason of the superior facility with which electricity adapts itself to the needs of the situation. It is the manifest destiny of the steam engine to be the handmaid of the electric generator in the application of power. To this end more attention should be given to the mutual adaptations of the two machines, from the point of view that electricity is not a rival of steam, but that the two are allied powers whose combined forces are capable of conquering territory which neither could alone put under subjection.—*Electrical Progress.*

The Relation of Electricity to Mechanics.

Electricity may, and is certain to revolutionize many of the industrial methods and conditions of life and have a powerful effect on all. Yet, howsoever great this effect may be, it can but intensify and make more certain our dependence on machinery. Electricity, the great revolutionizer, banding together for instant communication the utmost parts of the earth; transmitting at our pleasure speech, light, heat, or power. In the hands of the physician or surgeon, a gentle messenger of mercy; in those of the executioner, an avenger. Most simple of all power in its practical application; most wonderful in the diversity of its uses; most mysterious in its methods of operation; who can but watch with an absorbing interest its development in the service of man, fascinated by its mystery and marvelous works; already exerting an influence in industrial affairs little realized, except by a few. Yet this influence only faintly foreshadowing that of the near future.—*The Northwestern Mechanic.*

Electricity on the Railroad.

We have already, in previous issues, alluded to the new possibilities of what electricity may shortly accomplish in the way of displacing steam on our great railroads. There is only one man in the world whose opinion would be accepted for what he promises in the near future. That man is Thomas A. Edison. Mr. Edison, in speaking of electricity displacing steam, says: "It will displace it, if economy as well as speed and safety, is a factor of locomotion, not because it will make easily a speed of 100 miles an hour, while steam strains itself to make 60, but because it will get one-horse power out of from one to two pounds of cheap coal (water power), while out of six pounds of dear coal a locomotive engine can only get that same one-horse power. It will displace it because it will be cheaper."

Thus this greatest of inventors unhesitatingly announces the early ending of the present era of steam, and the birth of the new and improved, but not yet perfected era of electricity.

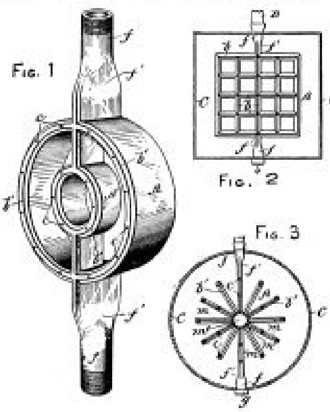
It is expected that the first authoritatively practical evidence of its wonderful achievement will be made at the Columbian Exhibition in Chicago—a most appropriate beginning of a new era of progress at the ending of the first 400 years of any real industrial progress which the world has ever made.

Mr. Edison declines to go into full details of all that he has in hand at this time, as he has not secured European protection and possibly has not fully perfected all his details in regard to moving overland trains. "But," he says, "I will say briefly that the current will pass from the stationary engine to a central rail between the tracks, thence through the mechanism attached to the bottom of the cars or motor (a freight train, of course, would need a motor, because of the number of cars, although a single passenger car could be run, carrying its own motor beneath it), thence to the wheels and thence back by the side rails to the power house or stationary engine. Three of these stationary engines with a horse power of 10,000 or 12,000 each would run the whole Pennsylvania Railroad system between Chicago and Philadelphia; freight, local, express trains, and all, at a great reduction of expense."

In alluding to this street car problem, Mr. Edison illustrates his low power system, which makes the transmission safe and at the same time all powerful, as follows: "You see I employ the heavy current with the low pressure. That is the whole secret of safety. The principle is this, that a stream of water 100 feet wide, which falls a foot, gives the same power as a stream one foot wide which falls 100 feet. The wide stream is my way, the high fall some other people's and the allowance of such pressures in public streets as some that are used, is like letting a man place a boiler in a vault under a street and put on 1,000 pounds of steam if he wants to do so. Electricity has developed too fast, you see, for the law to keep up with it. The whole question is one of expense. A low pressure trolley wire, for instance, occupies four times as much copper as a high pressure one. This system is the cheapest known and does not cost half as much as the cable.

STEAM JET BLOWER.

No. 467,427. WILLIAM MCCLAVE, SCRANTON, PA. *Patented January 19, 1892.* Fig. 1, is a perspective view of the blower as commonly made for operating in a conical pipe, which leads into the space below the grates of furnaces. Steam is taken in at one of the vertical ends *f*, and the other end is covered by a screw cap, which is removed whenever it is desired to blow steam through the device to remove rust, dirt, or sediment that may have lodged in the passages. All the passage-ways are flattened as much as



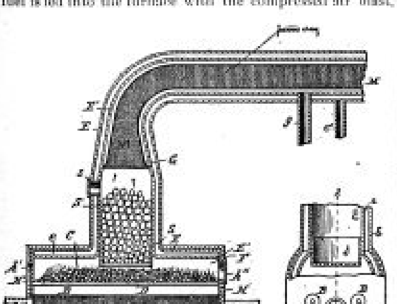
possible, and the edges are made V-shaped, so as to reduce the obstruction offered by them to the passage of air, to the least practicable amount. The jet holes *c* are drilled in the front edge of the passage-ways as shown.

Fig 2 shows a blower made on a rectangular plan to suit large square air flues, and Fig. 3 shows a construction in which the passage ways all radiate from a central hub. These blowers can also be used for exhausting, ventilation, etc.

GAS PRODUCER.

No. 466,603. CHARLES FIESSE, NEW YORK, N. Y. *Patented January 5, 1892.* This apparatus is designed to make fuel gas composed mainly of hydrogen and carbon monoxide, and to separate the two gases as far as possible. A fire is made on a grate D, of coal dust balls, coal, or coke. Above this fire is a pot S having a perforated bottom, and which is filled with broken stone, or clay, and oxide of iron, to serve as a strainer and purifier of the gases passing through. A pipe M made of porous material conducts the gas away. The furnace E^1 is jacketed by a shell E, and all the air used is drawn through this jacket by a fan so as to save the heat radiated from the furnace walls. The fuel which may be coal dust, or poorer stuff loaded with Lima oil or other hydro-carbons, is blown in through the pipe A below the grate D. Steam is blown in by means of porous pipes B. The operation is as follows: The bed of coal dust balls, charcoal, or coke on the grate D is blown up to a state of incandescence by a forced draft.

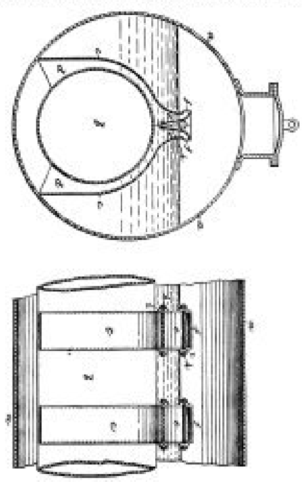
After the fuel is sufficiently incandescent, the pulverized fuel is fed into the furnace with the compressed air blast,



through A. Entering into the furnace the compressed air blast, loaded with pulverized fuel, diffuses itself all around the outlet, thus avoiding any destructive effects of the blast, and is ignited. The pulverized fuel burns out very fast in producing carbonic acid. By rising up through the bed of glowing fuel in the upper part of the furnace the carbonic acid takes up another atom of carbon, which converts it into carbonic oxide. After a run of about five minutes the blower is stopped. Then the steam is introduced into the porous cylinders B by means of the pipe *b*. The radiation of the heat in the lower part of the furnace having highly heated the porous cylinders B, it follows that said steam is readily superheated and passes through the pores of the pipes B nearly dissociated. In rising through the bed of glowing fuel the oxygen of the steam will combine with the carbon of the fuel, because of the high temperature and volatilization of the carbon in the furnace. Carbonic oxide will thus be produced and the hydrogen of the steam liberated. The transformation of the carbonic acid into carbonic oxide and the decomposition of steam to form carbonic oxide and hydrogen, said transformation and decomposition taking place in alternate runs of about five minutes each, the furnace being fed with pulverized fuel in the first run and with steam in the following run, will give off a great and even flow of gases, in which the nitrogen of the air, the only non-combustible element, will amount to less than thirty-five per cent. of the whole product. The heated air passing up through the space *e* can be drawn off through pipe e^{11} by a suitable exhauster and used for heating purposes, or as a hot blast to aid in the combustion of the gases generated by the apparatus. The gases generated in the furnace pass up through the pipe M. This pipe being porous, the hydrogen passes more freely through its pores than the heavier gases by reason of its feeble density, and by osmosis, and by the action of a suitable exhauster fixed to the pipe *g*. The gases collected in the annular space G, have therefore a higher percentage of hydrogen than those remaining in the pipe M and can be drawn off through pipe *g* and burned or stored separately from the gases delivered by pipe M. The heavier gases pass on through a metallic extension of the pipe M (not shown), and may be burned in any suitable apparatus or stored up for future use.

STEAM BOILER.

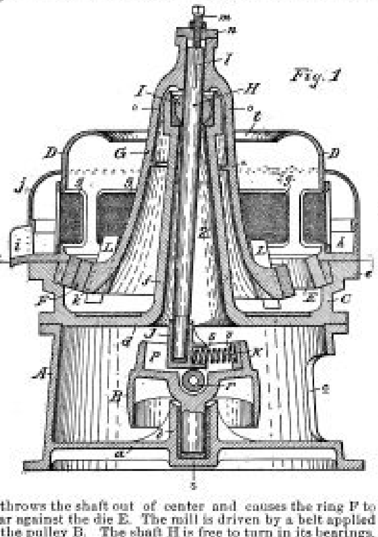
No. 440,780. JOHN GAMGEE, LONDON, ENG. *Patented Jan. 17, 1892.* This invention applies to boilers having one or more internal flues, and consists of tubes designed to regulate and assist circulation. The tubes *c* are made in sections which are bolted together as shown, upon the flue. Each piece is made of such a size that it can be taken in through the manhole and be applied to boilers already in



use. The tubes terminate in two spouts *f*, which shoot the mingled water and steam horizontally, thus liberating the steam from the water very thoroughly. The water passes down between the successive pairs of tubes and comes in again under the bottom ends *d*, to repeat the movement. A slight modification enables the tubes to be applied to boilers having two flues.

PULVERIZING MILL.

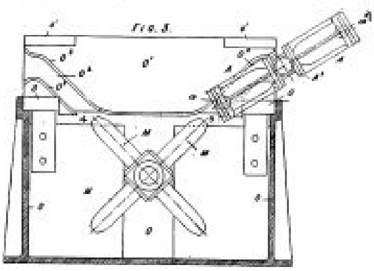
No. 466,864. EMORY I. NICHOLS, SAN FRANCISCO, CAL. *Patented Jan. 12, 1892.* The grinding is done between the roller edge F and the die E. The body or hub G of the roller is made bell-shaped as shown, and is keyed to the top end of the shaft H. The shaft turns and swivels in the ball bearing I, which is supported in the top of the cone 2. The cone is attached to or is cast in one piece with the pan C. The lower end of the shaft turns in a box J, which moves in an oblong slot *p*, formed by flanges cast on the top side of the driving pulley B. The weight of the box, with the shaft H, and roller G and F, is borne by the roller *r*, and the spring

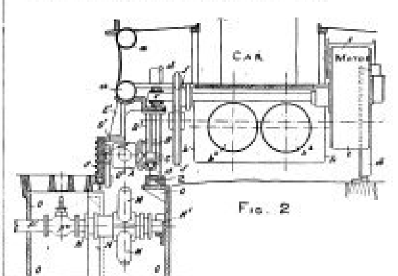


K throws the shaft out of center and causes the ring F to bear against the die E. The mill is driven by a belt applied to the pulley B. The shaft H is free to turn in its bearings, and as the driving pulley revolves, the roller turns on its axis, at the same time that it rolls around on the inner face of the die E. Scrapers L serve to stir up the pulp in the bottom of the pan, and also to throw the dust against the screens *g*. All that passes the screens falls in the circular chamber *h*, and is washed out at the spout *i*. Centrifugal force also assists to keep the roller edge in good contact with the die.

PROPULSION OF CARS BY COMPRESSED AIR.

No. 466,415. JOHN HUGHES, CHESTER, ENGLAND. *Patented Jan. 5, 1892.* In this system, compressed air is conveyed in pipes below the surface of the ground, and along the track, either between the rails or along one side, as shown in the drawings. Each car is provided with tanks b^2 as large as practicable, to store up air and thus obviate the necessity of too many charging stations. Each car carries an automatic apparatus which makes a connection between the air main and the tanks on the car, every time it passes a charging station, without stopping the car. Fig. 2 shows a cross-section of a car and a charging station. The car is provided with a double-ended sleeve or socket A, shown clearly in Fig. 3, which turns on the end of a pipe A^1 which goes to the tanks b^2. The air main P^1 runs into the box O, which is sunk in the ground alongside of the rail 2. The end of the air pipe carries a four armed nozzle M, which is free to turn on the pipe, and is provided with stuffing-boxes to prevent leakage as shown. Holes are provided in the end of the air pipe, marked N^1, upon which the nozzle turns, and corresponding holes are made in the hub of the nozzle in such position that no air will pass through while the nozzle stands in the position shown, but will pass air freely into the branch which is passing

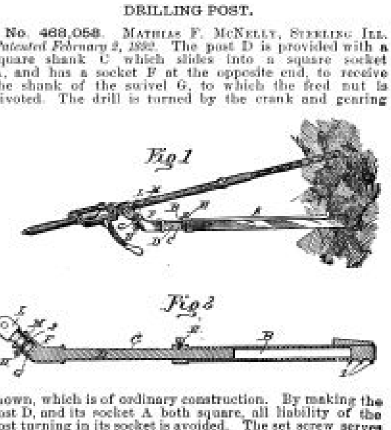




between 3 and 4. The box O is provided with a hinged cover O^1 which ordinarily lays down and covers the nozzle M. The car is provided with a kind of plow-bar D^1, which the motorman lowers by suitable levers, which catches the beveled end of this cover and turns it up vertically, as shown in Fig. 2. The under side of the cover is provided with grooves O^2 (see Fig. 3) which engage roller-pins a^1 at either end of the sleeve A, and guide the sleeve onto the nozzle M. The sleeve A is carried by a strong bracket B on the frame of the car, and as the car continues to move, the sleeve A and the nozzle M turn together on their bearings, and air passes from the mains into the tanks while they are turning. The groove at the other end of the cover guides the sleeve properly out of the box, and both A and M are left in position for future operation. The connection between the sleeve A and the nozzle M is made tight by large cup leathers in the end of the sleeve. Each half of the sleeve contains a check-valve to prevent back flow of the air in the tanks. The motor is a rotary engine. If the tanks are exhausted, the motor man can stop his car over the box and get as much air as he wants; or if he is running down grade and does not need any air, by holding up his plow-bar he can skip as many boxes or charging stations as he wants to.

DRILLING POST.

No. 468,058. MATHIAS F. MCNELLY, STERLING ILL. *Patented February 2, 1892.* The post D is provided with a square shank C which slides into a square socket A, and has a socket F at the opposite end, to receive the shank of the swivel G, to which the feed nut is pivoted. The drill is turned by the crank and gearing



shown, which is of ordinary construction. By making the post D, and its socket A both square, all liability of the post turning in its socket is avoided. The set screw serves to adjust the length of the post to the length of the auger, and the swivel G permits the drilling to be done in any direction.

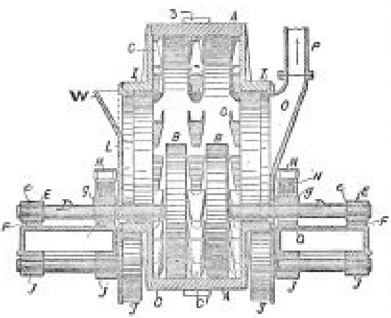
GRINDING MILL.

No. 467,368. William H. Coward, Bath, England. *Patented January 19, 1892.* A is the drum, revolved on a horizontal axis by peripheral spur-gear 3.

B are two sets of edge runners rolling upon paths side by side within the drum, and guided, so that bodily motion of the roller is permitted only up or down.

C C^2 are sets of elevating-cups fixed near the periphery of the drum, their mouths being in the direction of rotation of the drum, in order to catch the material after it has been crushed and carry it up and throw it down again in front of the edge runners, and at the same time expose it to the winnowing action of the air current.

Each edge runner B is fixed to the end of the shaft D, which passes out of the drum through a large circular opening in the side, and is journaled at its outer end in a swivel bearing E, which has lateral gudgeons *e*, pivoted in a rigid bracket F. So that while the edge runner and shaft are free to revolve the edge runner is prevented from deviating from its path, but is free to rise and fall on passing over the roughly-broken material, the slight lateral motion of the edge runner due to angular motion about the axis *e* of the



swivel-bearing E having the effect of supplementing the crushing action of the edge runner by an abrasive or rubbing action between the edge runner and the drum, which conduces to the more rapid reduction of the material. Each shaft D is guided by a bearing *g*, free to rise and fall in guides G, and pressed upon by an adjustably-weighted lever or by a spring H, regulated by screws *h*, in order to increase the crushing power of the edge runner.

The openings at the two sides of the drum are closed by stationary covers L, fitting within the surrounding flanges I, which are cradled upon sets of friction-rollers J, carried by shafts turning in bearings *j* on the bed-plate, the drum being thus wholly supported on the two sets of friction-rollers. The drum has three sets of elevating-cups—a set C, fixed to each side of the drum, as before, and a middle set C^2, fixed to the periphery of the drum and passing between the two sets of edge runners, the cups C^2 being larger than the cups C.

The cover L at one side of the drum is provided with a feed-hopper M, while the other cover N has an aperture at the upper part leading through an upwardly extending and gradually-contracted spout O into a vertical pipe P, which is carried up to a suitable height and then connected to an exhaust-fan. The current of air passing up this flue carries away the finely ground material, and no screens are needed.

ORE FEEDER.

No. 466,881. John R. Russell, San Francisco, Cal. *Patented January 12, 1892.* This apparatus is designed to feed ore into the mortar of a stamp battery, and is operated by the tappet on the stamp stem. The ore is placed in the hopper C and is fed down into the barrel B. The shaft D carries an oblique disc E, which operates at each rotation to push the ore forward toward the mouth of the barrel B. The front end of the shaft carries a spider F having suitable

Fig. 1.

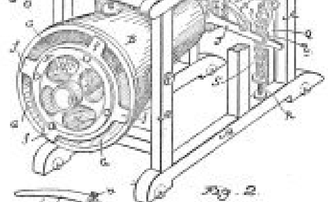
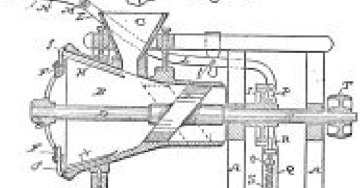


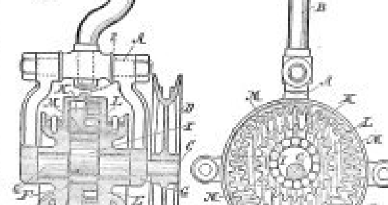
Fig. 2.



openings for the escape of the ore. When the ore is pasty or sticky, curved scraper arms H are attached to the spider to assist the delivery of the ore. The shaft D is rotated by a pawl K and ratchet wheel I. The pawl lever J is worked by the levers L, which are united at the front by the rod M. A toe or arm N is adjusted on this rod so as to follow the tappet on the stamp stem O, up and down continuously. The rotation of the feeding device depends upon the amount of motion given to the arm N by the tappet, consequently the feed is automatically adjusted to the stroke of the stamp and the condition of the mortar, feeding slowly when it is full, and fast when it is empty. The spring S compels the arm N to bear against the tappet at all times, and there is none of the jarring and racking of the feeder common to machines of this class in which the tappet strikes the feeding mechanism.

DIFFERENTIAL HOIST.

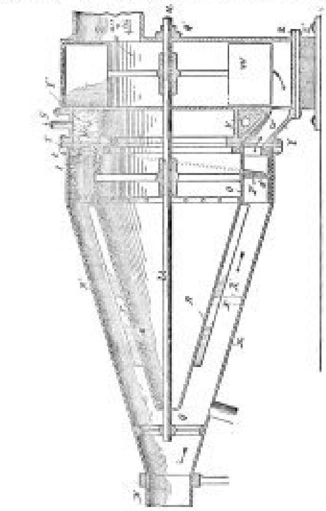
No. 467,513. Edward Y. Moore, Milwaukee, Wis. *Patented January 26, 1892.* This hoist consists of two chain wheels E and F, each of which has an internal spur gear E^2 and F^2 cast on one side, and a double spur pinion L and K which meshes with them. The chain wheels turn on bearings G which are made solid with the side frames A. The double gear L K turns on the eccentric I, running on the rollers M. The eccentric is keyed on the shaft C which runs through the bearings G, and carries the wheel D for the operating or hand chain. The hoisting chain H is double, both ends being attached to the hook; and it is so reeved that the load is suspended from both chain wheels, on one side of E, and on the opposite side of F. By this arrangement all tendency to run down is avoided. As the eccentric is revolved by the hand chain and wheel D, the gears L and K are compelled to mesh with all the teeth in the rims E^2 and F^2 at each revolution. L has 22 teeth, E^2 28, K



32 and F^2 has 38 teeth. In rolling once around the rim F^2, K makes 1[illegible] revolutions, as does L also. But the number of teeth in L multiplied by 1[illegible] = 30[illegible] teeth. The rim E^2 contains only 28 teeth, and consequently it is compelled to forge ahead 2[illegible] teeth at each revolution of the eccentric. This causes the chain wheels E and F to slowly revolve in opposite directions, but as the hoisting chain H hangs one strand on sheave E and the other on the opposite side of F, it follows that both strands go up or down together. As both sheaves are loose on their bearings they readily adjust themselves to the inequality in the motion of the two strands. Two separate chains may be employed—having hooks at each end—thus having one hook always down ready for use. The ratio between the gears employed may be varied to any extent, to secure any desired proportion between the load to be lifted and the pull required on the hand chain. Being composed wholly of spur gearing there is a minimum loss from friction.

BLOWER FOR PULVERIZED FUEL.

No. 466,603. Charles Fiesse, New York, N. Y. *Patented January 5, 1892.* The shaft U is horizontal and is turned by a belt and pulley not shown. It carries a fan wheel W, a drum O, O^1, having a spiral blade P between the rims, and a long conical drum R having a number of vanes *r* on its outer surface. Between the fan-wheel W and the drum O, a water block Y, Y^1, is provided, through which water can be circulated to keep the parts from getting too hot. The fuel which is pulverized is fed in through



the pipe 2 along with the air for burning it and is driven by the fan-wheel through the passage n^1 into the spiral passage formed by the blade P between the rims O, O^1. This spiral serves to make the delivery of the fuel uniform, and corrects the irregularity of the first feeding into the pipe 2. The mingled air and fuel passes onward over the drum R and out by the pipe N to the furnace. The air used is preferably heated as highly as possible in a regenerator connected to the furnace to which the fuel is supplied, thus securing a high degree of economy, and making it practicable to use a very low grade of fuel.

SAFETY LAMP.

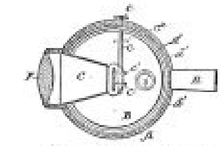
No. 467,193. George T. Parry, Philadelphia, Pa. *Patented January 19, 1892.* The case A is provided on its bottom plate with feet *a*, on which rests an ordinary lamp B, around which air can pass to the flame, and which is provided with a filling hole *b* and a ratchet-wheel shaft *c*, with ratchets c^1 to raise or lower the wick. The shaft *c* may be adjusted from the outside by a button c^2 on its end or on the inside of the lamp-case by a button c^3, located as indicated by dotted lines.

To the case section A an upper metal case section A^1 is screwed fast at *d*, as shown, making with an india rubber washer d^1 an air tight joint or connection.

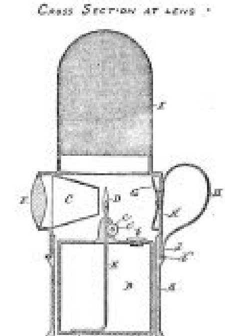
C represents a conical tube arranged in the front part of the section A^1 of the metal case and firmly secured therein in any suitable manner. The small end of this tube extends nearly to the flame D of the wick E and serves for concentrating the light from flame D.

In the front end of the tube C, a bull's eye F is placed, as shown. By means of the tube C the concentrated light is, thrown upon the bull's-eye in such a manner as to secure a brilliant illumination in the mine, a result that would not be accomplished without this tube in so perfect and effective a manner. Behind the flame D a reflector G may be arranged, the same being fastened to the metal case A^1.

Outside of the section A^1, at the rear of the lamp, a loop-handle H is provided. The upper part of the lamp above the case section A^1 is, as usual, formed of wire-gauze I which is fastened by its lower edge to the upper edge of



Cross Section at Lens.



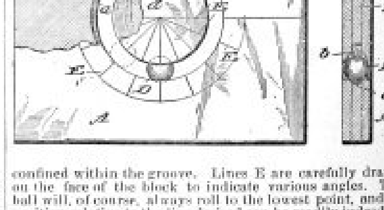
the section A^1, as shown. In the bottom of the section A a draft opening J is provided, and this opening is covered with wire gauze K of about the same mesh as the wire-gauze I. Under this construction in order to fill the lamp at the opening *b* the sections A^1 A^2 are separated by unscrewing the same at *d*.

It will be seen that all parts of the case containing the lamp are air-tight, excepting the wire-gauze I and the draft opening J, covered by the wire-gauze K. It will also be seen that the flame D from the lamp B will light up the safety covering gauze I the same as in the ordinary Davy lamp, while the projection of light from the bull's-eye F will be a bright and steady light for aiding workmen in their operations in the mine.

It will be further seen that the outer case of this lamp is constructed to form a chamber in which a reservoir lamp is placed, and that the reservoir lamp is a distinct structure from the case, and when placed within the case it is surrounded on all sides and at bottom by a large air space, through which air circulates for promoting combustion at the wick, and thus cools the body of the lamp.

PLUMB AND LEVEL.

No. 466,380. Newel H. Spencer, Elmira, N. Y. *Patented January 5, 1892.* This device is intended for attachment to straight edges or squares or other tools, or it may be constructed within the body of such tools. It consists of a block of metal having a circular groove accurately formed about the center *d*, and a ball of accurate shape which is



confined within the groove. Lines E are carefully drawn on the face of the block to indicate various angles. The ball will, of course, always roll to the lowest point, and its position relative to the line desired can be readily judged by the eye, quite as easily as the bubble in an ordinary spirit level can be centered; with the additional advantage that the ball will indicate as many different angles as there are lines E drawn upon the face of the instrument.

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VOL. XII.—NO. 10. SCRANTON, PA., MAY, 1892. WITH WHICH IS COMBINED THE MINING HERALD

THE ECONOMIC GEOLOGY OF COPPER.

The Mineralogy, Mode of Occurrence, and Production of Copper.

BY H. A. WHEELER, E. M., OF ST. LOUIS.

The number of copper-bearing minerals is very large, most of which have a green color, but until the opening up of the large deposits in Arizona and Montana within the last fifteen years, there were only two that were found in sufficient quantity in this country as to be of much importance as ores, or the native and "yellow-copper." Since the Far Western mines have become such heavy copper producers from the oxides, carbonates, silicate, and black sulphides, the number of important copper ores has considerably increased, so that it will be necessary to consider all of the following as now being of commercial importance.

Native Copper, as its name implies, is pure copper, which occurs naturally in very large quantities at Lake Superior, and in very small quantities, as mere specimens usually, at or near the outcrop of nearly every copper bearing vein. If untarnished, it has the characteristic copper red color, is very tough and malleable, rather soft, and very heavy (specific gravity is 8·9).

Chalcopyrite, or "Copper Pyrites," or "Yellow Copper Ore" is a sulphide of copper and iron, consisting of about equal parts of copper, iron, and sulphur. It is the most abundant ore of copper, and on account of its bright, metallic luster and brass-yellow color, it is very easily recognized. It is somewhat hard, rather heavy specific gravity is 4·2), gives a greenish-black streak, and is very brittle, by which it is quickly distinguished from native gold, which it resembles in color and for which it is occasionally mistaken.

Bornite, or Erubescite, or "Purple Copper Ore," or "Peacock Ore," is a sulphide of copper and iron that contains a variable amount of copper ranging from 50 to 70 per cent. It has a bright metallic luster, varies in color from purple to brown to bluish black, usually has a variegated tarnish and gives a black streak. It is rather soft, quite heavy (specific gravity is 4·4 to 5·0) and not very brittle.

Chalcocite, or "Copper-glance," is a black sulphide of copper that contains 80% of metal. It has a dull metallic luster, while the color and streak are black to lead-gray. It is quite soft, very heavy (specific gravity is 5·7), and is slightly sectile or is tough enough to be cut into small shavings.

Cuprite, or "Red Copper Ore," is the red oxide of copper and contane about 89% of copper. It has a non-metallic luster, varies from bright red to very dark red in color, and gives a brownish-red streak. It is rather hard, very heavy (specific gravity is 6), and very brittle.

Melaconite, or "Black Copper Ore," is the black oxide of copper and contains about 80% of copper. It has an earthy luster, a dark-brown to black color, and gives a black streak. It is usually very soft, very heavy (specific gravity is 6·2,) and very brittle.

Azurite is the blue hydrous carbonate of copper, and contains about 55% of copper. It has a non-metallic, vitreous to earthy luster, a deep blue color, and gives a pale blue streak. It is rather hard, not heavy (specific gravity is 3·7) and is very brittle.

Malachite is the green hydrous carbonate of copper, and contains about 57% of the metal. It has a non-metallic, silky to vitreous luster, light to dark green color, and gives a pale green streak. It is rather hard, not heavy (specific gravity is 3·8) and is very brittle. The compact varieties take a fine polish and are highly prized for ornamental purposes as a semi-precious stone.

Chrysocolla is a hydrous silicate of copper that varies considerably in its composition, ranging from 22 to 36% in copper. It has a non-metallic, vitreous lustre, varies from blue to green in color and gives a white streak. It is somewhat hard, very light (specific gravity is 2·2) and usually very brittle. It is very common, as a green wash or staining, along the outcrop of copper bearing veins, but seldom occurs in sufficient quantity to be of value as an ore, and it is an expensive ore to smelt on account of its low grade and high silica. It has deceived many a prospector by the conspicuous way in which it will make a great showing on the surface, but on assaying the green stained rocks they are usually found to be too poor to work.

Chalcanthite is the hydrous sulphate of copper or is the same as blue-vitriol. It is not often found as a vitreous, blue, soft solid, but frequently occurs in solution in the waters of old copper mines, from which it often pays to extract the copper by means of scrap-iron, on to which the copper is thrown down on prolonged standing. It is this mineral that gives the highly nauseating, metallic taste to the drainage from copper mines and causes the miners to break out in pimples and sores from the poisonous action of such waters when in contact with the skin.

Tetrahedrite, or "gray-copper," is a sulphide of copper and antimony that may contain as high as 42% of copper. It has a bright metallic luster, a steel-gray color, and gives a dark red to gray streak. It is rather hard, quite heavy, (specific gravity is 4·8), and is very brittle. It seldom occurs in large quantities and makes a very inferior quality of copper on account of the antimony it contains, but it so frequently carries silver as to often be a very valuable silver ore.

All the copper minerals are frequently found to contain paying amounts of gold and silver, and should always be assayed for the precious metals, which are rarely entirely absent, though in undisturbed regions the amount of the precious metals is usually too small to pay to extract.

In considering the deposits of copper, the most unique in character thus far found in the world, as well as of the greatest importance in regard to quality, are the famous deposits of the Lake Superior region, where all the copper is mined in the native or metallic condition. Native copper occurs in at least specimen quantities in many other places, and at Santa Rita, New Mexico, and some parts of Arizona, in even appreciable amounts; but thus far such natural occurrences of the metal elsewhere have never held out to any depth or been of much commercial importance. But the entire heavy output of the Lake Superior district is obtained exclusively from this ore, and it is found to be of exceptional purity, which is so important for the enormous electrical demand that has recently sprung up. Other ores of copper have been found in the Lake Superior district, but thus far in such small amounts as to be of no commercial value, and the profitable mines have all been opened on only the native copper veins. Another interesting feature about the copper lodes of Lake Superior is the fact that they are so low grade, as with one exception the average yield does not exceed 2%, and in one case a mine has paid regular dividends from an ore that yields only three-quarters of one per cent. of copper. Omitting the one lode that carries from 3 to 5% (the Calumet and Hecla), the Lake Superior copper companies are working lower grade ores than are worked any where else in the world. The uniqueness of the deposits, the permanence of the lodes, and the important position that "Lake" copper commands in the world's copper market, which until recently was the heaviest output from any one district, entitles this region to special consideration.

The present history of the Lake Superior copper region dates from the year 1845, when it made its first appearance in the copper market with an insignificant output, at a time when our country was producing a small amount of copper from a few mines in the Appalachian belt, but mainly depending on foreign sources for its supply. Though the occurrence of native copper in that region had been reported two centuries earlier by travelers, it was not until that late date that determined, vigorous efforts were made to open up mines in what was then an unknown wilderness. Since that year more and more mines have been developed, many of the old ones have enlarged their facilities, and so few of the lodes have thus far become exhausted, that the output has steadily risen until last year (1891) the output had increased to about 58,000 tons, and the preparations now being made at the Lake indicate that this heavy output will be considerably exceeded in the immediate future. But the past history of this region as a producer, when it was worked by the prehistoric miners, who have left such abundant evidence of their workings, is at present unknown, but some of the best lodes have been found by means of the remains of the workings of these ancient miners. None of these old workings are deep or very extensive, but considering the rudimentary methods they possessed of working these hard copper lodes by means of their stone implements, they must at least have given considerable attention to them.

The geological formation in which these highly productive copper lodes occur consists of a series of parallel beds of rocks of very great age (probably Cambrian) that extend from the end of the peninsula that juts out from the middle of the south shore of Lake Superior, known as Keweenaw Point, for a distance of at least 150 miles to the Southwest. This range of copper-bearing rocks is made up of alternating beds of compact lava known as "trap," of amygdaloidal lava known as "melaphyre" or "amygdaloid," and of coarse red conglomerates and brown sandstones. The copper rocks are from 3 to 7 miles wide, and have a general dip to the Northwest that varies from 20° to 55°.

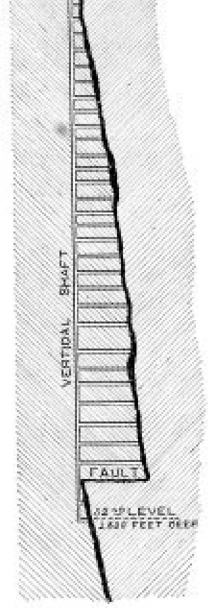
The copper occurs in these rocks in three classes of deposits: As (1) *fissure veins*, that break across the formation at right angles, and which are usually vertical; (2) as *contact veins*, or ore-bodies that lie along the plane of contact of the trap and conglomerate belts; and (3) as *impregnated deposits*, in which the old steam cavities in the amygdaloidal lava belts, or the interstices between the gravel and sand in the conglomerate belts have been more or less completely filled by copper.

The fissure and contact veins were most actively worked in the early history of the region, as they carry their copper largely in the form of solid masses that vary from a few pounds in weight up to 600 tons, and were therefore thought to be far more profitable than the amygdaloid and conglomerate belts in which the copper mainly occurs as small disseminated shots or granules. But the stern lesson of experience has shown that the expenses of mining such heavy masses of copper are much greater than when it occurs as small, scattered pellets, so that with the low prices of copper that have now ruled for some time, almost all of the vein mines have had to close down from their inability to compete with the belt mines. The vein mines are usually very narrow, or from one to three feet wide, rarely over five feet, while the belt deposits usually range from ten to thirty feet wide. While the fissures are found running across the formation throughout its entire length, they are much more numerous at the northern end of the range in Keweenaw County, where they have been very extensively worked, while the contact deposits, which are few in number, have only been worked at the southern end of the range, in Ontonagon County. The belts are found to run continuously from one end of the range to the other, but it is only in places that they are found to be rich enough in copper to pay to work, and thus far all the profitable belt mines have been opened up along the central part of the range, or in Houghton County. On account of the fine condition of most of the copper in the belt mines, it is necessary to crush the low-grade rock into sand, and then concentrate the heavy copper on jigs and slime tables, by which treatment the light rock is washed away, yielding a copper sand that will assay on an average about 70% in copper. For this purpose large mills are to be found along the lake shores, adjacent to, and connected with the mines by railroads, where powerful steam stamps are employed to perform the crushing that are capable of reducing from 150 to 300 tons of two and one-half inch rock to three-sixteenths inch sand in twenty-four hours per stamp. More or less pure copper is also found associated with the masses in the vein mines, but as the amount is comparatively small, the vein mines still use the old fashion drop stamps to crush the disseminated rock, which have a capacity of only two to four tons per stamp in twenty-four hours. The rich copper sands, or "mineral" produced by the stamp-mills merely requires melting to free it from the associated matter, to be put into merchantable condition as ingots for casting, bars for wire-drawing, and cakes for rolling into sheets.

The most prominent of the fissure vein mines are the Cliff, Phoenix, Copper Falls, and Central, all of which are in Keweenaw County, at the northern end of the range. The *Cliff Mine* was the first regular copper producer of Lake Superior, beginning its career in 1845, and was the first, and for a long time the heaviest dividend paying property of Lake Superior. The vein, which is about vertical, has been worked to a depth of nearly 1,700 feet, and as it has pinched and grown poorer with depth, work on it was finally abandoned in 1885, after it had produced about 19,000 tons of copper, from which it paid a total of $2,627,000 in dividends, or nearly 2,400% on the capital stock paid in.

The *Phoenix Mine* is better known by the 500 ton mass that it produced than by a brilliant record for either a large product or dividends. For while it was one of the very first to be worked, dating back as far as 1844, the vein has on the average been so poor that it had produced less than 8,000 tons of copper when it was shut down in 1887, after attaining a vertical depth of about 1,200 feet, and only $20,000 has been declared in dividends, while the assessments amount to about $1,000,000. It is an interesting instance of the expense of working the large masses that occasionally occur in the fissure veins that this 500-ton mass which was found in 1870, cost more to mine, cut up into manageable chunks, and raise than it finally realized, though copper was selling in those days for more than twenty cents a pound.

The *Central Mine* is the only other fissure vein property in the Keweenaw District besides the Cliff, that can make a satisfactory showing as a financial investment and it is now the "Last of the Mohicans," as it is the only fissure vein property being actively worked to-day in the State of Michigan. It was discovered in 1854, and has been worked continuously to date, having produced a total of about 22,000 tons of copper, and has now attained a depth of over 2,800 feet. It paid its first dividend in 1862, since which time it has returned from $1 to $8 per share per year, aggregating $1,970,000 in all, on a capital investment of only $100,000. The vein runs about north and south, dips to the east at the rate of 10 feet per 100 from the vertical, and like all the fissure veins, has a vein filling of calcite, quartz, and zeolitic matter, in which are found the masses and disseminated copper. This mine has produced a large number of masses, which were larger and much more abundant in the upper part of the mine than in the lower workings. One of these masses was a huge slab found lying against the wall of the vein that proved to to weigh about 600 tons, after it had been slowly and laboriously cut up into chunks of five to ten tons each. In mining such unmanageable slabs, it is necessary to stope away all the ground in front of one face of the mass, when by drifting behind the middle of it and filling a chamber with black powder to the extent of twenty-five to fifty kegs, it can be blown out free from the rock and is ready to be cut up. The cutting is done by special miners, who with long, sharp chisels and eight pound striking-hammers, slowly cut off pieces small enough to be hauled out through the drifts, and hoisted by a special engine of great power. The cutting is done by contract, and as high as $14.00 per square foot of face cut is paid, as the cutting has to be done chip by chip, which is very slow on such tough material. Recently the Central vein was found to be faulted, or lost, on the thirtieth level, or apparently the fissure extended no further; but later explorations have shown that it was "heaved," or thrown about 300 feet, from whence it again continues, as shown in sketch A.

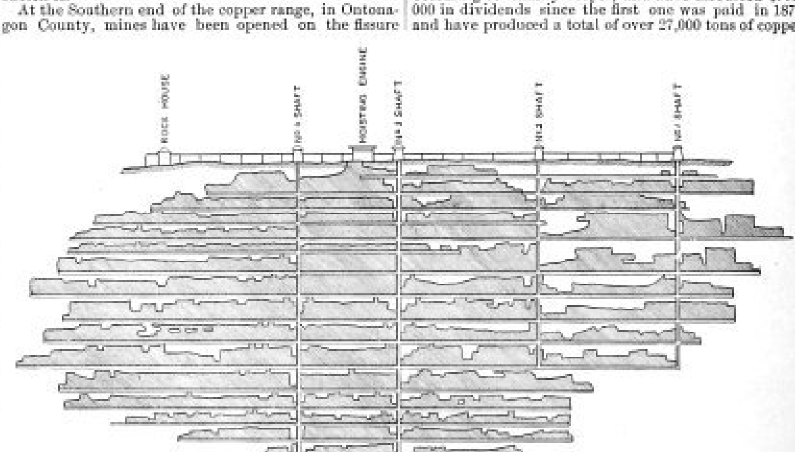


SKETCH A.—CROSS SECTION OF THE CENTRAL VEIN.

At the Southern end of the copper range, in Ontonagon County, mines have been opened on the fissure veins, on the amygdaloid belts and on the contact veins, and while quite extensive work has been done, the only successful enterprises have been the Minnesota and the National Mines, which are adjacent properties on the same contact lode that have both repaid all the money put into them and three times more in the latter case, and thirty times more in the first. The Minnesota Mine was very successful in its day, and has left a brilliant record. It was discovered in 1847, by the remains from the workings of the prehistoric miners, and a mass of about six tons weight was found already mined and blocked up by the aboriginal workers, who seemed to have been unable to utilize such a massive piece. After assessing to the extent of $900,000, the mine began paying dividends in 1852, which were regularly continued until 1865, a total of $1,920,000 having been disbursed from an output of over 17,000 tons of copper, besides putting about a third of a million into plant. The mine was shut down in 1870, after reaching a depth of 1200 feet, and only tribute work has been carried on since in a small way. The vein lies between a trap hanging-wall and a conglomerate foot, is from 2 to 8 feet wide, has a dip of 52° to 64°, and trends with the formation. The vein filling is mainly calcite, in which occurred many large masses, one of which was 45 feet long, had an average width of 13 feet, and an average thickness of 4 feet, with an estimated weight of 500 tons; it took 20 men 15 months to extract this one mass, which is famous as being the most solid mass ever found on the Lake, as it had a maximum thickness of 8½ feet. Almost the entire output of this mine has been from "*heavy*" copper or pieces of several pounds weight and upwards, the fine, shot copper having been of very minor importance.

Youngest in age but most important in the magnitude of its output and the magnificence of its dividends is the central portion of the copper range, in Houghton County, where all the mines work either belts of conglomerate or belts of amygdaloid. While this portion of the copper range has the largest number of dividend paying mines, it also has an abundance of properties that have failed to repay the large sums that have been put into many of them. One of the oldest mines of this district that as yet ranks next to the world famous Calumet & Hecla, is the Quincy, which operates a belt of amygdaloid that averages about 2% in copper, but which is found to be very bunchy in its copper contents and therefore neccessitates extensive exploration in the search for new ore-bodies. Unlike most of the belt mines, the Quincy lode carries considerable heavy copper, masses of five to even twenty tons not being infrequent, though its principal product is obtained from the stamp-rock or the finely disseminated copper. It began producing in 1856, since which time it has produced over 60,000 tons of copper, and paid dividends therefrom with great regularity that now aggregate the handsome sum of $6,170,000, besides paying for plant investments that exceed $1,500,000, on an invested capital of only $200,000. It is one of the deepest mines in this country, as its lowest level, the 41st, is 3200 feet deep as measured on the dip of the vein, which averages about 54°. Adjacent to the Quincy and operating the same belt is the Pewabic Mine, which after prolonged litigation and idleness, has been absorbed by the Quincy people; it paid $400,000 in dividends since it began operations in 1855, and produced about 14,000 tons of copper. Adjoining the Pewabic Mine and also operating the same lode is the Franklin Mine, which since 1857 has produced over 35,000 tons of copper, and paid $1,120,000 in dividends.

An admirable instance of the success of good management is to be seen in the Atlantic mine, which started in 1872 on the financial wreck of two previous administrations that had spent $1,000,000, and then failed when copper was high and the mine shallow, has become a decided financial success and one of the beacon lights of low grade mines. The lode is a very uniform belt of amygdaloid, about 15 feet wide, that yields only about ⅔ of one per cent. of copper. Yet by very careful management and operating on a large scale, they have been able to finally put it on a dividend paying basis, in spite of the low prices lately ruling and the mine becoming constantly deeper, and have disbursed $700,000 in dividends since the first one was paid in 1878, and have produced a total of over 27,000 tons of copper.



SKETCH B.—LONGITUDINAL SECTION OF THE ATLANTIC MINE.

For a longitudinal section of the mine, showing the regularity of the stopes and the mode of working, see sketch B.

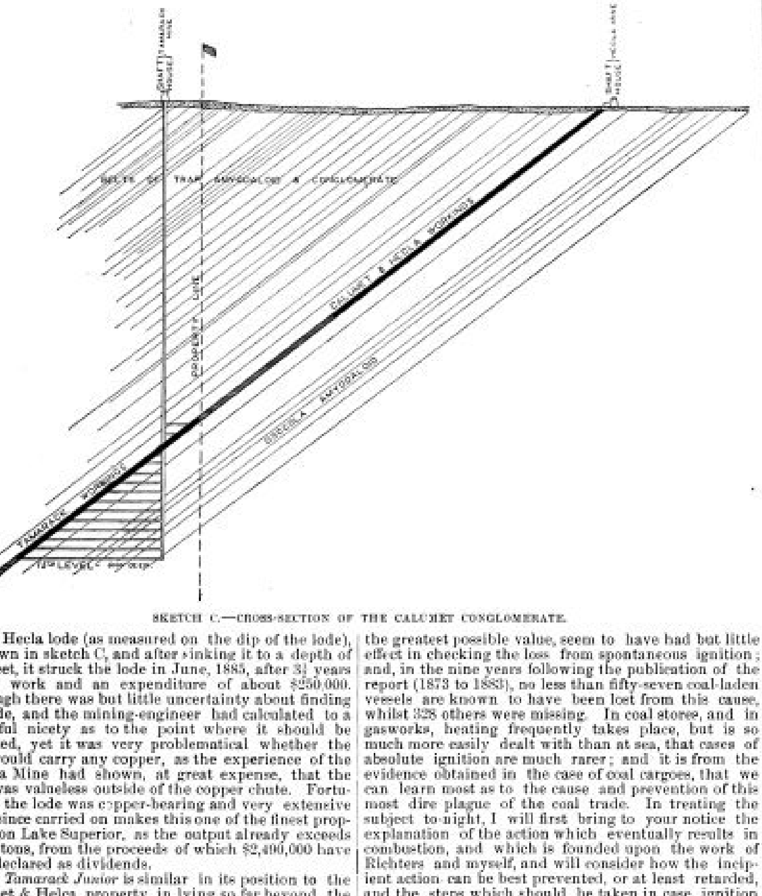
The *Osceola Mine* is a well managed property that was opened on the famous Calumet & Hecla conglomerate belt in 1873. Though it adjoins the Hecla mine, and the lode was very rich at first, it was soon found to have only the Southern end of the Hecla copper chute, and while the lode continues uninterrupted, it is practically barren of copper after a small portion adjacent to the Hecla property line had been exhausted. The mine would have been a failure if a new amygdaloid belt had not been discovered, on which a new mine has been opened since 1878, which has already attained a depth of 2500 feet on the lode. The total production of this property exceeds 30,000 tons, from which $1,547,000 has been paid as dividends.

The giant of the copper world when production and dividends are considered, is the famous *Calumet & Hecla Mine*, which began operations in 1865 on a conglomerate belt that has been proved to carry a very extensive chute of copper that yields from 3 to 5%. Originally started as two separate mines, the Calumet and the Hecla, which subsequently consolidated with an invested capital of $1,200,000, the annual output now exceeds 30,000 tons a year, which is more than the combined product of all the other mines on the Lake, from which $2,000,000 a year is usually paid in dividends, while the total output exceeds 350,000 tons, and the total dividends aggregate the enormous sum of $36,850,000, besides paying several millions more for one of the largest and most extensive surface plants to be found in the world. The lode varies from 10 to 20 feet wide, and the workings now extend to the 42d level, or over 4000 feet on the dip, which here amounts to about 38°; over 3000 tons of ore are hoisted a day, and about 25 acres are exhausted a year in maintaining this enormous output.

Adjoining the Calumet & Hecla property on the dip of the lode, are the *Tamarack* and Tamarack Junior Mines, which are remarkable instances of very bold and fortunately very successful prospecting. The Tamarack Mining Co. started a vertical shaft in February, 1881, about half a mile beyond the outcrop of the Calumet & Hecla lode (as measured on the dip of the lode), as shown in sketch C, and after sinking it to a depth of 2270 feet, it struck the lode in June, 1885, after 3¼ years steady work and an expenditure of about $250,000. Although there was but little uncertainty about finding the lode, and the mining-engineer had calculated to a beautiful nicety as to the point where it should be expected, yet it was very problematical whether the lode would carry any copper, as the experience of the Osceola Mine had shown, at great expense, that the lode was valueless outside of the copper chute. Fortunately the lode was copper-bearing and very extensive work since carried on makes this one of the finest properties on Lake Superior, as the output already exceeds 30,000 tons, from the proceeds of which $2,400,000 have been declared as dividends.

The *Tamarack Junior* is similar in its position to the Calumet & Helca property, in lying so far beyond the outcrop of the lode as to necessitate very deep shafts in order to reach the lode, with a by no means small possibility of finding the lode barren after the heavy outlay involved in reaching it. However, two shafts were started in May, 1888, and one of them struck the lode at a depth of 2,400 feet in a little less than 3 years time, and luckily found it copper bearing. The other shaft will have to go 2950 feet before it strikes the lode, and until then the property will not have had an opportunity to produce much copper.

[TO BE CONCLUDED.]



SKETCH C.—CROSS-SECTION OF THE CALUMET CONGLOMERATE.

THE SPONTANEOUS IGNITION OF COAL AND ITS PREVENTION.

BY PROFESSOR VIVIAN B. LEWES, F. I. C., F. C. S.

(From the Proceedings of the Society of Arts, England, March 2, 1892).

Last Autumn I had the honor of bringing before the Chemical Section of the British Association certain views, which are now widely gaining ground, as to the cause of the phenomenon of spontaneous ignition of masses of stored coal; and, in the discussion which ensued, Sir Frederick Bramwell expressed the hope that the paper would be followed by a second, in which methods for the prevention of this too often disastrous action might be discussed; and it is at the invitation of your secretary that I propose to bring my views on the subject before you to-night. Ever since the general adoption of coal as a fuel, the storing and shipment of masses exceeding 2,000 tons has been recognized as requiring great care; and if much small coal has been present, or if it has been stored wet, firing, or at any rate heating, of the mass has frequently taken place. On shore this has led to much inconvenience and loss, but it is during shipment that the real danger has occurred; and many a fine vessel, with all hands, has been lost from this cause, without even a record of the calamity reaching the land. In 1875 the loss of life and property from this cause became so serious that a Royal Commission was appointed to report upon the possibility of preventing these appalling disasters; but the recommendations contained in the report, although of the greatest possible value, seem to have had but little effect in checking the loss from spontaneous ignition; and, in the nine years following the publication of the report (1873 to 1883), no less than fifty-seven coal-laden vessels are known to have been lost from this cause, whilst 328 others were missing. In coal stores, and in gasworks, heating frequently takes place, but is so much more easily dealt with than at sea, that cases of absolute ignition are much rarer; and it is from the evidence obtained in the case of coal cargoes, that we can learn most as to the cause and prevention of this most dire plague of the coal trade. In treating the subject to-night, I will first bring to your notice the explanation of the action which eventually results in combustion, and which is founded upon the work of Richters and myself, and will consider how the incipient action can be best prevented, or at least retarded, and the steps which should be taken in case ignition should result. Coal is a substance of purely vegetable origin, formed out of contact with air by long exposure to heat and pressure, from the woody fiber and resinous constituents of a monster vegetation, which flourished long before the earth was inhabited by man; and coal may therefore be looked upon as a form of charcoal, which, having been formed at a temperature lower than that of the charcoal burner's heap, and under great pressure, is very dense, and still retains a quantity of those constituents which, in the latter case, are driven off as tar, wood naphtha, &c. These bodies consists essentially of compounds containing carbon and hydrogen, together with a little oxygen and nitrogen, and form the volatile matter and hydrocarbons of the coal. Besides the carbon and hydrocarbons, coal also contains certains mineral bodies, which were mostly present in the sap and fiber of the original vegetation, and which gives the ash which is left behind when the coal is burnt. These substances consist chiefly of sulphate of lime or gypsum, silica and alumina, whilst in nearly all kinds of coal is to be found a substance called disulphide of iron, coal brasses or pyrites, which has been formed by the gradual reduction of the sulphates by carbonaceous matter in the presence of iron salts, and which, during the combustion of the coal, is decomposed, giving off sulphur compounds, and leaving behind oxide of iron, which gives the reddish-brown color to the ash of many kinds of coal. Of these constituents of coal, the only ones which play no part in the phenomena attending heating and spontaneous ignition, are the mineral constituents other than the pyrites, and we have, therefore, to deal with the chemical actions which take place when the carbon, hydrocarbons, and brasses contained in newly-won coal come in contact with air and moisture.

THE INFLUENCE OF CARBON IN PRODUCING HEATING.

Carbon is one of those substances which possess to an extraordinary degree the power of attracting and condensing gases upon their surface, this power varying with the state of division of the particular form of carbon used. The charcoal obtained from dense forms of wood, such as box, exhibits this property to a high degree, 1 cubic inch of such charcoal absorbing:

	Cubic inches.
Ammonia gas	90
Sulphureted hydrogen	55
Carbon dioxide	35
Ethylene (olefiant gas)	35
Oxygen	9·25
Nitrogen	6·5

whilst certain kinds of coal also exhibit the same power, although to a less degree. The absorptive power of newly-won coal due to this surface attraction varies, but the least absorbent will take up one and a quarter times its own volume of oxygen, whilst in some coals more than three times their volume of the gas is absorbed. This absorption is very rapid at first, but gradually decreases, and is, moreover, influenced very much by temperature, for reasons which will be explained later. The absorption is at first purely mechanical and itself causes a rise of temperature, which, in the case of charcoal formed in closed retorts, as in preparing alder, willow, and dogwood charcoal for powder making, would produce spontaneous ignition if it were not placed in sealed cooling vessels for some days before exposure to air. The rate of absorption varies with the amount of surface exposed, and, therefore, able to take part in this condensing action, so that, when coal or charcoal is finely powdered, the exposed surface being much greater, absorption becomes more rapid, and rise of temperature at once takes place. If, after it has been made, charcoal is kept for a day out of contact with air, and is then ground down into a powder, it will frequently fire after exposure to the air for thirty six hours, whilst a heap of charcoal powder, of 100 bushels or more, will always ignite. It is for this reason that in making the charcoal for powder, it is always kept, after burning, for three or four days in air-tight cylinders before picking over, and ten days to a fortnight before it is ground. In the case of coal, this rise in temperature tends to increase the rate of the action that is going on, but is rarely sufficient to bring about spontaneous ignition, only about one-third the amount of oxygen being absorbed by coal that is taken up by charcoal; the action also being much slower, tends to prevent the temperature reaching the high ignition point of the coal. Air-dry coal absorbs oxygen more quickly than wet coal.

THE ACTION OF THE BITUMINOUS CONSTITUENTS OF THE COAL IN SPONTANEOUS IGNITION.

All coal contains a certain percentage of hydrogen which is in combination with some of the carbon, and also with the nitrogen and oxygen, and forms with them the volatile matter in the coal. The amount present in this condition varies greatly, being very small in Anthracite and very great in cannel and shale. When the carbon of the coal absorbs oxygen, the compressed gas becomes chemically very active, and soon commences to combine with the carbon and hydrogen of the Bituminous portions, converting them into carbon dioxide and water vapor. This chemical activity increases rapidly with rise of temperature, so that the heat generated by the absorption of the oxygen causes it to rapidly enter into chemical combination. Chemical combination of this kind—*i. e.*, oxidation—is always accompanied by evolution of heat, and this further rise of temperature again increases rapidity of oxidation, so that a steady rise of temperature is set up, and this taking place in the center of a heap of small coal, which, from the air and other gases enclosed in its interstices, is an admirable non-conductor of heat, will often cause such heating of the mass that, if air percolate slowly into the heap, in sufficient quantity to supply the necessary percentage of oxygen for the continuance of the action, the igniting point of the coal will soon be reached. The effect of rise of temperature in increasing the rapidity of chemical actions of this kind can be realized from the effect which it has in the spontaneous ignition of oily waste or rag. If a substance like cotton waste be rendered oily with anything except the mineral oils, it acquires the power of taking up oxygen from the air, and this oxidizing the oil gives rise to heat. At ordinary temperatures this oxidation is slow, and, consequently, it may be days before the rise in temperature becomes sensible, but when this point is reached the oxidation proceeds with remarkable rapidity, and in a few hours the point of ignition is reached, and the mass bursts into flame, whilst if the oily waste be placed in a warm place at first, spontaneous ignition is only a question of hours, or sometimes even minutes. Galletley found that oily cotton at ordinary temperatures took some days to heat and ignite, whilst, if placed in a chamber warmed to 130 degs. to 170 degs. Fahr. (54 degs. to 76 degs. Cent.), the cotton, greasy, with boiled linseed, ignited in one hour fifteen minutes, and olive oil on cotton in five hours; and in a chamber heated to 180 degs. to 200 degs. Fahr. (82 degs. to 93 degs. C.) olive oil on cotton ignited in two hours. It has been suggested that very Bituminous coal, such as cannel, shale, and coals containing schist, is liable to spontaneous ignition from the fact that a rise in temperature would cause heavy oils to exude from them, which, by undergoing oxidation, might cause rapid heating. But experiment not only shows that this is not the case, but that the heavy mineral oils have a remarkable influence in retarding heating; cotton waste, oily with easily oxidizable oils mixed with 20 per cent. of heavy mineral oil, being exempt from heating.

THE ACTION OF IRON DISULPHIDE, PYRITES, OR COAL BRASSES IN PROMOTING SPONTANEOUS IGNITION.

The earliest theory as to the cause of spontaneous ignition in coal was, that it was due to the heat given out during the oxidation of pyrites (the disulphide of iron) into sulphates, and this idea has been adopted, and has held its own, in this country up to the present time, although the researches of Dr. Richters, some twenty years ago, clearly prove that the explanation was an erroneous one, and the late Dr. Percy, as early as 1864, pointed out that probably oxidation of the coal had a great deal to do with the action. This disulphide of iron is found in coal in several different forms, sometimes as a dark powder distributed throughout the mass of the coal, and scarcely to be distinguished from coal itself. In larger quantities it is often found forming thin golden looking layers in the cleavage of the coal, while it sometimes occurs as masses and veins, often 1 in. or 2 in. in thickness, but inasmuch as these masses of pyrites are very heavy, they rarely find their way into the screened coal for shipment, many hundreds of tons of these "brasses" being annually picked out from the coal at the pit's mouth, and utlized in various manufacturing processes. The yellow pyrites which form the large masses in the coal, and even the dark varieties when in the crystalline form, remain practically unaltered, even after long exposure to moist air, but the amorphous and finely divided portions, which probably contain lower sulphides mixed with the disulphide, will oxidize and effloresce with considerable rapidity when exposed to moisture and air, forming mixtures of ferrous sulphate and basic sulphates of iron, and it is during this process of oxidation that the heat supposed to bring about the ignition of the coal is generated. In some of the coals most subject to spontaneous ignition there is only 0·8 per cent. of pyrites, and if we imagined the whole of this to be easily oxidizable, and to be concentrated in one spot instead of being spread throughout the mass, and to be entirely oxidized in a few hours, the rise of temperature would only be a few degrees; whereas, under existing circumstances, it is manifest that practically no determinable increase can be generated by the action. Under certain conditions the oxidation of masses of pyrites first gives rise to the formation of ferrous sulphate, and sulphur dioxide with liberation of sulphur, and my early experiments led me to believe that inasmuch as sulphur has an igniting point of 250 degs. Cent., this free sulphur might play an important part in the action, by lowering the point of ignition; latter experiments, however, show that this could only take place with large masses of pyrites undergoing oxidation, and that with the amounts present in coal, if the air were present in sufficient quantity to oxidize the pyrites, the small trace of sulphur liberated would be oxidized to sulphur dioxide at temperatures as low as 60 degs. C. This oxidation of sulphur at low temperatures is not a generally known action, but my experiments show that it takes place with considerable rapidity. The only way in which pyrites can assist spontaneous ignition is that when they oxidize they swell, and cause disintegration of the lumps of coal, so exposing fresh surfaces to absorb oxygen and afterwards carry on chemical action. I have carefully determined the igniting point of various kinds of coal, and find that cannel coal ignites at 698 degs. Fah. = 370 degs. C.; Hartlepool coal ignites at 766 degs. Fahr. = 408 degs. C.; lignite coal ignites at 842 degrees Fahr. = 450 degs. C.; Welsh steam coal ignites at 870·5 degs. Fahr. = 477 degs. C. So that no stretch of imagination could endow the small trace of pyrites scattered through a large mass of coal, and undergoing slow oxidation, with the power of reaching the needful temperature. When coal is heating, it gives out a distinctive and penetrating odor, which is the same as that noticed when wood is scorched. The gases evolved by the heating coal consists of nitrogen, water-vapor, carbon dioxide, carbon monoxide, hydrocarbons of the paraffin series, and sulphureted hydrogen, the presence of the latter gas showing beyond doubt that oxidation of sulphur had nothing to do with the action. We can now trace the actions which cumulate in ignition. The newly-won coal is brought to the mouth of the pit, and at once commences, by virtue of its surface action, to absorb oxygen from the air; but unless piled in unusually large heaps, and a great deal broken, it does not, as a rule, show signs of heating, as the exposed surface is comparatively small, and the air, finding its way freely between the lumps, keeps down the temperature. The coal is now screened, and the obtrusively large lumps of brasses picked out; it is then put in the trucks, and enjoys the disintegrating processes of joltings and shuntings innumerable, every jar adding to the percentage of small coal present, and a corresponding increase in the size of the surface exposed to the air. Arrived at the docks, it has to be transferred from the truck to the ship, which is done by one of the numerous forms of tips, shoots, or spouts employed for the purpose, and it is during this operation that more harm is done than at any other period. The coal first shot into the vessel, by reason of the distance which it has to fall, is broken down into small lumps, and having to bear the impact of the succeeding load falling upon it from a height, rapidly becomes powdered into slack, whilst the succeeding loads falling in on the cone so formed get more or less broken down, so that by the time the cargo is all taken in a dense mass of small coal is to be found under the hatchway, and it is invariably at this point that heating takes place, as the large surface exposed fresh to the air by the breaking down of the coal causes rapid absorption of oxygen, and consequent rise of temperature. This sets up chemical combination between the oxygen absorbed by the coal and the hydro-carbons and coal brasses. On examining the evidence to be obtained as to the conditions under which spontaneous ignition of coal in ships usually takes place, it is found that liability to ignition increases with:

1. *The Increase in Mass of Coal.*—Thus, in cargoes of under 500 tons the cases reported amount to a little under ½ per cent. for shipments out of Europe; from 500 to 1,000 tons, to over 1 per cent.; from 1,000 to 1,500 tons, to 3·5 per cent.; 1,500 to 2,000 tons, to 4·5 per cent.; and over 2,000 tons to no less than 9 per cent. The evidence demonstrating this very remarkable result is to be found in the Report of the Royal Commission for 1875, p. 8, and clearly shows the influence of mass upon this action, which acts in two ways: (*a.*) The larger the mass, the more non-conducting material will there be between the spot at which heating is taking place and the cooling influence of the outer air. (*b.*) The larger the mass the greater will be the breaking down action of the impact of coal coming down the shoot upon the portions first loaded into the ship, and the larger, therefore, the fresh surface exposed to the action of the air.

2. *The Ports to which Shipments are made.*—26,631 shipments to European ports, in 1873, only resulting in ten casualties, whilst 4,485 shipments to Asia, Africa, and America gave no less than sixty. The startling result is partly due to the length of time the cargo is in the vessel, the absorption and oxidation being a comparatively long action; but a far more active cause is the increase in the action brought about by the increase of temperature in the tropics, which converts a slow action into a rapid one, and if statistics had been taken, most of the ships would have been found to have developed active combustion somewhere about the neighborhood of the cape, the action developed in the tropics having raised the temperature to the igniting point of the coal by that time.

3. *The Kind of Coal.*—Some coals being specially liable to spontaneous heating and ignition. This is a point on which great diversity of opinion exists, but I think it will be pretty generally admitted that cases of heating and ignition are more frequent in coals from east coast ports than in shipments of the South Wales coals. The idea that the percentage of pyrites present is any indication of the liability to spontaneous combustion must be entirely discarded, as experiments show that many coals poor in pyrites frequently ignite, whilst others rich in them are perfectly safe. A much surer guide is to be found in the quantity of moisture present in an air-dried sample of coal, which is a sure index to the absorptive power. The higher the amount of moisture held by the coal, after exposure for some time to dry air, the greater will be its power of absorption for oxygen, and the greater therefore its liability to spontaneous heating and ignition. This is beautifully shown by the following table, in which the percentage of pyrites and moisture present in some coals are contrasted with their liability to self-ignition.

Liability to Spontaneous Ignition.	Pyrites. Per cent.	Moisture. Per cent.
Very slight	1·13	2·51
	1·01 to 2·04	2·75
	1·51	3·90
Medium	1·20	4·50
	1·08	4·55
	1·15	4·35
Great	1·12	4·85
	0·85	5·30
	0·84	5·22
	1·00	9·04

The percentage of moisture shown in this table is not due to external wetting, but is moisture absorbed from the air and held by the coal, so that the amount of it present is an indication of the power of absorption possessed by the coal, and which will give it the power of taking up oxygen as well as water vapor.

4. *The Size of the Coal.*—Small coal being much more liable to spontaneous ignition than large. This, as has been pointed out, being entirely due to the increase in active absorbent surface exposed to the air, a fact which is verified by the experience of large consumers of coal on land; gas managers recognizing the fact that coal which has been stamped down or shaken down during storage being more liable to heat than if it has been more tenderly handled, the extra breakage causing the extra risk.

5. *Shipping or Storing Coals while Wet.*—The effect of moisture upon coal is very remarkable. At first external wetting retards the absorption of oxygen by the coal, but the presence of moisture afterwards increases the action of the already absorbed oxygen upon the hydrocarbons of the coal, and so causes a serious increase in the heating. Of late years the researches of Cowper, Baker, Dixon, and others have shown so fully the important part which moisture plays in chemical combination, that it is now fully recognized as a factor of importance in actions of this kind. During last autumn a very marked case of the influence of moisture in the action taking place came under my notice. A ship took in a cargo of coal at a South Wales port, the weather being fine and dry whilst she was loading at the main hatch, and wet whilst taking in the coal at the after hatch, with the result that the temperature after the first few days was uniformly about 10 degs. higher in the coal that had been loaded wet than in the dry portion of the cargo, spontaneous ignition being the ultimate result.

6. *Ventilation of the Mass of Coal.*—The so-called ventilation, which has from time to time been introduced into coal ships, is undoubtedly one of the most prolific causes of spontaneous ignition. For ventilation to do any good, cool air would have to sweep continuously and freely through every part of the cargo, a condition impossible to attain, whilst anything short of that only increases the danger, the ordinary methods of ventilation supplying just about the right amount of air to create the maximum amount of heating. The reason of this is clear. A steam coal absorbs about twice its own volume of oxygen, and takes about ten days to do it under favorable conditions, and it is this oxygen which, in the next phase of the action, enters into chemical combination, and causes the serious heating. A ton of steam coal occupies 42 to 43 cubic feet, and if properly loaded contains between the lumps, as nearly as possible, 12 cubic feet of air space—that is to say, of the 42 cubic feet, 12 cubic feet is air, and 30 cubic feet is coal. Thirty cubic feet of coal, with its fresh absorbing surfaces laid bare by the crushing incidental to loading, will in the first ten days after being taken on board, absorb 60 cubic feet of oxygen, if it can get it. Now, air contains only, roughly, one-fifth of its volume of oxygen, so that 60 cubic feet represent 300 cubic feet of air, or twenty-five times as much as is present. It is therefore evident that if the air could be excluded, there would be only one twenty-fifth the quantity of oxygen present that is needed for complete action, and any heating would, in consequence, be very slight, whilst to produce the greatest heating it would be necessary to change the entire air in the cargo twenty-five times in the first ten days, and this is just about what the old method of taking a box shaft along the keelson with Venetian lattice upshafts from it would give. The most forcible illustration of the evil of such ventilation is to be found in the case of the four colliers, "Euxine," "Oliver Cromwell," "Calcutta," and "Corah," which were loaded at Newcastle under the same tips, at the same time, with the same coal, from the same seam. The first three were bound for Aden, and were all ventilated. The "Corah" was bound for Bombay, and was not ventilated. The three thoroughly ventilated ships were totally lost from spontaneous ignition of their cargo, whilst the "Corah" reached Bombay in perfect safety.

7. *Rise in Temperature.*—It has been fully pointed out that anything which tends to increase of initial temperature increases the rapidity of chemical action, and in most cases of spontaneous combustion in coals stored in this country, the cause can be traced to a steam pipe or boiler-flue in contact with the mass of coal, or even fixed to a wall against which, on the other side, the coal is heaped. Sometimes the coal store is close to the benches of retorts, in a gasworks, or even against the wall of the benches, and in such cases, with certain classes of coals, ignition would be almost certain to take place. In a paper read at the last meeting of the Gas Institute, it was proposed to lead the flues from the benches under the coal store, in order to dry the coal, a device which would infallibly lead to spontaneous ignition. On colliers there are many causes for increased temperature, amongst them being the introduction of triple expansion engines and high pressure boilers. Steam at 80 lbs. boiler pressure has a temperature of 324 degs. Fahr. (162 degs. Cent.), and a common stoke-hole temperature, with boilers worked at this pressure is 100 degs. to 130 degs. Fahr. (or 38 degs. to 54 degs. Cent.) Steam at a boiler pressure of 155 lbs. has a temperature of 368 degs. Fahr., or 186 degrees Cent., and gives a corresponding increase of temperature in the stoke-hold and other adjacent portions of the vessel, the temperature in the stoke-hold under these conditions being from 110 degs. Fahr. (43·5 degs. Cent.) to 140 degrees Fahr. (60 degs. Cent.), an increase of about 10 degs. Fahr. Then, again donkey boilers will often be found recessed into bunker bulkheads, and steam pipes led alongside the bulkheads, with the cargo close up against them on the other side. The effect of temperature due to climatic influences has already been dealt with under the influence of ignition of ports to which shipments are made.

Having now discussed the chemical and physical conditions which lead to the phenomenon known as "spontaneous ignition," we can formulate precautions which will tend to prevent such disasters:

1. *The Choice of Coal for Storage or Shipment.*—The coal should be as large as possible, free from dust, and with as little "smalls" as can be helped. It is better as free from pyrites as possible, and it should contain, when air-dried, not more than 3 per cent. of moisture.

2. *Precautions to be taken in Storing or Loading.*—The coal store should be well roofed in, and have an iron floor bedded in cement. All supports passing through and in contact with the coal should be of iron or brick; if hollow iron supports are used they should be cast solid with cement. The coal must never be loaded or stored during wet weather, and the depth of coal in the store should not exceed 8 ft., and should only be six where possible. Under no condition must a steam or exhaust pipe or flue be allowed in or near any wall of the store, nor must the store be within 20 ft. of any boiler, furnace, or bench of retorts. No coal should be stored or shipped to distant ports until at least a month has elapsed since it was brought to the surface. Every care should be taken during loading or storing to prevent breaking or crushing of the coal, and on no account must a large accumulation of small coal be allowed. These precautions, if properly carried out would amply suffice to entirely do away with spontaneous ignition in stored coal on land, and we have now to consider a far more important phase of the question.

3. *Precautions to be taken on board Coal-laden Ships.*—This phase of the question is undoubtedly the most important, and in order to ensure any successful treatment of the coal cargo at sea, to prevent undue heating and ignition, the means adopted must be as nearly automatic in their working as possible, as it is useless to expect the master or any officer on board a collier during rough weather, &c., to comply with any instructions, such as daily taking the temperatures in various parts of the cargo, and so on. The iron bulkheads dividing the coal storage from the other parts of the vessel should be made double, and spaced 6 in. to 1 ft. apart, with openings (which could be closed water-tight) every few feet, to allow of the interior being from time to time coated with protective compositions. Through this double casing sea water would be allowed to circulate, and would not only effectually prevent any penetration of heat from the stokehold, boilers, or engine room to the coal, but also do away with any chance of leakage of gases from the coal cargo into others

portions of the vessel, and so would minimize the danger of explosions. A similar double partition should run down the center of that portion of the vessel in which the coal was stored, and it would be sufficient if this were packed with silicate wool; this partition would serve to prevent any heating which might take place in one part of the cargo being communicated to the other half, whilst it would also perform the important function of helping to prevent shifting of the cargo during heavy rolling. When the coal has all been taken in it should be battened down, and the hatches should not be again opened until the vessel reaches her destination, the only ventilation allowable being a 2 in. pipe just inserted into the crown of each coal compartment, and led 12 ft. up the nearest mast, the top being left open. This would be quite sufficient to allow free egress to any gases evolved by the coal, but would not allow undue excess of air. Into the body of the coal cargo itself would be screwed, at regular intervals of about 10 ft., iron pipes, closed at the bottom and containing alarm thermostats, so arranged that when a rise of temperature causes expansion of the mercury in rising in the tube it makes a contact; and the wires from these tubes are in connection with an electric bell, index board, and battery in the captain's room; so that the moment the temperature is reached to which the thermometers have been set the bell rings, and will continue to ring until the temperature again sinks, the spot in which heating is taking place being indicated by the index board. In the evidence given before the Commissioners in 1875, Mr. J. Glover strongly advocated the use of carbon dioxide, or carbonic acid gas, as it is more usually termed, for extinguishing ignition when it had broken out in a coal cargo, and for stopping heating when it had reached a dangerous pitch. His proposal was to generate the gas by the action of hydrochloric acid upon chalk, and to lead it by gas pipes to the compartment affected; and this gas, being heavier than air, and a non-supporter of combustion, was to displace the air and its contained oxygen, and so to prevent further action by surrounding the coal with an atmosphere which could not carry on combustion. The idea was a good one, but there were many difficulties in the way of carrying it out, one being that, for every 1,000 tons of coal carried, 80 cwt. of hydrochloric acid would have had to be shipped; also the gas could not have been driven down into the hold if any serious heating had taken place, as an up-current would have been formed, and would have carried it away; whilst in the state of gas it fails to give any great cooling effect and so would have exercised but little influence upon the mass of red-hot fuel. These objections weighed so strongly with the Commissioners that, in their final report, we find the following sentences: "Several methods for generating carbonic acid gas, and applying it to the ignited portion of a coal cargo, have been proposed for our consideration. We consider, however, that although this gas might be useful for excluding atmospheric air (which is essential to support combustion), yet it will not, as water does, exert any very sensible cooling effect, which is a point of vital importance in the case of a mass of ignited coal. We are of opinion that water and steam are the only agents practically available for the purpose of extinguishing fire in coal cargoes." Applied in the way which was suggested, there is no doubt but that the carbonic acid gas would have been practically useless; but there is another way in which it could be used, which would make it a most powerful cooling agent, an instantaneous quencher of fire, and would prevent any further tendency to heat on the part of the coal treated with it. If carbonic acid gas is compressed under a pressure of 36 atmospheres at a temperature of 32 degs. Fahr. (0 degs. Cent.), it is condensed to the liquid state, and can be obtained in steel vessels closed with screw valves. In opening the valve some of the liquid is ejected into the air, and, and in coming into the ordinary atmospheric pressure, is in a moment converted into a large volume of gas. Conversion from the liquid to the gaseous state means the absorption of a large amount of heat; and so great is this, that everything near the stream of new-born gas is cooled down, and some of the escaping liquid is frozen to a solid, having a temperature of—78° Cent., or—108·4 Fahr. This liquid carbonic acid gas is now extensively manufactured, and is used abroad to a large extent for aerating waters, driving torpedoes, and for freezing machines; and I should suggest its use in the following way for the checking of ignition in the coal cargo: The nozzle attached to the screw-valve on the bottle of condensed gas should have a short metal nose-piece screwed onto it, the tube in which should be cast in solid, with an alloy of tin, lead, bismuth, and cadmium, which can be so made as to melt at exactly 200 degs. Fahr. (93 degs. Cent.) The valve should then be opened, and the steel bottle buried in the coal during the process of loading. The temperature at which the fusible metal plug will melt is well above the temperature which could be reached by any legitimate cause, and would mean that active heating was going on in the coal; and under these conditions the pressure in the steel cylinder would have reached something like 1,700 lbs., and the moment the plug melted the whole contents of the bottle would be blown out of it into the surrounding coal, producing a large zone of intense cold, and cooling the surrounding mass to a comparatively low temperature. The action, moreover, would not stop here, as the cold, heavy gas would remain for some time in contact with the coal, diffusion taking place but slowly through the small exit pipe.

When the coal has absorbed as much oxygen as it can, it still retains the power of absorbing a considerable volume of carbonic acid gas; and when coal has heated, and then been rapidly quenched, the amount of gas so absorbed is very large indeed, and the inert gas so taken up remains in the pores of the coal, and prevents any further tendency of heating; indeed, a coal which has once heated, if only to a slight degree, and has then cooled down, is perfectly harmless, and will not heat a second time. It is not by any means necessary to replace the whole of the air in the interstices of the coal with the gas, as a long series of experiments show that 60 per cent. of carbonic acid gas prevents the ignition of the most pyrophoric substances. One hundred cubic feet of gas can be condensed in the liquid state in a steel cylinder 1 ft. long and 3 in. diameter, and it has been shown that a ton of coal contains air spaces equal to about 12 cubic feet; therefore, one of these cylinders would have to be put in for every 8 tons of coal, as, although the gas formed at the first moment would only occupy a small space, on account of its low temperature, it would rapidly expand in contact with the hot coal. These cylinders should be distributed evenly throughout the cargo and near the alarm thermometers, which should be set to ring a degree or two below the point at which the fusible plug would melt. The bell ringing in the captain's room would warn him that heating was taking place, and the bell would continue to ring until the cylinder had discharged its contents, and had cooled the cargo down to a safe degree, so that the whole arrangement would be purely automatic, and yet the officers would know if everything was safe. This liquid is now being made at a comparatively cheap rate, and, with any demand for it, machinery could be put up at the principal coaling ports to charge empty cylinders at a very low rate, so that the initial cost of the steel cylinders once got over, the expenses would not be worth considering, more especially as only one, or two at most, of the cylinders in use would be likely to go off. If the precautions advocated were taken, no danger could arise until the arrival of the ship at her destination, and the commonest precautions would then suffice. On removing the hatches no naked light must be allowed near them, and no one must be allowed to descend into the hold until all the gases have had time to diffuse out into the air. If the cylinders have gone off, there will be but little fear of explosion, as a high percentage of the carbonic acid gas lowers the explosive power which the mixture of marsh gas (given off from some coal) and air possess; but the carbonic acid gas would overcome and suffocate a man descending into an atmosphere containing any considerable percentage of it. When a safety-lamp, lowered into the hold, continues to burn as brightly as it did in the open air, then it is perfectly safe to descend. When once coal in a cargo has fired, pumping in water is of practically no use, as the fire is, as a rule, near the bottom of the mass of coal, and the flow of the water is so impeded by the caking of the heated mass above the fire, that in percolating through the interstices of the heated coal, it is converted into steam before it can reach the seat of combustion. The most effective way to apply water would be to have 3 in. pipes laid along the floor of the coal compartments, about 6 ft. apart, these tubes having a ½ in. hole bored in the upper side every foot or so, and each pair of pipes coming through the bulkhead, and connecting on to two 6 in. pipes, passing through the side of the vessel, the sea water being prevented from entering by means of screw valves. As soon as the alarm thermometer gave notice that heating had reached a dangerous point, these valves could be opened and the lower portion of the cargo drenched with salt water. This, evaporating rapidly, would give large volumes of water vapor which, passing up through the heated coal, would lower its temperature, but would not be nearly as effective as the method before advocated. It might, however, be used in conjunction with that method, and would, in many cases, save the carbonic acid gas. In the case of coal bunkers, in modern steamers and warships, the conditions under which the the coal is placed are so totally different from those existing in a collier, that no comparison can be drawn between them. In the coal bunker, the question of mass, which plays so important a part in a hold laden with coal, is almost entirely eliminated, as 50 to 400 tons would be about the capacity of any ordinary bunker, and it has been before shown that the cases of spontaneous ignition in masses of coal less than 500 tons does not amount to more than ½ per cent., and the question of initial temperature becomes the most important factor. A few years ago such an occurrence as a coal bunker on fire was rare, whilst at the present time hardly a week passes without some more or less serious cases occurring on the fast liners, and it is evident that there must exist some well-defined cause for this enormous increase in cases of spontaneous ignition. On collecting evidence on this point, the first thing that strikes one is that bunker fires are almost entirely confined to vessels in which the bunker bulkheads are only separated from the funnel by a narrow air space, or in close proximity to the boilers themselves, but where the bunkers are stepped back from the funnel casing and boilers, spontaneous ignition is a great rarity. Taking the case of a fast liner, it is found that the temperature in a coal bunker varies very considerably according to its proximity to the air channel round the funnel casing. Close to the outside of the bulkhead the temperature is often as high as 200 degs. Fahr. (93 degs. Cent.), whilst inside 120 degs. would be a fair estimate, and from the center of the bunker to the side of the vessel it is seldom above 75 degs. Fahr. (24 degs. Cent.); the temperature, however, being higher near the iron decks, which, being in contact with the heated bulkhead, conduct the heat through the coal and raise the temperature often up to 100 degs. Fahr. It has been pointed out that if coal be kept at a high temperature, even though it be far below its igniting point, ignition is only a question of time; and if the bunker coal next the bulkhead be kept at 120 degs. Fahr., any coal with a tendency to absorb oxygen will run a great chance of igniting within a few days. It is manifest that if this is the real cause of ignition, the seat of the fire ought to be found close to the heated bulkhead, but this is very often not the case, the mass of fire being found near the centre of the bunker, and sometimes even towards the sides of the vessel; but careful examination soon reveals the cause of this, as a line of charred coal is mostly to be found running from the heated bulkhead to the seat of active combustion, showing that the fire, started by the high initial temperature, has not had sufficient air near the bulkhead to do more than smoulder, but that as soon as it came in contact with a current of air passing up through the coal from the hatches in the decks, the smouldering mass began to burn fiercely. In order to prevent spontaneous ignition of the coal under these circumstances, all that is necessary is to reduce the temperature of the bulkhead in contact with the coal, as, if this is kept at a temperature not exceeding 82 degs. to 90 degs. Fahr., there is little or no fear of the oxidation of the hydro-carbons of the coal proceeding with such rapidity as to cause ignition in such a quantity of coal as can be carried in the bunkers—the iron decks, by sub-dividing the mass, also helping to reduce any risk. In order to reduce the temperature to the required extent, it would be necessary to make the bulkheads close to any heating surface, such as the funnel casing, double. Through this double casing sea water would be allowed to circulate very slowly, and would effectually prevent any undue rise of temperature; whilst to make the arrangements complete, a thermostat should be fixed on the inner plate of each bulkhead, which, if the temperature rose to a hundred degs. Fahr. (38 degs. Cent.), would ring a bell in the captain's room, when the rate of flow of water could be increased until the required fall in temperature took place. Should this arrangement prove impossible from any structural cause, then a rapid current of air forced through the bunkers by means of a fan, or even an up-current formed by a good air pump ventilator in the crown of the bunker, would go far to keep the temperature within safe limits. In a coal cargo perfect ventilation is impossible, on account of the mass of coal present, and, therefore, the hold should be battened down, and everything done to prevent imperfect ventilation, gas-tight bulkheads being a necessity for this purpose. In coal bunkers, on the other hand, on account of free access being obtained to both top and bottom of the coal, and also the small mass present, perfect ventilation is possible, and should be attempted, whilst the water bulkheads will do away with any undue rise of temperature. Chemists have been repeatedly asked if analysis gives no indications by which a coal liable to spontaneous heating, can be distinguished from another which is perfectly safe for storage or shipment in bulk; but up to the present time the action has been so little understood, that no such differentiation was possible, but with a clear conception of the causes which lead to heating, it should be quite possible to do so. As I have shown, all coals, when heated to a temperature a little above that of boiling water, have their power of absorbing oxygen so increased that they will, in a few hours, absorb sufficient to give a perceptible increase in weight, and the greater their absorption power the greater will the increase be; and as it is upon this that the liability to heat depends, the amount of increase in weight would give a sure indication of the liability to spontaneous ignition. We have at present, however, no data to show what is a safe amount of absorption and with what amount danger commences, and the owners of collieries yielding coal liable to heating are so anxious to prevent the fact leaking out that there will be considerable difficulty in obtaining authentic samples to make the determination with. My own experience, however, leads me to think that if an air-dry coal does not contain more than 3 per cent. of moisture, and when powdered and heated to about 250 degs. Fahr. in an oven for three hours does not increase more than about 2 per cent. in weight, it may be looked upon as a safe coal to store in bulk. I am perfectly aware that the precautions I have suggested will never, unless pressure is brought to bear upon them, be adopted by the owners of colliers, on account of the slight extra expense and trouble they would envolve; but if Lloyds could be prevailed upon to lower the rate of insurance upon coal cargoes treated in this way, and substantially increase the rate upon cargoes in which these precautions had not been adopted, a class of disaster as appalling in nature as it is destructive in result would soon be entirely done away with.

Electric Mining Machines.

The Jeffrey Manufacturing Co. of Columbus, Ohio has now in successful daily use 51 Electric Mining Machines.

Up to the present time, this company has sold, and has in actual daily use more electric mining machines than all their competitors combined. With experienced men, together with their business experience of the past three years, they are enabled to contract for complete plants under guarantee to accomplish all they claim for them. In addition to the machines already in use, they have just booked the following new orders: Second order for one Jeffrey Electric Mining Machine from the Congo Mining Co. Congo, Ohio. Third order for one Jeffrey Electric Mining Machine from the Redstone Oil, Coal and Coke Co., Grindstone, Pa. Also three orders—First equipment for complete Jeffrey Electric Coal Mining Machine Plants for the Hocking Valley, briefly described as follows:

Two plants, each consisting of boilers, engines, dynamos, and all necessary connections to run four Jeffrey Electric Mining Machines, with a daily tonnage capacity of 800 tons. One plant complete to run six Jeffrey Coal Mining Machines, with a daily tonnage capacity of 1200 tons.

The Jeffrey Manufacturing Co. is also enjoying a flourishing business in their chain specialties. The demand for their new detachable drive chains [see advertisement in this issue] has reached their most sanguine expectations, while the outlook is very bright for a largely increased demand.

Last month we announced the completion of the new boiler shops of Messrs. Thos. Carlin's Sons, the progressive manufacturers of mining machinery, boilers, etc., at Allegheny, Pa. The shops are now in complete working order, and the first boiler was completed in them and shipped to Mr. J. S. Sauters, on the 18th ult.

TABULAR ESTIMATE

SHOWING THE APPROXIMATE QUANTITY, PAST AND FUTURE, PRODUCTION OF COAL IN THE SEVERAL DISTRICTS OF THE NORTHERN ANTHRACITE COAL BASIN OF PENNSYLVANIA.

By William Griffith, Engineer and Geologist, Scranton, Pa.

1	2	3	4	5	6	7	8	9	10
DISTRICTS.	NAMES OF THE COAL BEDS.	DESCRIPTIVE REMARKS.	Average thickness of beds.	Approximate workable area of bed in acres.	Approximate quantity of solid coal originally in place before any was mined, 25 % of contents of all beds deducted for refuse, faults, thin coal, etc., leaves, 1,400 tons per ft. per acre, good coal, 2,240 lbs. per ton.	Approximate area of mine workings to January 1, 1892, in acres.	Equivalent area for bed 1 foot thick.	Approximate number of tons produced to January 1, 1892—800 tons per foot thickness of bed per acre.	Approximate quantity of coal wasted (including culm of washed coal at 20 per cent. of production)—162·7 tons per foot per acre.
Forest City and Carbondale District. From extreme Northeastern end of basin to Powderly Slope, two miles South West of Carbondale Station, D. & H. R. R.	Top Coal	Known as Slope Bed at Forest City.	6·85	6,700	64,253,000	2,010	13,770	11,374,026	2,274,805
	Bottom Coal or Shaft Bed	Principal beds of district.	6·63	6,800	63,117,600	2,230	13,688	11,471,488	2,294,297
	Clifford Bed, Dunmore, or Third Bed	Only workable over portions of area with an outcrop.	4·1	7,490	42,992,600	155	634	523,684	104,736
Production, 1891, 1,069,818 tons.		Totals	17·58	20,990	170,363,200	4,395	28,092	23,369,198	4,673,838
Jermyn District. From Carbondale District to ¾ mile South West of Jermyn Station, D. & H. R. R.	Diamond	Not Worked.	5·0	10	70,000				
	Rock	Not Worked.	5·8	70	568,400				
	Grassy Island	Good.	9·0	700	8,820,000	90	810	669,060	133,812
	New County	Not Worked.	3·0	2,500	10,500,000				
	Archbald	Principal bed of district.	8·7	3,000	37,027,200	1,680	14,616	12,072,816	2,414,563
	Dunmore	Very thin and sometimes absent.	2·0	2,000	5,600,000				
Production, 1891, 1,281,817 tons.		Totals	33·5	8,320	62,585,600	1,770	15,426	12,741,876	2,548,375
Archbald District. From Jermyn District to Winton Station, D. & H. R. R. Includes S. V. White and Eaton Collieries.	New County Bed	Small area, thin and divided.							
	Archbald	Principal bed of district.	8·0	3,100	34,720,000	1,470	11,760	9,713,760	1,942,752
	Dunmore or Red Ash	Very thin over large part of the area within the outcrop.	3·0	3,300	13,860,000				
Production, 1891, 540,961 tons.		Totals	11·0	6,400	48,580,000	1,470	11,760	9,713,760	1,942,752
Peckville, Olyphant, and Priceville District. From Archbald District to Dickson Station, D. & H. R. R.	Olyphant, No. 1	Very clean.	8·0	335	3,752,000	335	2,680	2,147,000	429,020
	Olyphant, No. 2		7·5	250	2,625,000	225	1,687	1,393,402	278,022
	Coal Bed	Thin, not workable at present.	2·5	1,800	6,300,000				
	Coal Bed	Thin, not worked.	3·0	2,000	8,400,000				
	Diamond	Thin, not worked.	3·5	2,800	13,720,000	25	87	71,862	14,372
	Rock	Often contains dividing stratum of rock.	3·0	5,700	23,940,000				
	Grassy Island	Principal bed of district.	9·0	4,500	56,700,000	1,650	14,850	12,266,100	2,453,220
	New County	Sometimes double this thickness. Rock or slate parting.	2·6	6,500	32,760,000	1	3	2,973	594
	Clark	Usually divided, rock parted, and not much worked at present.	7·0	7,200	75,460,000	170	1,190	982,940	196,588
	Dunmore, No. 1	Only one bed workable at present.	4·0	9,600	53,760,000	130	520	429,530	85,904
	Dunmore, No. 2		2·0	10,100	28,000,000				
	Dunmore, No. 3		2·5	10,700	37,450,000				
Production, 1891, 1,301,390 tons.		Totals	57·6	50,985	345,877,000	2,526	20,937	17,294,457	3,458,890
Scranton District. From Priceville District to ½ mile North East of Moosic Station, D. & H. R. R. Includes Pancoast and Sibley Collieries.	Bristin	Thin Cover.	8·9	40	498,400				
	Richmond		5·0	2,380	16,660,000	320	1,600	1,321,000	264,200
	Church Slope		3·5	5,000	24,500,000	30	105	80,730	17,346
	Diamond		9·4	7,700	101,332,000	2,890	27,966	23,099,916	4,619,983
	Rock		6·4	7,760	69,529,600	1,380	8,832	7,295,232	1,459,046
	Big	Principal bed of District.	11·7	9,200	150,696,000	1,425	51,772	42,763,672	8,552,734
	New County	Large area divided and thin.	6·9	9,330	90,127,800	1,150	10,935	6,554,310	1,310,862
	Clark	Often in two parts, separated by rock.	7·3	15,180	155,339,400	2,700	19,710	16,280,460	3,256,092
	Dunmore, No. 1	Large area not workable.	4·0	10,000	56,000,000	800	3,200	2,643,200	528,640
	Dunmore, No. 2		4·8	19,700	132,384,000	1,960	9,408	7,771,008	1,554,201
	Dunmore, No. 3	Large area not workable.	3·9	12,020	65,530,000	645	2,496	2,061,696	412,339
Production, 1891, 6,131,297 tons.		Totals	71·8	98,290	862,337,400	16,300	136,024	119,877,224	21,975,444
Pittston District. From Scranton District to ½ mile North East of Plainsville Station, L. V. R. R. Includes Keystone Colliery.	Hillman		7·2	300	3,064,000	5	36	29,736	5,947
	Coal Bed. (?)		3·5	2,400	11,760,000				
	Checker or 7 ft.		6·8	6,348	60,401,760	1,120	7,616	6,290,816	1,258,163
	Pittston or 14 ft.	Principal bed of District.	11·2	8,030	126,694,400	3,810	42,672	35,247,072	7,049,414
	Marcy	Sometimes divided by rock.	7·0	12,700	124,460,000	1,300	9,100	7,516,600	1,503,320
	4 ft. or 4th Bed	Known also as Checker Bed. Often carries considerable refuse.	5·4	8,000	60,480,000	20	108	89,208	17,841
	Powdermill or Red Ash	Generally divided by thick rock parting.	10·1	19,800	279,972,000	1,700	17,170	14,182,420	2,836,484
Production, 1891, 3,777,802 tons.		Totals	51·2	58,128	671,838,160	7,955	77,026	63,355,852	12,671,169
Wilkes-Barre and Plymouth District. From Pittston District to ½ mile North East of Warrior Run Station, L. V. R. R. Includes Avondale and Maffet Collieries.	Abble or New		3·7	500	2,590,000	1	4	3,304	661
	Snake Island or K Bed		7·4	4,000	41,400,000	10	74	6,112	1,222
	Abbott, 7 ft., or Hutchinson		5·2	9,200	66,976,000	250	1,300	1,073,800	214,760
	Thin Coal Bed	Only limited area.	2·9	5,000	20,300,000				
	Lance, Kidney, or Bowkley		6·3	11,000	97,020,000	600	3,780	3,024,000	604,800
	Hillman		10·0	13,800	193,200,000	1,190	11,900	9,829,400	1,965,880
	Lodgment	Workable for small area only.	4·3	4,000	24,080,000				
	G or Old Bennett		5·9	15,200	126,378,000	40	236	194,936	38,987
	5 ft. to 6 ft. or Lance		5·8	19,800	160,776,000	275	1,595	1,317,470	263,494
	Cooper	These two beds often unite and form the Baltimore. Principal bed of district.	9·1	21,500	273,910,000	5,160	46,956	38,785,656	7,757,131
	Bennett		8·5	22,000	261,800,000	5,180	44,030	36,370,736	7,274,747
	Checker	Workable for limited area.	4·5	12,000	75,600,000				
	Ross	Often split or divided into Upper and Lower Ross.	10·0	25,000	350,000,000	1,020	10,404	8,593,704	1,718,741
	Red Ash	Often split or divided into Top and Bottom Red Ash.	14·0	26,772	524,731,200	1,940	26,931	22,245,606	4,449,001
Production, 1891, 7,332,687 tons.		Totals	97·6	189,872	2,218,761,200	15,666	147,316	121,447,124	24,289,424
Nanticoke and Mocanaqua District. From Wilkes-Barre and Plymouth District to South West end of basin. Includes Chauncy and Warrior Run Collieries.	George		4·6	2,400	22,176,000				
	Mills		4·7	4,000	37,520,000				
	Hillman		6·2	5,200	45,136,000	180	1,116	921,816	184,363
	G		2·5	5,500	19,250,000				
	Lance or 4 ft.		4·0	6,000	33,600,000				
	Cooper		7·3	7,500	76,650,000				
	Bennett or Forge		7·9	8,000	88,480,000	550	4,345	3,588,970	717,794
	Ross	Frequently divided into Upper and Lower Ross.	6·6	12,100	111,804,000	630	4,224	3,489,024	697,805
	Red Ash or Buck Mt.	Often split into Upper and Lower Red Ash. Principal bed of District.	13·2	13,250	244,860,000	1,600	21,120	17,445,120	3,489,024
Production, 1891, 2,111,018 tons.		Totals	61·0	63,950	679,476,000	2,950	30,805	25,444,930	5,088,986
Total production, 23,629,083 tons.		Grand Total		505,935	5,057,808,360	53,033	467,287	383,244,421	76,648,478

TABULAR ESTIMATE.--CONTINUED.

11	12	13	14	15	16
Approximate quantity of coal remaining in worked areas, (pillars, gob, etc.)—408 8 tons per foot per acre.	Approximate area from which no coal has been mined—the unworked areas.	Approximate quantity of solid coal in place in the unworked areas—1,400 tons per foot per acre.	Approximate future production for unworked areas, based upon the present yield per foot per acre, and present prices, mining methods, etc.; including, however, the thin seams as minable.	Production for past five years and percentage of total produced by each district.	Approximate time required to exhaust the coal at about present rates of production. Approximate percentage of the minable coal possessed by each district.
			Factor 900 tons per acre.		1,200,000 tons per year. About 70 years. 31½ % of future production.
5,629,167	4,650	44,976,400	28,913,100	1887— 886,845 1888—1,024,823 1889— 872,157 1890—1,016,220 1891—1,009,518	
5,595,654	4,570	42,418,600	27,269,100		
259,179	7,335	42,102,200	27,065,700		
11,484,000	**16,595**	**129,497,200**	**83,248,200**	Past production 6 % of whole production.	
	10	70,000	45,000		1,400,000 tons per year, excluding New County bed, 14 years; including New County bed, 19 years. 1½ % of future production.
	70	568,400	365,400		
331,128	610	7,686,000	4,941,000	1887— 759,201 1888— 897,955 1889—1,014,338 1890— 986,338 1891—1,183,827	
	2,500	10,500,000	6,750,000		
5,975,020	1,300	16,564,800	10,648,800		
	2,000	5,600,000	5,600,000		
6,306,148	**6,550**	**40,989,206**	**26,350,200**	Past production 3 % of whole.	
4,807,488	1,630	18,256,000	11,736,000	1887— 470,538 1888— 505,775 1889— 424,788 1890— 455,925 1891— 540,961	550,000 tons per year. Archbald bed only, 21 years; including thin beds 36 years. 00½ % of production.
	3,300	13,860,000	8,910,000		
4,807,488	**4,930**	**32,116,000**	**20,646,000**	Past production 2 % of whole.	
1,062,580	10	112,000	72,000	Past production 4 % of whole.	At 1,400,000 tons per annum, excluding the thin beds, 75 years; including the thin beds, 140 years. 8½ % of future production.
788,645	125	1,311,500	843,500		
	1,800	6,300,000	4,050,000		
	2,000	8,400,000	5,400,000		
35,560	2,775	13,652,800	8,776,800		
	3,700	25,900,000	16,650,000		
6,050,680	2,850	35,910,000	23,085,000		
1,471	6,199	32,734,400	21,056,400		
486,472	7,530	73,794,000	47,439,000		
212,576	9,470	53,032,000	34,092,000	1887— 876,029 1888—1,135,825 1889—1,020,523 1890— 935,017 1891—1,301,500	
	10,000	28,000,000	18,000,000		
	10,700	37,450,000	24,075,000		
8,650,284	**57,459**	**316,517,000**	**203,539,500**		
			Factor 800 tons per acre.	Past production 31 % of whole.	6,300,000 tons per annum, excluding two thin beds, 53 years; including two thin beds, 61 years. 16% of future production.
	40	498,400	284,000		
654,080	2,060	14,420,000	8,240,000		
42,924	4,970	24,353,000	13,916,000		
11,432,500	4,830	63,299,600	36,171,200		
8,690,521	6,380	57,164,800	32,665,600		
21,164,393	4,775	78,213,800	44,693,600		
8,243,756	8,180	79,018,800	45,153,600		
8,057,418	12,480	127,545,600	72,883,200		
1,308,560	9,200	51,520,000	29,440,000	1887—5,871,260 1888—6,629,634 1889—5,643,260 1890—5,960,379 1891—6,190,290	
8,845,990	17,740	119,212,800	68,121,600		
1,050,364	11,355	61,997,600	35,427,200		
54,379,536	**81,990**	**677,244,400**	**386,996,000**		
14,717	795	8,013,600	4,579,200	Past production 16 % of whole.	At 4,000,000 tons per year, excluding thin bed, 81 years; including thin bed, 83 years. 14% of future production.
	2,400	11,760,000	6,720,000		
3,113,420	5,228	49,770,000	28,440,000		
17,444,333	4,270	66,903,600	38,259,200	1887—2,514,170 1888—2,818,633 1889—2,357,976 1890—2,962,473 1891—3,777,982	
3,720,060	11,400	111,720,000	70,840,000		
44,156	7,980	60,328,800	34,473,600		
7,019,096	18,100	255,934,000	146,248,000		
31,355,776	**50,173**	**564,480,000**	**329,560,000**		
			Factor 700 tons per acre.		At 7,500,000 tons per year, excluding thin beds, 127 years; including thin beds, 131 years. 12% of future production.
1,635	499	2,584,400	1,292,200		
3,025	3,900	41,336,400	20,668,200		
531,440	8,950	65,156,000	32,578,000		
	5,000	20,300,000	10,150,000	Past production 32 % of whole.	
1,545,264	10,400	91,728,000	45,864,000		
4,964,720	12,610	176,540,000	88,270,000		
	4,000	24,080,000	12,040,000		
96,476	15,260	126,047,400	63,023,800		
452,086	19,525	158,543,000	79,271,500		
19,195,612	16,340	208,171,600	104,085,800	1887—7,363,877 1888—8,177,357 1889—6,760,061 1890—6,510,451 1891—7,312,687	
18,601,916	16,820	200,158,000	100,079,000		
	12,000	75,600,000	37,800,000		
4,253,155	23,980	335,720,000	167,860,000		
11,009,392	24,832	486,707,200	243,353,600		
60,154,671	**174,306**	**2,012,672,200**	**1,006,336,100**		
	2,400	22,176,000	11,088,000	Past production about 6 % of whole.	At 2,500,000 tons per year, excluding thin beds, 121 years; including thin beds, 138 years. 14% of future production.
	4,000	37,520,000	18,760,000		
456,220	5,020	43,598,800	21,799,400		
	5,000	19,250,000	9,625,000		
	6,000	33,600,000	16,800,000		
	7,500	76,650,000	38,325,000	1887—2,210,204 1888—2,626,071 1889—2,379,630 1890—2,176,412	
1,774,236	7,450	106,875,200	53,437,600		
1,726,771	11,480	80,875,200	40,437,600		
8,688,856	11,650	215,292,000	107,646,000	1891—2,111,018	
13,593,083	**61,000**	**635,037,200**	**317,518,000**		At 24,000,000 tons per year the whole basin will be exhausted in about 99 years.
189,739,986	**[illegible]**	[illegible]	**2,374,194,600**		

EXPLANATION OF TABULAR ESTIMATE.

Showing the Approximate Quantity, Past and Future, Production of Coal in the Several Districts of the Northern Anthracite Coal Basin of Pennsylvania.

Editors "The Colliery Engineer":

SIRS:—I herewith offer for publication an estimate of the approximate quantity and past and future production of coal in the several districts of the Northern Anthracite Coal Basin, more generally known as the Wyoming and Lackawanna Coal Fields.

In making this estimate it was found most convenient to divide the region into districts as shown in Column No. 1 of the table, this will serve to show the distribution of the coal. Column No. 2 gives the local names applied to the various beds in each district, and are arranged with reference to their relative positions in the measures.

Column No. 3 contains short descriptive remarks as to known peculiarities of the individual beds. Column No. 4 contains the average thickness of the individual coal beds in each district and includes all beds that average over two feet thick. While these thin beds are not worked at the present time, they cannot be disregarded in an estimate of this sort, as the time will doubtless come when they will be profitably mined. The items in this column were obtained by taking the average thickness of each bed as found by using all the bore-hole, shaft, and other sections in the different parts of the basin, as published in the atlases of the State Geological Survey of the region.

The number of columnar sections of the measures thus used was 352, about evenly distributed throughout the basin. The totals in this column show the aggregate thickness of coal beds at the deepest point of the measures for each district. The items given in this column includes whatever slate, bone, and other refuse there may be in the beds.

Column No. 5 contains the approximate superficial area of workable coal in each bed, and was obtained from the published maps of the Geological Survey, which very correctly show the outcrops of the lowest coal bed and one other bed that is the most worked in each locality.

The outcrops of all the other beds were sketched approximately upon these maps by the author from his personal knowledge of the geology of the region, aided by the published cross sections and columnar sections. The area of each bed was then computed for each district, deductions were occasionally made from the areas thus found, in order to allow for those areas where certain beds are known to be too thin to be included in the table.

Owing to the prevailing flatness of the measures in this region, no account has been taken of the greater area of coal caused by steeper dips at the margin of the basin, or on the sides of the anticlinals. The actual area of the coal beds will therefore be somewhat in excess of the items given in the table, but this increase of area will doubtless be more than counter-balanced by the loss caused by poor and unminable coal on the outcrops, anticlinals, faults, troubles of various kinds, etc. The totals in this column show the area that would be covered if the beds were spread out side by side upon a level surface.

Column No. 6 contains the approximate quantity of solid coal in the ground before any was mined. The items are obtained by multiplying the thickness of each bed as is given in Column 4 by the items in Column 5, and this product by the factor 1,400, as being the number of tons of pure coal per foot per acre in the average coal bed after deducting 23·4% for the slate, bone, and other refuse, including an allowance for rock, and dirt faults, etc., which always occur in greater or less degree in all large areas.

In order to arrive at an average percentage for the refuse, the author obtained bed sections in various parts of the region from as many coal beds as possible, and from them ascertained the facts shown in table on following page.

The table would seem to show that the refuse material in the average coal bed will amount to 18·7 % of the contents of the bed.

The frequent occurrence of troubles, such as thin and poor coal, various kinds of faults, slips, squeezes, etc., etc., would seem to call for an allowance in addition to those referred to under Column 5, an arbitrary deduction of 4·7% is therefore made on this account. Therefore taking specific gravity of Anthracite coal at 1·5, the weight of good coal in ground per foot thickness of bed per acre would be

Weight of solid coal per foot thick per acre		1,828 tons
Deduct 18·7% for refuse	342 tons.	
Deduct about 4·7% for faults, troubles, &c.	86 tons.	
	428	428 tons.
Good coal in ground per foot thickness of bed per acre		1,400 tons.

The long ton of 2,240 lbs. is used throughout this estimate.

Column No. 7. The items in this column were found in manner similar to No. 5, by measuring the area worked in each bed as shown upon the published Mine Sheets of the State Survey. In doing this the areas were measured full to make approximate allowance for the areas mined over since the date of publication of the maps.

Column No. 8 is found by multiplying items of column 7 by those of column 4.

Column 9. The total approximate production of this coal basin to Jan. 1, 1892, as found from Mine Inspectors Reports and other published statistics is about 383,244,421 tons, and this amount divided by the grand total footings of Column 8 would give 826 tons as the average quantity of coal produced per foot thickness of bed per acre, to Jan. 1, 1892. The items of Column 8 multiplied by the factor 826 will give the items of Column 9.

While the factor 826 tons may fairly represent the average yield for the whole basin in the past, it will not necessarily be correct for the special areas, particularly in the future when more mining is done in deeper parts of the basin.

The conditions under which coal is mined have a direct effect upon the yield per acre, where the conditions are favorable (North of Scranton for instance), light covering over the coal, few surface improvements, little trouble from gas, etc., etc., more tons per acre can be won than in the Wilkes-Barre region where the beds are deep and gassy, surface either much improved or covered by deep gravel deposits filled with water, that will flood the mine if the roof is cracked, thus requiring stronger pillars, better ventilation and more careful mining in every way.

Column 10 is intended to show the approximate quantity of clean coal wasted in mining and preparing the coal for market. (The slate, bone, and other refuse being fully accounted for above under head of Column 6.)

In 1890 and '91 The Clear Spring Coal Company produced 342,523 tons of coal; and 66,532 tons of culm (including all the buckwheat coal) went to the culm pile, *i. e.*, the culm was about 19·7% of the total production, this seems to agree fairly well with the experiments made by the Lehigh and Wilkes-Barre Coal Company as published in Report A, of the Geological Survey of Pennsylvania, page 56, where the average percentage of waste for old style rolls is shown to be 15·7% of quantity charged into the breaker or 19·8% of the coal shipped. And on page 123 another experiment shows the culm to be 21·4% of shipments. The average of these percentages shows the culm to be 20·3% of the production.

Of course in cases where the buckwheat and birdseye are taken out the percentage is much reduced; this is now being done to a large extent: quite a saving is also made by using the more improved machinery. On the other hand all of the pea coal and much of the chestnut formerly went to the culm pile, so that the factor 20 per cent. of the production, or 165·2 tons per foot per acre as used in this column cannot be considered as excessive for the waste in the past.

	No. of bed sections.	Total thickness of beds.	Total thickness of refuse.	Per cent. of refuse.
Wilkes-Barre and Plymouth District	61	593·01 feet	115·1 feet	19·46
Pittston District	28	236·91 "	43·3 "	18·46
Scranton District	33	322·72 "	57·5 "	17·85
Total	122	1152·64 "	21·59 "	18·75

Column 11. By deducting the sum of factors used in Columns 9 and 10 from the factor 1400 we have 408·8 as the percentage of coal per foot per acre now remaining in the ground in the areas that have been mined over, it exists in the form of solid pillars, and coal wasted with the "gob" or mine refuse. While part of this area has been worked out there are still considerable areas where much coal can yet be won by robbing these pillars, but no account has been taken of this item in the table.

By deducting the items of Column 7 from those of Column 5 we obtain the items of Column 12, and using these as a basis we obtain the items of Columns 13 and 14 from it, in same way as Columns 6 and 9 were obtained by using Column 5.

In Column 14 in view of the facts referred to under Column 9, as to the effect of the conditions under which the coal is mined upon the yield per acre, we have thought best to use a larger factor, *i. e.*, 900 tons for the yield per acre for areas North of Scranton where the conditions are more favorable for mining in the future.

For the Scranton and Pittston districts 800 tons per acre is used, and for the lower end of the basin 700 tons, as this is about all that can be obtained under the present conditions, methods of mining, etc.

From the footings of Columns 13 and 14 we see that the result of the estimate is that something over half the solid coal remaining in the ground can be mined.

Column 15 shows the production of the several districts for each year for the past five years, together with the percentage of the total output that each has produced.

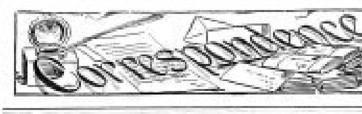
Column 16 shows approximately the probable life of each district at present rate of production, also the percentage of total quantity of coal in the field that each district possesses.

The greatest portion of the mining in the past has been at those points where the coal was thickest, best and most accessible, where the mining could be done at the greatest profit to the operator, and those parts where the beds were thinner have been left for the future, and hence the items in Column 4 which represent the average thickness of beds for the whole district, may be less than the average thickness of same beds for area worked in any particular district, while at the same time they may be more than average of the unworked areas. In this case the quantity of coal we have credited to the unworked areas would overrun because the beds would not be as thick as estimated. In view of this therefore the estimate may be somewhat excessive. On the other hand future developments may prove more and better coal than has been anticipated in portions of these unworked areas.

In addition to this, the experience and methods of mining that have prevailed in the past (and upon which our estimate is based), which have been to say the least very wasteful, may be very much improved in the future, so that larger yields per acre will eventually be obtained from the unmined areas, and the worked and abandoned parts of the region may be partially remined and thus increase the quantity of available coal above our estimate.

WM. GRIFFITH.

Scranton, Pa., April 20, 1892.



This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.

"Watercracks" in Steel.

Editor Colliery Engineer:

SIR:—I would esteem it a favor if some of your correspondents would answer the following question: Is there any remedy for what are called "watercracks" in steel (especially rock drills), tempered in water?

Yours, etc.,
BURLEIGH.

Nanaimo, B. C., March 31st.

Ventilation.

Editor Colliery Engineer:

SIR:—In replying to "H. L. D. W.," of Cincinnati Ohio, in your January issue, I would like to transpose his order of questions, taking *a* as the 300′ at outlet, *b* the 300′ in the middle, and *c* the 300′ at the inlet.

(*a*.) Now for the 6,000′ × 5′ × 8′, we have

$$p = \frac{k\,s\,v^2}{a} = 5·2893 \text{ lbs.}$$ pressure per square foot of area, and for the 300′ × 5′ × 2′, 9·114 lbs. pressure per square foot of area. Then, the total pressure for the 5′ × 8′ × 6,000′ portion = 211·57 lbs., and for the 5′ × 2′ × 300′ = 91·14 lbs.

211·57 + 91·14 = 302·71 lbs. total pressure.

The total pressure at inlet would equal $\frac{302·71}{40}$ = 7·5677 lbs. per sq. ft. The units of work for the 6,000′ part are found by multiplying the pressure by the quantity, or $p\,q$ = 75677 *u*, and for the 300′ part $p\,q$ = 91140 *u*, making a total of 166,817 units, or about 55 H. P.

(*b*). In this case we have three sections, the last section requiring a pressure of 2·6446 lbs., the middle section *alone* requiring 9·114 lbs., but having a total of 105·786 lbs. pressure to overcome at the first section. The pressure at the entrance of the 300′ section equals

$\frac{105·786 + 91·14}{10}$ = 19·6926 lbs., also the 1st 3,000′ takes a pressure of 2·6446 lbs., by adding the separate totals we find the total at inlet to be 302·71 lbs., which equals 7·5677 lbs. per sq. ft. as in case (*a*); but it is different with the power, the units in last section = $p\,q$ = 26,446; for the middle 196,926, and for the first section 75,677, or a total of 299,049 units which equals about 9 H. P.

(*c*). Now in this case we have 300′ at inlet employing 9·114 lbs. pressure per sq. ft., or 91·14 lbs. total pressure, but having the 211·57 lbs. pressure of the 6,000′ section to overcome. This makes a total of 302·71 lbs. for the 10 sq. ft., which equals a pressure of 30·271 lbs. per sq. ft. at inlet, and 5·2893 lbs. at entrance of the 6,000′ × 5′ × 8′. The units of work for each would be 302,710 and 52,893 respectively, or a total of 355,603 units, or 10·7 H. P.

To find the quantity that would be obtained from the above pressure, the whole length being 6,300′ and the area 5′ × 8′, we use the formula

$$Q = \sqrt{\frac{p\ a}{k\ s}} \times a.$$

I am well aware of the apparent anomaly in the power in the three cases, but the more one looks at it the more we find it is only apparent. This shows the folly (not to say wilful waste of power) of having small inlets with long air courses.

Yours, etc.,
J. V.

Punxsutawney, Pa., March 21st.

Mechanics.

Editor Colliery Engineer:

SIR:—Please insert the following in reply to "J. T. G.," of Braidwood, Ill., in your September issue:

On an incline rising 1 in 10, the loads weighing 12,000 pounds and the empties 3,000 pounds, the drums, ropes, and sheaves 5,000 pounds; the friction of the cars equal 1% of their weight, and the friction for drums, ropes, and sheaves $\frac{1}{400}$ of their weight. When they are being let down by a brake, it takes 4 minutes to run 300′, now what is the amount of friction applied by the brake?

The total friction is found to be 275 lbs. as follows:

$12,000 \times \frac{1}{100}$ = 120 lbs., friction of load.

$3,000 \times \frac{1}{100}$ = 30 lbs., friction of empties.

$5,000 \times \frac{1}{400}$ = 125 lbs., friction of drums, ropes, etc.

275 lbs., total friction.

$\sqrt{\frac{30}{16·1}} \times \frac{300}{30}$ = 13·65 seconds theoretical time; and 12,000 − 3,000 = 9,000 lbs. load overbalancing the empty sets.

$\frac{9,000 \times 30}{300}$ = 900 lbs., the power acting vertically that will hold the load on the plane independent of friction.

Also

$\frac{900 \times 13·65}{900 - 275}$ = 19·656 seconds the actual time if the brake were not applied.

The total friction is found thus,

$900 - \left(\frac{900 \times 13·65}{240 \text{ seconds}}\right)$ = 848·8125 lbs. total friction, then

848·8125 − 275 = 573·8125 lbs. friction applied by the brake.

Therefore,

$\frac{900 \times 13·65}{900 - 848·8125}$ = 240 seconds, actual time when the brake is applied.

Yours, etc.,
F. B.

Maccan, N. S., March 25th.

Examination Question.

Editor Colliery Engineer:

SIR:—I submit the following solution in reply to question by "J. W. S.," of Westville, Pictou Co., N. S., in your July, 1891, issue.

"A furnace at the bottom of a shaft 400′ deep produces 15,000 cubic feet of air per minute with 5·2 lbs. pressure per square foot. The temperature in the downcast shaft is 40° F., what is the temperature in the upcast shaft?"

Solution: 5·2 ÷ 400 = ·013 lb., or one cubic foot of air in the upcast weighs ·013 lb. less than one cubic foot of air in the downcast. A cubic foot of air at 40° weighs

$\frac{1·3253 \times 30}{459 + 40}$ = ·079677; then ·079677 − ·013 = ·066677 weight of one cubic foot of air in upcast shaft.

Therefore

$\frac{1·3253 \times 30}{·066677}$ = 596·44 − 459 = 137·44°, the required temperature in the upcast. This result can be proved by reversing the operation.

Yours, etc.,
THOS. J. SIMPSON.

Osceola Mills, Pa., March 28th.

Specific Gravity of Gases.

Editor Colliery Engineer:

SIR:—I submit the following in hopes that it will give "Miner," of Uniontown, Pa., some insight into the specific gravity of gases:

The relative weight is a term used in chemistry whereby it is shown that the specific gravity of a compound gas is not the mean or average weight of the constituent atoms in the molecule, but a weight resulting from the condensation of a group of atoms of hydrogen. For example: Carbon dioxide = CO_2, now here we have three atoms and if no condensation resulted, the molecular weight would be

$$\frac{C + O + O}{3} = \frac{12 + 16 + 16}{3} = 14\tfrac{2}{3}.$$

The true relative weight, however, is

$$\frac{C + O + O}{2} = \frac{12 + 16 + 16}{2} = \frac{44}{2} = 22.$$

From this we get the general law at once simple and and easy to deduce. All the compound gases found in mines have a relative weight, which is found by dividing the sum of the weights of the constituent atoms by two.

To atmospheric air the above law does not apply as air is a mechanical mixture. Nitrogen and oxygen are mixed in the following proportions by weight: Nitrogen, 77; oxygen, 23; and as N = 14 and O = 16, it follows that the specific gravity of air when weighed against hydrogen is

$$\frac{79 \times 14}{100} + \frac{21 \times 16}{100} = 14·42,$$

which means that $\frac{77}{100} \times 14$ added to $\frac{23}{100} \times 16$ will give the specific gravity of air.

We find, then, in mine ventilation we have to deal with five elementary bodies—nitrogen, oxygen, hydrogen, carbon, sulphur, and seven compound gases, viz.: Carbon monoxide, carbon dioxide, hydride of ethyl, methyl hydride, watery vapor, hydrogen sulphide, nitric oxide, and one mechanical mixture, atmospheric air. The specific gravities of gases are found by weighing them in equal volumes against hydrogen, thus H = 1, then carbon monoxide = 14; methyl hydride = 8; hydride of ethyl = 15; watery vapor = 9; carbon dioxide = 22; hydrogen sulphide = 17; nitric oxide = 15; and atmospheric air = 14·42.

Yours, etc.,
WM. STUBBS.

Frugality, Cambria Co., Pa., Apr. 5th.

Ventilation.

Editor Colliery Engineer:

SIR:—Having examined the answer of "T. S. C." to question of "R. R. S.," of Winburne, Pa., in the September, 1891, issue, I am at a loss to see the method by which he attains the results.

"T. S. C." claims that the answer given by "S. U. P." in August issue is too great a quantity, as it would require a pressure of more than 16 lbs. to pass 12,962 cubic feet of air per minute in the question given.

"T. S. C." begins by saying that the question can be answered in several different ways and for which he submits two, but I fail to comprehend the meaning of his formula.

I have several books on ventilation and have carefully searched for the formula in question, but cannot find it.

I took the formula given in Fairley's book where a road of various dimensions can be reduced to a uniform or typical road that will offer the same resistance and took the quantity as found by "S. U. P.," but did not find anything like the pressure, viz., 16 lbs.

I will be obliged to "T. S. C." if he will kindly inform me in what book to find the formula used by him, as it appears that either Mauchline or "S. U. P." must be wrong.

Yours, etc.,
X. Y.

Nanaimo, B. C., Apr. 4th.

Mensuration.

Editor Colliery Engineer:

SIR:—Replying to "L. P. H.," of Avoca, Pa., in the April issue, I beg to submit the following:

The "flat bottomed-kettle" would be in shape a frustum of a cone, and, as such, the formula for finding its contents would be $\frac{a}{3}(B + b + \sqrt{B \times b})$, a, being the altitude, B = the area of large base and b = area of small base. If we let $25\,x$ = B and $9\,x = b$ and substituting the known quantities we have the equation:

$$\frac{12}{3}(25\,x + 9\,x + \sqrt{25\,x \times 9\,x}) = 3{,}666 \text{ cubic inches}$$

which is the number of cubic inches in a score of gallons, less seven, of 282 cubic inches each. $25\,x$ and $9\,x$ are selected because the diameters of the bottom and top are to each other as 5 is to 3, and circles are to each other as the squares of their diameters. The above equation becomes successively

$$\frac{12}{3}(25\,x + 9\,x + \sqrt{225\,x^2}) = 3{,}666$$
$$4\,(25\,x + 9\,x + 15\,x) = 3{,}666$$
$$100\,x + 36\,x + 60\,x = 3{,}666$$
$$196\,x = 3{,}666$$
$$x = 18{\cdot}7$$
$$9\,x = 168{\cdot}3 = \text{area of top in inches.}$$
$$25\,x = 467{\cdot}5 = \text{area of bottom in inches.}$$

As the area of a circle is equal to the diameter squared multiplied by ·7854, if we divide 168·3 and 467·5 by this number we get 214·28 and 595·24 respectively, and then extracting the square root we have 14·6 + inches and 24·4 + inches as the top and the bottom diameters of the kettle.

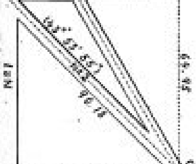
Yours, etc.,
COAL.

Pratt Mines, Ala., April 11th.

Mensuration.

Editor Colliery Engineer:

SIR:—Please publish the following in answer to John Cayar, of Gervias, Ohio: In the sketch No. 1 represents the main gangway of a mine, a breast, A B is opened off from it at right angles and is 25 yards long. From B it runs to C, a distance of 75 yards, and at an angle of 60°. At C it intersects gangway No. 2, now what is the length of No. 2, or from A to C, and what is the angle?



The following rule will answer for all cases of this kind:

R : h :: sine : P or, 64·95
R : h :: cosine : B or, 37·50
B : R :: P : tang., or 43° 53′ 55″, and sine : P :: R : h, or 90·13 yards.

Yours, etc.,
RICHARD LEWIS.

Gasford, Pa., Apr. 15th.

The Co-efficient of Friction.

Editor Colliery Engineer:

SIR:—I think your editorial on "The Co-efficient of Friction," in your April issue, was very timely and to the point. I have no doubt but what the majority of your readers fully agree with you, and thank you for the stand you have taken.

The co-efficient of friction, as formulated by some of the authors, has long been a stumbling block for the average miner to understand and correctly figure out.

Looking at the value of k, as given by the different authors, in the table published by you, we again find the usual disagreement among experts. Some of the figures seem to be founded more on the hair-splitting theory than on actual facts. Naturally we might expect to find considerable difference among authors as to what ought to be the proper co-efficient, on account of the variable and changeable condition in the rubbing surface found in mines. Take our Anthracite mines for an example: From a large roomy gangway, at a comparatively slow velocity, the air current might have to travel behind a brattice, or up behind man-ways, and through small cross-cuts, and finally through a small or partially obstructed return air-way. Even under most favorable conditions, in actual practice there exists no cause or reason why the co-efficient should be carried to the sixth or seventh decimal, except ambiguity or confusion is the aim. It is, of course necessary to make it high enough to cover any ordinary condition, found in actual practice. When the motive power is sought for, it is generally economy, and always desirable, to have ample power. Atkinson's co-efficient, as improved by you, I think is amply sufficient, simple, easily understood; and, until actual experience and demonstration has established a more correct one, ought to be generally used and accepted.

Yours, etc.,
JAMES BOHLIN,

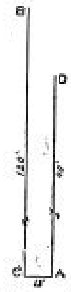
Freeland, Pa., April 23d.

Mensuration and Mathematics.

Editor Colliery Engineer:

SIR:—Will some of your able correspondents kindly answer the following questions:

(1.) Two entries are driven parallel to each other as shown by the diagram, now, wishing to drive from A



to B and from C to D, what would be the distance from A C to where the lines would cross each other?

(2.) A coal barge full of Bituminous coal displaces 6,625 cubic feet of water, how many tons of coal does the barge contain?

Yours, etc.,
R. L.

Gasford, Pa., April 13th.

Pumping.

Editor Colliery Engineer:

SIR:—The following question was asked in the August issue of your journal: "In a shaft 100′ deep, a pump is placed with 5″ suction and 95′ discharge. Will it require more or less power if the pump is placed up the shaft with 20′ suction and 80′ discharge?"

The question has been answered by a number of your correspondents and I think shown and proven in a plain simple manner that the power would be one and the same in both cases. In the March issue C. Walters, of Leisenring No. 1, Pa., explodes the whole theory of pumps by stating that as the 15′ more suction needs no power to bring the water up to the pump, only the power to overcome the extra friction of the extra suction, that the weight of water being less in the discharge pipe would need less power to discharge it and would result in a shorter steam line."

I would like (as, no doubt, would many others of your correspondents) to know how Mr. Walters can lift water 15′ without using any power. It is contrary to the laws of nature, and I would like to see it explained. As the question, as answered by Mr. Walters, would be misleading to some of your readers, I think a reply to it is called for. That water has weight no one will deny, and to talk of raising it without power is wrong. Steam-lines should be shortened where possible without interfering with any other part of the work. In this case the shortening of the steam line 15′ would be a little benefit, if it were not for lengthening the suction pipe, but as it is almost impossible to make a suction pipe of a pump air tight. I think the shortening of the steam line would not compensate for the lengthening of the suction. In the 15′ suction there would be more places for leaks to occur and a very small leak would make quite a difference in the amount of water discharged, and I will stand by my first assertion that the 5′ suction would give best results. Hoping to hear from Mr. Walters I remain,

Yours, etc.,
J. N. K.

Mansfield Valley, Pa., March 17th.

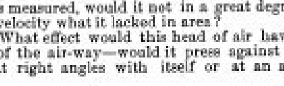
Ventilation.

Editor Colliery Engineer:

SIR:—Please insert the following questions that some of your readers may give their views concerning them:

(1.) A mine is ventilated by exhaust fan; distance from fan to incast is 1500 yards, air measure at incast is 12,000 cubic feet per minute; area, 84 sq. ft. Now what amount of air should be measured at upcast, and if the area was smaller at upcast, where the air was measured, would it not in a great degree make up in velocity what it lacked in area?

(2.) What effect would this head of air have on the walls of the air-way—would it press against the air-way at right angles with itself or at an angle be-



tween 45° and 90° in the direction it is traveling; or would it produce a suction instead of a pressure on the walls of the air-way (see diagram), and would pressure or suction be the same at inlet as at outlet, other things being equal?

(3.) Would it be possible at any time of the year for a hole or holes broken through to surface at any point between the incast and upcast of this mine to become the upcast for the air as long as the fan produced this amount of air, and the air traveled in the mine mouth?

Yours, etc.,
READER.

Mutual, West'd Co., Pa., Mch. 28th.

Ventilation.

Editor Colliery Engineer:

SIR:—I submit the following reply to "Alberto's" question, No. 4, which was published in March number of THE COLLIERY ENGINEER: "The main entry of a mine divides into two entries, each of which extends to the surface. If the pressure in main entry is 4 lbs. per sq. ft., what is the pressure in the two drifts?" As the pressure will vary inversely as the area, it will be necessary to assume the size of the entry, also the two drifts, therefore assuming the size of main entry to be 6′ × 14′ = 84 sq. ft. area, and 6′ × 8′ each for the two drifts, would = 6′ × 8′ × 2 = 96 sq. ft. area for the two roadways, or entries. Then as 96 : 84 :: 4 : x or 3·5 lbs. pressure per sq. ft. of sectional area of the two drifts.

Yours, etc.,
T. K.

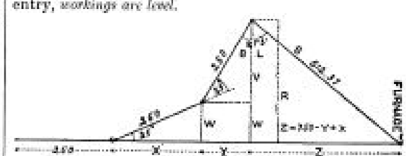
Mount Olive, Ill., April 12th.

Surveying.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to question by Miner, of Elk Garden, W. Va., in the March issue:

A main entry running 1,000′ due East has a furnace at the East end. Through carelessness the entry has been closed; desiring to get back to the furnace we go into the main entry 250′ from the West end and turn to the North 25° and run 250′ then turning 35° still further North, we run 250′ more. Now, I would like to know the degree of bearing from last given point and what the difference of travel would be from mouth of entry, *workings are level.*



In solving the problem we use the following formulæ:

x = 250 cosine 25°	w = 250 sine 25°.
y = 250 cosine 60°	v = 250 sine 60°.
Sine 25° = ·4226	x = 250 × ·9063 = 226·575.
Sine 60° = ·8660	y = 250 × ·500 = 125·000.
Cos. 25° = ·9063	w = 250 × ·4226 = 105·650.
Cos. 60° = ·500	v = 250 × ·8660 = 216·500.

Then

$$z = 750 - (226{\cdot}575 + 125{\cdot}000) = 398{\cdot}425.$$
$$R = w + v = 105{\cdot}650 + 216{\cdot}500 = 322{\cdot}150.$$
$$S = \sqrt{z^2 + R^2} = \sqrt{398{\cdot}425^2 + 322{\cdot}150^2} = 512{\cdot}37.$$

$$\text{Tan. L} = \frac{z}{v} = \frac{398{\cdot}425}{322{\cdot}150}\ 1{\cdot}2368 = 51°\ 3', \text{ nearly,}$$

and 51° 3′ + 30° = 81° 3′. S = v secant 51° 3′ = 322·150 × 1·5908 = 512·37.

The difference in travel will be 250 + 250 + 250 + 512·37 = 1262·37′ − 1000′ = 262·37′, distance on main entry.

Yours, etc.,
W. S G.

Walls, All'y. Co. Pa., March 21st.

Ventilation.

Editor Colliery Engineer:

SIR:—Will you please insert the following plan of a mine so that some of your correspondents may show the best way of ventilating it:

I would like it ventilated without doors being used, and so that both sides of the mine could be worked at the same time. Either No. 1 or No. 2 may be used as the downcast shaft.

Yours, etc.,
STRAGGLER.

Mineral Ridge, Ohio, March 31st.

Crushing Strength of Coal.

Editor Colliery Engineer:

SIR:—Can any of your readers inform me where I can find particulars of any reliable tests on the strength of various qualities of coal to resist crushing or compression? If any of your correspondents would kindly contribute particulars of any tests made by them (describing also the kind of coal), it would, I feel sure, be a great boon if published in the columns of THE COLLIERY ENGINEER.

Yours, etc.,
LONGNECK.

Grape Creek, Ill., Feb. 25th.

Mechanics.

Editor Colliery Engineer :

SIR:—Please insert the following question in your Correspondence Department:

If a mine car weighing 4 tons be suspended by a rope on rails at an angle of 45°, what weight will be on the rails and what weight will be on the rope?

Yours, etc.,
JOHN MOSES.

Jeddo, Luzerne Co., Pa., Apr. 25th.

Ventilation.

Editor Colliery Engineer :

SIR:—I submit the following in reply to question by "Practical Fact," of Plains, Luzerne County, Pa., in your March issue:

Before the fan stopped, the gangway and return was clear from gas. The stopping of the fan allowed the gas to gather in a body which formed like that of a battery against the air which was the obstruction in the way and for said reason the air took the shortest and easiest way to the fan. After headings A, B, C, D, E, F and G, had been bratticed, the pressure of air at point O became greater than that of the gas, consequently the gas was cleared away leaving the air-course and gangway clear for the air to travel through at the same time taking the pressure from the closed headings.

Yours, etc.,
J. E. B.

Glen Carbon, Schuylkill County, March 21st.

Specific Gravity of Gases.

Editor Colliery Engineer :

SIR:—I submit the following rule in answer to "Miner," of Uniontown, Pa., in the April issue:

The specific gravity of a gas is the proportion which exists between its weight and that of an equal volume of distilled water at an equal temperature and pressure. One cubic foot of water at 32° F. and bar. 30″ weighs 62·355 lbs.; one cubic foot of air under the same conditions weighs ·0809749 lb., now if we divide the weight of one cubic foot of air, or of any gas, we will get the specific gravity, thus—·0809749 ÷ 62·355 = ·001298, the specific gravity of air. In the same way computing the weights of one cu. ft. of CO_2, O, and N, we find their specific gravities to be respectively:

·123353 ÷ 62·355 = ·001978 sp. gr. CO_2.
·089255 ÷ 62·355 = ·001431 " " O.
·078416 ÷ 62·355 = ·001257 " " N.

If "Miner" wishes to obtain a simple formula taking air at 1·000 he will find it in Wardle's book, p. 35.

Yours, etc.,
M.

Bevier, Mo., Apr. 15th.

Eleven Miners Drowned.

By a body of water that had collected in old workings breaking through the pillar into the workings of the Lytle Coal Co.'s colliery, near Minersville, Schuylkill Co., Pa., eleven men were drowned on the 21st ult.

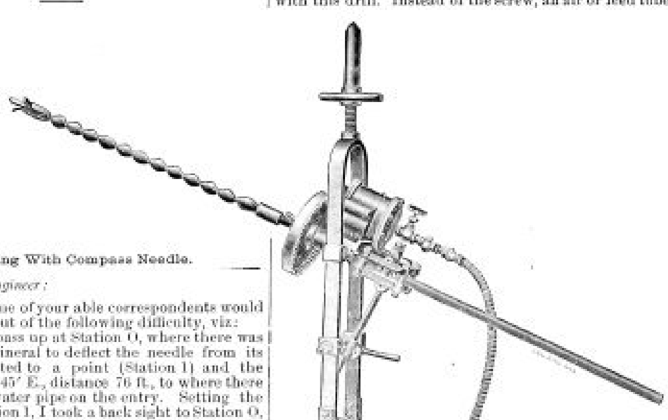
The Lytle Coal Co. were at work opening a colliery at a level lower than that which had been worked years ago, and which had been allowed to fill with water. Considerable of the water in the old workings had been pumped out before work was commenced on the coal lower in the basin. The water that caused the disaster was dammed back by falls, and was not drained off by the pumps.

As a precaution against accident, drill holes were kept in advance of most of the live workings to insure safety. There were no maps of the old workings in existence, and this made the officials extra cautious. But the break occurred at a point where it was least expected and there were no drill holes. It came so suddenly that Thomas Buggy, James Dolbin, John Zerbey, and eight Italians were drowned. The bodies of the drowned men were not recovered for several days, as the amount of water that caused the damage was larger than was at first supposed, and considerable pumping was required before exploring parties could enter. The last body was recovered on April 26th, and the funerals took place on the 27th. Foreman Adams of the colliery was untiring in his efforts to recover the bodies, and with no thought of his own safety, performed heroic work in his efforts to recover the bodies of the unfortunate men. In his work he was ably assisted by a corps of hardy men, always ready to follow where he led. The accident was an entirely unforseen one, as the officials of the colliery had taken every precaution they thought necessary to avert such a disaster.

It was entirely due to the lack of surveys in the old workings, which were operated when the mine surveyor was almost an unknown personage in the Anthracite regions. Had there been even an approximately correct map of the old workings the accident would not have occurred.

Jeffrey Giant Drill.

The accompanying illustration represents the Jeffrey latest improved Power Drill which will be known as their "Giant Drill." The general construction of the frame is the same as the drills heretofore furnished and which are now used largely throughout the coal fields. The Giant Drill, so called on account of the increased power derived from the new pattern of engine used, consists of a double rotary valve engine which in actual service develops great power with a minimum amount of air. This feature is covered by patents and users of the drill will get the benefit of this improvement which will be of great importance. A new, as well as simplified feed arrangement has also been added, making this drill without doubt superior to any power drill yet offered. An air feed can also be used with this drill. Instead of the screw, an air or feed tube



is substituted, being operated by air, the feed is not positive, which allow the auger or drill bit, to advance slowly, when striking an unseen sulphur ball, or hard cutting, thus preventing more or less strain. The manufacturers, The Jeffrey Mfg. Co., of Columbus, Ohio, are to be congratulated on their success which has been achieved with these drills and as a further inducement they now offer these at prices which are about 25 or 30% lower than formerly quoted.

Surveying With Compass Needle.

Editor Colliery Engineer :

SIR:—I wish some of your able correspondents would enable me to get out of the following difficulty, viz:

Setting the compass up at Station O, where there was no iron or other mineral to deflect the needle from its true course, I sighted to a point (Station 1) and the needle read S. 33° 45′ E., distance 76 ft., to where there was some 4-inch water pipe on the entry. Setting the compass up at Station 1, I took a back sight to Station O, and the bearing read N. 39° 30′ W., a difference of 5° 45′ between the foresight and backsight of Station O and 1, I desire to start an entry at Station 1, where the iron pipe is (and which deflected the needle 5° 45′ out of its true course) to go on a true bearing of S. 58° E. Now what I want to know is whether I should add the 5° 45′ to S. 58° E. and start the entry at S. 63° 45′ E. or subtract the 5° 45′, and start the entry S. 52° 15′ E. so as the entry will be going on a true needle bearing of S. 58° E. when it gets away from the influence of the iron pipe.

Yours, etc.,
YOUNG SURVEYOR.

Pomeroy, Ohio, Apr. 20th.

Specific Gravity of Gases.

Editor Colliery Engineer :

SIR:—In answer to "Miner," of Uniontown, Pa., in your April issue, I would refer him to Mauchline's book, p. 10, where he will find the rule he wants. If he hasn't that book, however, it can be found by proportion as follows:

14·4 : 8 :: 1 : ·555, the specific gravity of fire-damp; 14·4 being the atomic weight of air, 8 the atomic weight of CH_4, and one that of H.

Also, the specific gravity is found by dividing the atomic weight of gas by the atomic weight of air, thus for carbonic acid gas—22 ÷ 14·4 = 1·527, specific gravity.

Yours, etc.,
L. P. H.

Avoca, Pa., Apr. 19th.

Mine Inspectors' Examination at Olympia, Wash.

An examination of applicants for State Mine Inspectorships was held at Olympia, Washington, on Jan. 17th. The Board of Examiners was composed of D. T. Davies, Supt. of Carbonado Mines; Morgan Morgan, Supt. of Black Diamond Mines; S. Ronald, Supt. of Roslyn Mines; Oscar Huber, Mining Engineer of Spokane; Mitchell Love, Miner, of Renton; T. Ismay, Miner, of Bucoda, and Wm. Richards, Miner, of Roslyn. There were eight candidates. The two successful applicants were David Edmunds, of Franklin, and Joseph James, of Carbonado. Both of the successful applicants were one time students in the Drifton, Pa. School of Mines.

COLLIERY IMPROVEMENTS.

Colliery Owners, Superintendents, Mining Engineers, Contractors, and others are respectfully requested to inform us as early as possible of all improvements contemplated at their mines. We desire to make this department as complete as possible.—*Editor.*

*** The Lehigh and Wilkes-Barre Coal Company Elmer H. Lawall, General Superintendent, Wilkes-Barre, Pa., will shortly make some important improvements at Lance, No. 11, Colliery. Among the changes will be the erection of one 100 H. P. Dimmick & Smith boiler; the erection of annexes on each side of the breaker, which will increase its capacity from 40 to 75 cars per day; the erection of an additional chestnut and stove coal screen, and the remodeling of the dust fan in the breaker. The shaft will be continued to the Ross seam, a new fan 12 ft. x 35 ft. will be erected, and there will be important changes made in the ventilation of the inside workings.

*** At the collieries of the Silver Brook Coal Company, at Silver Brook, Pa., the following improvements have been made or are in progress under the supervision of Mr. H. C. Zacharias, Superintendent and Engineer of the company:

No. 1 Colliery.—In No. 1 slope from main west gangway, an inside slope has been sunk 30 yards to the first lift, and 90 yds. to the second lift. It is now being sunk to the basin. The self-acting plane has been extended 100 yards. A new slope, called No. 2 Slope, 800 yards southwest of the breaker, has been sunk 140 yards on the No. 6 seam. Two lifts are turned off on the west side, and one on the east.

No. 4 stripping has been opened up, and the removal of the surface for a new stripping on the Mammoth seam is in progress.

A 100 H. P. Dimmick & Smith boiler has been added to the steam plant and extensive repairs and alterations have been made to the breaker, thereby greatly increasing the facilities for preparing the coal.

No. 2 Colliery.—The Slope on the No. 6 seam is now down 240 yards to the basin. The first lift is turned off to the west and the lower lift east and west.

A large area of the Mammoth seam has been uncovered at the stripping started in November, 1890. The new breaker which is in course of erection will be completed in ample time for the fall trade. It is being fully equipped with first-class modern machinery.

A 500 H. P. Babcock & Wilcox boiler, and a pair of 22″ x 36″ hoisting engines with double drums have also been erected.

*** The Peel Splint Coal Company, of Lewiston, West Va., Mr. Z. T. Krieger, General Manager, is laying 3,300 ft. of steel rail around the hill, and in the main entries of the mine. This will result in changes that will increase the capacity of the mine 200 tons per day, and will enable the officials to more economically and expeditiously handle the output.

*** Mr. George Prentis, of Canon City, Col., the Superintendent of the Prentis Coal Mine, is making some radical changes in the methods of mining. He is erecting an air compressor and putting in a number of mining machines.

*** The Leavenworth Coal Company, of Leavenworth, Kansas, Mr. J. E. Carr, General Superintendent, has just completed the erection of a large 25-foot fan, built by the Vulcan Iron Works, of Wilkes-Barre, Pa. This company has also remodeled the shaft head and all cars are handled by machinery operated by a 10 H. P. engine. The machinery is worked by paper friction wheels and rack gear. There are 9 levers, all centering at one point, and arranged to be worked by one man. This machinery was designed by the officials of the company.

*** The Coal City Mining Company, of Coal City, Ala., Mr. Wm. Herbert, Superintendent, is operating at present one slope with an output of 250 tons. The seam is four feet thick, of excellent quality, and makes a coke that is said by foundrymen and furnacemen to be equal to Pocahontas coke. Preparations are now being made to open another slope, and a 100 H. P. Lidgerwood engine is on the ground with two 50 H. P. boilers under construction for use at this new slope. This company intends to increase its output by next fall to 600 tons per day.

*** The H. G. Davis Coal Company, whose office is at Piedmont, West Va., and whose mines are at Thomas, West Va., under the management of Mr. H. G. Buxton, recently completed its second shaft. The main shaft 12′ x 24′ was commenced May 3d, 1891, and the coal was reached at a depth of 179 ft. 9 ins. on September 7th, 1891. The shaft passed through very hard sand rock for almost its entire depth, and it was timbered as the sinking progressed. The sinking of the air shaft, 14′ x 14′, was begun September 14th, 1891, and reached the coal at a depth of 187 ft. on January 21st of this year. Several delays were caused in each shaft by the breaking of pumps. The shafts were sunk to open the Davis seam, which lies 192 ft. below the Thomas seam, which was the only coal heretofore mined by this company, and which was opened by drifts. The coal of the Davis seam has an excellent reputation as a smithing, steam, and coke coal. The output is expected to reach 1500 tons per day by the beginning of next year.

*** The Gallitzin Coal and Coke Company, of Gallitzin, Pa., have lately been putting in a new basket for lowering the coal into the cars without breaking. They also have added an elevator to carry the slack and a car haul operated by rope transmission. This machinery was constructed and installed by the Link Belt Engineering Company, of New York. It handles the coal rapidly and economically.

*** Mr. Jacob Stineman, at South Fork, Cambria county, Pa., contemplates putting in a new rope haulage plant 1500 feet in length in a dip and 1000 feet on the level, also a new 20 foot fan for ventilating.

*** Rapid progress is being made with the new shaft of the Consolidation Coal Company, near Lonaconing, Md. The shaft is known as a "square" shaft, having two sections 8x10 feet each. A Rand compressor engine of three drills capacity is used with the aid of the Ingersoll drill. The winding engine used is reversible, and is fed by two boilers of 85 horse-power each. Mr. R. S. Randolph, the efficient Superintendent of the company, is determined to make this shaft a model of its kind, and to this end is procuring only the most modern machinery.

*** Work on the large haulage plant at Big Soldier Run Mine, Reynoldsville, Pa., has been actively begun. The foundations for the boiler-house and engine house are being laid. The chimney is to be thirteen feet square at base and 100 feet high, and large enough to serve for six 100-horse power boilers. There is also to be erected an iron and steel tipple building 36 feet wide and 120 feet long.

PERSONALS

Mr. A. A. McLeod, President of the Philadelphia & Reading Railroad Company, is to-day perhaps the most prominent business man in America. He is not only the president of the great Reading corporation but is also general manager of its business. His rise to his present position has been phenomenally rapid. He first became connected with the company in November, 1886, having been appointed general manager by Austin Corbin, the then president, who recognized Mr. McLeod's great executive ability. On the resignation of Mr. Corbin as president of the company in 1890, Mr. McLeod was elected his successor, though he still retained the general managership. Under his direction the Reading company has made the most remarkable advances in its history. His foresight, energy and pluck led him to make innovations and extensions that to more conservative men were appalling in their scope, but results have proven the wisdom of his course. In personal appearance he is over six feet tall and splendidly proportioned. He has an erect firm carriage and is a striking figure in any assemblage of men. His features are large and regular, his forehead is broad and high, and his clean cut lips are shaded by a heavy brown mustache.

He wears no jewelry. His taste in personal adornment is exhibited in dark clothing of faultless finish and quiet style, neckwear of subdued colors and always a broad-brimmed beaver hat.

In his personal contact with individuals of all classes he is one of the most affable of men. There is a conspicuous absence of that brusqueness which is affected or becomes second nature, in men who represent great interests and to whom, above all others, time is money. A section foreman whose duties at some period of his life may call him to the president's office receives as much sincere attention and courtesy as does the official representative of a great corporation who may desire to discuss traffic arrangements with the head of the Reading Railroad.

His business habits are very methodical, and he is one of the first to reach the Fourth street offices of the company and the last to leave. Unless called away from the office on official business, he is at his office every day from 9 a. m. till 6 p.m. Naturally, a man having the direction of as much business as he has, must be protected from the interruption of callers desirous of seeing him on trivial matters or with chimerical schemes. Therefore all callers are received by his private secretary, Mr. Frank G. Odenheimer, who is uniformly courteous to all. If the business is of a nature that an interview with Mr. McLeod will expedite it, the interview is readily secured, and the business is rapidly disposed of. While Mr. McLeod is a thorough American by birth and education, his ancestry was Scotch, as is readily shown by his full name Archibald Angus McLeod.

Mr. Peter Sheridan, of Highland, Pa., has accepted the position of mine boss for Coxe Bros. & Co., at Oneida.

The Governor of Ohio has re-appointed Robert M. Hazletine, of Mahoning County, as Chief Inspector of Mines of that State for a term of four years.

Mr. Thomas H. Carey, who has been superintendent of the Woodward Colliery of the D., L. & W. R. R. Co., in Plymouth township since its start, has been placed in charge of the operations of the same company in Hanover township where a breaker still larger than the Woodward is to be erected. Mr. William Beacham, who has had charge of the Dodge Colliery near Bellevue, will succeed Mr. Carey at the Woodward.

Baird Halberstadt, E. M., recently connected with the coal department of the U. S. Census, but now Assistant State Geologist of Pennsylvania, is at work in the Eighth Bituminous district gathering data for a map of the Bituminous regions of the State.

Judge Rice, of Luzerne County, has appointed the following Boards to examine mine foremen in the Third, Fourth and Fifth Districts respectively. They will serve until the first term of Common Pleas Court, 1893:

Third District—S. B. Bennett, operator, West Pittston; Patrick A. Sweeney, miner, Pittston; John F. Evans, miner, Pittston.

Fourth District—Elmer H. Lawall, superintendent, Wilkes-Barre; Thomas Owens, miner, Plymouth; Patrick McGrane, miner, Sugar Notch.

Fifth District—J. C. Haydon, operator, Jeanesville; Michael Mulligan, miner, Upper Lehigh; John Scott, miner, Hazleton.

Mr. John L. Williams, of Shenandoah, Pa., Division Superintendent of the Philadelphia and Reading Coal and Iron Co., has resigned to accept the position of General Superintendent of the Union Coal Co., with headquarters at Shamokin, Pa., vice Mr. Holden Chester, who resigned on account of age, and a desire for relief from his arduous duties. By this change the Philadelphia and Reading Coal and Iron Co. has lost one of its most efficient officials, and the Union Coal Co. has secured a superintendent whose superior as a practical mine manager cannot be found. The writer's aquaintance with Mr. Williams began in 1875, when he occupied the position of Assistant Inside Foreman at Indian Ridge colliery. He was promoted from this position to the foremanship, and from the latter to that of District Superintendent on the death of John Reese, who lost his life with Jonathan Wasley and Frank Willman at Kehley's Run colliery. After serving about four years as District Superintendent of the Shenandoah District. Mr. Williams was appointed Division Superintendent, and had charge of all the Philadelphia and Reading collieries in the Mahanoy and Shenandoah Valleys east of Big Mine Run, 23 in all. Under his direction some of the most important coal developments in the Mahanoy Valley were made, and his mining ability was recognized on all sides. Our acquaintance with Mr. Williams has been a long and an intimate one, and we heartily wish him the same measure of success in his new position as he won in his past.

On the evening of the 30th ult. Mr. Williams was tendered a banquet by his associates among the officials of the Philadelphia and Reading Co., and Inspector Stein, at the Ferguson House, Shenandoah, Pa. The banquet was a very pleasant affair, and at opening District superintendent Elijah Gregory, on behalf of the company assembled, presented Mr. Williams with a beautiful case of drafting instruments in a neatly worded speech which expressed the sentiments of his associates in bidding an official farewell to Mr. Williams. Inspector Stein accepted the gift on behalf of Mr. Williams, and then the entire company joined in the banquet which was prepared by Landlord Hutchinson. At its close the entire company filed past Mr. Williams, shook him by the hand and wished him unbounded success and prosperity in his new field.

Mr. Thomas Mitchell of East Brady, Pa., President of the Diamond Coal Co., died on March 31st, aged 62 years. Mr. Mitchell was a native of England, and emigrated to America in 1854. In 1869 he was appointed General Manager of the Pittsburgh Coal and Mining Company's mines at Catfish, Pa. He discharged the duties of this position for ten years, and then, in company with James B. Stephenson, engaged in mining and shipping coal at Pine Run, near East Brady. After several years work, this mine was exhausted, and in company with his sons he secured coal lands on the Sligo branch of the Allegheny Valley Railroad and opened the Diamond mines. These mines are still in operation, and are now surrounded by other mines opened by parties who followed Mr. Mitchell in this region. During all the years that Mr. Mitchell was engaged in the coal business, he commanded the respect of all who came in contact with him. Honest and upright in all things, and of a kindly nature, he not only won the esteem of his business associates, but had the affection and esteem of his workingmen as well. Some of the latter who had removed to other fields traveled over 100 miles to pay a last tribute of respect and affection to their deceased friend on the day of his interment.

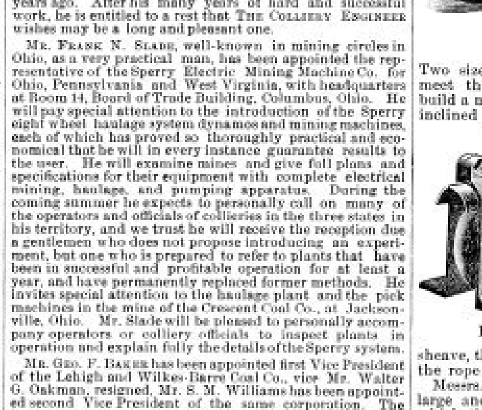
In the retirement of Mr. Holden Chester, of Shamokin, from the superintendency of the Union Coal Co.'s collieries, one of the best known men connected with colliery management in the lower region permanently retires from the business. For many years Mr. Chester was the superintendent of the Mineral Railroad and Mining Co.'s collieries, and when the late Hon. Wm. L. Scott leased from that corporation several of its largest mines purchased large tracts of anthracite coal lands and formed the Union Coal Co., he made Mr. Chester his general superintendent. Up to the time of his death he had unbounded confidence in Mr. Chester's ability, and when the latter spoke of retiring from active duty several years ago, Mr. Scott personally requested him to remain with the Union Co. until he could find an equally competent successor. Had it not been for this Mr. Chester would have retired from active work several years ago. After his many years of hard and successful work, he is entitled to a rest that The Colliery Engineer wishes may be a long and pleasant one.

Mr. Frank N. Slade, well-known in mining circles in Ohio, as a very practical man, has been appointed the representative of the Sperry Electric Mining Machine Co. for Ohio, Pennsylvania and West Virginia, with headquarters at Room 14, Board of Trade Building, Columbus, Ohio. He will pay special attention to the introduction of the Sperry eight wheel haulage system dynamos and mining machines, each of which has proved so thoroughly practical and economical that he will in every instance guarantee results to the user. He will examine mines and give full plans and specifications for their equipment with complete electrical mining, haulage, and pumping apparatus. During the coming summer he expects to personally call on many of the operators and officials of collieries in the three states in his territory, and we trust he will receive the reception due a gentlemen who does not propose introducing an experiment, but one who is prepared to refer to plants that have been in successful and profitable operation for at least a year, and have permanently replaced former methods. He invites special attention to the haulage plant and the pick machines in the mine of the Crescent Coal Co., at Jacksonville, Ohio. Mr. Slade will be pleased to personally accompany operators or colliery officials to inspect plants in operation and explain fully the details of the Sperry system.

Mr. Geo. F. Baker has been appointed first Vice President of the Lehigh and Wilkes-Barre Coal Co., vice Mr. Walter G. Oakman, resigned. Mr. S. M. Williams has been appointed second Vice President of the same corporation. The circulars announcing these appointments also states that Genl. Supt. E. H. Lawall will report direct to, and receive instructions from President Maxwell, and that the General Auditor and Purchasing Agent will report to, and receive instructions from second Vice President Oakman.

Friction Drums and Guide Sheaves.

Messrs. Thos. Carlin's Sons, of Allegheny, Pa., who have for years made a specialty of double friction drum power hoists, as used for tail rope system for operating derricks, and other works where power is obtainable either through sprocket chain or belting, herewith



illustrate their drums that have proved so successful wherever used. A driving pulley or other means of

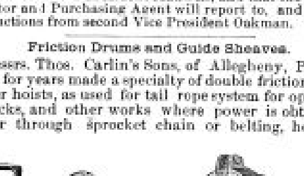


Fig. 1.

transmitting power is furnished with each hoist. Each drum may be fitted with foot breaks as shown, and cut heads or winches may be placed on the far end of the drum shaft, for use in some locations where it is desired to drag cars on side tracks.

When fitted for tail rope haulage, the several levers may be combined so that the operator may have perfect control of the machine by a hand and foot lever.

As will be seen in the cut, the gearing runs constantly, but the drums operate only when the friction levers shown in the front are moved. It is a very strong machine and takes up but little floor space.

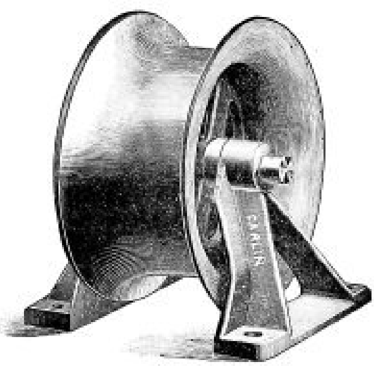


Fig. 2.

Two sizes are made and drums are constructed to meet the requirements. Messrs. Carlin's Sons also build a machine of the same general design for use on inclined planes, etc.

Fig. 3.

The pulleys shown by the three cuts, show their several designs of guide sheaves for use with wire rope haulage. It will be seen by reference to Fig. 1 that the vertical guide sheaves have a neat iron base plate, which can be bolted to the cross-ties. They are made in two sizes. The carrier sheaves (Fig. 2) with stands have chilled bearings and are very neat and strong. Fig. 3 shows a tail rope carrier sheave, the frame of which makes a guard that keeps the rope from coming out of the groove.

Messrs. Carlin's Sons have recently issued a very large and complete catalogue of their specialties, in which they illustrate and describe in detail all their products. It is a very complete work, and can be secured by actual purchasers on application.

Nothing Succeeds Like Success.

The invention of a piece of machinery is one thing. Its successful introduction is another. When an invention is such that it economizes labor and makes it possible to do more work with less cost, its introduction is comparatively easy. All that is needed is a good machine, and the faculty of making its merits known to those who will be benefited by its use.

The Cannelton Supply Co. of Cannelton, Beaver Co., Penna., have a good and cheap machine in the Grim Patent Coal Drill, and have brought it to the attention of the miners and operators in all parts of America through the medium of an advertisement in the columns of The Colliery Engineer during the past year. Mr. Heilman, the manager of the company, informs us that they have been very successful in introducing it into every coal field in America, and among the recent prominent purchasers who are using it with success are:

The Coahuila Coal Co. of Mexico, 16 sets, and the Winifrede Coal and Coke Co. of West Va. Messrs. Wolf, Lane & Co. of Pittsburgh, who represent the company in the Pittsburgh region disposed of 52 sets in March alone. The Short-Frick Mercantile Co., of Dillonvale, Ohio, who also handle these drills have in a comparatively short time disposed of over $900 worth of them.

They are largely used in the Anthracite regions and are particularly in favor in the Shamokin region. They are adapted to all kinds of coal, and need only a trial to ensure their permanent adoption. The following letter from one of the most prominent colliery officials in Pennsylvania, shows the favor in which the Grim drill is held:

Bell, Lewis & Yates Coal Mining Co.
Reynoldsville, Pa., Feb. 12th, 1892.

Cannelton Supply Co.
Cannelton, Pa.

Gentlemen :—

I am in receipt of your favor and will reply that at our mines at both DuBois and this place, we are using your drills and they have given us very good satisfaction We are not now in need of any more, but when we shall be in the market we will undoubtedly call on you as heretofore.

Yours truly,
S. B. Elliott, Gen'l Manager.

The Colliery Engineer.

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RENEWALS, ETC.

If you do not want THE COLLIERY ENGINEER continued for another year after your subscription has run out, you should notify us by postal card to discontinue it. The courts have decided that subscribers to newspapers who do not order their paper discontinued at the expiration of the time for which it has been paid, are held liable for the payment of their subscriptions up to the date when they order the paper discontinued.

NOTICE OF DISCONTINUANCE.

THE COLLIERY ENGINEER is sent to subscribers until an explicit order for its discontinuance is received by us, and all payment of arrearages is made, as required by law. *Papers returned are not notice of discontinuance, as we cannot tell where they are from.*

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A Subscriber wishing to have his address changed should be careful to give his *former* as well as his present address; otherwise we cannot find his name on our mailing list.

All communications should be addressed

THE COLLIERY ENGINEER COMPANY,
Coal Exchange,
Scranton, Pa.

Cable Address—"Retsof, Scranton."

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THE METROPOLITAN PRESS AND THE COAL COMBINE.

THE enterprise of the more prominent American daily newspapers, as a rule, is such that it excites the wonder and admiration of all intelligent readers. But there are subjects on which their writers generally display ignorance that under the circumstances is almost criminal. One of these subjects is coal.

The recent great union of coal roads was a matter that in the importance of its results, entitled it to the most careful investigation on the part of news writers before opinions regarding its effect were expressed. In regard to the capital invested, and the people directly affected, it was more important in many ways, to the general American public than any of the political changes south of the Rio Grande, or on the continent of Europe.

But, the subject of coal and coal mining has always been one on which the metropolitan news writers have as a rule displayed either amazing stupidity or a sensationalism that is only equaled by the literature distributed by dime museums or the peripatetic circus. Those unfamiliar with the technicalities of coal mining accept their false statements as gospel truths, while those familiar with the subject are impressed with the idea that if a newspaper will make such absurd and erroneous statements on one subject, it must also be unreliable on others.

The statements that are daily published attributing to the officials and stockholders of the several companies, a desire to corner the Anthracite coal market and force prices to a point that will be burdensome and that will practically drive consumers to the use of Bituminous coal, are ridiculous because it is unreasonable to suppose that those with capital invested in an industry will deliberately ruin it.

The Anthracite coal business for a number of years past has been such that except in a few isolated cases the cost of production was fully equal to or exceeded the price the coal brought on cars under the breaker. The great cost of Anthracite mining plants and the expenses connected with the mining and preparation of the coal, including the necessary drainage, ventilation, etc., are not understood by the metropolitan news writers, simply because they have never taken the trouble to inquire into details. The coal is limited in its supply, and when once taken from the mine is gone forever. A new crop cannot be raised the following year as with vegetable productions. This is another phase of the subject never taken into consideration.

Another point to be considered is the law of supply and demand. When the demand is not equal to the supply in any other branch of business, the supply is curtailed, and there is no reason why this rule should not be enforced regarding coal as other productions.

For years the men employed at the Anthracite collieries have been working but part time and at wages that are not such as they should receive. This was due to the low price paid for coal under the breakers. The operators can not afford to pay higher wages and the workingmen have gone on without resorting to strikes, which they knew could not benefit their condition.

The new state of affairs, it is hoped will remedy these conditions. Coal will either be mined at prices that will ensure a fair profit to the operator and fair wages to the miner, or it will not be mined at all.

It cannot be claimed that Anthracite is a necessity as breadstuffs are, for if it becomes too expensive, the cheaper Bituminous coal can and will take its place. The men at the head of the new deal understand this and they have too much hard business sense to advance prices enough to discourage consumption. Before jumping at conclusions it would be well for the New York dailies and their followers among the provincial journals to send conservative intelligent men into the Anthracite region to study the existing conditions and the policy of the corporations and operators interested. If they do this, and then base their editorial utterances on the facts gleaned, they will, if honest, commend rather than condemn a policy that is rational and equitable, and one that is designed to bring about a condition of affairs in the Anthracite region that will prove beneficial, not only to the capital invested in the coal business, but to every workingman and business man dependent upon the industry.

ANOTHER USE FOR COKE BYE-PRODUCTS.*

IN the production of coke by the crude method of the old oven, whereby the only product is coke, there is an enormous waste of valuable fuel under the name of bye-products.

The tar and tar oils, which are the result of coke manufacture, differ from the tar products of the gas works, but such difference as exists is not of material importance in some respects. It is perhaps inferior as a source from which the creosote oils can be made which seem best fitted for use in the preservation of railroad ties. But apart from this question of creosote, or of artificial manures there is the growing importance of tar as a fuel.

Under the head of liquid fuel we may include every combustible substance which will flow through pipes of an inch or two inches diameter when warmed, and in this category come practically all the bye-products of the distillation of Bituminous coal. There are of course certain constituents of all such products which have a comparatively low temperature of volatilization and it is well that such substances should be eliminated, as they may readily be, prior to the employment of the tar as a fuel, but this done there appears no good reason for doubting the entire safety of liquid fuels for the purposes of the steamship or of the railroad. Needless to say common caution would point to the use of properly devised tanks for their reception, whether in the tender of the locomotive or the bunker space of the steamship, and there are those who hold it essential that under no circumstances should the feed of liquid fuel to the furnace be in the slightest degree aided by gravity. This is, perhaps, a fair and proper precaution to exercise as a safeguard against the possible breakage of the pipe connections and the sudden escape upon the floor of the stokehold of a quantity of the fuel before it could be shut off at some point nearer to the tanks themselves.

The convenience of a gravity flow is not so great but that such a precaution may not be cheerfully accepted and it may be pointed out that in the locomotive also, the arrangement of the oil tanks can be such that the flow need not be assisted by gravity. For some years there have been at work in Russia, near the oil fields, many locomotives which use petroleum as their sole fuel.

The earliest experiments in Russia with petroleum fuel were made in 1874, but the fuel was abandoned on account of cost at that time but has since been adopted, as the fuel of the Tsaribein Railway.

As compared with Bituminous coal, petroleum refuse showed, according to the locomotive superintendent an advantage of fifty-six per cent. in weight, and sixty-six per cent. in cost, and when carried in bulk the loading and unloading of any liquid is so easy that there appears good reason to suppose that the use of petroleum refuse will extend. But petroleum refuse is not the sole liquid fuel by any means.

Apart from the tar produced from coal in the process of manufacture of illuminating gas, there is a tar which is saved from blast furnaces, and a tar from coke ovens. Blast furnace tar, produced by cooling the gases from blast furnaces, is stated to possess the following properties and composition by Watson Smith.

The example analyzed had a specific gravity of ·954 and was distilled to dryness with the following result:

	Percentage of Products	Specific Gravity.
Volatilized below 446° F.	Water 30·6 by volume	1·007
	Oil 2·9 by volume	·889
Volatilized at 446°—572°	7·0 by volume	·971
Volatilized at 572° till oils solidify	18·0 by volume	·994
Soft Paraffin scale	16·7 by volume	·987
Coke	21·5 by weight	
Loss	5·5 by weight	

As a fuel therefore something like seventy per cent of this tar is combustible.

The tar from Jameson coke ovens is of very similar composition, and we may probably take it that the water present in the crude tar would all pass off with the first distillates, leaving behind an anhydrous liquid, free from the more volatile constituents which can be better utilized, and eminently suitable for use as a liquid fuel.

This, it appears, is generally, if not invariably, thrown away in America, and some interest may be aroused as to the latest English practice with liquid fuel At the outset it may be stated that England does not present a specially favorable field for the employment of liquid fuels.

The ties used on English railroads are half square timbers, usually of Baltic Fir, and they are usually heavily treated with creosote. There is thus a large demand for the tar of the gas works, which not many years ago was a nuisance, and it is converted variously into aniline dyes, artificial manures, and creosote for ties, and pitch for paving purposes.

Coal, too, is plentiful, and it is unlikely therefore that liquid fuel can oust coal. Nevertheless on the Great Eastern Railway the locomotive superintendent has evolved a system of liquid fuel combustion which possesses considerable merit, for it has involved no departure from the normal style of coal burning furnace, which can prejudicially affect the capacity for burning coal alone.

The arrangement consists of a pair of steam actuated injectors, fitted at the rear of the firebox, under the foot plate, about twenty inches apart and ten inches above the grate level. Their nozzles are placed centrally in two five-inch holes cut through from outside to inside of the back of the firebox, the holes being tubed from box to casing, through the water space. Each nozzle has a double opening, one directly forward, the other toward the middle space of the firebox.

Round each nozzle is a ring pierced for several small steam jets, which induce air currents into the firebox round the injector nozzles.

The action of the injectors is to finely spray the liquid fuel, brought to them by pipes from a tank at the rear of the tender, and distribute it in the furnace, any which is not consumed falling to the grate or settling upon the brickwork of the smoke arch, which at once volatilizes it.

The grate is thinly covered with a fire made up of coal and broken chalk, its object being to serve as a lighter of the oil, and preserver of temperature during stoppages, as well as to intensify and ensure a more perfect combustion, sufficient air being allowed through the grate to maintain this light fire and assist to burn the oil likewise, but more air being provided by the air injection jets of the two fuel injectors, by which latter indeed the correct air supply is maintained at the point when smoke is just formed in occasional light puffs.

The preservation of a bed of actual fuel has the advantage that lighting up can be just the same as in any other engine, and the oil fuel need not be used till the engine takes its turn with a train.

Any failure in the supply of oil can make no difference, for coal can at once be used instead without the least inconvenience. This is an advantage which is unattainable where a special brick furnace is built for oil burning, as is done on the Russian line using petroleum.

The latest engine fitted with liquid fuel on the Great Eastern Railway is one of a class of ten similar express engines, and, as compared with the other nine engines doing the same round of duty, the oil burner has used about one-third the weight of coal per mile, and about as much oil as coal in weight. Her total fuel is thus about two-thirds by weight what it would be if all coal. The liquid practically gives an efficiency of double its weight of coal. The writer has had runs on this engine when burning mixtures of plain gas tar and creosote residuals, warmed up, in the tank which is placed at the rear of the tender, to a liquidity sufficient to cause it to flow freely through the injector pipes, and to destroy its viscosity so that it would spray finely from the nozzles. Its behavior in the furnace is satisfactory, filling the firebox with white flame, while the air rings admitted of the most delicate adjustment of the supply of air to effect perfect combustion without air excess. Steam was made most freely.

A discussion took place in the English papers on this locomotive. It was urged that the combined system of solid and liquid fuel was not so economical as the all, liquid furnace. On the other hand it was urged that the ability to use either or both fuels at a moment's notice and to make the change instanter was an advantage not to be lightly despised. Where the firebox is filled with cellular brickwork, this cannot of course be done and there can, after all, be no refractory material as a covering for the bars and as an incandescent bed for ensuring volatilization of any oil which may fall, superior to a thin fire of coked coal, clinkers, and chalk lumps, as used in Holden's system on the G. E. Railway. The elasticity of the system commends it where a locomotive may run through a district in which alternations of coal or liquid fuel occur.

In England, for example, gas tar can be picked up at a country town at a distance from any tar distillery works for a price less by the carriage than it can be had where there is a creosote works, and where liquid is cheaper it may be used in a compound furnace just so long as it can be had in sufficient quantity. The reduction in the labor of the fireman is very marked, and the cleanliness when burning oil is equally noticeable.

With such an immense field open for the consumption of all the tar which can be produced there should be no throwing such a valuable article to waste to the blackening of the atmosphere and injury of vegetation. Its saving is called for, to redeem American coke making from the stigma of extravagance. The coke industry cannot afford to throw away such valuable bye-products.

THE NORTHERN ANTHRACITE COAL FIELD.

ON another page we publish a tabular estimate showing the approximate quantity, and the past and probable future production of coal in the several districts of the Northern Anthracite coal field, prepared by Mr. Wm. Griffith, engineer and geologist, late of the geological Survey of Pennsylvania.

This table is accompanied by an explanatory letter from Mr. Griffith explaining the methods whereby he arrives at his deductions, and we think all readers will agree in the opinion that his figures are as nearly correct as it is possible to make them. The compilation of this table entailed on Mr. Griffith an immense amount of research and hard work. He was, however, specially fitted for the undertaking by his experience on the Geological Survey and his practical acquaintance with the geology of the region. The table, will, on inspection, be found very interesting, and the interest will not end with its first examination. It contains a vast amount of information concerning the great Northern coal field, arranged in the most convenient form, and for years to come it will no doubt be used as a work of reference and as a basis for calculations.

A careful study of the table reveals the following interesting generalities:

It shows that in the past nearly sixty per cent. of the coal originally in the ground has been won—this includes shipments and local consumption.

Mr. Griffith thinks the future production cannot well be expected to much exceed fifty-three per cent. of the coal remaining in the ground, but this may be increased somewhat by improvements in the methods of mining, but as most of the coal remaining is at the lower end of the field, where the measures are deep and gaseous, some radical change in methods will be necessary to materially increase the percentage stated.

The large yield of sixty per cent. in the past, as shown by the table, may be partially accounted for by the fact that the coal has been mined from the margin of the field and points where it is not so deep and the surface of little value, so that more coal per acre could be taken out.

According to Mr. Griffith's deductions the several minor divisions of the field will, at the present rate of production, last the following lengths of time:

District.	Time of exhaustion excluding thin seams not now worked.	Time of exhaustion including thin seams not now worked.
Forest City and Carbondale	70 years	
Jermyn	14 "	19 years
Archbald	21 "	86 "
Peckville and Olyphant	75 "	140 "
Scranton	53 "	61 "
Pittston	80 "	83 "
Wilkes-Barre and Plymouth	127 "	134 "
Nanticoke and lower end	121 "	138 "

Of course, as the northern districts are exhausted the production will be greatly increased in the lower end of the basin. A large percentage of the coal north of Scranton is in thin beds that have not yet been worked to any extent, and in this portion of the field more robbing can be done, as the beds are not deep, and the surface is not very valuable. This statement makes plain the relations existing between the figures in the above table.

In the following table is shown the proportion of the whole quantity of coal still unworked by districts and the percentage of the 53% of the whole quantity (that may yet be mined), which will probably be produced in each district.

District.	Percentage of coal remaining in the ground.	Percentage of 53% of coal that may be mined.
Forest City and Carbondale	2·0	3·5
Jermyn	0·7	1·1
Archbald	0·6	0·9
Peckville and Olyphant	4·5	8·6
Scranton	16·0	16·0
Pittston	18·0	14·0
Wilkes-Barre and Plymouth	47·0	42·0
Nanticoke and lower end	16·0	14·0

Of all the coal remaining in the ground, including pillars in the mines, the Wyoming Valley has about 70 per cent. and it has produced about 54 per cent. of all the coal produced from the entire Northern Field. The Lackawanna Valley has 30 per cent. of the coal remaining in the ground, and has produced 46 per cent. of the total production. The past production divided up by districts, gives each district the following percentage:

Forest City and Carbondale, 6%; Jermyn, 3%; Archbald, 2%; Peckville and Olyphant, 4%; Scranton, 31%; Pittston, 16%; Wilkes-Barre and Plymouth, 32%; Nanticoke and lower end, 6%.

Of all the solid coal in the unworked areas, about 20% is contained in seams that have not been worked to any extent in the different districts.

The greatest thickness of the measures is at Wilkes-Barre, where they have at the deepest point, fourteen beds, aggregating 97·6 ft. in thickness. The Archbald and Carbondale districts have the least thickness, the former having two beds with a total thickness of eleven feet, and the latter three beds with a total thickness of seventeen feet.

To give an idea of the magnitude of the amount of prepared coal still to be produced from this field (2,374,194,600 tons) it is necessary to use something beside figures. This amount would fill an ordinary 60 feet wide city avenue, 60 feet deep, or level with the top of an ordinary fifth story window, for a distance of 5,000 miles.

WHAT IS A "MINER?"

THE Anthracite Mine Law of Pennsylvania (1891) states (Art. 8, Sec. 4) "Certificates of qualification as mine foremen and assistant mine foreman shall be granted by the Secretary of Internal Affairs to every applicant who may be reported by the examiners, as heretofore provided, as having passed a satisfactory examination *and as having given satisfactory evidence of at least five (5) years practical experience as a miner.*"

What constitutes a "miner," however, is not defined and the real meaning of the word is the subject of some dispute.

It seems that some candidates on presenting themselves for examination have been refused the right to sit because they could not give satisfactory evidence of having *mined coal* for five years. Is this right?

When we speak of any craftsman, we speak of a man who is competent in all branches of his trade, and who is especially competent in the more important and dangerous branches. It is very rarely, however, that we find in any trade a man who is an all-round, first-class workman. In large industries it is well known that the greatest amount of work can be got out of a certain number of men by apportioning a particular piece of work to each, and we must be content therefore to consider any man an artisan who has a good knowledge of the most important branches of his trade.

In reading the law under question we must consider the object which it is intended to accomplish. It is called "*An act to provide for the health and safety of persons employed in and about the Anthracite coal mines of Pennsylvania, and for the protection and preservation of property connected therewith.*"

The intention of the section of the law under consideration is to provide competent foremen, and the workman who knows most about all the work in mines will make the best foreman, as the more he knows the better able is he to protect life and property.

We do not think five years coal hewing is a sufficient training in this respect, and personally we would rather trust ourselves underground with a man of five years general experience, than in the care of a man who has done nothing but hew coal for the same period.

According to law, any man who has labored underground two years can receive a certificate that he is a miner, and if a miner is to mean only a coal hewer, then, after working other five years, perhaps in a single chamber, with never a thought only to secure so many cars of coal a day, and with no experience in timbering, tracklaying, bratticing, door building, or any other branch of the work except cutting coal, he can present himself at an examination and be allowed to sit while the man who has had experience at all the work but digging, and who for years has had charge of the doors, and brattices, and timbering, which supply pure air and safe travel to the digger, is refused the right to sit.

The term "miner," as used in this section of the act, must certainly mean a workman in the mines who has had five years of general experience in the work underground and who understands the practical details of every branch of the underground work well enough to qualify him to be a competent foreman.

Whether the candidate possesses these qualifications which will constitute him a "miner," and qualify him to stand for examination is a matter to be decided in each individual case by the Board of Examiners.

THE COLUMBIAN EXPOSITION AND THE MINING INDUSTRY.

CONSIDERABLE misapprehension exists, both in this country and abroad, as to the mines and mining exhibit which is to be made at the Exposition. At World's Fairs, heretofore, the mineral and allied exhibits have been shown in the manufacturers' building, or in annexes to other structures occupied by exhibits having but remote relation to anything of the mineral description. Many press notices and comments indicate that the impression prevails widely that such is to be the case at the Exposition of 1893. But that is far from being true. "Mines and Mining" has been made a separate and distinct "Department" of the Classification of Exhibits, and will have the exclusive use of one of the finest and largest of the Exposition buildings. The mines and mining building measures 350 by 700 feet, has a total floor space of almost 9 acres, and cost $265,000. The fact is that, at the World's Columbian Exposition, for the first time in the history of such enterprises, the mining industry and products are accorded the recognition which their exceedingly great importance to the wealth and prosperity of all civilized nations really demands. Mr. Skiff, Chief of the Department, says that it is already assured that in the Mines and Mining Building will be gathered in 1893 incomparably the largest array and most complete and most instructive evidence of the mineral wealth and progress of the mining industry ever collected or attempted.

With the mining industry so well taken care of, there is every reason to suppose that enterprising manufacturers of mining machinery will endeavor to make such displays of their products as will show the high standard to which American ingenuity and skill have brought the construction of all kinds of mining appliances.

During a recent visit to Chicago, the writer spent a pleasant and profitable hour with Mr. Skiff, and afterwards visited the exposition grounds and buildings. Everything connected with the exposition is on an elaborate and stupendous scale, and the manufacturer of mining machinery who fails to avail himself of the opportunity to show his products to the mining officials and engineers of the world will miss a great opportunity.

Comparitively few persons have any idea of the high grade and powerful machinery used in coal mining. The terms, engines, fans, pumps, etc., as applied to coal mines are to them merely the names applied to rough small pieces of mechanism of most primitive construction. For them to see the character of the machinery used will be an education. In fact so general is the idea that almost any kind of an engine will do for use at a colliery, that it can best be illustrated by the following incident:

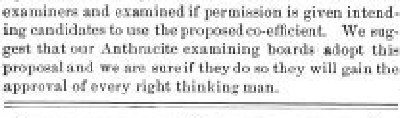
A representative of this journal recently called at the works of a prominent firm manufacturing machinery for metalliferous mines in one of the large cities and endeavored to secure from them a contract for advertising. He was courteously received by a young man in charge, who made the absurd statement that their works "manufactured no hoisting machinery suitable for coal mines. They made only large direct-acting hoisting engines." There was no use in trying to show him his error. He knew all about it. If a man holding as high a position as he does in such works is so ignorant, what must be the ignorance of the general public on the subject.

A first class display of coal mining machinery will effect a double purpose. It will show the mining world that American manufacturers lead those of all other nations in the production of serviceable, convenient and economical mining machinery, and it will show them that both directly and indirectly the coal they consume is only mined and marketed by the expenditure of large outlays of money and exercise of engineering skill.

The manufacturers of mining machinery suitable for coal mines have not been as active in their arrangements for exhibiting their products as have others, and it is time they took the matter up. The expense of a good display will be found a most profitable investment.

THE CO-EFFICIENT OF FRICTION.

IN our correspondence columns we publish a letter from a subscriber commending our editorial on the above subject in the April issue. The co-efficient we proposed (·02 the pressure for a velocity of 1,000 feet per minute) is so much more easily used than Atkinson's, and the difference in the result of calculations will be so little that we fail to see any reason why it should not be adopted. The annual examinations for mine foremen in the Anthracite regoins are about to be held and in such examinations every minute is valuable to candidates who are not adepts in writing, and if their thorough knowledge of formulæ can be demonstrated without long calculations such as Atkinson's figures entail, surely it will be a convenience to both examiners and examined if permission is given intending candidates to use the proposed co-efficient. We suggest that our Anthracite examining boards adopt this proposal and we are sure if they do so they will gain the approval of every right thinking man.



The Anthracite Trade.

The Anthracite trade opens this month in excellent condition. The accumulations of coal have been reduced to a minimum at all points, and the output from the mines has been kept rigidly down to the requirement of the markets. On the first of the month the increased prices went into effect, and the output for this month has been placed at 2,750,000 tons. By placing the output at this amount the new prices will be maintained. These new prices are as follows:

Stove coal, \$4.15; chestnut, \$3.90; egg, \$3.75; broken, \$3.65. These are tide-water rates f. o. b., and are for a ton of 2240 lbs.

Unbusinesslike competition and excessive production has ceased. Anthracite coal will either be sold at a reasonable profit to the producer, or not mined. The advance in prices will not only enable a profit to be made on the capital invested in mining, but will also result in better wages to the workingmen who naturally share in the advance of the sliding scale system of payment at the collieries in the Schuylkill region, and it is but natural for the wages of the miners in the other regions to be placed on the same relative figures. Navigation on the great lakes has opened and western shipments have begun.

Unfilled orders for coal at old prices have been cancelled, and a determined stand for better prices is being made. All the coal that can be sold will be mined and there will be no excessive charge made for it. The prices will be fixed at figures that will result in reasonable profits, and in reasonable wages to the miners. The only parties who will object to this, are the sensational writers on the New York dailies, who endeavor to stir up dissension and trouble by unwarranted attacks on the "Coal Barons" which are inspired either by dense ignorance, or ulterior motives.

The Bituminous Trade.

Since the making of the larger contracts early last month the Bituminous trade in New York and Philadelphia has settled down to ordinary business. There is a fairly good demand from those who held off in the expectation of lower prices during the contract season. The advance in the price of Anthracite has had a stiffening effect on Bituminous coal, and shippers are anxious to get coal to tide. Conservative dealers do not think this effect will be a permanent one, as the Anthracite advance is not large enough to effect a material change from hard to soft coal by consumers.

The supply in all the larger southern markets is large, and business for the operators shipping there is naturally dull. Business at Chicago is active and coal is in excellent demand. The railroads are placing their contracts, and competition for them is brisk. There is considerable uncertainty regarding the prospects for labor troubles in Northern Illinois, and users of coal from that section are laying in supplies. The Indiana miners and those of the Pittsburgh region have signed their respective scales, and peace between operators and workingmen in these fields is assured.

The Coke Trade.

The coke trade is in rather an unsatisfactory condition and production is being curtailed. The larger operators in the Connellsville region have shut down a large number of ovens, so that now only about two-thirds of the total number in the region are in operation. The idea of the operators being to work a portion of the ovens full time rather than all of them part time. Prices are quoted at the same figures as have prevailed for many months, though they are cut by some of the smaller operators. The larger operators controlling about nine-tenths of the output of the region are, however, firmly holding to the quotations.

The Explosion at McAlester, Indian Territory.

In previous issues we gave in detail an account of the explosion at the Osage Coal Mining Co.'s shaft No. 11, at Krebs, near McAlester, Indian Territory. At the request of Mr. R. M. McDowell, the General Manager of the company, Messrs. Walton Rutledge, Inspector of Mines, Fourth District of Illinois, C. C. Woodson, State Mine Inspector of Missouri, and Jno. T. Stewart, State Inspector of Coal Mines, of Kansas, made an investigation and inquiry into the cause of the explosion. Their report to Mr. McDowell has just been issued and corroborates the accounts published in our columns. It also contains as an appendix some recommendations regarding the future working of the mine which we print in full, as they are of a nature that may prove beneficial to other mines working coal of a similar nature.

The recommendations were as follows:

"We would recommend that this system of working the coal in Mine No. 11 be changed, as the coal is of a highly Bituminous nature, very dusty, and gives off small quantities of fire-damp. Powder should be very carefully and judiciously used; no shots to be fired unless properly undercut in rooms; in entries the coal to be sheared on one side and properly undercut; no holes to be drilled ahead of the cutting; no entry or room or other workmen allowed to fire shots, except the properly appointed shotfirers, and all men to be out of the mine except those engaged in firing shots; no more than enough powder to be in the mine at any one time except for one day's use, and the powder to be kept in proper air-tight powder cans, and the cans to be kept in a close, tight-locked box, said box to be at least sixty yards from the working face; and a sufficient interval must be given between the firing of each shot, to allow for the smoke to pass away and the subsiding of the coal-dust.

"At the intake on the slope, on account of the stoppings being blown out, we could not get a proper measurement of the ventilating air current. We measured in returns, and found the total quantity to be 23,135 cubic feet of air per minute. A Crawford & M'Crimmon fan, fifteen feet in diameter, four feet wide, making ninety revolutions per minute, is used for the ventilation. The volume of air herein described, in our opinion, is not sufficient for the number of men employed and extent of the workings; but it should be mentioned that the large falls not yet cleared from the slope or main intake form a serious obstruction to the current, and make it impossible for us to judge closely the quantity of air passing previous to the explosion.

"The fan shaft No. 7 and the escape shaft are located too far from the center of the workings, causing unnecessary friction of the air currents. As the escape shaft is so far from the main workings, sign boards ought to be posted up at each angle or turn, indicating the road to the escapement shaft. We would also recommend that the mine should be ventilated by split currents of air; overcasts should be put in, giving each set of working entries a separate split or current of air not more than fifty men to work in one split, as we consider it very dangerous in a dry or dusty mine, giving off fire-damp, to have the air passing around in one continuous current. The air is now split in Mine, 11 at the bottom of the slope, passing through the workings in two currents.

"We would also recommend a proper system of sprinkling, by introducing a system of pipes on the slope, engine plane, and entries, the water to be introduced into the intake air current in a finely divided spray.

"All mines in this seam of coal have been exclusively worked on the room and pillar plan since the time operations were begun, twenty years ago, except centerly for a short time, in Mine No. 8, now abandoned.

"In our opinion Mine No. 11 could be more economically worked, the coal produced at a less cost, a more efficient ventilation produced, and the mine kept in a safer condition, by Longwall system of working, the condition of the roof and bottom being very suitable for the same. Such an explosion as that at Mine 11 would be impossible under the Longwall system of working, as little or no powder would be used.

"The company have introduced this plan into their new mine, No. 12, in a different seam, which gives evidence of working very satisfactorily wherever the Longwall work is given a chance; but the miners are so wedded to the use of powder and so disinclined to mining or undercutting that every obstacle has been thrown in the way."

WALTON RUTLEDGE,
State Inspector of Mines, Fourth District, Illinois

C. C. WOODSON,
State Mine Inspector of Missouri.

JOHN T. STEWART,
State Inspector of Coal Mines, Scammon, Kansas.

Recovery of the Bodies of The Hill Farm Mine Victims.

The bodies of twenty-two of the thirty-one miners entombed in the Hill Farm Mine at Dunbar, on June 16, 1890, were recovered on March 23, after nearly two years of unceasing work and the expenditure of an immense amount of capital. The men whose bodies were found had been suffocated, and their death was a sudden and comparatively painless one. The coroner's jury that held an inquest on the first six bodies recovered, rendered the following verdict, which meets the approval of every person conversant with the facts connected with the unfortunate accident and the untiring work of Gen'l. Supt. Frank A. Hill and his assistants in their efforts to recover the bodies:

We, the jury, find that these six bodies came to their death by suffocation from smoke caused by the turning of a brattice cloth. And we further say that the Dunbar Furnace Company deserve great credit for the interest and expense they have shown in recovering the bodies, and also Frank A. Hill, General Manager, Superintendent Robert Lang, and other officials of the company are deserving of great credit for their perseverance in recovering the bodies.

BOOK REVIEW.

PROCEEDINGS OF THE ENGINEERING ASSOCIATION OF N S. W. FIVE VOLUMES 1885-90. We have just received a copy of the above transactions from the secretary, Mr. Henry V. Ahrbecker M. I. Mech. E. They contain papers read by members and the discussions thereon and cover the field of Mechanical, Marine, and Mine Engineering. They are well gotten up, well illustrated and printed and are a valuable addition to the library of any engineer.

REPORTS AND STATISTICS OF THE MINING DEPARTMENT OF VICTORIA (AUSTRALIA) FOR THE QUARTER ENDED 30TH SEPT., 1891. COMPILED AND ARRANGED BY THE SECRETARY FOR MINES.

It is a difficult matter to dress up a batch of statistics in a form that will be interesting, but Mr. A. W. Howitt the Victorian Secretary for Mines seems to make such a task successful. The above quarterly report which we have just received is the best Government report that we have seen. Besides the usual particulars of production of ore, number of men employed, etc., there are mineralogical reports and assays, notes on boring operations, with numerous diagrams of sections and a well illustrated article is given on Lake Karng, and another on the country lying between north and south Mirboo.

ANTHRACITE COAL STATISTICS.

Statement of shipments of Anthracite coal for month of March, 1892, compared with the corresponding period last year. Compiled from the returns furnished by the Mine Operators.

	MARCH. 1892.	MARCH, 1891.	DIFFERENCE.		FOR YEAR 1892.	FOR YEAR 1891.	DIFFERENCE.	
From Wyoming Region, - -	1,622,938·15	1,300,240·03	Inc.	322,698·12	4,709,386·19	4,219,737·19	Inc.	549,649·00
From Lehigh Region, - - -	433,016·06	399,381·11	Inc.	33,634·15	1,318,596·06	1,273,529·01	Inc.	45,067·04
From Schuylkill Region, - -	1,016,894·18	815,838·05	Inc.	201,056·13	3,011,705·17	2,538,355·15	Inc.	473,350·02
Total - - - - - - -	3,072,849·19	2,515,459·19	Inc.	557,390·00	9,039,689·01	8,031,622·15	Inc.	1,008,066·06

The stock of coal on hand at tide-water shipping points, March 31, 1892, was 821,023 tons; on February 29, 1892, 885,653 tons; decrease, 64,630 tons.

NEW MINING COMPANIES.

Names and Post-Office Addresses of the New Mining Companies Incorporated in the United States Since Our Last Issue.

Keystone & King Mining and Milling Co.,	Carter, Mont.
Chester Mining Co.,	Missoula, Mont.
Zenith Iron Co.,	Duluth, Minn.
Brush Heap Mining Co.,	Kingston, N. M.
Fire Center Gold Mining Co.,	Milwaukee, Wis.
Pennsylvania Zinc and Iron Co.,	Roanoke, Va.
Richmond Mica Co.,	Richmond, Va.
Hamilton, Lowe & Co.,	Chicago, Ill.
Oxford Mining Co.,	Chicago, Ill.
Montana Silver Mining Co. of Chicago,	Chicago, Ill.
Seymour Concentrator Co.,	Chicago, Ill.
The Carroll County Zinc Mining Co.,	Logansport, Ind.
The Sterling Iron and Railway Co.,	Warwick, N. Y.
Beaver White River Stone and Marble Co.,	Eureka Springs, Ark.
The Grand City Coal Co.,	Chicago, Ill.
Silver Plume Consolidated Mining Co., of Nebraska and Colorado,	Lincoln, Neb.
The Douglass Lava Co.,	Colorado Springs, Colo.
The Extension Gold Mining and Milling Co.,	Denver, Colo.
The Crown Point Mining and Milling Co.,	Creede, Colo.
The Nelson Tunnell Mining Co.,	Creede, Colo.
The Cripple Creek Mining and Milling Co.,	Fremont, Colo.
Vermont Red Slate Co.,	Fair Haven, Vt.
Iowa Fuel Co.,	Oskaloosa, Iowa.
Charlerol Coal Co.,	Charlerol, Pa.
Madison Gas Coal Co.,	Greensburg, Pa.
Northern Light Iron Co.,	Duluth, Minn.
The Jefferson Mining Co.,	Moreland, Colo.
The Tabor Mines and Mills Co.,	Denver, Colo.
The Solar Fuel Co.,	Denver, Colo.
The Mineral Hill Mining and Tunnel Co.,	Fremont, Colo.
Evans Mining, Milling, and Smelting Co.,	Baltimore, Md.
The Heirs of Philippe Francois Renault Title Co.,	Jersey City, N. J.
The Calectin Co.,	New York City, N. Y.
Libertyville Clay and Gravel Co.,	Libertyville, Ill.
The Vermillion Sandstone Co.,	Danville, Ill.
The Peerless Coal Co.,	Calvert, Texas.
Monte Cristo Development Co.,	Everett, Wash.
The Wannicut Lake Mining Co.,	Spokane, Wash.
The Eastern Consolidated Mining Co.,	Missoula, Mont.
Illinois Mining & Investment Co.,	Helena, Mont.
The Peerless Cement Plaster Co.,	Saline, Kan.
The Miners Union Association,	Creede, Colo.
The Paystone Mining and Milling Co.,	Aspen Colo.
The Murdie Mining and Milling Co.,	Village of Chaney, Colo.
Caskill Gravel Mining Co.,	Marysville, Cal.
Cottonwood Milling and Mining Co.,	Fort Bidwell, Cal.
Mexican Zaragosa and Hidalgo Gold and Silver Mining Co.,	San Francisco, Cal.
Don Carlos Gold Mining Co.,	Santa Cruz, Cal.
Blue Mountain Oil and Mineral Co.,	Waveland, Ark.
Nebava Iron Mining Co.,	Duluth, Minn.
The Polaris Mining & Milling Co.,	Dillon, Mont.
The Champion Empire Mining Co.,	Aspen, Colo.
The Summit Mining and Milling Co.,	Colorado Springs, Colo.
The Nellie Sandborn Mining Co.,	Pueblo, Colo.
The American Lithograph Stone Co.,	St. Louis, Mo.
The Adair Coal Mining Co.,	Fort Worth, Texas.
The Vermont Quarry Co.,	Montpelier, Vt.
Salmon River Placer Mining Co.,	Salmon City, Idaho.
The Farmers Mutual Gas Company of Jackson,	Jackson, Ind.
Swan Lake Iron Mining Company of Minneapolis,	Minneapolis, Minn.
The Carnegie Mining Co.,	Duluth, Minn.
Chicago and Assiniboia Railroad Co.,	Clinton, Iowa.
The Aztec Onyx Co.,	Albuquerque, N. M.
Excelsior Red Stone Co.,	Hancock, Mich.
Denny Clay Co.,	Seattle, Wash.
The Franklin Mining Co.,	Pueblo, Colo.
Hamar Zinc and Lead Mining Co. of New Jersey,	Jersey City, N. J.
Mosley Zinc Company,	Plainfield, N. J.
The Sandia Mining and Smelting Co.,	Hoboken, N. J.
Aurora Iron Co.,	Duluth, Minn.
Idaho Springs Mining and Development Co.,	Denver, Colo.
The Gregory Consolidated Mining Co.,	Denver, Colo.
The Alamo Mining Co.,	Colorado Springs, Colo.
The Addie E. Mining and Milling Co.,	Colorado Springs, Colo.
The Coronado Gold Mining Co.,	Pueblo, Colo.
The C. and I. C. Gold and Silver Mining Co.,	Denver, Colo.
The Hindoo Mining Co.,	Pueblo, Colo.
The Squaw Gulch Gold Mining Co.,	Colorado Springs, Colo.
The New Zealand Mining Co.,	Denver, Colo.
The Pneumatic Ore Milling and Mining Co.,	Denver, Colo.
Rolfe Coal and Coke Co.,	Rolfe, W. Va.
Big Four Wilmington Coal Co.,	Chicago, Ill.
Cambria Coal Mining Co.,	Williamsport, Pa.
The Climax Oil and Gas Co.,	Woodsfield, Ohio.
Morning Mining Co.,	Mullan, Idaho.
The Beatric Consolidated Mining Co.,	Colorado Springs, Colo.
The Louise Mining Co.,	Denver, Colo.
The Nogal & Bonito Mining & Milling Co.,	St. Louis, Mo.
The Wittenmeier Stone Co.,	Columbus, Ohio.
Bessemer Iron Mining and Manufacturing Co.,	La Fayette, Texas.
Eagle Iron Co.,	Spring Valley, Wis.
Pacific Coast Prospecting & Developing Co.,	Springfield, Ore.
The Belmont Oil & Gas Co.,	Wheeling, W. Va.
Angeleno Oil & Mining Co.,	Los Angeles, Cal.
Forest Grove Stone Co.,	Forest Grove, Ore.
The Bright Light Mining Co.	Portland, Ore.
The Imperial Mountain Iron Mining Co.,	St. Paul, Minn.
The Brown Bonnell Iron Co.,	Youngstown, Ohio.
The El Dorado Gold Mining Co.,	Chicago, Ill.
The Foley Mining Co.,	St. Cloud, Minn.
Sedalia Mining & Prospecting Co.,	Sedalia, Mo.
Casey-Grimshaw Mining Co.,	Kansas City, Mo.
The Gilpin Franklin Gold Mining Co.,	Denver, Colo.
The Summit Mining & Smelting Co.,	Denver, Colo.
The Camp Bird Mining & Milling Co.,	Denver, Colo.
The U. S. Paymaster Mining Co.,	Denver, Colo.
The Gold Field Mining Co.,	Moreland, Colo.
The Pony Express Mining Co.,	Colorado Springs, Colo.
The Beaver Dale Placer Mining Co.,	Colorado Springs, Colo.
Wilmington Star Mining Co.,	Summit, Wis.
The Salina Cement Plaster Co.,	Salina, Kas.
W. T. C. Maculler Co.,	Portland, Me.
South Aberdeen Improvement Co.,	Tacoma, Wash.
The Elk Iron Mining Co.,	St. Paul, Minn.
The Home Mining Co.,	Bozeman, Mont.
Eagle Gas and Oil Co.,	Wheeling, W. Va.
Warren Zinc Co.,	Saco, Me.
Riverside Stone Co.,	Great Falls, Mont.
The Topeka Mining Co.,	Denver, Colo.
The Copper Monarch Mining, Smelting and Refining Co.,	Pueblo, Colo.
The Eunice Mining Co.,	Denver, Colo.
The Bear Mountain Mining and Milling Co.,	Aspen, Colo.
The Kreutzer Sonata Consolidated Mining Co.,	Creede, Colo.
The J. A. J. Mining and Milling Co.,	Denver Colo.
The Gold Standard Mining and Tunnelling Co.,	Barry, El Paso Co., Colo.
Grizzley Mining Co.,	San Francisco, Cal.
The Esmeraldas Gold Mining Co.,	Jersey City, N. J.
Marcus & Co.,	Mont Clair, N. J.
The Amethyst Mining Co.,	Denver, Colo.
Vermont Slate Mining Co.,	Poultney, Vt.
The Reno Mining and Milling Co.,	Denver, Colo.
The Florence E. Mining Co.,	Colorado Springs, Colo.
The Columbian Mining & Milling Co.,	Denver, Colo.
The Cripple District Mining Co.,	Denver, Colo.
The Milwaukee and Colorado Gold Mining Co.,	Boulder, Colo.
The Golden Star Mining & Milling Co.,	Livingston, Mont.
The Sapphire & Ruby Co., of Montana, L't'd.,	Helena, Mont.
Rock Creek Mining Co.,	Rockfield, Ind.
Cajon Mining and Water Co.,	Los Angeles, Cal.
Gold Bar Quartz Mining Co.,	Grass Valley Cal.
The Rockdale Mining and Manufacturing Co.,	Rockdale, Texas.
The Arco Mining and Milling Co.,	Chicago, Ill.
Occident Iron Mining Co.,	Chicago, Ill.
The Mary McKinney Mining Co.,	Colorado, Springs, Colo.
Solomon Solar Salt Co.,	Kansas City, Mo.
Reginia Land and Mining Co.,	Joplin, Mo.
The Columbus Oil Co.,	Pittsburgh, Pa.
The Nay Aug Coal Co.,	Scranton, Pa.
Cranberry Improvement Co.,	Philadelphia, Pa.
New Wales Hard Vein Slate Co.,	Easton, Pa.
The Yernerthal Stone Co.,	Buffalo, N. Y.
Eureka Onyx Co.,	Lebanon, Ind.
Citizens Gas, Land & Improvement Co., of Selma, Ind.,	Selma, Ind.
Western Washington Mining & Manufacturing Co.,	Seattle, Wash.
The Sultan Mining and Prospecting Co.,	Orting, Wash.
The Cardinal Bullion Co.,	New York City.
Middle Creek Mill and Mining Co.,	Sacramento, Cal.
The Powder River Milling Co.,	Denver, Colo.
The Lawrence Mining & Milling Co.,	Canon City, Colo.
The Forest Mining Co.,	Fort Collins Colo.
The Seven Forty Consolidated Mining Co.,	Denver, Colo.
The Black Wonder Gold & Silver Mining Co.,	Boston, Mass.
The Mayflower Mining and Milling Co.,	Denver, Colo.
Henrichs Mining Co.,	Joplin, Mo.
The Poland Mining Co.,	Colorado Springs, Colo.
Red Cloud Gold Mining and Milling Co.,	Portland, Me.
Addie May Mining Co.,	Portland, Me.
The Reading Coal & Coke Brick & Tile Co.,	Athens, Ohio.
The Carbondale Coal Co.,	Chillicothe, Ohio.
The Salem Co.,	Leetonia, Ohio.
Delphi Mineral Mining Co.,	Delphi, Ind.
International Nickel Mining Co.,	Chicago, Ill.
The Sapphire Corundum & Emery Co.,	Chicago, Ill.
Ortiz Irrigation & Mining Co.,	Chicago, Ill.
The Red Mountain-Corn-Belle Mining Co.,	Colorado Springs, Colo.
Ruby Placer Mining Co.,	Anacortes, Wash.
The Floria Gold Mining Co.,	Ouray, Colo.
Scotland Mining Co.,	Scotland, Mo.
Keewatin Iron Co.,	Superior, Wis.
Colonial Mining Co.,	Portland, Me.
Hutchinson-Jenkins Steel Co.,	New York City, N. Y.
Lamont Iron Co.,	Chicago, Ill.
St. Charles Lead & Zinc Co.,	East St. Louis, Ill.
The Columbian Lithographic Stone & Cement Co.,	Chicago, Ill.
The Granite Construction Co.,	Montpelier, Vt.
Banner Gold Mining & Milling Co.,	San Francisco, Cal.
Blair Consolidated Mining Co.,	San Francisco, Cal.
Phoenix Mining & Milling Co.,	San Francisco, Cal.
The Little Anaconda Mining & Milling Co.,	Denver, Colo.
The Boston & Colorado Smelting Co.,	Argo, Colo.
The Mount Esther Mining & Milling Co.,	Colorado Springs, Colo.
White Swan Mining Co.,	Baker City, Ore.
The W. L. Scott Co.,	Erie, Pa.
The Stoddard Coal Co.,	Gilberton, Pa.
The Rock Island Mining & Milling Co.,	Rock Island, Ill.
Wyoming Iron Co.,	Duluth, Minn.
St. Paul & Duluth Mining Co.,	St. Paul, Minn.
Licking Mining Co.,	St. Paul, Minn.
King Solomon's Mining Co.,	Kansas City, Mo.
Duval Mining & Oil Co.,	Laredo, Texas.
The Margary Mining Co.,	Denver, Colo.
The Tom O'Shanter Gold Mining Co.,	Fremont, Colo.
The Hamburger Mining & Prospecting Co.,	Denver, Colo.
The World's Fair Mining Co.,	Fremont, Colo.
Stein's Pass Mining & Reduction Co.,	Deming, N. M.
Sunset Mining Co.	Mogollon, N. M.
The Plymouth Rock Mining Co.,	Fremont, Colo.
The Jackson Mining and Exploring Co.,	Denver, Colo.
Donnelly Lead Co.,	St. Louis, Mo.
American Rose Garnet Co.,	New York City, N. Y.
The Asbestos Pulp Co.,	Rochester, N. Y.
Minnehaha Mining & Milling Co.,	Minneapolis, Minn.
Pend D' Oreille Milling & Mining Co.,	Spokane, Wash.
Chicago Lead & Zinc Co.,	Chicago, Ill.
The Erie Coal Co.,	Athens, Ohio.
Georgia & Florida Investment Co.,	New York City, N. Y.
The Cachavi Co.,	New York City, N. Y.
The Potlatch Mining & Milling Co.,	Moscow, Idaho.
The Cripple Creek Golden Egg Mining Co.,	Fremont, Colo.
The Standard Mining & Land Co.,	Colorado Springs, Colo.
The Blue Bird Placer Mining & Milling Co.,	Fremont, Colo.
Columbus Mining Co.,	Cedar Rapids, Iowa.
Bozeman & Butte Mining Co.,	Bozeman, Mont.
United States Mineral Black Paint Co.,	Roanoke, Va.
The Amazon Mining Co.,	Denver, Colo.
The Iron Dollar Silver Mines Co.,	Pueblo, Colo.
The Magna Charta Mining & Milling Co.,	Colorado Springs, and Fremont, Colo.
The Midland Gold Mining Co.,	Colorado Springs, Colo.
Pennsylvania Mining & Improvement Co.,	Everett, Wash.
The Anthony Phosphate Co.,	Anthony, Fla.
American Mining Co.,	Kansas City, Mo.
The Henrietta Iron Co.,	Minneapolis, Minn.
Silver Gulch Mining Co.,	Barker, Mo.
The Pharmacist Mining Co.,	Colorado Springs, Colo.
The American Zinc Co.,	Joplin, Mo.
Wisconsin Valley Land Co.,	Wausau, Wis.
Fidal Oil Co.,	New York City, N. Y.
The Baytonit Coal Co.,	Columbus, Ohio.
Trabuco Gold Mining Co.,	Los Angeles, Cal.
Hudson Bay Consolidated Gold Mining Co.,	San Francisco, Cal.
Butte Belle Gold Mining Co.,	San Francisco, Cal.
McKinley Mining Co.,	Great Falls, Mont.
Hercules Mining Co.,	Butte, Mont.
Athens Mining Co.,	Peoria, Ill.
The Roderick Gas Co.,	Eaton, Ind.
Maton Gold Mining Co.,	Council Bluffs, Iowa.
Eureka Onyx Mining Co.,	Chicago, Ill.
Mount Vernon Mining & Smelting Co.,	Mount Vernon, Wash.
Shepherd Oil Co.,	Roanoke, Va.
King Exploration Co.,	Roanoke, Va.
Virginia Hard Coal Co.,	Radford, Va.
Palisades Trap Rock Co.,	North Bergen, N. J.
The El Dorado Gold Mining & Milling Co.,	Colorado Springs, Colo.
The Granite Hill Mining & Milling Co.,	Colorado Springs, Colo.
The Temony Mining and Milling Co.,	Colorado Springs, Colo.
Magnolia Marble Company, of Georgia,	Pittsburgh, Pa.
Queen City Coal Co.,	Queen City, W. Va.
Oasis Mining Company of Nevada,	Rattle Snake Canyon, Nev.
The Mountain Gold and Gem Exploration Co., Limited,	Helena, Mont.
Fayette Oil Co.,	Uniontown, Pa.
Aroma Gas Coal Co.,	Greensburg, Pa.

Single Connection Sight Feed Lubricator.

This lubricator has been devised to meet the demand for a low priced cup, suitable for small engines and steam pumps. They are simple and very effective. The oil reservoir and arms are cast all in one piece, so there are no joints to leak or rack loose. A very desirable and convenient feature of this cup is in the mode of attachment. The stop valve N is so made as to be attachable to a vertical or horizontal steam pipe or directly to the steam chest as may be desired, by

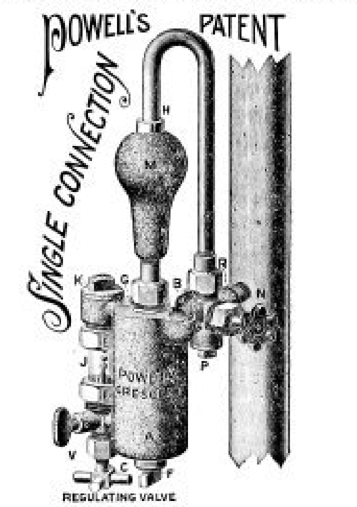


FIG. 1.

simply transposing the position of the screw nipple R and plug P.

Fig. 1 shows side connection and Fig. 2 shows bottom connection when it is desired to attach the lubricator to a vertical pipe, an ordinary short pipe nipple, as shown in Fig. 1, should be used. If it is desired to attach to a horizontal pipe or steam chest, the plug P, and nipple R, should be removed and changed places as show in Fig. 2. Should the nipple R be too short,

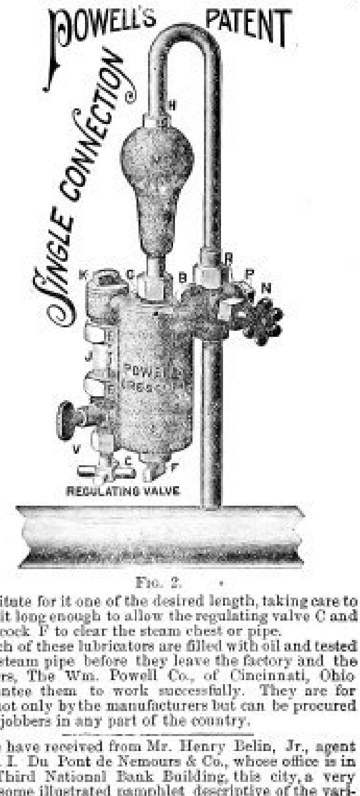


FIG. 2.

substitute for it one of the desired length, taking care to have it long enough to allow the regulating valve C and vent-cock F to clear the steam chest or pipe.

Each of these lubricators are filled with oil and tested on a steam pipe before they leave the factory and the makers, The Wm. Powell Co., of Cincinnati, Ohio guarantee them to work successfully. They are for sale not only by the manufacturers but can be procured from jobbers in any part of the country.

We have received from Mr. Henry Belin, Jr., agent for E. I. Du Pont de Nemours & Co., whose office is in the Third National Bank Building, this city, a very handsome illustrated pamphlet descriptive of the various types of explosives manufactured by the Du Ponts. Besides being a beautiful specimen of typographical art, it contains among other interesting data a table showing at a glance the periods during which the game laws are not in force in the different States and Territories throughout the Union, and at which time sportsmen are at liberty to go in pursuit of game.

LEGAL INTELLIGENCE.

Lehigh & Wilkes-Barre Coal Co. vs. Delaware & Hudson Canal Co.—Miners—Equity—Flooding—Pressure on Pillars—Fire. A fire occurred in Deft's Mine which threatened to destroy both Deft's Mine and those of the adjoining mine owners. To prevent the injury the mine was flooded. The Plaintiff asked the Court for an injunction alleging that the barrier pillar was not strong enough to withstand the pressure of the water. On a motion for a preliminary injunction, the Common Pleas of Luzerne County held that the preliminary injunction should be refused.

Opinion delivered January 11, 1892.—Rice, Presiding Judge. The plaintiff is the lessee of a colliery known as the Hollenback mine, and the defendant is the lessee of an adjoining colliery known as the Conyngham mine. In each there is a large quantity of unmined coal, and each is connected with other mines. The two mines are separated by a barrier pillar of solid coal, which, according to the plaintiff's affidavits, has a minimum thickness of fifty feet. The vein of coal as mined is seven or eight feet in thickness. About a year ago a fire occurred in the Conyngham mine, whereupon the defendant company turned water into the mine and filled the same to a height of two hundred feet above shaft level. The plaintiff alleges that the effect of turning in the water was to bring on a squeeze or crush of the barrier pillar and to endanger the Hollenback and all the connected mines, as well as the lives and safety of persons employed therein. The plaintiff's witnesses, including the mine inspector of the district, testify that when the water reached a height of two hundred and thirty feet it came through the pillar with considerable force, the coal was cracking off the pillar, and the signs that the pillar was weakening were unmistakable. On the other hand, the defendant's engineer, who was present at the same examination, testifies that the cracking of the pillar and percolation of water do not prove pressure from the column of water on the other side, that the same often happens without any danger or undue pressure, and that the cracking was not of a character to indicate a squeeze. We shall not undertake to decide between these witnesses upon this question of opinion, but it is a significant fact, tending to corroborate the testimony of the plaintiff's witnesses, that when the water was at a height of one hundred feet the pillar showed no signs of weakness and was apparently safe, and that these signs, which the plaintiff's witnesses say were unmistakable, did not appear until afterwards.

At all events, there was so strong probability that these manifestations were due to the pressure as to make it necessary, in the exercise of ordinary prudence, to strengthen the pillar. The method adopted is thus described by the plaintiff's superintendent: "A borehole was put down by one company to connect with the return air-way, which is parallel with said pillar, and said air-way and the adjacent breasts have been partially filled with culm, which has the affect of re-enforcing and strengthening the pillar to such an extent that the mine inspector is now willing that our men, who have been idle in that mine for three months, shall return to work provided no more water is put in the Conyngham mine." It is claimed that while the barrier pillar as re-enforced is sufficient to resist the increased pressure which will be caused by raising the water to any considerably greater height, and therefore the plaintiff prays for an injunction.

The defendant claims: (*a*) that in re-enforcing the pillar it was possible for the plaintiff company to have so placed timbers as to put the resisting strength of the barrier beyond all question; (*b*) that the present barrier will successfully withstand any pressure of water that will be brought against the same. The mine inspector, although not going the same length, says: "My opinion as to the weakness of the barrier pillar . . . was based on the fact that of the coal cracking off the pillar, and yet I learn that under similar circumstances in a mine at Harleigh, notwithstanding the cracking of the barrier pillar, the parties continued the filling of water to a height of two hundred feet additional, and the pillar successfully withstood the pressure. In that case the vein, as mined, was about thirty feet thick, while here it is only seven or eight feet thick, which is an advantage in favor of the defendant's mine. I learn ten feet thick held the water at Kohinoor mine."

In the disposition of this motion we are to consider, first, the probability of injury to the plaintiff's property consequent upon raising the water in the Conyngham mine to any greater height than it now is; second, the consequences to the defendant if it should be enjoined.

That great damages, which could not well be measured and compensated in money, would ensue to the plaintiff if this barrier pillar should give way, cannot well be doubted. Work would have to be suspended in the Hollenback, and probably in the connecting mines, a very large number of men would be thrown out of employment, the ventilation would be disturbed, and the mines would be filled with explosive gases, and the gangways and air-ways with *debris*. But it is equally true that the only practicable way of putting out the fire in the defendant's mine is by flooding it in the manner proposed, and that if the fire is permitted to go on it will prove ruinous to the Conyngham mine, and may prove destructive to adjoining owners. The mine inspector says: "It is to the interest of the plaintiff company and all the neighboring owners to have this fire extinguished." This is a fact which scarcely needs proof. We have, then, on the one hand, an anticipated injury which may occur, but which is not certain to occur if the defendant is not enjoined, and, on the other hand, an injury which will certainly occur if the injunction is granted. It will be observed also that the act to be enjoined is not a trespass, nor a nuisance *per se*, but is a lawful use of the defendant's property, and is necessary to prevent destruction and injury to adjoining properties. A man may not use his own so as to injure another's property. But the question here is not whether the defendant could defend an action at law in flooding the plaintiff's mines upon the ground that it was necessary to the preservation of its own property, but whether the fact of its act will cause injury to the plaintiff's property is established with such certainty that a court of equity would be justified, under all the circumstances, in enjoining it. In cases of doubt as to the plaintiff's right, or the imminence of the danger, the uniform rule is for the court to withhold its hand, especially where the injury which would result from granting the injunction is greater than that which would result from refusing it: Richards' Ap., 57 Pa. 105; Gray *vs.* Ohio & Penna. R. R. Co., 1 Gr. 412; Harkinson's Ap., 78 Pa. 196-204; Dilworth's Ap., 91 Pa. 247.

Anticipations of danger which may never occur, apprehensions merely speculative, eventual, and contingent, where the grounds on which they rest are denied, rarely warrant interference by injunction: Rhodes *vs.* Dunbar, 57 Pa. 274—287—289; Spring Brook Railway Co. *vs.* Bryan 4 Luz. Leg. Reg. 117; New Boston Coal & Mining Co. *vs.* Pottsville Water Co., 54 Pa., 164; Huckenstine's Ap., 70 Pa. 102—187.

Appreciating fully the seriousness of the dilemma in which these parties find themselves, and not by any means wishing to be understood as making light of the plaintiff's apprehensions, we are, nevertheless, compelled to say that in view of the certain injury which would ensue if the injunction were granted, and the doubt raised by the defendant's affidavits as to the necessity for the exercise of this extraordinary power we would not be justified in interfering at this time. Therefore the motion for preliminary injunction is denied.

Who Owns the Culm Piles?—Some days ago, one of the staff of The Colliery Engineer interviewed Charles L. Hawley, Esq., of this city, concerning a matter of much interest to many of our readers. In answer to the question, "Who owns the culm piles?" Mr. Hawley said:

One of the greatest of the changes which have taken place in the coal business during the past few years is in the treatment of culm and the value placed upon it.

Millions of tons of it are piled up near the various breakers over the whole Anthracite coal region—at as late a time as five years ago the lessee of coal lands did his best to get his lessor to allow him to burden as much as possible of his, the lessor's, land with what was then supposed to be valueless waste, or culm, and he thought himself shrewd when he piled upon such land every year thousands of tons of it containing coal which is now being delivered at houses in this city for two dollars per ton—at least one instance has been brought to my notice in which the very man who threw it away, with the mental ejaculation "good riddance to bad rubbish" recently tried to buy from his lessor the right to screen it out at a substantial per ton royalty.

When these culm piles were built—excuse the term—the lessors, lessees, and public generally considered them, not only of no value but an actual incumbrance on the land; but now that they have been shown to have a value in the market, conflicting claims to them are likely to be made and the courts will, no doubt, be called upon in many cases to decide upon the respective rights of lessors and lessees claiming limited or absolute ownership thereof.

In very many cases the lessors sold to the lessees "all the merchantable coal" under certain lands and gave to their lessees the right to deposit culm on the surface of a certain part of said lands described in the lease. For years all parties to the lease treated the culm like anything in the world but "merchantable coal" and are now estopped from claiming differently. In these cases the coal in the culm pile, as well as the pile itself, as a whole, belongs to the lessors who own the land on which it is; the lessees by their conduct having waived their right, (if they ever had such right *after throwing the culm away*, which I very much doubt) to screen out the good coal in the culm, even upon paying to their lessors. The same per ton royalties called for in the lease.

In such cases the terms of the lease must be interpreted with reference to the common understanding at the time the lease was made; and the thing farthest from the minds of the parties to the lease was the final screening over a small mountain of apparently worthless refuse. It was thrown aside as waste—all parties agreed upon that way of treating it and now they have to stand by it.

This view of the case seems to have been sustained by the courts of our State: In Erwin's case, an owner of lands in Berks County (Pennsylvania) in 1877 leased to another for a per ton royalty the right to mine and dispose of the iron ore in said lands. The refuse resulting from the mining of such ore was afterwards found to contain, not only iron but valuable ochre. In 1887 our Supreme Court sustained a lower court in holding that the lease was made by the parties to it not upon "future possibilities but upon the obvious facts of everyday life," and that the lessees should be enjoined from obtaining the ochre from the refuse.

Years ago the parties to a coal lease did not believe that the lessors were selling what was then considered "waste" to the lessees as "merchantable coal." Had the lessors sued the lessees for royalty on the "merchantable coal" in the dump, would the lessees have fought the case? The question answers itself. While the Berks County case does not precisely cover the point, it does go far enough to establish that when the lessees threw away the refuse they lost their dominion over it.

This position is further sustained by a Lehigh County case (Doster vs. Zinc Co)., decided last year, in which the court say: "However general the terms may be in which an agreement is conceived, it only comprehends those things in respect to which it appears that the contracting parties proposed to contract and not others they never thought of."

One must not be misled by the usual clause, giving the lessee the right to pile the refuse on his lessor's land into the belief that the lessee is thereby given an estate in the land covered by the dump and the possession of the same for the purposes other than the depositing, (for example the screening) of the culm. The clause is much the same as if the lessor had said to the lessee "Mine all you can and put *what you don't want* on my land." The lessor simply agrees that his land may be burdened by the waste. Under a lease of *all the coal* with a royalty to be paid on all coal passing over a certain mesh the lessee would no doubt have the right to prepare and sell, without payment of royalty thereon, all coal passing through such mesh. But to avail himself of such right he must prepare and sell the same without first storing it as waste for years, on the land of his lessor and to his injury. The minds of the parties to the lease when they made it did not unite in such interpretation of its terms.

Lunkenheimer's Glass Body Oil Pump.

Our illustration below shows one of Lunkenheimer's Glass Body Oil Pumps, and is a very important adjunct to an engine. This is intended as an auxiliary to the sight feed lubricator, and is in fact so necessary that no engine should be without one. With this pump any amount of oil can be supplied to the cylinder at any time.

The advantages of this can readily be seen when starting up the engine. Or suppose an accident happen to the sight feed lubricator in the breaking of a glass tube. This would cause great annoyance, but all this can be obviated by having one of Lunkenheimer's Glass Body Oil Pumps on the steam chest or cylinder. These pumps are simple and practical in construction, durable, efficient and very ornamental. They have been adapted by the leading engine builders in the United States, and are highly endorsed by them and thousands of other users. They are strictly first-class and warranted; made in two sizes, holding one-third and one pint respectively, and furnished highly finished either in brass or nickel plated. The glass body shows the stage of oil. It will pay you to investigate this useful article, as it can save its cost many times over in a year. Can be supplied by any dealer in brass goods or by The Lunkenheimer Brass Manufacturing Co., Cincinnati, Ohio, U. S. A. Our 1892 catalogue of superior steam specialties, valves, lubricators, glass oil and grease cups, etc., will interest you. Write for one. See our advertisement on another page.

ATLANTIC CITY.

And the Reading's Royal Route.

The popularity of Atlantic City long since reached National proportions, and it continues to grow from year to year. The approaching season promises to be the greatest ever known at this, the greatest of all seaside resorts. The Reading Railroad, whose superbly magnificent line between Philadelphia and Atlantic City has become famous throughout the country as the "Royal Route to the Sea," will continue to be the principal and favorite means of getting to and from the City by the Sea. The Reading's superiority in equipment is generally conceded. Its chief advantage consists in the fact that it has the only double track line of railroad to Atlantic City. The importance of this cannot be overestimated. Not only does it insure the absolute safety of passengers, but it admits of quicker and more reliable transit. The Reading line is also several miles shorter than any other road to Atlantic City, and it runs almost as straight as the crow flies. The great "Seventy-five Minute Flyers" are the most talked-of trains in America. For beauty, elegance, and speed they are literally beyond rivalry and those of our readers who visit Atlantic City should not fail to experience the delight of a ride on one of these matchless trains. The summer schedule will comprise a larger number of fast express trains than has ever heretofore been run on any line. Trains will start at such frequent intervals that one can scarcely fail to catch a "Flyer" at whatever time he may desire to go. The "Royal Route's" Philadelphia stations are at Chestnut and South Street wharves, and all Ticket Offices on the Reading System have through tickets and baggage checks for Atlantic City.

Mr. George Wise, of Jeddo, Pa., the general agent for Beagle's Patent Mine Hames, which have through their superiority over other hames, replaced all other styles in the more prominent collieries in every American coal field, writes us as follows: "The hame and harness trade is tip top, and my advertisement in The Colliery Engineer is to blame for it."

Our shoulders are broad enough to carry all the *blame*, but it is but fair to state that some of it is due to the merits of the goods and Mr. Wise's straightforward business methods.

EASY LESSONS FOR BEGINNERS

IN THE STUDY OF THE

ART OF MINING

AND THE

SCIENCES RELATED TO IT.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the theory of mining and to learn how to answer the questions in ventilation, mine surveying, and mechanics which are asked at the examinations for mine manager's and mine foreman's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine manager's and mine foreman's certificates and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and the calculations are worked out at length for the benefit of those who are not familiar with figures.

PENMANSHIP.

The capital letter V consists of a capital loop, the same as is employed in making the letter U, and a compound curve extending upwards two-thirds of the full height of the letter, joined by a turn at the base line. This capital is written correctly in the first letter at the left of Fig. 43. In the second letter from the left the

FIG. 43.

compound curve retraces the capital loop making an angular turning at the base. The third letter is imperfectly made, in that the capital loop is contracted and the turn at base too wide. The fourth law of penmanship is violated in writing the fourth letter from the left, namely, all curves should be elliptical.

In Fig. 44 the first letter W satisfies the requirements of the four laws of penmanship and is pleasing to the eye. Its development consists of a capital loop, a right curve which is joined at the base by a sharp angular turn to the bottom of the loop, and a slight left curve which is joined at the base with an angular turn to another left curve which extends upwards two-thirds of

FIG. 44.

the height of the letter. The last left curve turns a little to the right. The second letter is a deformity arising out of the imperfect development of the curves near the base line. In the third letter the capital loop is carelessly made, and is out of proportion to the rest of the letter. The turns at the base are too wide, and the second law of penmanship broken in that the strokes are not proportional in distance. The fourth letter shows a common mistake in writing the capital loop, viz., that of making its general shape round instead of oval. The curves are on a wrong inclination, being vertical instead of slanting.

The capital letter X is shown as it should be written in the first letter, counting from the left of Fig. 45.

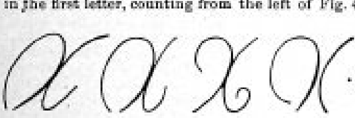


FIG. 45.

It consists of a capital loop, a left curve which touches the loop at one-half its height, and a right curve which is one-third of the height of the letter. In letter 2 the loop is a little too circular and on the wrong inclination. The third letter shows the loop incomplete, and as a consequence offends the eye. In finishing the letter an extra curve is made which spoils the looks of the letter and prevents its union with the following letter in writing a word. In letter 4 the capital loop and left curve do not come together. This is an error which should be guarded against, as it destroys the symmetry of the letter. It is also terminated with a straight line instead of a curve.

METHODS OF MINING.

Shaft Sinking—Tunneling—Systems of Working Coal and Metals—Timbering in Mines.

46. Is this a good form?

It is the commonest and is very strong. The joints must be nicely cut and no spikes used. All the plates must be perfectly level and the posts plumb.

47. Is it not expensive?

It is not hard to make and is very quickly set.

48. Is it used for large shafts too?

Yes, those of three or four compartments are timbered in this style.

49. How are the compartments made?

At every ten or twelve feet buntons, or cross-pieces, are laid, and to them the partition planks are nailed, or else the cage guides are spiked to them.

50. How many compartments should a shaft have?

Always one for a ladder-way, and one for the pump pipes and steam pipes, besides as many hoist-ways as the mine requires.

51. Why are they laid side by side and not in a group?

FIG. 14.

It has been found that a shaft is stronger with the compartments laid as in Fig. 14, instead of as in Fig. 15.

52. Is the round shaft better than the oblong?

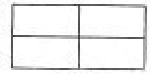


FIG. 15

In general, the round shaft is stronger than the oblong, but it is not so convenient to divide it up into compartments. There is some waste room. There is another reason to account for the round shaft. Many of them have been sunk through wet, or very soft ground and, as we shall see, the method of sinking produces a round shaft which can not cheaply be lined with wood.

53. Is there any other method of lining with wood than what you gave in question 45?

Yes. In firm rock a small shaft may be lined with three-inch plank on edge. Each plank is cut like the pattern shown in Fig. 16 with a shoulder at each end. The left hand cross-plate is not placed. Another common method is that shown in Fig. 17, in which the same kind of a shoulder is cut as in the planks in Fig. 16 but

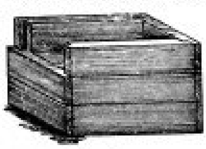


FIG. 16.

they are wider. In Fig. 16 the shoulders are only one-half the thickness of the plank. In Fig. 17 they are as wide as the width of the plank. Besides the planks are laid on their broad side, not on their edge. The two methods last mentioned require sawn and dressed lumber. The first will do with hewn logs.

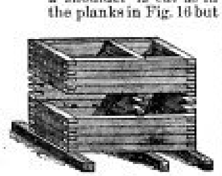


FIG. 17.

54. Are these methods of timbering strong enough for shafts through soft rock?

For rock not crumbling, or swelling, this latter form of timbering with four or six inch scantling is quite strong enough. If the ground requires stronger support, it would be better to use iron or masonry built up in sections.

55. How is a round shaft lined with masonry?

The shaft is timbered rather strongly, and when it is down far enough the masonry is built upwards. At every thirty or fifty feet a strong set of timbers is set into the walls for a foundation, and from this the bricks are built up like a round chimney-wall to the next upper set.

56. How is an iron lined shaft put down?

About in the same way as with masonry. The iron lining is in sheets flanged so as to fit together around the temporary timbers, and also to be fitted together up to the surface.

57. Can not the iron lining be put in as the shaft goes down just as we do in timbering a shaft with wood?

Yes, if the iron tubing is hung from the surface until the foundation has been prepared for it. Then the tubing is lowered to rest on the foundation of stulls.

58 Is there any other method of lowering the iron tubing, or of sinking the shaft?

Yes; a process known as Kind-Chandron bores the shaft down into moderately hard rock without men going down into it at all. The tools are like the oil well rigs, but the drill is thirteen feet across and bores a shaft thirteen feet diameter and quite fast, too. Then, if the shaft should strike soft running ground like water or sand, the tubing is lowered and an arrangement is added below by which the bottom of the tubing is closed completely, preventing the tubing from sinking or the water from rising. A stop-cock in it can be opened if desired and that would let the water out from below and thus permit the tubing to sink. This scheme works very beautifully.

59. Is there any different method of sinking a shaft?

Yes, the late General Henry Pleasants, of Pottsville, Pa., at the time Chief Engineer of the P. & R. C. & I. Co., at the sinking of Ellangowan shaft had diamond drill holes put down holes two inches in diameter, 400 feet deep. These were about 36 inches apart and as many were drilled as would cover the entire area of the shaft. Then the holes were filled with sand, all except for three or four feet deep. They were fired off, all together, by electricity and dualine. After clearing away the broken rock another three-foot section was cleaned out of each hole and fired. So on all the way down.

60. What are the methods of timbering and supporting the roof or the hanging wall?

One way is to leave portions of the vein untouched, as pillars. Every shaft, slope, entry, air-way, or gallery should have pillars of the vein matter on each side, so as to protect these haulage ways against a crush of the roof. The size of them should increase as the gangway increases in importance. Rooms have pillars on either side for protection, which are larger as the mine is deeper. They should be large for a firm roof, because then the weight on the roof, instead of breaking it, falls upon the pillars, so the pillars receive both the weight above them and that on the roof too. With a strong roof the rooms may be wide; if the roof is weak the rooms must be narrow.

61. What are panel pillars?

They are especially large pillars left in the mine to enclose a large area of the workings. A panel is a section of the mine surrounded by panel pillars. Each panel has a set of rooms or stopes which are ventilated separately from the others.

62. What is the advantage of this panel pillar?

It is so strong that if anything happens in a panel, the panel pillar prevents the accident from spreading too far.

63. How else may the roof be supported?

You may timber it up. For a vein of ordinary thickness the ordinary post and cap, or collar will do. But the post is not very strong, so it must not be expected to support very much of the roof. So the posts must be near together. It is safer to have a number of them near together than to have only a few large posts. In working Longwall the miner should keep at least three rows of posts behind him, and not over three feet apart nor over six feet from the face, unless the roof is very good.

64. May these props be used in thick veins too?

They are not advisable. Ordinarily thick veins are worked in slices between the partings (see Question 55 Geology); or else they are worked in slices about six feet high just as if they were veins of that thickness. Then other roof may be propped up temporarily and the props removed afterwards, before beginning the next slice to it. But this is a dangerous plan. When timbering is to be used the plan is what is called the Nevada system. A gang of men work a face six feet high by six wide, and as soon as they have advanced six feet they build up a set of timbers, cut by machine, that fit together like the edges of a box. There are four pieces laid on the floor, making a square; four posts rest at the corners and on them a square of four pieces is laid. This makes one square set. Imagine, now, the men going ahead another six feet. They then lay three sills down on the floor in the same direction as the others. Then put up two posts at the far corners.

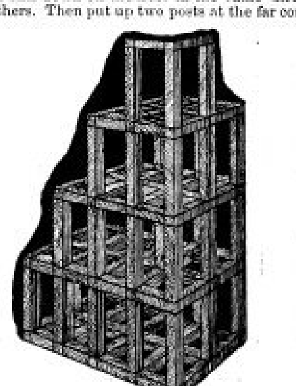


FIG. 18.

On top of the two they rest a cross sill, and finally they place one on each side, resting on one of the last posts and one of the posts of the first set. They proceed building up a honey-comb square set behind them. Then other gangs start on each side and also on top, each building his set onto the first sets. Soon the room will look like Fig. 18 where the men are supposed to be mining to the right, left and ahead.

65. Is this a good method?

Yes, but it is expensive. Think of the amount of timbering to be done! It must be cut faultlessly perfect and fitted well. They have machines for cutting the pieces all exactly alike, so there is no play at the joints. If each joint should have, say, one-fourth inch play you can see that if the roof begins to squeeze or slide, that in a few sets the pieces will slip out of place and then the whole timbering is destroyed. Or if a post or sill breaks for some reason or other, those standing receive more than their proportion of the pressure and the weakest of them is liable to break, then the next weakest, and in a few minutes the whole room is in ruins. A room I know of, ninety feet high, was timbered in this way. When the foreman noticed a broken sill he ordered the men all out, and in ten minutes the crushing had progressed so rapidly as to bury the entire mass.

66. Is the entire vein mined out in this way?

The richest parts are taken out and the space supported by timbers. The iron mines of Lake Superior are worked in this way, and the Comstock silver mines of Nevada. So also the flat lead mines of Colorado are timbered.

67. For what kind of ground is the square set used?

For thick veins of soft ore.

[TO BE CONTINUED.]

POWER IN MINING.

The Elementary Principles of Mechanics—Steam—Boilers—Engines—The Machinery Employed in Mines.

50. Can you write out a simple relation for the second motion engine?

Let W be the weight of cage, car, and rope.
P be the pressure on the crank pin.
c be the length of the crank arm.
d be the diameter of the drum.
y be the diameter of the friction band, or spur wheel.
x be the diameter of the pinion wheel.
R be the pressure between the teeth or friction surfaces,

then $W\,d = R\,y$,
and $P\,c = \frac{1}{2}\,R\,x$

from which we get, $W = \dfrac{2\,P\,c\,y}{x\,d}$.

Try this on the example in Question 45.

51. How would this apply on a direct-acting engine? You know that in a direct acting engine the crank pin is on a wheel that is on the same shaft with the drum. Then, in that case, there is no pinion or geared wheel, so that y and x are each zero, and they drop out of the formula given in Question 50.

52. According to the formula, then, one can not hoist a very large load unless one makes the drum smaller than the friction band, or makes the crank arm larger than the pinion wheel?

That is true.

53. Has not the connecting rod some effect upon the power of the engine?

Yes, it makes the power of the engine vary because it is so short (and it would not pay to make it long because the machinery would have to be so big). The explanation for that is very difficult. At any rate, when the crank is at its dead points, that is, when the piston is at one end of the cylinder, all the power of the steam imaginable could not turn the drum. When the crank is the least bit up from the dead point then the steam power has a leverage so it can turn the drum,

FIG. 9.

In Fig. 9, the leverage of the steam is the distance A B. If the piston moves as shown by the arrow, the distance A B becomes larger until it is equal to the length of the crank arm. Then it becomes small again

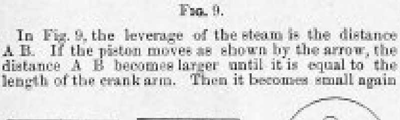


FIG. 10.

to the other dead point, and so on around. That is the reason why the engineer will not let his engine stop at the dead point. For when he tries to start it again it will not start with a very big load. The best place to stop it is at a quarter from the dead point.

54. How may I know the length of the lever arm, A B?

When you know the angle of the crank you can easily enough find A B, because A B is the sine of the angle times the length of the crank. It will be as easy, however, instead of finding A B to calculate the rotational force operating on the crank and multiplying by the length of the crank arm. I give here an average case of connecting rod 5½ times as long as the crank. For

Angle of Crank. Forward.	Angle of Crank. Return.	Position of Piston.	Rotational Force.
0°	360°	0·000	0·202
20°	340°	0·035	0·393
40°	320°	0·13	0·713
60°	300°	0·278	0·914
79° 48'	280° 12'	0·45	1·000
84° 48'	275° 12'	0·50	0·992
90°	270°	0·54	0·972
120°	240°	0·785	0·764
150°	210°	0·946	0·418
180°	180°	1·000	0·000

any other ratio you will need a different table. This is the average case for hoisters. At 0° the crank is at its inner dead point, then moves on the forward stroke to outer dead point at 180°. Thence it returns to 360° or 0°. If the rotational force be multiplied by the steam pressure and by the area of the cylinder also by the length of the crank (or half stroke) you have the movement of the engine power which operates to turn the drum and move the load.

55. Suppose the engine does stop at a dead center, it could not hoist a load?

If the engine is at dead center it could not start a load at all, so the engine would have to be backed up or else assisted.

56. Is that the reason why two cylinders are used?

By using a "duplex" engine—that is two steam cylinders—with the cranks set at right angles to each other there is never any fear but what one of the crank arms is off from dead center.

57. Is there any other advantage with a duplex engine?

In a duplex engine one cylinder is placed on each end of the drum or pinion shaft, and the drum turns smoother with less twisting on the axle.

58. Could not a drum be used for two ropes, one lowering while the other is hoisting?

Yes and if they are keyed to one shaft, each helps the other. Imagine in Fig. 11 the rope A to be hoisting and the rope B as lowering. Hanging from B is a short rope, cage, and car, or a bucket, at the surface. The rope A extends all the way down the shaft and at the bottom has another cage, and car, or bucket hanging from it. The rope and the weight is trying to turn the drum right-handed while the rope and weight A is endeavoring to turn the drum left handed. Each has a lever arm of the same length so we have the weight of two cages and cars, or of the buckets balancing one another and the engine has to start only the long rope A and the ore or coal in the car. As the coal comes up on A, the rope B is going down. The weight of the rope A is constantly growing less while the rope B is lengthening out as it reaches the bottom. When the two cages pass each other, half way down, the rope, cage, and car of A balances the rope, cage, and car of B, and the engine need only be powerful enough to raise the ore. After that the rope B more than balances the rope A, until just before they are landed the weight of the rope A is very small and that of the whole rope B may even balance the weight of the coal.

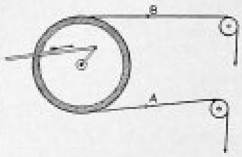


FIG. 11.

59. That ought to be a very good idea?

Yes, it is. Remember, however, I am neglecting friction; of that, I will speak later. But there is a still better plan for saving power than by using double rope on one drum. By the way, what I have explained assumes that the ropes pass off and on the same drum or different drums feathered on the same shaft. If the lowering drum is thrown out of gear while the hoisting drum is geared to the engine, you gain nothing then for the effort of the lowering rope and cage is all spent upon the brake which the engineer has thrown on.

60. Are many drums arranged so they turn on the shaft?

Not many, though it is a convenient plan. If the drum was fixed to the crank shaft you could not lower the rope B without, at least, running the engine. So in such a hoister, the engine must be reversible so as to turn right handed or left handed. Some of them use steam always, even for lowering, whether there are two ropes or only one. The Lidgerwood reversible link motion is one of this variety.

61. What was the method you mentioned as still better than the one described in Question 59?

By a tail-rope system. Imagine, in Fig. 12, A and B to be cages under each is an old rope, too weak to be safe for hoisting passing around a sheave at the bottom. Now, no matter where the cages are, you see that each top sheave has hanging from it a cage, a car and a full length of rope. These always balance while the engine has only to hoist a load of ore. This form of counterbalance or counterpoise works very well if the shaft is clear enough to allow of it.

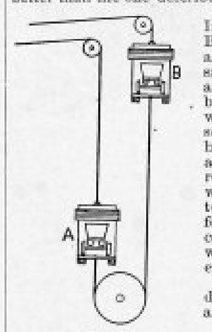


FIG. 12.

62. These all require double rope. Is there any arrangement for single rope?

Yes the double rope requires often a larger shaft than the mine has, so for a single rope there are two forms of counterbalance. One uses a cylindrical drum which we have just been considering, and the rope A is still the hoisting rope. Instead of lowering rope B, Fig. 13, there is a heavy chain so-proportioned with weights as to balance fairly well. It hangs down in a small shaft and when the cage on A is at the bottom, the whole weight of the chain is balancing the cage, rope and car. As the load comes up the chain lowers until it strikes the bottom of the shallow shaft, and coils up there just as fast as the rope A becomes shorter and lighter, until when the load is landed only a little chain is hanging from the drum, by a length of rope. This is used in Australia and in Germany.

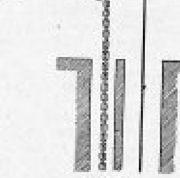


FIG. 13.

[TO BE CONTINUED.]

GEOLOGY

In its Relation to Coal, Iron, Oil, Gas, and Ores.

47. Have these faults anything to do with the cleat of coal?

Not at all. By the name of "cleat" we mean the joints in the coal. All rocks have joints and split along them giving smooth surfaces. Slate cleaves into thin slabs and building stones have also that tendency. But besides breaking into slabs, many stones break across them into blocks more or less like a cube. The joints, along which the stones naturally break are called cleavage joints or "cleats." These joints are natural to every material. Even volcanic rocks, as we shall soon see, have cleavage planes. (See page 287, July, 1891, issue of THE COLLIERY ENGINEER).

48. Are the cleats the same distance apart in all coals?

No. The soft coals have the cleats nearer together than in the hard coals. But for a particular coal they are the same distance apart. Sometimes they are in such directions as to give a cubical shape to the coal. At other times, the cleats are at an angle.

49. What is the cause of cleats?

It is the natural condition of the coal just as the "mundic," "iron," or "pyrites" in the coal always occur as a cube.

50. Are cleats of any help to the miner?

Yes, indeed. The coal breaks off easily at these joints and so the lever will cut under as far as a cleat and then let the coal fall. To make this possible, it often happens that direction of the cleat fixes the direction of the working faces. So the rooms are turned off from the gangways so that their faces shall be with cleat. Mines working by the "pillar and stall" method can take advantage of the cleat in this way. Those working Longwall can not always. In Anthracite, the cleat is not an important enough matter to determine the direction of the working faces. The coal seams are generally too steep there.

51. How does the coal look on the cleat?

Smooth and shiny.

52. Can you explain the methods of mining as you mentioned them?

I leave that to another time.

53. Is the coal often crushed badly by these folds, bends, and faults?

Oh yes. In the hollows of the sharp bends there is a great deal of finely broken coal. The quality of the coal is very much injured and the loss by waste is often very high from this cause.

54. May it be that the "dirt faults" and "rock faults" are caused by grinding of the strata on each other?

Yes, the name of dirt fault is often applied to places where the coal has been badly broken up. Sometimes though the term like that of rock fault or slate fault is used to express the idea that the coal has thinned out and is replaced by dirt, rock, or slate.

55. What are "partings?"

They are seams of clay or slate found in the coal beds that divide the coal into several layers. Rarely is a coal bed without them. They occupy on an average one-seventh of the entire thickness of the bed. These partings are mud deposits that show the bottoms of the ancient marshes had been raised or that the currents flowing through them had changed in direction or speed.

56. What is the amount of coal yet remaining in the U. S.?

That is hard to say. But the Census Bureau estimates 250,000 square miles of coal beds of all varieties and thicknesses. Assuming 5 feet as the average thickness of the coal and an average of 1000 tons of coal that can be recovered from every acre of coal bed of one foot thickness, we have,

$250,000 \times 640 \times 5 \times 1000 = 800,000,000,000$ tons as the total amount of coal.

57. How long will that last?

Last year there was sold and used 128,000,000 long tons. At that rate there is supply for 6250 years. But population is increasing and the demand increases likewise. From the past experience, it has been found that the consumption doubles every 16 years. On this basis, in 190 years all the coal will have been burned up unless other sources of power and of heat are meanwhile discovered or else more economy shown in the burning of fuel.

58. Am I to understand that all coals are made of the same vegetable decay?

We believe so, that club mosses, ferns and trees like our ground pine furnished the most of the mineral coal of the Carboniferous age.

59. How about the cannel coal?

That is a compact smooth-breaking coal which will light with a match just as a candle would. It is formed of the finer grained marsh weeds.

60. I can not understand how so much coal could be formed from one marsh. For the peat and wood must have lost much of its oxygen and of its weight in being compressed to coal?

Yes, so it has, wood actually loses three-fifths of its weight in being altered to Bituminous coal, and three fourths of it is lost in being changed to Anthracite. Besides this, the decayed matter is compressed and loses in bulk. So that, altogether, it took about 5 feet of vegetable marsh to make one foot of Bituminous coal and 8 feet to produce one foot of Anthracite.

61. How thick is the coal?

Coal occurs in marshes very thin at the edges and thick in the middle. In some places a single bed is as thick as 40 feet (one in Colorado is 90 feet thick) but a pure seam is seldom over eight feet. Any thing over that is a compound seam, in which the streaks are separated by thin partings.

62. How many coal seams are there in a district?

In Pottsville, Pennsylvania, there are 113 feet of coal seams; and in the U. S. the largest number of seams, one above the other is 42. In Wales there are 100, of which 70 are worked. In Nova Scotia there are 81 workable seams.

63. Did you say that these different seams were caused by the ocean overflowing the land several times?

Yes. The forests and swamps were covered by sediments and became hidden from view. The marshes sunk during the disturbances that followed. Then the ocean flowed over it and brought more mud. The peat bog compressed and coal began to form there under the clays. After a rest during which more mud and sand was deposited, more disturbances occurred. Some ground went up, some fell. Forests began to grow and more ferns flourished to form marshes. After these had decayed, another sinking is supposed to have taken place, and another mass of peat was buried to afterwards form coal. This must have been repeated as many times as there are seams of coal. Sometimes salt water covered the marsh, sometimes it was fresh water.

64. How long did all this take?

I have seen estimates making it over a million years.

65. How is that measured?

An ordinary forest will make about 2000 pounds of organic matter per acre, each year. This is 200,000 pounds in a century. One hundred tons compressed to be as heavy as coal will make 2420 cubic feet. If these are spread over an acre of 43560 square feet surface, they will form a layer only two-thirds of an inch thick. But in the formation of coal four-fifths of the material escapes as gas, oil, or water and only one-fifth remains in it, therefore it must take 500 years, instead of 100, to make a layer of coal two-thirds of an inch thick. For a coal seam of the standard size, four feet, it must therefore have required 72 times 500 years to make it, or 36,000 years. But some coal regions have over 100 feet of coal. To form the coal alone would therefore require about 900,000 years. Think of it! and we are using it up as fast as we can, and have perhaps enough for the sixth generation beyond our own.

66. What is meant by an ore?

An ore is an accumulation of mineral in such quantity and of such a quality as to pay for mining.

67. What is a mineral?

A mineral is the compound of a metal in chemical union with a non-metallic substance, as sulphur, carbonic-acid (the choke-damp of mines), etc.

68. Will you give some examples?

Iron and sulphur make a mineral called pyrites; lead and sulphur give a mineral known as galena; iron with oxygen makes a very common iron mineral, and silver with arsenic and sulphur is often seen. And when a big bed of any of these minerals is found it is mined for the ore of iron, of lead, or of silver.

69. Is pyrites a common ore of iron?

No. Pyrites is the commonest occurrence of iron in the earth, but it is mined not for iron manufacture but for the sulphur in it. Hence it is not an iron ore. It does not pay to roast off the sulphur and make iron of it when there is so much of a better ore to be had.

[TO BE CONTINUED.]

ANALYSES OF COAL, ORES, ETC.

Instructions in Sampling and in Making Analyses to Ascertain the Quality and Value of Coal, Ores, &c., &c.

The accompanying table gives briefly the results of analyses of some of the varieties of coal:

	Locality.	Sulphur	Fixed Carbon.	Water and Volatile Matter.	Ash.
Plumbago..........	Penn.		94·30	0·60	5·06
Anthracite..........	Rhode Island	0·26	85·84	*10·30	3·60
"	Mauch Chunk	0·50	90·1	6·6	3·3
"	Lehigh	1·00	87·5	7·5	4·0
Bituminous..........	Indiana	·75	75·	21·	4·
"	Penn.		75.4	16·4	8·2
"	Va.	1·1	58·9	30·5	8·6
"	Ohio.	0·7	53·2	43·8	2·3
Fat "	Penn.	·3	49·8	42·7	7·
"	Mo.	1·8	50·7	33·8	14·1
"	Ill.	1·	45·5	43.5	1·0
Lignite..........		1·2	27·1	60·0*	11·6

* 33 per cent. is water.

Determination of Sulphur.—The Sulphur exists in the coal in organic combination, partly in iron pyrites and perhaps as sulphate. So that properly, the sulphur should be reported separately.

Take 30 grains of the pulverized coal and mix it with 30 grains of calcined magnesia and 15 grains of carbonate of soda. Heat in a platinum crucible for an hour, or until the mass melts without boiling. Then lift crucible and all off and let them cool. Place in a glass beaker, or better, in a porcelain dish, and treat them with water and bromine (about ten grains). Filter through a glass funnel. (The filter papers can be had already cut to different round sizes. One of these is folded once across to form a half circle, then the paper is crimped by beginning as shown at A, Fig. 3 and folding A on B then doubling both of them back under. Now bend C and take all three as shown, to form the next crimp and so on till the operation is complete and the paper looks like Fig. 4. Now open the paper out and place it in the glass funnel, wet it a little with clean water and you have a very rapid filter. Looking into the funnel it is like Fig. 5.)

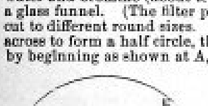


Fig. 3.

Fig. 4.

The portion which has filtered through into a glass beaker is slowly treated to some hydrochloric (muriatic) acid as long as any bubbling of carbonic acid is shown. Now place the beaker on a wire cloth or asbestos cloth, boil off the bromine, add some chloride of barium. A white precipitate forms; this contains the sulphur. Filter this through a funnel as before, dry the paper and its contents slowly, burn off the paper and let the contents fall into a small watch glass or place paper and contents in a platinum crucible and burn off the paper. Weigh and find out how much the precipitate weighs. Multiply that weight by 13·73 per cent. and you have the weight of the sulphur. For example, 30 grains of coal gave us a precipitate which weighed 2·4 grains. Now $2{\cdot}4 \times 13{\cdot}73 \div 100 = 0{\cdot}329$ grain of sulphur. That corresponds to 1·09 per cent. of the coal. As pyrites has 53·33 per cent. of sulphur in it, there was 2·06 per cent. of pyrites, probably.

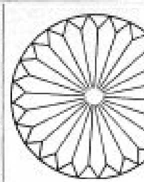


Fig. 5.

Calorific Effect of Coal.—This is measured in a variety of ways. But if you read under Geology of this series questions 116 to 125, you will find a discussion of this matter. The simplest heat measurer is the thermometer. But it only measures the degree of heat, not the amount of heat. For example, a small stove fire may show the thermometer to read 2000° F. inside of it, and so will that in a very large stove. But the small one cannot heat as large a room as the big stove, because it does not contain as much heat. True, the amount of heat does depend upon the temperature of the body, but also upon the mass of that body.

The standard unit of heat is that amount of heat which is necessary to raise one pound of water 1° Fahrenheit. A hot substance, therefore which raised 100 pounds of water 1° F. or 1 pound of water 100° F. has given out 100 heat units. Now it is the number of heat units which coal will give out that we want to know in order to ascertain the calorific—or heat making—value of fuel. This I have explained under questions 116 to 125 in Geology, basing the calculations on the ultimate analysis of the coal. (This latter form of analysis differs from that previously described, in that it requires very elaborate apparatus and aims to convert all the carbon into carbonic acid, weighing the amount produced and collected in a tube. It also converts all the hydrogen into water and weighs that. Then there are 40·7 per cent. of carbon in the carbonic acid 11·1 per cent. of hydrogen in the water. The method described was an approximate analysis which serves for most purposes). See also page 18, of August, 1891, number.

Besides desiring to know the number of heat units, it is equally as important to ascertain the evaporative value of a fuel when placed under a boiler. This may be ascertained quite well by the use of an appliance shown in Fig. 6. This consists of a glass cylinder which will hold 29·01 grains of water (or a multiple of that quantity) up to a certain mark, A. A perforated copper stand, B, has a socket, C, and a copper cylinder D, having springs as shown.

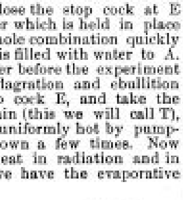


Fig. 6.

The copper cylinder is charged with 30 grains of the pulverized coal, 80 grains of nitre and 240 grains of chlorate of potash. *Do not grind these after mixing.* This mixture is packed gently in the copper cylinder in and around a cotton fuse that is saturated with nitre. Ignite the fuse, close the stop cock at E and put on the copper cylinder which is held in place by the springs. Place the whole combination quickly into the glass cylinder which is filled with water to A. The temperature, *t*, of the water before the experiment is noted. As soon as the deflagration and ebullition has ceased in D, open the stop cock E, and take the temperature off the water again (this we will call T), making sure that the water is uniformly hot by pumping the combination up and down a few times. Now allowing 10 per cent. loss of heat in radiation and in warming up the apparatus, we have the evaporative power of the fuel.

Assume as an example,

t, before the test is	62·1° F.
T, after " " "	73·2 F.
Then the rise of temperature is	11·1°
Loss by radiation	1·11
Result	12·21°.

The ratios and proportions are so taken that the rise in temperature corresponds to the number of pounds of water evaporated by one pound of the fuel under test. From this we learn that one pound of fuel would evaporate, under favorable conditions 12·21 pounds of water. The fuel value of coal does not depend only upon the percentage of combustible matter nor is it exactly proportional to it. A deduction must be made for stoking and the removal of ash. It is because of the increased difficulty of firing that smalls sell at less price than lump, rather than because of the excess of production over the demand for small sizes. In any event, however, consumers are not so careful to ascertain the heating value of the coals as one might expect. If a certain fuel is advertised as a strong steam coal, it is accepted irrespective of its chemical impurities.

[TO BE CONTINUED.]

SURFACE APPLIANCES.

The Preparation of Coal and Ores for Market.

43. Is that the way you control the jigs, too?

Yes, the less water used the cleaner will be the coal in the trough or the jig.

44. Why not do that then?

The trouble is that if you use little water, only a little coal is washed out clean, and the operation is too slow. It would not pay to make such perfectly clean coal as to make the output small. So that the general plan is to work as fast as you dare without producing too bad a coal. So the jig pistons are run fast, and the troughs or sluices are set steep to give a big output of rather clean coal rather than to get a small turnout of very clean material.

45. Are these sluices much used?

You will see them in some coal washing plants in Kentucky, Indiana, West Virginia, and England. They are used in cleaning iron ores, and for washing iron sand out of clay. They are also common for washing dirt and gravel from gold.

46. How are they used for gold?

The cleats are fast to the trough and mercury is placed behind them (gold mines call the cleats, riffles). As the ore is washed down the sluices, the gold settles at the bottom and rolls in behind the cleats where the mercury catches it and holds the precious metal.

47. Are these cheap to work?

Yes, that is their advantage. They will wash only very small coal, and use much more water than jigs. They are not as good washers as some of the jigs.

48. Are they no better for ores?

They work quite satisfactory where there is a great difference between the weights of the material to be saved and that of the waste; so that for ores, or gold washing they work quite well.

49. Can coal be cleaned by any other forms of machines?

Yes, there are the Osterspey Siphon and other conical washers and also bumping tables. These will clean coal nicely and other varieties of these machines used upon ores too.

50. How does the Osterspey Siphon work?

If you notice in Figure 3 you will find a tank having two partitions reaching nearly to the bottom and forming three compartments. Water pours down the central compartment and rises in the other two. In the right hand one, the automatic balance is connected with the lever, rod, and plug of the left hand compartment. The coal and other stuff to be washed enters the left hand compartment and tends to fall down to the bottom but it meets a current of water rising in it. The pyrites is heavy enough to fall against the upward current, but the coal can not. So the pyrites settle in the hopper at the bottom while the coal is washed out at the top. The material is fed constantly so as to make it a continuous machine.

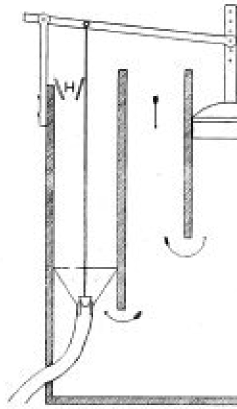


Fig. 3.

51. But the pyrites and slate which accumulate in the hopper will soon choke it up so that the water can not get through?

True, when the water can not get through the right hand compartment comes into play for the water tries to get out there. It raises the balance I mentioned before and that raises the plug which opens the bottom of the hopper and lets the pyrites escape through the tube.

52. Why is this called a siphon washer?

It does not act like a siphon at all and there is no accounting for the name. However, it works well.

53. Does this machine clean the coal well enough without repeating it?

Generally two or three or four of these machines are placed side by side so that the overflow from one washer goes to the next, and so on. This gives a very good quality of coal at the end. Jigs are also arranged the same way so that the overflow from B, Fig. 1, goes to other similar machines alongside of, and slightly below it. By this plan, without any great difficulty, the material gets three or four cleanings.

54. How many times may the coal be cleaned by machines?

Just as along as there is any impurity mixed with the coal, but there comes a time when it does not pay to treat the material more; because the value of the coal after that is not enough greater to pay for the time lost and cost of handling. The cheaper the mineral the sooner that comes. For example: It does not pay to wash coal more than in one class of machines, that is on jig, on sluice, or in an Osterspey; lead and zinc ore are usually treated two, sometimes three times. But silver and gold ores are treated on a variety of machines, over and over again, as I will explain.

55. Is there any other form of coal dresser?

Yes, one which I have not seen frequently here. A form of table that is inclined and about 10 feet long by 3 or 4 feet wide. The material to be separated is delivered at the upper part of the table and tends to flow down it. But the table is hung from rafters overhead and is bumped at the end and the result is that the slate and pyrites actually climb up to the top and fall off into a chute while the coal makes off at the bottom. This goes on continuously.

56. Why should these separate?

Lay a nickel coin on the table, then with your nail catch the table cloth and stretch the threads of the cloth. If you suddenly let go, the cloth will move under the coin which will be stationary. By repeating this you will find that the coin actually moves toward your hand. Now that is what takes place on the bumping table. Under ordinary conditions the coal, pyrites, and all would wash down the table. But it is struck at the end by a wiper A, Fig. 4, striking the block B. A is in continual revolution so it strikes B about 30 times a

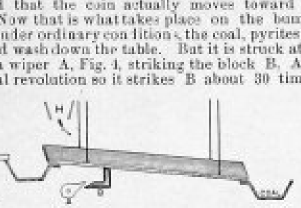


FIG. 4.

minute. So the table is jarrred or "bumped" 30 times a minute. Now all the stuff resting on the table would behave just like the nickel coin on the table cloth, if it were not for the water, which washes the material down hill. One force tries to wash every thing down and another to help every thing up. Between the two, you can arrange the supply of water so as just *not* to wash the slate and pyrites down. As you vary the water supply so you vary the cleanness of the coal. With little water you will have very clean, but only a little coal, With much water you get a bigger output, but there may be some impurities mixed with it.

57. Then this is automatic?

Yes, unless these machines work automatically without constant watching, they would be of no value.

58. How much can these machines treat in a day?

That depends upon how clean the coal is to be made. Of course you do not try to clean coal any better than is necessary for a sale. But a jig will handle about 30 tons of coal a day; a sluice has about 20 tons capacity; while the siphon washer (Q. 50) can treat 40 tons. A table will handle 30 tons without trouble.

59. Do these machines take much power to run?

No, I should say that a jig or table can be run with about ½ a horse power.

60. Are they expensive?

The cost is not high, $300 will set up a large table or jig. Of course for a big plant a number of these will be required, so that the cost runs up, as I said to many thousands.

61. Are there any other means of treating coal that you have not described?

Not that I am aware of.

62. How is it with ores?

They are treated in much the same way.

63. What is the first step?

The ore must be broken just as the coal was. The material however is much harder and therefore requires very powerful machinery to break it.

64. What is in the ore?

Quartz, limestone, pyrites, galena, blende, and silver mineral.

65. What is an ore?

Anything that has a mineral in it enough in quantity and pure enough in quality to pay for mining.

66. Then coal is an ore?

Yes, though some of it is very poor. While other coal is so far away from railroad as will not yet pay to mine. Often, clay of good quality may be an ore.

67. Please define minerals and those you mention in Q. 64.

See questions under Geology, in June and July issues for an explanation of the different minerals in ores.

68. Please explain the kind of breaker used to crush metallic ores?

The ore falls between the rough jaws of the crusher One jaw is fixed while the other swings from the top. An eccentric forces the lower movable end against the lower end of the fixed jaw. The rock which falls between the two is crushed to about walnut size and smaller. I cannot conceive any rock that cannot be broken by this machine.

69. Then it does not work like the steamboat rolls?

No, those rolls will do for coal, but not for quartz.

70. Is that all the breaking the ore gets?

No, the broken stuff slides down the chute to a pair of rolls—just like those for coal, only they have no teeth. These rolls turn constantly in opposite directions to one another and are so set that they break the ore very fine—to one-half inch or less.

[TO BE CONTINUED.]

VENTILATION IN MINES.

Including a Description of the Gases Met With in Mines and the Atmospherical Conditions Necessary to Be Known to Understand the Laws of Ventilation.

26. What effect has the falling of the barometer upon the ventilation of the mine?

The pressure outside being so much less, air is sucked up, just like the water, only faster, because air is lighter.

27. How does it effect the gas in the goaf?

In the same way. It "sucks" the gas into the gob roads or air-ways because a partial vacuum is produced by the escape of mine air, at the surface, and the gas rushes out to help fill the space abandoned by the mine air.

28. Is that the principle of the fan exhaust?

Yes, the fan revolves very rapidly and produces a vacuum into which the air rushes to fill because at the downcast shaft the atmosphere is forcing air through the mine and up the return way.

29. Is that what produces the current?

Yes, the downcast is like the arm N, of Fig. 3. Upon it the weight of the atmosphere added to the air in the intake is pressing on one side trying to balance the weight in the arm M. But just as fast as air enters the mine, an equal amount goes out of it at the upcast and the current is circulating.

30. The U tube in Fig. 3 looks like the water-gauge we use.

So it is, just the same. The air of the intake forces N down and M up, the latter being connected with the upcast. The height M N measures the difference of pressures in the two shafts. If the fan makes a vacuum so that the barometer reads in the fan way 29 inches of mercury while the barometer outdoors reads 30 inches, the mine air weighs only $\frac{29}{30}$ of the atmosphere.

31. How much does the water-gauge read?

In an easy mine to ventilate, the gauge pressure is not over ¾ inch—that is the difference between the levels of the water in the two arms is about ¾ inch. A mine which is large and has long, or narrow, entries and air-ways requires a pressure equal to a 4-inch difference in level.

32. What is the pressure corresponding to the water-gauge readings mentioned?

You may remember that the atmosphere weighs 14·7 pounds for a pressure of 34 feet, or 408 inches of water column. Then for the gauge readings mentioned we have 0·027 pounds and 0·144 pounds, because

$$408 : \tfrac{3}{4} :: 14{\cdot}7 : 0{\cdot}027$$
$$408 : 4 :: 14{\cdot}7 : 0{\cdot}144$$

33. What is meant then by saying the pressure is 10 pounds in speaking of mine ventilation?

The figures I gave are for each square inch, but mining men prefer to figure in feet. So as there are 144 square inches in every square foot, it follows that the pressure per square foot of area, produced by the atmosphere is $14{\cdot}7 \times 144 = 2086$ pounds.

Those given above are 3·9 pounds and 20·7 pounds. The 10 pounds you refer to mean that the difference in the water column levels is such as to correspond to 10 pounds weight per square foot or 0·07 pounds per square inch.

34. How may I best calculate the pressure?

The formula we use is $p = 5{\cdot}184\ g$. In this p is the pressure in pounds per square foot; 5·184 is the weight of a column of water 1 inch high and 1 foot across while g is the difference in level of the water columns.

35. What is the pressure when the gauge reads 2 inches in my Anthracite mine?

The pressure is 10·4 pounds per square foot.

36. Would this be true in the light air of Colorado, too?

Yes, the pressure would be the same anywhere.

37. Of what use is it to know the gauge pressure?

It measures the force necessary to drive a current of air through the mine. One arm of the tube projects through a door into the intake current and the other arm is on the other side of the partition in the return air-way. If there is any difference in the levels of N and M, Fig. 3, then that measures the difference in the pressures of the incoming and outgoing air. It measures therefore the loss of pressure by reason of the "drag" or friction of the air in passing through the airways. To overcome the friction, greater force must be given to the current in proportion as the gauge reading is great.

38. Then the gauge only indicates the drag of the air, not the amount of air?

That is so. It does not follow that because a mine has a high gauge reading of, say 4 inches, that it is receiving any more air than one working with a ¾-inch gauge.

39. How is the required pressure obtained?

You can get it by an exhaust fan, a blowing fan, or by the furnace?

40. Which is the best?

Generally speaking, an exhaust fan is preferred because it is cheap to run, and always reliable. The blowing fans are used to ventilate the faces of breasts working on a steep pitch. The furnace is dangerous, consumes more coal than the steam engine running a fan and is not as good as a fan for mines of moderate depth.

41. But there are more furnaces than fans used?

Yes, but fans are being acknowledged better and nearly all new mines are putting in fans instead of furnaces. A good fan and engine is cheaper than a furnace for a mine not deeper than 4,000 feet. Below that, a furnace may be more efficient. Hence, the utility of the furnace is confined to very deep shafts.

42. Are they not good ventilators?

Yes, furnaces are fairly good, but they are limited in capacity because they can burn only a certain fixed quantity of fuel and the temperature to which they can raise the air is therefore limited.

43. How is the difference in pressure produced?

Do you remember, how in Question 23 I explained the suction with a tube? Well, an exhaust fan does the same thing. If it turns very fast it draws the air out which the atmosphere tries to replace. If the fan could be worked air-tight like the plunger of a pump, a very strong suction could be produced, but this is out of question.

44. What is the idea with the furnace?

To produce a volume of air, at the bottom of the upcast, hotter than the air in the intake. The hotter a gas is, the lighter it becomes. So as the light, hot gas rises the atmosphere drives cold air down the other shafts.

45. How may we know the effects of the fan?

By the water-gauge and by our knowledge of the weight of a gas. A gas increases in weight as its pressure increases. You remember that the weight of the gas in Scranton is greater than that in Colorado, because the pressure under which it is is also greater, Fig. 1. Again the weight of a gas decreases as its temperature increases. So the weight of a cubic foot of gas is equal to

$$W = \frac{1{\cdot}3253\ B}{459 + t}$$

In this B is the number of inches of mercury of the barometer and t, the number of degrees Fahrenheit of the thermometer. From this we can calculate all conditions of ventilation.

46. Our mine is 600 feet deep and the furnace gives us gas 150° Fahrenheit, how am I to know the weight of the gas?

At the sea level the barometer stands at 30 inches of mercury, so one cubic foot of gas will weigh

$$39{\cdot}759 \div 609 = 0{\cdot}0653 \text{ pounds.}$$

If the temperature of the air outside is 60° F., then one pound of it weighs 0·0766 pounds. Every cubic foot of air in the downcast weighs 0·0766 pounds while each cubic foot of the upcast weighs 0·0653 pounds. Each shaft is 600 feet deep. Now, a column of air 600 feet high and one square foot of base weighs 600 times 0·0653 (= 39·18 pounds) in the upcast, and 600 times 0·0766 (= 45·96 pounds) in the downcast. Then one side weighs more, for every square foot, than the other by 6·78 pounds. And just as the columns of water in Fig. 2 changed because of the pressure on one side so here, if you imagine the water at the higher side to run over at the top just as air does. The ventilating pressure of that furnace is therefore 6·78 pounds, or 1·30 inches of gauge (see Question 34).

[TO BE CONTINUED.]

First Class Mine Cars.

There is no equipment of a colliery that requires more care and better work in construction than the mine cars. They are subject to the severest usage, and to be of most service they must not only be constructed of substantial materials, but they must also be so made as to run with a minimum amount of friction.

The Star Manufacturing Company, of New Lexington, Ohio, recognized these facts when they started in business, and the result has been that to accommodate their steadily growing trade they have largely increased their works, and at the same time introduced such machinery and system that they are able to turn out first-class cars at very low prices. They are prepared to build mine cars of any shape or size, and use in their construction nothing but the best Muck bar iron and seasoned timber.

Every portion of the car is made so as to secure the greatest strength and convenience in handling. When brakes are required they are arranged so that they are most efficient and convenient.

Their wheels and axles are deservedly popular wherever used, and their points of excellence are as follows: They are made of the best grade of charcoal iron, carefully selected for the purpose. The wheels are cast in chills that give them an exceptionally deep chill. The oiling device is simple and economical, and makes an easy running wheel. The wheels are made either self-oiling or plain and sample sets are sent on approval. They are all bored out in the hub, true to fit the spindle, before they leave the factory, and are carefully inspected so that none but perfect wheels are shipped.

Wheels, axles or car irons, of any size or description, are sold separately whenever it is desired to construct the cars at the mine.

The facilities of the factory are such that orders can be filled at short notice, and we advise our readers to write them for their special circular describing their mine cars. One of the features of this establishment is a blank form which they cheerfully send to mine owners or superintendents. These blanks are so printed that the superintendent can readily fill them out so as to describe exactly the size and character of car desired, and prompt estimates will be made from them when returned to the shops. Or, if the gauge of track, size of wheel, height of car, height of coal, and capacity of car is given, they will cheerfully give their ideas of the size of car and irons adapted to the same, based on their past experience. As stated before, the Star Manufacturing Company's shops are located at New Lexington, Ohio.

Anti-mony Rubber.

In the present age of diffused knowledge it is surprising how little is known about India Rubber although the consumption of that article runs into the millions per annum and many companies with millions of dollars capital, are daily manufacturing and putting it before the public. Buyers keep on purchasing and using rubber that don't last half as long as it would if intelligently ordered. A case in point is Drill hose, so largely used in mines. In a late edition of that bright trade paper, The Rubber *World*, we read: "We think that the very best rubber which in the present state of knowledge upon the subject, it is possible to manufacture is what is known as 'Anti-mony Rubber.'" Now, how many of our subscribers know what Anti-mony Rubber is, or why it is better than sulphur cured rubber? In fact, how many of them know the different terms by which the trade distinguishes between Sulphur cured and Anti-monial cured Rubber? And yet for purposes where Rubber is constantly subjected to steam-heat there is probably double the life in the Anti-mony (or Mineralized) Rubber, than there is in the Sulphur (or Vulcanized) Rubber.

Again it is a well established fact that Mineralized Rubber will withstand the action of earth oils far longer than Vulcanized and yet what engineer takes this into consideration in ordering? It is not a case of price. Quality for quality, we believe that the Mineralized is as cheap as the Vulcanized, although probably the former is not susceptible of being adulterated to the extent that the latter will bear.

These remarks are communicated by the Mineralized Rubber Co., whose advertisement will be found in our columns and who, despite their name, supply both Vulcanized and Mineralized Rubber, and who will gladly reply to any further enquiries that may be addressed to them at their offices in Cliff St., New York.

USEFUL INFORMATION

The Columbus of History.—How his Character appears under the Search-Light of Modern Investigation.

The Columbus of history is one of its least pleasing characters. He was evidently a searover and a buccaneer. He sold his services to Rene of Anjou, or Charles of France indifferently. A rude uneducated seaman, he joined in the barbarous sea-fight off St. Vincent, and aided in the massacre of honest traders and useful men. Time somewhat softened his harsher traits, but his early impulses never left him. He became familiar with the slave-trade in Portugal, and introduced it to the New World. He treated the natives of the new land with pitiless severity. He threw them into chains, cut off their hands and feet, or sold them as cannibals to misery and death. He probably invented the fiction of the Caribs only to destroy them. Las Casas thought that the judgments of Heaven had fallen upon the merciless discoverer. In almost every trait of moral excellence Columbus seems equally wanting. To the Spanish settlers in Hispaniola he was a hated tyrant, a cruel usurper. He threw Moxica over the walls of his fort with his own hands, and spurned him as he fell. His victims, hung by the neck, shocked the humanity of Bobadilla. It was believed that Columbus and his brothers planned a new empire in the Indies, and hoped to throw off the yoke of Spain; in later years Columbus engaged in a treasonable correspondence with Genoa. His ingratitude to the Pinzons, his betrayal of Beatrix Enriquez, his falsehoods, his fierce bursts of rage, his avarice, his revenge, his wild ambition, his pious frauds, his fanatical faith, can never be forgotten; they may be forgiven. Harsh, fierce, severe, the features of Columbus look down upon us over the flight of four centuries, the symbol of his cruel age.

Columbus found the natives of America full of the passion for gold. The glittering particles had for them an irresistible attraction, as to so many of what are called the educated races. They searched in the rivers and sands for gold, and when they had found it hung it in their ears and noses. Sometimes the more highly cultivated beat it into plates, which they fastened around their necks. It was their chief and almost only ornament, almost their only dress they used, too, paint, feathers, and strings of pearls. The universality of this strange passion for the ductile metal in civilized and savage man is without an explanation; it is natural. We are told that there are ants that heap together glittering particles of precious or colored stones; it is their instinct. In Columbus the passion raged with a violence seldom known. He dreamed of golden palaces, heaps of treasure, and mines teeming with endless wealth. His cry was everywhere for gold. Every moment, in his fierce avarice, he would fancy himself on the brink of boundless opulence; he was always about to seize the treasures of the East painted by Marco Polo and Manderville. "Gold," he wrote to the king and queen, "is the most valuable thing in the world; it rescues souls from purgatory and restores them to the joys of paradise."

It was something of his early pirate life that stirred him in his plans of discovery. He was always a buccaneer. He was always a slave trader. He selected the port of Navidad because it seemed a convenient harbor for slave-ships. He made slaves wherever he went. In his fierce avarice, when he found the naked Indians had little gold, he proposed to sell them, and thus establish a wide source of profit. Gold he must make by some means. He urged upon the king and queen his infamous project. They seemed at first to disapprove, and afterward countenanced it. They could scarcely fail to see that hunting the helpless natives through the islands and the continent to sell them into slavery was not a Christlike trade. They gently rebuked the discoverer, but soon after we find them lending him their approval. "Let him be informed," they wrote, "of what has transpired respecting the cannibals that came to Spain. He has done well," etc. Soon every Spaniard who sailed to America became a slave-trader. Ojeda and Americus Vespucius filled their ships with "cannibals," and the brothers of Columbus followed the example of the admiral. A boundless horror settled upon the new-discovered lands. Las Casas thought the sickness and pains that fell upon Columbus a judgment for the woes he had inflicted upon the helpless Indians.—*From "The Mystery of Columbus," by Eugene Lawrence, in Harper's Magazine for April.*

Ocean Depths.

The eight or nine mile depths in mid-ocean, declared very probable by Maury, are not found by later actual investigation, according to the *Engineering News*. A depth of five to six miles is very exceptional and the average appear to be about 2,500 fathoms for the waters of the globe. The greatest depth yet found is 4,575 fathoms (5¼ miles) south of the Ladrones, and 4,561 fathoms north of Porto Rico, near St. Thomas. The deepest sounding, then, in the North Atlantic is 4,561 fathoms, and in the South Atlantic bottom is always found at a less depth. The Mediterranean gives 2,150 fathoms as a maximum to date, and the deepest known water in the Indian Ocean is 3,199 fathoms. The polar basin seems to grow shallower as the North Pole is approached, and bottom was found at 72 fathoms in the most northern sounding made. These soundings, so far as made, also disprove the theory that the ocean bottom is a counterpart of the dry land in its irregularity of surface. It has its peaks and deep gorges, but as a rule, the surface lies in very gentle undulations, without abrupt or steep slopes.

The Problem of the Age.

"The labor problem" remarked a political philosopher from Western New York, "not only puzzles the student of economics in your big cities, but it tries the soul of the agricultural bosses. I own some large farming tracts in the Northwest and West and understand pretty thoroughly the conditions that prevail there, as well as in the interior of our own State. There are hungry hordes of unemployed men and women in every large city in the land. I am assured that there are thirty thousand unemployed in the city of Chicago alone, and probably as many here in New York. The same holds good proportionately in other cities. Not the same persons all the time, perhaps, but an average—some working to-day and some to-morrow, for a few weeks or a few months, another set being idle while these have work, and so on. When we consider the still greater number who labor at a recompense so slender that it serves merely to keep soul and body together, who live practically in perpetual bondage to their daily necessities this view is appalling. As a matter of cold fact there is employment to-day for every able-bodied man and woman in the United States—remunerative employment.

LABORERS WANTED.

"There is more territory and are more interests suffering to-day for want of laborers than there is territory overcrowded or are interests oversupplied. There are vast sections of this country where it is actually impossible to obtain help, male or female, and where that is we have arrested development. I know it to be a fact that within twelve hours of Chicago enough help cannot be obtained to carry on farming operations. There are no farm hands to be had, although homes and good pay are offered on yearly contracts.

"There are no house servants to be hired for love or money, and the well-to-do are obliged to do their own washing and other housework. The absence of help is as marked in all the small Western towns as in the country. I believe there is some kind of employment and a home for every man, woman and child in this country who can do anything.

"The trouble is just where the trouble is with contracts—the question of exchange. People are freezing to death within a few hours of coal regions; other people are starving here while corn is being burned for fuel in Kansas. Our grain rots in the shock for want of help to garner it, and thirty thousand hungry mouths and idle hands are within a day's travel of us.

THE RUSH FOR THE CITY.

"The high daily wages of manufacturing centers drains the country of young men, and once there they will never return. Their children would rather live in garrets in the city than go on a farm and plough and plant and do housework. The real labor problem is to equalize things, to draw off the surplus from the congested points and spread it on the deficient spots. If the so-called labor leaders and humanitarians could work earnestly together to that end the labor problem might be solved. I do not say it could be accomplished without the co-operation of labor, for it couldn't. You can't take an unemployed man or woman off the streets of a city and compel him to accept work and a home. You can't make him stay if you get him. If you could do that the question could be settled. It rests with the labor world. The employers of labor don't want it settled. The sharper the competition the cheaper they get their work done."—*New York Herald.*

"Records for One Mile."

Of the various methods which man has found or invented to get himself over the ground as rapidly as possible, railroad travel is the fastest. The following table gives the fastest time for one mile of the leading methods:

Railroad Train	49 sec.
Ice Yacht	1 min. 10 sec.
Running Horse	1 min. 35 sec.
Torpedo Boat	1 min. 50 sec.
Pacing Horse	2 min. 4 sec.
Trotting Horse	2 min. 8 ¾ sec.
Steam Launch	2 min. 12 ¼ sec.
Skating	2 min. 12 ⅗ sec.
Bicycle	2 min. 15 sec.
Ocean steamship	2 min. 40 sec.
Foot Running	4 min. 12 ¾ sec.
Four-oared shell	4 min. 51 sec.
Single sculls	5 min. 1 sec.
Eight-oared shell	5 min. 4 ⅘ sec.
Walking	6 min. 55 sec.
Swimming	12 min. ½ sec.

Training the Memory.

A splendid way to improve the memory is to begin by treating it as if it were another person, and then charging it upon penalty of a severe upbraiding, to keep until wanted the information, fact, date, name, or whatever is to be remembered. By this course you unconsciously do two things—you sort out things worth while to know, and you impress them upon the memory in such a way as to cause it to grasp and keep them.

The latter is a most important thing to do. Half of one's forgetfulness comes from failure to properly grasp what it is that you are to remember. It is said of Thomas B. Reed, the famous member of Congress from Maine who was Speaker of the House of Representatives for two years, that he considered it a great hardship to have to tell a man the same thing twice.

You ought never to cause any one such hardship.—*From Harper's Young People.*

MECHANICAL NOTES

Precious Metals.

Many of the elementary metals are more valuable than gold. To speak of them as being mined is, however, hardly precise. They are extracted by tedious and expensive processes in chemical laboratories in infinitesimal quantities. The following is a recently prepared list of the elements whose market value exceeds that of gold, the price of the latter being $299.72 per pound, avoirdupois:

	Value Per Lb.		*Value Per Lb.*
Vanadium	$4,792.40	Indium	$1,522.08
Rubidium	3,261.60	Ruthenium	1,304.64
Calcium	2,446.20	Columbium	1,250.28
Lantalum	2,446.20	Rhodium	1,032.84
Cerium	2,446.20	Barium	924.12
Lithium (wire)	2,935.44	Thallium	788.20
Lithium (globules)	2,224.76	Osmium	652.32
Erbium	1,671.57	Palladium	498.30
Didymum	1,630.08	Iridium	466.30
Strontium	1,576.44	Uranium	434.88

These are not nominal values, as many of the elements are used in the arts. Vanadium, for instance, is employed in the production of analine black. It requires some twenty-five distinct chemical operations to extract vanadium from sandstone.—*New York Herald.*

A Great Pumping Engine.

An engine for pumping, which is said to be the largest ever built in this country, will soon be placed in position at the Spring Garden Water Works near Girard Avenue bridge, Schuylkill River. It has just been completed by the Southwark Foundry and Machine Company, at Fifth Street and Washington Avenue, this city. A daily journal says of it:

The mammoth engine, which is of the twin compound condensing type, will have a capacity of 20,000,000 gallons per twenty-four hours delivered against a head of 250 feet above the water in the fore-bay, through a rising main of 48 inches diameter and 14,000 feet length. The order for it was placed with the company about a year ago, and it has required ten or eleven months to make the patterns and build it. Considerable time and care were devoted to the study of the designs, it being the purpose to meet as completely as possible the special conditions of space alloted for the pump at the Spring Garden Works, the work to be performed, the convenience of operating, and the durability of the details of the engine.

The entire pump weighs 950,000 pounds. It will occupy a floor space of 40 by 30 feet and is 35 feet in height. Two massive bed plates, single castings, weighing 80,000 pounds each, will support the steam and water cylinders and also carry the bearings for the beam shaft, crank shaft, fly wheel, and steam cylinders.

The pump is supplied with two high-pressure steam cylinders of 3 feet 8 inches diameter each and two lower pressure steam cylinders, each 7 feet 4 inches in diameter.

The water cylinders are placed horizontally with valves moving in a vertical direction. The fly wheel, 20 feet in diameter and weighing 90,000 pounds, is carried by the main shaft. A triangular walking beam is employed for transmitting the power to the pump. The two pump plungers are of the double-acting pattern, each 37 inches in diameter.—*Philadelphia Manufacturer.*

How a Thermometer is Made.

The making of a thermometer may be either a delicate scientific operation, or one of the simplest tasks of the skilled mechanic, according to the sort of thermometer made. With the extremely sensitive and minutely accurate instruments designed for scientific uses great care is taken, and they are kept in stock for months, sometimes for years, to be compared and recompared with instruments that are known to be trustworthy.

But so much time can not be spent over the comparatively cheap thermometers in common use, and these are made rapidly, though always carefully. The method of manufacture has been so systematized within a few years that the very cheapest thermometer should not vary more than a fraction of a degree from the correct point.

Whether the thermometer is to be charged with mercury or alcohol; whether it is to be mounted in a frame of wood, pressed tin, or brass, the process is substantially the same. Mercury is used for scientific instruments, but most makers prefer alcohol, because it is much cheaper. The alcohol is colored red with an aniline dye which does not fade.

The thermometer-maker buys his glass tubes in long strips from the glass factories. The glass-blower on the premises cuts these tubes to the proper lengths, and with his gas-jet and blow-pipe makes the bulb on the lower end. The bulbs are then filled with colored alcohol, and the tubes stand for twenty-four hours.

On the following day another workman holds each bulb in turn over a gas-jet until the colored fluid, by its expansion, entirely fills the tube. It then goes back into the hands of the glass-blower. He closes the upper end, and turns the tip backward to make the little glass hook which will help keep the tube in place in the frame.

The tubes now rest until some hundreds of them, perhaps thousands, are ready. Then the process of gauging begins. There are no marks whatever upon the tube, nothing to show the temperature of the atmosphere, and the first guide-mark to be made is the freezing point, 32 degrees Fahrenheit. This is found by plunging the bulbs into melting snow. No other thermometer is needed here for a guide, for melting snow gives invariably the exact freezing point. This is an unfailing test for any thermometer whose accuracy may be suspected. But melting snow is not always to be had, and a little machine resembling a sausage grinder is brought into use. This machine shaves a block of ice into fleecy, snow-like particles, which answer the purpose as well as snow.

When the bulbs have been long enough in the melting snow a workman takes them one by one from their icy bath, seizing each one so that his thumb-nail marks the exact spot to which the fluid has fallen. Here he makes a scarcely perceptible mark upon the glass with a fine file, and goes on the next.

The tubes, with the freezing point marked upon each, now go into the hands of another workman, who plunges them, bulb downward, into a vessel filled with water kept constantly at 64 degrees. A standard thermometer attached to the inside of this vessel shows that the temperature of the water is correct. Another tiny file-scratch is put at 64.

Then a third workman plunges the bulbs into another vessel of water, kept constantly at 96. This is marked like the others, and the tube is now supplied with these guide-marks, each 32 degrees from the next. A small tab is then attached to each tube on which its number is written—for owing to unavoidable variations in the bore of the tube each one varies slightly from the others.

With its individuality thus established the tube now goes into the hands of a marker, who fits its bulb and hook into the frame it is to occupy, and makes slight scratches on the frame, corresponding to 32, 64, and 96 degree marks on the tube. The frame is given a number corresponding with the number of the tube and the tube is laid away in a rack amid thousands of others.

The frame whether it be wood, tin, or brass, goes to the gauging room, where it is laid on a steeply-sloping table, exactly in the position marked for a thermometer of that size. The 32, 64, and 96 degree marks must correspond with the marks upon the table; if they do not the error in marking is instantly detected, and the frame is sent back for correction.

A long, straight bar of wood or metal extends diagonally across the table, from the lower right-hand corner to the upper left-hand corner. On the right this works upon a pivot, and on the left it rests in a ratchet, which lets it ascend or descend only one notch at a time. That notch marks the exact distance of two degrees. With the three scratches already made for basis the marker could hardly make a mistake in the degrees if he tried.

The marks made upon the frame or case are all made by hand with a geometric pen and India ink if the frame is of wood, and with steel dies if it is of metal.

The tube bearing the corresponding number is next attached to the frame, and the thermometer is ready for the market without further testing. Some makers use only two guide marks; but the best makers use three.

In the process of manufacture the ordinary thermometer goes through the hands of nineteen workmen, half of whom are often girls and women.

Some of the larger concerns in and near New York produce several hundred thousand instruments annually, and on every one of them the purchaser may see, if he looks closely, the tiny file scratch on the glass at 32, 64, and 96 degree marks—or somewhere near them, as different makers use different points.—*William Drysdale, in Philadelphia Inquirer.*

HOW TO LIVE

Civilization as a Cause of Disease.

Dr. Wm. Cushing, in a lecture recently, maintained that to live in accord with the present civilization it is impossible to conform to the laws of health; hence civilization and health are not cordial in their relations, the chief aim of study in the past has been to cure disease that has taken such fearful hold of civilization; the study of the future will be to prevent disease. The best means to that end will be to properly educate the people.

One of the greatest sources of evil in civilization is the use of stimulants; it has indeed come to be regarded as necessary. As a scientific fact, however, stimulants are not necessary.

No beverage in use is so hurtful as tea, particularly to women. It excites and shocks the nervous system and results finally in prostration. The tannin in tea is a poison that only serves to impede all the natural functions. Coffee is much less hurtful because it interferes less with nutrition.

ALCOHOL HURTFUL.

Alcohol is bad in its concentrated form and the primary cause of a great many disorders. In its lighter forms it is less hurtful, and in some forms even beneficial if properly used. As it exists in malt and light wines it is an aid to nutrition and prevents the waste of tissue. The study of civilization should then be to learn the proper use of alcohol.

Tobacco has no redeeming qualities; it is bad from beginning to end, and absolutely no good comes from its use. It impairs to a greater or less extent all the senses; but its chief evil is its hurtful influence on the heart and brain. It is particularly injurious when taken into the immature system. If people are determined to use it, the effect would be much less hurtful by waiting till after they are 21 years old.

Overeating is a dreadful vice of civilization. It takes into the system an excess of material that cannot be thrown off, and the inevitable consequence is the turning of that into poison, the chief agency of disease. People eat too much meat, too many varieties of food and too much trash, which moves in genteel society under the alias of "pastries." Meat once a day is usually enough for any one, and there is no better specimen of health than the ruddy German, who is glad to get it twice a week. Too much food results in fatty degeneration.

EATING TOO FAST.

An evil hardly less hurtful than overeating is fast eating. This, too, is one of the pernicious products of civilization. People not only eat too fast, but they live too fast, and the extra energy they expend is taken off the end of life.

The fast living of civilization causes riot among all the natural functions. The nervous system becomes irritated and weakened till it can no longer resist fatigue. Then disease takes hold.

Contagious diseases are peculiar to civilization. Consumption, scarlet fever, typhoid fever, cholera, smallpox and others, all contagious, are rare among the aborigines. They are in the great majority of cases the result of drinking impure water.

The cure of all this is the education of the people. Every school in the land should have one or more competent teachers of hygiene. For every dollar spent in building schools, a like amount should be spent in providing proper means for physical training.

Night Air and Malaria.

"Ever since I can remember, I've heard changes rung on the necessity for sitting in doors at night, especially in malarial districts. To walk about much in the evening was deadly. To sit on the porch or door step was to take one's life in one's hands, while riding or driving were only permitted as matters of necessity, and the team generally went home against time, in order to get us in out of the night air.

"Now, the physician comes in here and attends a patient suffering from a malarial disease, and after divers and sundry other directions, tells us, that, whatever we do, we must not shut fresh air out of the sick-room even at night, but must have the windows so arranged that the ventilation will be as nearly perfect as possible.

"Now, this is a malarial locality, at all events it is considered so, and the patient contracted whatever disease there may be just here. If you will tell me what difference there is between breathing night air indoors, and night air out of doors, it will relieve my mind of great anxiety. We would no more think of spending the night, or any portion of it, in the hammock on the porch than we would of seeking suicide in any other direction, and yet here is this medical authority insisting that we bring indoors the very elements that we are supposed to stay in the house in order to avoid.

"Now, don't understand that I am quarrelling with anybody's notion on the importance of fresh air, for I am not, but I am trying to make up my mind why so much is said against spending a little time out of doors in the evening, and so much in favor of bringing the same atmosphere into the house. For my part, I think that a great deal of the danger from night air comes from the fact that people go out without sufficient wrappings. I think that I could spend half of my evenings on the piazza, and not receive the slightest injury, if I protected myself in a proper way, but I should wear a cloak as thick as the one I use in midwinter, and should keep a hood or light shawl over my head all of the time. I once spent a season in one of the worst malarial districts I ever knew. It was confidently predicted by every one who knew me, that I would have malaria-fever, because I insisted on sitting out on the porch of evenings, but I always put on a jacket, and then wrapped myself in a mackintosh with a hood pulled over so as to cover all but my face. I didn't catch cold, nor did I have an ache or a pain either that season or the next. Almost every one around there had ague and chills and fever and aches of all sorts, but I assure you that the sick ones were those who went out without wrappings, and always declared: "Oh, it won't hurt me to go out a little while; I never take cold;" but they took the consequences of their imprudence, and some of them paid for their folly with their lives. This and similar experiences have fully satisfied me that it is less what you do than the way you do it, which preserves the health; therefore, I am going to obey the doctor's orders and open the windows, but they will not be the windows of the sick-room. I shall let in the air to the other rooms first, and ventilate entirely in what you might call a secondary fashion. I shall also take the precaution to put an extra blanket over the sufferer, or, what is often better, a very thick linen sheet, which is a more complete protection under such circumstances than the heaviest blanket."—*New York Ledger.*

The Balance Sheet in Life.

It is said that the world gets value received for all of its acts and doings, and that the law of compensation is so accurately adjusted that the balance sheet tallies to the millionth part of a fraction.

It might be interesting to note the operations of this law as regards drunkenness and other excesses. There is a Scripture text which seems to bear directly upon this subject: "Because sentence against an evil work is not executed speedily, therefore the heart of the sons of men is fully set in them to do evil." To put off the day of accounting, to be fully persuaded in their own minds that because it has not appeared to come it never will, is the line of reasoning which the self-indulgent sinner adopts, and feeling secure on this ground, he gives himself up to license of all sort, and actually revels in wrong doing.

So much for the present evil. The law of compensation does not appear as yet; but it is leavening this lump of defiance, and sooner or later will have its perfect work. Some day there is a pain in the head, an "all gone" feeling that destroys ambition and puts hope out of joint; or there is a slight attack of dizziness, some symptoms of apoplexy, or a scarcely perceptible feeling of numbness over one side or in the hand or foot. The law is beginning its work. But some way proceedings seem to be stayed; the reconstructive powers of nature rally a little, and enable the victim to pull himself together and to go on again, often with more recklessness and less reason than ever before. Of course, nature finally rebels, and the result is either a mental wreck or a physical burden.

And the real reason for all of this breaking down is never given to the public, if, indeed, it is not carefully concealed by the physician, even from the patient himself. He is often called the best doctor who humors the patient's whims, and, wise man that he is, he allows a certain amount of dissipation, on the theory that a too sudden breaking off is not wise. In this way the victim's conscience is lulled to rest, and he is "kept comfortable," the friends say, when in reality he is still clinging with the feeble grasp of a dying man to the few vices which his circumstances and surroundings will permit. But the doctor is building better than he knows, and is helping to finish the work by permitting these indulgences. The struggle cannot last long, and soon nature feels that she has had enough of such a destroyer of her handiwork, and quietly drops him, as not worth looking after any longer. Better men than he are ready and anxious to fill his place in the world, and nature has vindicated her great and unchangeable laws.

Well would it be for the sons of men if they gave heed to these warnings. But they go about, blinded by ignorance and an overwhelming desire to prove all things which are evil. And this is the way in which lives are wrecked and hearthstones are made desolate.

"Because sentence against an evil work, is not executed speedily, therefore the heart of the sons of men is fully set in them to do evil."—*New York Ledger.*

SCIENTIFIC ADVANCEMENT

Astronomical Advance.

No department of science has made greater progress in late years than has astronomy, and the discoveries brought about by the aid of photography may yet compel a revision of the existing theories in regard to the solar and stellar systems. Reference has already been made in these columns to the investigations into the variations in the light of Algol, which the Arabs call the Demon Star, and to the discovery that these variations are due to a huge, dark body revolving around Algol, which at regular intervals comes into the line of sight between the latter star and the earth, and thus partially eclipses the Demon Star.

Certain irregularities in the motions of these two bodies have given rise to the suggestion that possibly their erratic movements may be due to the presence of another star in their immediate neighborhood; and Mr. S. C. Chandler, of Boston, has, after careful calculations, come to the conclusion that such a star actually exists, and that it is far more massive than either Algol or its companion. Mr. Chandler goes even farther, and says that there are several other stars known to astronomers to be variable which evidently have one more dark companions like those of Algol; and if this speculation should prove to be true it would simply be additional evidence of the great number and variety of material objects that undoubtedly exist in the stellar system.

The announcement made last month of the appearance of a new star in a constellation in the Milky Way has also attracted the attention of astronomers. New stars have heretofore been supposed to be stars of the ordinary kind, suddenly subjected to some process which has driven them into a condition of fervent heat; but new facts obtained by the use of the spectroscope have suggested that the former theories need to be entirely recast. In a memoir on this subject, presented recently to the Royal Society, Mr. G. Norman Lockyer, the great English astronomer, declared that one by one "the facts have been established that the solar system may, at a former stage of its history, have been a swarm of meteorites; that the spectra of nebulæ and of a certain class of stars remarkable for the appearance of bright lines in their spectra are similar to a degree hitherto undreamt of; and finally, that in a nebula so-called stars may vary their brilliancy with unimagined rapidity, and that even such stars as the Pleiades may in all probability be only the bright centers of a nebulous assemblage, a meeting-place of meteoritic streams."

During the last twenty years astronomers have been at work on new stars with the spectroscope, and it has been discovered that the quality of the light emitted by the stars is intimately related to comets and nebulæ. It has also been discovered that by heating a meteorite in a vacuum tube a bright light may be produced in the spectrum which disappears when the temperature is increased. It was also found that this line of light was coincident in position with the one observed in new stars, in nebulæ, and in faint comets; and the conclusion has, therefore, been reached that the appearance of a new star is due to the collision of two meteor swarms of different densities.

The amazing progress of science is strongly illustrated by these discoveries. In his lonely tower the astronomer scans the heavens, with his instruments, weighs and measures the flaming masses that are whirling through space billions of miles away, recognizes the colors which they give out as easily as those which come from the flame of his spirit lamp, and describes the composition of a flaming sun as readily as can the geologist the constituent parts of the rock which he is chipping with his hammer. Each fresh discovery, too, adds to the mystery of the heavens, and causes the finite mind to stand amazed at the complexity of the laws which rule the universe.—*Philadelphia Record.*

Sun Spots and the Aurora Borealis.

Observers of the sun's face have for centuries noticed at times dark spots on it. Now we know from the accumulated observations that the extent and number of these spots vary. Sometimes we can see very few, or even none at all, and sometimes we can see a great many, some of which are visible to the naked eye when protected by a colored or smoked glass. Such a spotted region is now (February 18th) passing out of sight on the southwestern limb of the sun; but a second group of spots is finely visible on the northern hemisphere, stretching in a long line from the eastern edge to the center of the sun. But what has the sun to do with the aurora? Simply this: It has been shown that when we have the greatest number of sun spots, then we have the most frequent and most gorgeous displays of the aurora. When there is a great storm on the sun-producing spots, then we feel at once on our little earth a disturbance of electrical conditions. The display of the aurora on February 13th is regarded as an accompaniment of the solar disturbances which have produced the tremendous spotted regions mentioned.

The average time from when the spotted area on the sun is greatest to the next maximum is a little over eleven years. The last spot maximum occured in 1883-4, a year or two behind the average time, and we seem now to be approaching a maximum in 1892-3. We may therefore fairly conclude that during this year we shall be favored with numerous and brilliant aurora.—*Professor John K. Rees, in Harper's Young People.*

ELECTRICAL PROGRESS

Electrical Action of the Human Body.

In the course of a series of lectures delivered by Prof. McKendrick before the Royal Institution of London, the speaker showed some interesting experiments to demonstrate that there was in reality a distinct electrical action of the human body. He showed the effect of animal electrical currents by means of a very sensitive galvanometer. Current from animals such as the torpedo fish had long been known, he said, but it was much disputed whether there was such a thing as an electric current from man. This man-current he demonstrated by putting his hands into a three-quarter per cent. solution of common salt contained in two flat vulcanite dishes. The effect upon the galvanometer was greater as the number of fingers inserted was increased, and was greatest when the muscles of the arm were contracted. There were no fewer than 50 species of animals that were living electric batteries, the speaker declared, although only five or six were generally known.

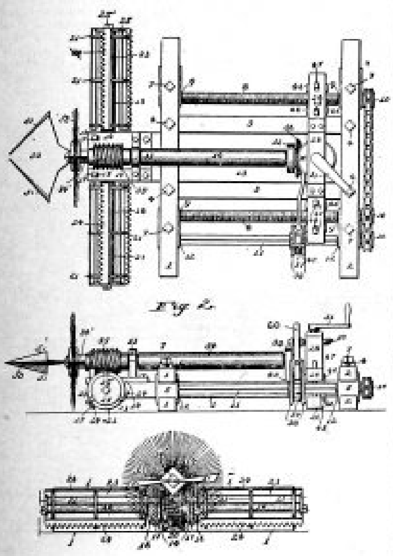
Is Electricity a Manufactured Article?

If electricity is a manufactured article, so is the atmospheric air we breathe, and the one is quite as much open to taxation as the other. Atmospheric air is utilized in many ways. Take one, for example, viz.—blast furnaces. The air which surrounds this globe of ours, and without which active natural life (animal or vegetable) cannot exist, is drawn by the blast engine into its cylinders, and there compressed and forced out through the tuyeres into the furnace with the force required to raise its contents to melting heat; it undergoes no chemical or other change; it is not manufactured by a combination of other elements; it is certainly a combination of gases, but that combination is not the result of human agency, and it is free to all creation; consequently cannot by any laws or possible course of reasoning be brought under the head of a manufactured article.

In its utilization for the above-mentioned and for hundreds of other purposes, it undergoes no change of any description, and cannot be placed in the same category as gas. Electricity is an element similar to atmospheric air. Every one who knows anything about electricity knows that it pervades everything in the universe, in a positive or negative state, and by disturbing the equilibrium which if left to itself maintains, certain effects are produced. Electrical machines of whatever description, do not manufacture the electric fluid. They are merely suitable forms of machines for collecting, or *generating* (though it is a question whether the latter is a strictly correct term) the electric fluid which already exists; just as the blowing cylinder of the blast engine draws in and compresses the air, so the dynamo draws off from the surrounding earth its supply of electricity, which by careful insulation is utilized as required in its efforts to return to its normal condition. Blast is conveyed by pipes from the blowing cylinder, and air vessels (when they are used) to the furnaces or to whatever other use the compressed air is to be applied. The electric current is conveyed by insulated wires and cables to whatever use it is to be applied, but man did not make the air or the electric fluid but he does make the gas, because by a mechanical process he produces it from a substance—coal—which undergoes a change and yields other products besides gas. Neither the atmospheric air or the electric fluid undergo any change in their constituents by utilizing the energy collected, and stored in the appliances and apparatus in use at electric lighting stations, or at the blast furnaces of iron companies, and the latter could not reasonably be taxed for the supply of air drawn from nature any more than the electric fluid can be taxed which is also drawn from nature. Water works companies do not manufacture the water which they supply to the public, but all three industries derive pecuniary profit from the supply of these articles to the public, with which articles they are supplied by nature, and consequently to determine the point mooted in your article it is for legislators to decide whether setting aside the nature and description of article (atmospheric air, electricity, or water), the industry itself as a profit-producing business taken from the same aspect as any other profit-producing business in which capital is invested, is or is not liable to taxation on the profits of the concern; if it is not taxed the chances are the public will not be supplied a whit cheaper, and if it is taxed the public will indirectly pay the tariff.—*W. D. Baylis in Discovery.*

ORE MINING MACHINE.

No. 471,434. James C. Robertson, Glen Campbell, Penna. *Patented March 22, 1892.* A large triangular drill head 50 is mounted on the end of the drill shaft 34, which is rotated by hand by means of the crank 31, and the bevel gears 30 and 33. The drill shaft carries a large brush 52, to clear away the borings made by the drill head 50. It also carries a worm 35, which drives a worm wheel 20 (seen in the front end view) and the cutter shaft 18. This shaft has several flanges or discs 21 which are notched to receive and hold three cutter bars 24. These cutters are notched on their edges as shown, and they serve to tear out the ore that is loosened by the drill. The cutter shaft and the drill shaft are mounted on a sliding plate 13, which slides between the front end bars 1, and the side bars 3. A cross head composed of two transverse bars 26 is attached to 13 and guides it, and also carries the driving gears and crank. It is provided with two nuts, made in halves, which engage



the screws 8. These feed screws are journaled in suitable boxes in the front and rear frames 1 and 2, and are turned by a chain and sprocket wheels 10. The third sprocket is carried on the end of the square shaft 31, which is rotated by a ratchet 37 and a pawl carried on a lever 60. This lever is vibrated by a pitman attached to a crank pin on the face of the gear 36 and the throw of the lever is varied by connecting the pitman at different points, for which purpose the lever is provided with several holes. In operation the frames 1 and 2 are securely fastened in place by jack screws or bars, and the crank is rotated until the drill and cutters are driven as far forward as the crosshead will carry them. Then the keys 47, on each side of the feed nuts, are drawn out allowing the nuts to open. Next the frame is moved forward by bars or handspikes, until the rear bars 2 encounter the crosshead; the feed nuts are closed, and the machine is ready for another advance.

GAS APPARATUS.

No. 469,574. James R. Kendall, Terre Haute, Ind. *Patented February 23, 1892.* The shell or casing A, is made of wrought iron plate, and is lined with fire-brick *a*, as is its cover T, which has in it the valve T^1 closed by the hinge E.

The apparatus has within it three chambers B, C, and D, of which B and C are heating and decomposing chambers, and D the gas receiving chamber, the remaining space within the cylinder being filled with brick "checker work," in which the currents of gas passing in through the cylinder are interrupted and broken up, thus causing a thorough diffusion and mixture of the gases throughout the cylinder or retort. The top layers of the checker-work are covered with a layer of fire-brick balls *s s*, which form grate-like bottoms for the heating or decomposing chambers.

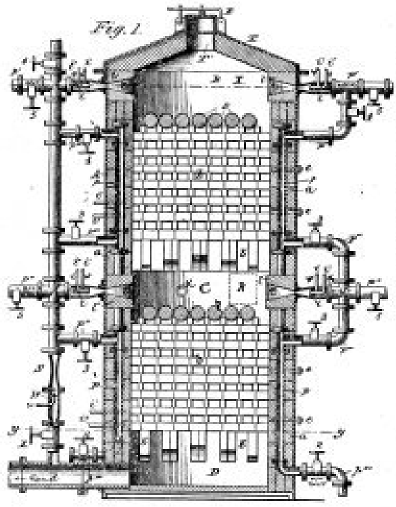
Access to the chamber B for the purpose of cleaning, repairs, and inspection is had through the valve-opening T^1, and to the chamber C through the man-hole R. The valves K and T^1 are used to admit air while the retort is being heated to the proper degree for fixing the gas and are closed during the operation of fixing.

Blocks l l^1, of suitable refractory material, which contain the curved and flared tuyeres t t^1, are set into the lining of the retort in such a manner as to cause the hydro-carbon vapor, steam, and air passing through them to spread out and rotate around the chambers, thereby diffusing and commingling the same.

The gas receiving chamber D is provided with the discharge-pipe *d*, through which the gas which has entered it from the chambers B and C and passed through the checker work *b b*, leaves the retort or generator.

Embedded in the lining of the retort are the circumferential steam pipes i^{11} i^{12} and the vertical air-pipes *p p*, which connect by means of the pipe p^{111} p^{11} and p^1 p^{11} with the tuyeres t^1 t^2. These pipes p^1 p^{11} at the point where they enter the retort are connected to the tuyeres are considerably contracted in diameter, forming nozzles *i i*, at the larger end of which, as shown in Fig. 1, enter the nozzles i^1 i^2, which admit the hydro-carbon to the retort, and behind them the pipes i^{11} i^{12} in the lining of the retort, through which is admitted steam to the retort at i^1 i^2. The nozzles *i i* are really injectors, the steam-jet spraying and vaporizing the oil as it enters the nozzles and carrying it into the decomposing chambers. The pipes p^1 p^{11} connecting with the nozzles or injectors *i i*, are used to admit air directly to the retort.

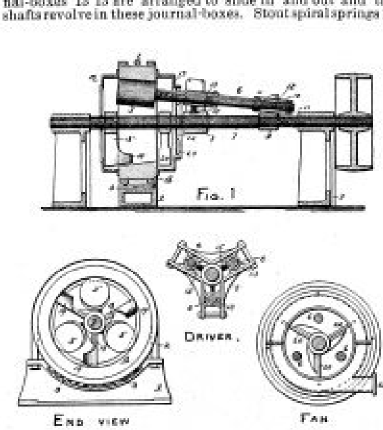
A draft pipe 8, is attached to the gas pipe *d*, and is provided with a steam jet blower W, to aid in blowing up the fire. The apparatus is started by building a wood fire in the top chamber B, and starting the upper injectors and blowing in some oil spray. At the same time the valves T^1 and K are opened, also the valves 1 and 6 in the pipe 8, and the steam jet W is started. As soon as the checker work begins to get hot, the valves T^1 and K are shut, and air is taken in only through the pipes *p*. As soon as the brick



are heated to incandescence, the valves I and 6 are shut, the air supply is shut off, and all the injectors are turned on to full capacity. The oil vapor and steam are broken up by the intense heat, and combine to make permanent water gas, which passes off to the holder by the pipe *d*. This process of gas making is continued until the checker work is cooled to the point where it will not dissociate the vapors, when the gas valve in pipe *d* is closed, and the blower W is started up, and the process of blowing up the heat to incandescence is resumed. Thus the process of gas making and heating up the apparatus are alternated at intervals depending upon the size of the apparatus.

GRINDING MILL.

No. 469,145. Samuel Hughes, Charleston, S. C. *Patented February 16th, 1892.* A represents a circular die. This die is set horizontally on a bed 1, where it is held securely by a bolt or band 2 as shown. The die is preferably constructed with a tapering bore 4, and rolls 5 5, preferably cylindrical in form, are arranged to co-operate with this die to crush, grind, and pulverize the material fed into the mill. To properly balance the machine, three rolls are desirable. These are secured on shafts 6 6, which in turn are arranged equidistant from one another around a horizontal drive-shaft 7. A pair of drivers 8 and 9 are secured to the main shaft 7 at suitable distances apart. In the former the shafts are arranged to vibrate or slide radially from the shaft 7. The end of the shaft passes through a sleeve 10, where it passes, revolves freely as occasion requires it, and to prevent endwise movement collars 11 are secured on the shafts at the ends of the sleeves. The sleeves themselves are provided with trunnions 12, by which they are supported in driver 9. In the large driver sliding journal-boxes 13 13 are arranged to slide in and out and the shafts revolve in these journal-boxes. Stout spiral springs 15

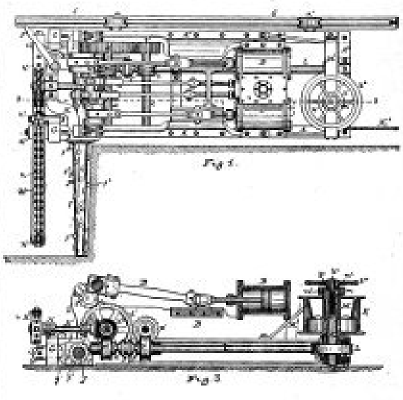


15 of sufficient tensile strength to sustain the weight of the rolls and their shafts, are interposed between the journal boxes and the hub of the driver, to resist the downward tendency of the uppermost roll or rolls when not held outward by centrifugal force. The drivers hold the rolls to their work and prevent lateral strain which would otherwise result. The heads 16 and 17 are secured to the opposite ends of the circular die, as shown in Fig. 1, and the rock is fed through the former.

To regulate the passage of the material through the machine and prevent its being fed through too rapidly, feeding-arms 18 18 are secured to the main shaft 7 just inside the head of casing 16. These arms are preferably about three in number, and as they rotate they catch the material and drive it inward. From the enormous speed there is a tendency to drive the material entirely through the die at once before it is ground; but this is prevented by bending the arms at their ends to form hooks 19 19. These catch the material and tend to stop it or retard its progress. At the opposite end of the circular die the paddles or fans 20 20 are secured. These devices create a draft, which forces it out through a discharge 21, and, in this manner, the material is removed from the mill, after which it may be screened.

MINING MACHINE.

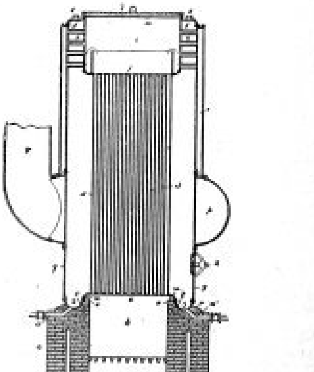
No. 469,260. Jonas L. Mitchell, Chicago, Ill. *Patented February 23, 1892.* This machine employs a long taper cutter bar F, which is armed with projecting teeth as shown, and is rotated by a pinion *f* gearing into the wheel d^1. This wheel is driven by the pinion shown on the engine shaft. The engine is double and is intended for the use of steam or compressed air. The driving wheel d^2 also drives a pinion e^1 on a shaft *e*. The machine is dragged along the face, and the cutter bar kept up to its work by a cable K^1, which is wound up by the drum K. The end of the cable is hitched to a jack-screw fixed at some convenient place ahead. The drum is driven at either of two speeds by the worms shown on the shafts *e* and *d*. Both worm wheels are loose on the shaft *l*, and turn at different speeds, in the same direction. A clutch P serves to engage either worm wheel to the feed shaft *l*, which turns the worm wheel L on the foot of the drum shaft *k*. Connection is made to the drum by means of the friction clutch M, which is operated by the screw k^3 and hand wheel k^4. In case hard coal or other obstructions are encountered, the clutch M may be eased off, and the drum be allowed to slip until the obstruction is cut through or removed. The



chips are cleaned out from the cut by a chain *h*, which is driven by a sprocket wheel H^4, and is guided by bars h^2. Motion is imparted to H^4 by the shaft H^1 and miter gears H^2, H^3 which are driven by the shaft *d*. The cutter bar is removable from the main frame of the machine, to facilitate the moving of the machine around the chamber. To do this, the cutter bar journals are made to run in square boxes. The rear end of the frame is provided with heavy straps *g* and keys as shown. The square boxes pass between the straps and are secured by driving in the keys. The tendency of the machine to work itself out of the cut is resisted by a rail C, which is laid on the floor and is held in place by suitable jack-screws. The outer bar of the main frame is supported by the wheels *a*, but the inner side runs on a shoe plate laid on the floor.

STEAM BOILER.

No. 469,124. Thomas R. Butman, Chicago, Ill. *Patented February 16, 1892.* This boiler has a plain cylindrical shell *g*, which is closed at the bottom by a semi-circular ring *s*, which provides a good receptacle for sediment and scale. The upper tube sheet is riveted to an inner shell *i* which is



closed at the top by a cover *l*, lined with brick or tile *m*. A great number of short tubes *n*, run from the smoke box through the shells *i* and *g*, to the outer smoke flue or jacket

o. This jacket extends downward to the chimney belt p. The furnace is circular, and is made with double walls, and the air for the fire is taken in between the walls, for the purpose of economizing heat and increasing the combustion of the fuel. A deflecting ring f is provided at the top of the tubes to equalize the draft through the tubes n.

The hot gases from the fire pass upward through the tubes d, into the smoke-box, and out through the tubes n, then downward through the jacket o, to the belt p, and pass from there up the stack q. The water line is carried above the top tube sheet. In all but the smallest boilers there is enough room between the shell g and the tubes, for a man to pass around, to inspect and clean the interior.

TRACTION DEVICE.

No. 468,860. Walter B. Wright, Chicago, Ill. *Patented Feb. 16, 1892.* It is found that in the case of light cars, such as tram and street cars in which the propelling power located upon the car is employed, the weight of the car is not sufficient to cause the desired degree of adhesion of the running-gear to the supporting track. Particularly is this deficiency remarked in the event of heavy grades and slippery tracks being encountered.

To remedy this trouble, a wheel O^2 running in a conduit P^4 is employed, to grip the flanges of the conduit against the traction-wheel with any desired force.

C is a traction-wheel on the short axle D, which is supported in the bearings E E, so as to move vertically on the hangers F F. G is a sprocket-wheel upon the same axle driven by the drive-chain H, from the sprocket-wheel J on the armature shaft K of the dynamo L. M M are the arms of a yoke, in which is also journaled the axle D, and these

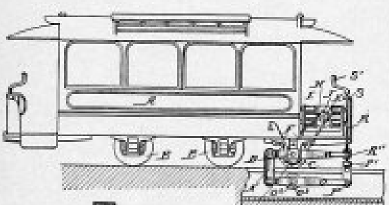


Fig. 1

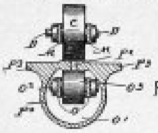


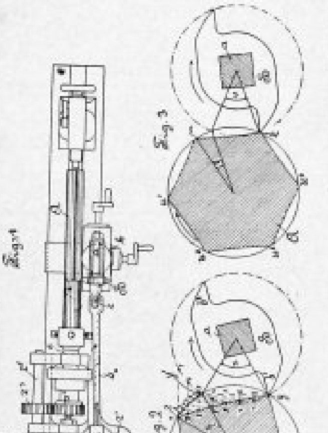
Fig. 2

arms are linked by the link N to similar arms O O within the channel O^1. These arms support the short axle O^3, which carries the wheel O^2. At the forward ends of the arms O they are connected by the link P^1, which passes up through the slot P^2 between the side sections P^3 P^3 of the conduit pipe P^4.

The grip handle S^1 and its shaft S passes down through the platform and is provided with a screw thread on the lower end, which engages the nut P^1. The grip shaft also has a collar bearing on top of the swivel R^{11}. When the car arrives at a hill, or a piece of slippery track, the motorman can secure all the adhesion he wants by turning the handle S^1, and thus increasing the pressure between the wheels C and O^2 upon the flanges of the conduit.

LATHE.

No. 469,813. Carl G. Dahlgren and John H. Svensson, Goteborg, Sweden. *Patented March 1, 1892.* The object of this invention is to turn blanks to square, hexagonal, or other prismatic form, in a lathe of ordinary construction. Fig. 1 shows a top view of the lathe and special cutter, and Figs. 2 and 3 show the relative positions of the blank and the cutter at successive moments, when producing a

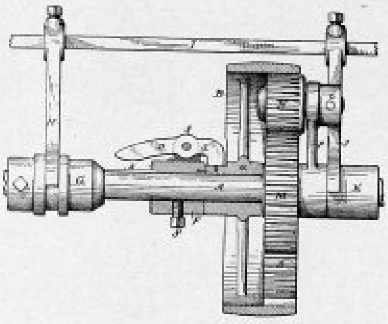


square and a hexagonal column. It is found that a cutter having two equidistant blades will, if driven with a velocity double that of the blank, cut out a four-angled figure, the faces of which are slightly convex. If driven with a velocity treble that of the blank, it will but out a hexagonal figure the faces of which will be slightly concave.

In the drawings, A is the blank, which is fixed on the live-spindle c in the usual manner. The live-spindle c drives the shaft z^1 by means of toothed wheels z^5 z^4. On the shaft z^1 is the toothed wheel z^2, which gears with the spherical toothed wheel z^3, through which passes the shaft d, connected to rotate with the wheel z^3 by means of a long feather d^1 thereon moving in a keyway in the wheel, so that the shaft d is freely movable in the line of its axis back and forth through said wheel. The shaft d is connected to the shaft a, carrying the cutting-tool b, said shaft a being journaled parallel to the blank in a rest-block with usual adjustments parallel to and perpendicular to the blank. The joint connecting the shafts d and a may be of any known construction of rocking joint, whereby the shaft d may revolve the shaft a at all times, whatever may be the relative angular position of the axis of the shaft during the working of the machine. By replacing the one or other pair of wheels z^1 z^2 or z^3 z^4 by similar gearing-wheels of different relative sizes the proportion between the velocities of the spindle c and the shaft d, or between the blank and the cutting-tool may be altered at will. If the tool be moved up too close, the blank will be merely reduced in size although it will be properly shaped, but if the tool be moved too far away it will only flat off or hollow out the sides of the blank. Thus the size of the work turned out is limited by the size of the cutter.

DRIVING PULLEY FOR LATHES, ETC.

No. 469,468. Perry R. Gilbert, Chambersburg, Pa. *Patented Feb. 23, 1892.* The shaft A is driven by the pulley B, or vice versa. The hub of the pulley is made with several notches b, which are engaged by the dog D. The shipper rod I carries two arms or forks H and J. Arm H takes hold of the cone G, which slides on a feather in the shaft, and serves to throw the lever or dog D into the position shown. The collar which carries the dog is fast on the shaft, and when the cone is moved up against the collar F, the pulley hub is seized by the dog and it is compelled to revolve with the shaft A. When it is desired that the pulley should run the reverse way, the cone G is moved away to the position shown, the spring d throws the dog



up out of the notch b, and the shipper rod is moved to the left until the arm J obstructs the hub i on the arm P, as shown. This arm turns loosely on the shaft and carries a pinion N, which gears with a spur wheel M (which is keyed on A) and with teeth on the inside of the pulley rim. While the pulley is clutched to the shaft by the dog D, and cone G, the arm P and its pinion all go around with the pulley, but when the arm P is stopped by the shipper arm J, the pinion revolves on its pin and transmits the motion of the spur wheel M to the rim S of the pulley, moving it in the opposite direction, and at a lower speed. The device is thus adapted to drive machines having a slow driving motion and a quick reverse or return movement.

LIGHTING DEVICE FOR SAFETY-LAMPS.

No. 469,918. John B. Harris, John T. Griffith, and Thomas B. Harris, Wilkes-Barre, Pa. *Patented March 1 1892.* The letter A represents an oil-reservoir of the usual construction, which constitutes the base of a lamp and is adapted to be screwed to the lower section of a lamp. This reservoir is provided with the usual wick-tube and wick-raising devices, as shown, and in proximity to the wick-tube A^1 is arranged the open-ended tube or casing B, within which is arranged the traveling fulminate-carrier, which

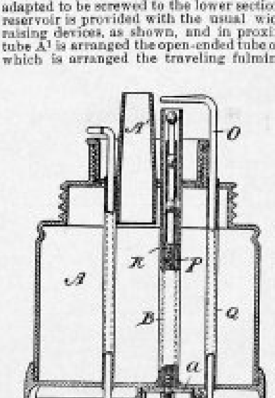


Fig. 1

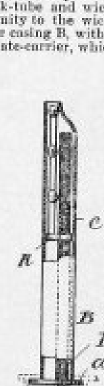
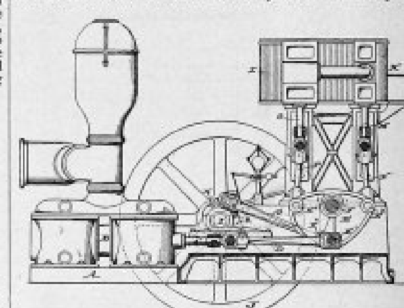


Fig 3

consists of a flat elongated plate R, having a screw threaded opening, through which passes the screw rod P, which is suitably swiveled at its lower end in a cap-plate a, which latter rests upon the end of the nut or screw-threaded ring T, which is secured to the bottom of the oil-reservoir by screwing the same into the ring or circular flange U, said cap-plate serving also as a cover for the lower end of the tube B, thereby cutting off all communication with the atmosphere and thus preventing the admission of air and gases through the same, the carrier for the inflammable substances being thus completely housed within the containing tube. The tube B is formed with an interior recess or niche to receive the rod P, which latter is provided at its lower end with a thumb-nut or handle e, by which it may be rotated so as to cause the fulminate-carrier R to move up or down for the purpose of bringing a pellet or the end of a match-stub into position to be operated upon by the igniting device O, for the purpose of lighting the lamp, the formation of the tube or casing being such that a number of match-stubs, as shown in Fig. 3, or other suitable inflammable substances may be placed therein at one side of the rod P and supported upon the carrier, one above another, so as to be brought successively into position to light the lamp. These simple contrivances afford a ready means for supplying a miner's lamp with a number of fulminating-pellets, for the purpose of lighting or relighting a lamp by manipulating the igniting device from the outside, without danger of explosion or the necessity for leaving the mine.

PUMPING ENGINE.

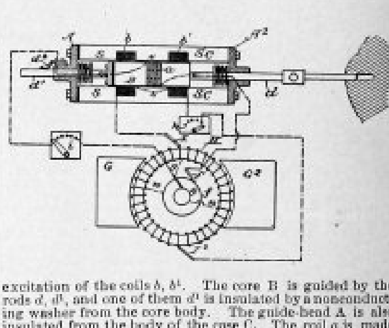
No. 469,661. Wm. E. Good, Philadelphia, Penn'a. *Patented Feb. 23, 1892.* The plungers are double acting, and are driven by a connecting rod D, which takes hold of a pin E^1 on the triangular beam E. The pistons of the high pressure cylinder K, and of the low pressure cylinder L, are connected by the rods N and P to the opposite ends of the same beam, by the pins E^2 and E^3. Two of these engines are usually built in one frame, and the fly-wheel J is located between them. Each end of the fly-wheel shaft is pro-



vided with a crank H, and the shaft is rotated by connecting rods G, which are coupled to a fourth pin E^4 on each beam. The valve mechanism (not shown) is driven by a "Fink" link, and is controlled by a "Porter" governor as shown. By this construction the working parts are made very easy to get at, and a great economy of room is secured. The foundations required are of the plainest kind and consequently the expense for buildings and masonry is smaller than with other types of pumping engines.

ELECTRIC RECIPROCATING ENGINE.

No. 469,441. Merle J. Wightman, Scranton, Pa. *Patented Feb. 23, 1892.* This engine employs a continuous current in the field coils b, b^1, which are stationary, and an alternating current in the armature coil a on the reciprocating core B, at the same time. The field coils are contained within groves in the outer iron case C, and are connected at one end to the brush I, and at the other end to the brush I^2. A resistance box h, is provided in the circuit to vary the



excitation of the coils b, b^1. The core B is guided by the rods d, d^1, and one of them d^1 is insulated by a nonconducting washer from the core body. The guide-head A is also insulated from the body of the case C. The coil a is made principally of plates, and the ends of the coil are connected to the rods d and d^1, and through them to the brushes g^1, f^1. These brushes bear on the continuous rings g and f and consequently receive an alternating current, while the brushes I and I^2 bear on opposite sides of an ordinary commutator and take off a continuous current. The polarity of the field is thus constant, while that of the core is rapidly reversed. The alternating current can be varied in strength by the resistance box i. The movement of the core may be made much stronger in one direction than in the other. This is done by connecting the armature coil a to the continuous current circuit, through a resistance that can be varied at will. If the continuous and alternating currents be equal then the core B will be inert, and its moving force will increase exactly as the continuous current is withdrawn. As long as both currents excite the core, the movement outward or away from the center of the case C, will be equal to the difference in force of the two currents, but the return will be accomplished by the combined force of the two, and will consequently be far more rapid and forcible than the outward motion. The operating currents may be derived from the same machine, as shown, or from separate dynamos. Or a continuous generator may be used with a pole changer to produce the alternating current.

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Coal and Metal Mining and Kindred Interests.

VOL. XII.—NO. 11. SCRANTON, PA., JUNE, 1892. WITH WHICH IS COMBINED THE MINING HERALD.

THE ECONOMIC GEOLOGY OF COPPER

The Mineralogy, Mode of Occurrence, and Production of Copper.

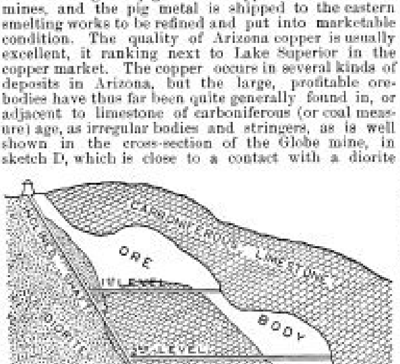
BY H. A. WHEELER, E. M., OF ST. LOUIS.

[CONCLUDED.]

Of even greater importance, at present, than the Lake Superior region, is the copper output of Montana, which since 1887, has been the heaviest producer in the world. This great output comes from the immediate neighborhood of Butte City, where a series of parallel fissure veins have been worked for a distance of over three miles. The veins occur in a dark granite, and carry ore bodies that run from 10 to as high as 150 feet wide. At first the ores were largely oxides and purple ore that ran from 10 to 50% in copper, but as the mines get deeper, the ores become more base, or change into the poorer chalcopyrite, so that to-day the ores of Butte may be said to run from 5 to 10% in copper. They all carry some silver, and usually in sufficient amounts to more than pay for its extraction. In fact, the famous Anaconda, the giant producer of the camp, was originally started as a silver mine, as no copper of any importance was struck until a depth of over 400 feet had been attained; but at that depth large bodies of very rich oxidized ores were found, which at greater depths have changed into the sulphide. On account of the lower grade of the ores since the mines have worked below the permanent water level, concentration mills have had to be erected to enrich them before smelting which latter operation produces a product called "*matte*" that will assay from 35 to 70% in copper. This copper matte is shipped to Eastern and Continental smelting works, to be further treated and converted into casting copper or ingots. Although copper ore of high grade had been previously shipped out of Butte to Colorado and other smelters, the real history of Butte as a copper camp may be said to date from 1880, when it first enjoyed railroad facilities and began to do its own smelting. Since then the output has steadily grown until it exceeded 56,000 tons in 1891, of which the Anaconda group of mines, though shut down for several months, produced 23,000 tons, the Boston & Montana Company 13,000 tons, Parrott Copper Company 7,000 tons, and the Butte & Boston 9,000 tons. In spite of these large outputs the profits have not been very large, for while the ores are much richer than at Lake Superior, the working expenses and transportation changes are much higher than at the "Lake", while the copper sells for ½ to 1½ cents a pound less than lake copper on account of its inferiority for wire-drawing or rolling. So with the comparatively low prices that have ruled for copper since Butte has become such an active competitor in the world's copper market, the dividends have not been very heavy; however, the Boston & Montana Company have paid out \$2,075,000 and the Parrot Company \$850,000, as dividends, while no official information is published as to the profits of the Anaconda Company, though it probably does not begin to rival its great lake competitor, the Calumet & Hecla, as a money maker.

Next in importance in the far west to Montana comes Arizona, which began to regularly produce copper, though in small amounts, in 1873; a new era of activity began in 1880, which has finally resulted in making this territory one of the most important producers of this country. Copper is very liberally diffused throughout most of Arizona, and if it enjoyed good and cheap railroad facilities, with an abundance of water and fuel, it would become a very heavy producer. As it is, only rich and large ore bodies can be worked at a profit, on account of the heavy expenses for operating, and the excessive transportation charges. This latter item brings the price of the coke used for smelting that costs \$2.00 at the coke ovens, up to \$20.00 to \$60.00 a ton at the mines, depending on their proximity to the railroads.

The ores thus far worked in Arizona have been almost exclusively the oxidized series, or the oxides, carbonates, and silicate, which in one smelting operation yield a pig copper that will assay about 96%. This smelting into pig or block copper is done at the mines, and the pig metal is shipped to the eastern smelting works to be refined and put into marketable condition. The quality of Arizona copper is usually excellent, it ranking next to Lake Superior in the copper market. The copper occurs in several kinds of deposits in Arizona, but the large, profitable ore-bodies have thus far been quite generally found in, or adjacent to limestone of carboniferous (or coal measure) age, as irregular bodies and stringers, as is well shown in the cross-section of the Globe mine, in sketch D, which is close to a contact with a diorite



SKETCH D.—CROSS SECTION OF THE GLOBE MINE, ARIZONA.

dike (after Wendt). The ores as delivered at the furnace, after sorting or concentrating, will assay from 8 to 20% in copper; but as the mines become deeper, as they are still quite shallow, the oxidized ores will give place to the poorer, and probably less pure sulphide ores. The largest producer in Arizona is the Copper Queen Mine, which has for the past four years shipped about 4,700 tons of copper a year, and has paid \$1,500,000 in dividends since it began producing in 1880. This mine and the Halbrook & Cave properties, which produced 1,400 tons in 1891, are in the Bisbee district, near the Mexican border.

Next in importance to the Copper Queen Mine is the Old Dominion Mine, in the Globe district, in the central portion of the territory. This district is the most disadvantageously located of any of the copper producers of Arizona, as all the supplies for the mine, and the pig copper sent out has to be hauled 120 miles by wagon, before reaching the Southern Pacific R. R., at an expense of \$30.00 a ton. But on account of the richness of the ore it has been a very profitable property since 1882 on an annual product ranging from 2,300 to 3,900 tons of copper.

The Arizona Copper Co., at Clifton, in the south-eastern part of the territory, built a railroad seventy miles long in order to do away with the heavy haulage charges that they formerly had to bear in working a property that yields from 2,300 to 3,800 tons of copper a year. The Detroit Copper Co., which produces about 2,500 tons of copper a year, is also in this Clifton district, which is the oldest in the territory, it having been a constant producer since 1873.

The United Verde mine, in Yavapai County, with a production of about 3,300 tons in 1891, and a few small mines bring the total production of Arizona up to about 20,000 tons in 1891, which is the largest record in the history of the territory.

As Lake Superior, Montana, and Arizona produced about 93% of the copper product of the United States in 1891, it leaves but little to be considered as the present results of the other copper-producing districts.

Colorado produces but little copper from mines worked solely for this metal, but considerable is obtained as a secondary or by-product in working the gold and silver ores in several parts of the state, especially in Gilpin and Clear Creek Counties, and the total output in 1891 was about 3,400 tons.

California produces a little copper from a property in the southern part of the state that is now operated by a French company, and which at one time promised to become an important producer. The output of this state in 1891 was only about 1,800 tons.

Utah produces some copper, but mainly as a by-product in working copper-bearing gold and silver ores, the amount not exceeding 1,000 tons in 1891.

New Mexico and *Texas* have had flattering prophesies made of their copper resources, but thus far their copper production has never been large or important, the New Mexican output having been only about 800 tons in 1891.

The Appalachian belt, from Canada to Alabama, contains more or less copper, and many attempts have been made to work these deposits in Maine, Vermont, New

Hampshire, Pennsylvania, Virginia, Tennessee, and other Eastern States, but with the exception of Vermont, they have not proved a success as a financial investment. At Ely, Vermont, the copper vein, which is a segregated deposit, has been exceptionally rich and persistent for these Appalachian chalcopyrite ore-bodies.

This Ely Mine has been worked to a depth of over 2300 feet, on the pitch of the vein, in working an ore that runs 3 to 7%, and formerly produced as much as 1500 tons annually, which is a very large output for an Eastern copper mine. The total product of the Eastern and Southern States in 1891 was less than 1000 tons.

In considering the copper production of the world, the heaviest pro,ducing district after those of the United States, is the be't of crystalline rocks of Paleozoic age that stretches for a distance of 140 miles from Western Spain into Portugal, and on which are the famous Rio Tinto, Tharsis, Mason & Barry, and other mines. In this belt, which is 30 miles wide, occur lenticular masses of copper-bearing pyrites, as contact deposits, along porphyry intrusions. The ore varies somewhat in richness, but usually runs from 2·5 to 3·5% in copper, while the ore bodies vary from a few inches to over 500 feet in thickness, and as much as 3000 feet long. Large quantities of this low grade ore is shipped to Europe, where its high sulphur contents is first utilized in making sulphuric acid, before the copper is extracted by smelting from the roasted residue. Much larger quantities of the poorer grades are treated at the mines, and the total production of these Iberian mines in 1890 is given as 53,000 gross tons, of which the Rio Tinto company is credited with 30,000 gross tons.

Next in importance to Spain in Europe are the copper-bearing slates of Mansfeld, Germany, from which large amounts of silver-bearing copper ore has been mined from a 12 to 22 inch seam of Bituminous slate for a long time. The ore will average from 2·5 to 3·0% in copper, though some is as poor as 2% and a little as rich as 10%. The usual output of this district, at present is from 12,000 to 16,000 tons of copper per annum.

None of the other European countries produce any large amount of copper, and the famous Cornwall district in England is now of trifling importance as a copper producer, as its output in 1890 was only about 1,000 gross tons.

Chili was one of the most important copper producers of the world for quite a long period, but its annual product quite steadily declines, through the impoverishment and exhaustion of its mines, and the output in 1890 was 26,000 gross tons, which is about half as much as was produced in 1879.

Japan is quite a copper producer, its output in 1890 amounting to 15,000 gross tons.

Australia, South Africa, Venezuela, and Mexico produce some copper, which when added with various other scattering countries of still less importance, assist in bringing the total copper production of the world up to about 270,000 gross tons in 1890, according to the annual statistics of the *Engineering and Mining Journal*, from which most of the preceding statements of production have been obtained.

Nova Scotia Explosives Commission.

Reference was made some time ago in our columns to the appointment of a Commission by the Government of Nova Scotia, to examine into the question of replacing gunpowder by an explosive equally effective but less dangerous in the presence of gas and dust. The question was forced upon the Government owing to the inquest upon the Springhill disaster proving that the immediate cause of the explosion was due to the flame of a charge of gunpowder used in blasting. The Commission, with the Inspector of Mines as chairman, has had several meetings and has experimented with the most promising explosives in the Pictou and Cape Breton mines. The results are not yet known, but it is understood that two explosives have proved satisfactory so far. One of these is roburite, already well known in England, although not yet officially endorsed by the British Government; the other is understood to be similar to the mixture of dynamite and nitrate of ammonia approved of by the French Government as having, when detonated, a temperature less than that of the ignition of fire-damp. As the exact compositions of these explosives calculated to be safest for coal mining have not yet been settled, the labors of the Commission are still unended. This subject is one of great importance, and has been studied by many of the leading chemists of the present day. The report of the French Commission is considered the most valuable contribution to the literature of modern explosives. They started out to find an explosive which, when fired in a mine, would not produce heat enough to ignite fire-damp. After researches and experiments extending over several years, they have announced four such compounds. Two of these have hitherto appeared desirable to the Nova Scotia Commission. If the further investigations of this Commission, which appear to be deliberately and carefully conducted, result in giving the public a safe explosive, the Nova Scotia Government will have rendered a great service to the coal mining industry of the Continent. Undoubtedly public opinion in the United States will follow that of Nova Scotia and demand that where gas is found in coal mines a safe explosive must replace gunpowder, and as the difference in cost of these explosives, as compared with gunpowder, is pound for pound, inconsiderable operators will not be able to raise the cry of increased cost of production. It is understood that as soon as a definite conclusion is reached by the Commission, the miners of British Columbia who have suffered from explosions will demand at the hands of their Provincial Government a similar measure of protection.—*Canadian Mining Review.*

EXTRACTION OF ORE FROM WIDE VEINS OR MASSES.

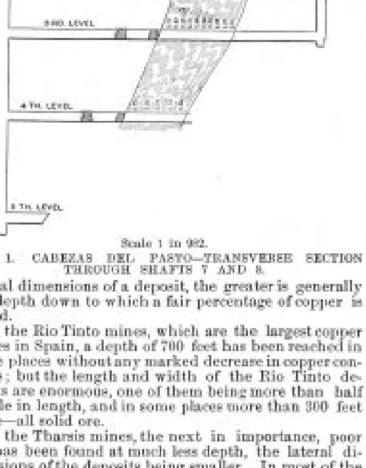
BY G. D. DELPRAT, LONDON, ENG.

[From the Transactions of the American Institute of Mining Engineers.]

The object of this paper is to describe an application of the cross-cut system of mining, as carried on in the Cabezas del Pasto mine, one of the copper-mines in the south of Spain. The system is not new; but it is not very generally adopted. It offers, however, decided advantages over other systems more in use; especially where the ore is found in large masses or wide lodes, it allows the extraction of all the ore without leaving any pillars or roofs. A somewhat detailed description of the various operations and costs of working may not only be interesting, but may possibly lead to a more general adoption of this method in cases where at present the pillar and stall system is preferred.

The copper-lodes in the south of Spain and Portugal are the following: They are nearly all lenticular masses of great lateral dimensions and unascertained depth; their direction is approximately east-west, and their dip towards north. Some are contact-lodes, having slate on the hanging-wall and porphyry on the foot wall; others are imbedded in porphyry, and others again are imbedded in clay-slate.

The upper portion of these lodes consists of "gossan," a siliceous peroxide of iron, mixed with more or less clay. The depth to which the gossan goes down varies in different localities, from 40 feet to 120 feet, and more. Below the gossan is found the iron pyrites, with about 2 to 3 per cent. of copper. The gossan is generally admitted to be the result of the decomposition of the pyrites, the copper rendered soluble, filtering into the underlying layers of undecomposed ore, and enriching the ore below the gossan above the general average. Very rich pockets and streaks of ore, containing sometimes 10 per cent. of copper and more, are often found in the upper portions of the lodes. The copper contained in the ore is generally in the shape of gray and black sulphides and copper pyrites; rich pockets often show chalcopyrite and fahlerz. In nearly all the mines the ore has been found to get poorer in copper with greater depth; a cross section through the Cabezas del Pasto mine (Fig. 1) shows this dimunition, and may be taken as a fairly representative case. The greater the



Scale 1 in 982.

FIG. 1. CABEZAS DEL PASTO—TRANSVERSE SECTION THROUGH SHAFTS 7 AND 8.

lateral dimensions of a deposit, the greater is generally the depth down to which a fair percentage of copper is found.

In the Rio Tinto mines, which are the largest copper mines in Spain, a depth of 700 feet has been reached in some places without any marked decrease in copper contents; but the length and width of the Rio Tinto deposits are enormous, one of them being more than half a mile in length, and in some places more than 300 feet wide—all solid ore.

In the Tharsis mines, the next in importance, poor ore has been found at much less depth, the lateral dimensions of the deposits being smaller. In most of the smaller mines the ore gets too poor to be worked at a profit at a depth less than 300 feet. One per cent. of copper is generally taken as the limit of workable ore.

The following is a complete analysis of a fairly representative sample of ore from the Rio Tinto mines:

Sulphur	48·3
Copper	3·44
Iron	43·33
Bismuth	·02
Lime	·36
Lead	1·00
Gold	·0005
Silver	·004
Cobalt	·05
Arsenic	·75
Antimony	·07
Calcium oxide	·23
Manganese	·05
Silica	1·80
Moisture	·48
Selenium	traces.
	99·95405

There are some exceptional deposits, which are of a different nature, such as the "Esperanza", near Tharsis, where the copper is found as a sulphide impregnating the slate, but they need not here be mentioned.

The ore is generally sorted by hand into two classes. The richer ore is sent to England and the Continent, to the sulphuric acid manufacturers (who, after burning off the acid, send the residue to the copper-works), and the purer ore is generally treated for copper only in proximity to the mines.

Two systems of mining are very generally adopted.

When the gossan is comparatively shallow, and the mineral mass is wide, the ore is generally got by open-cast working; the over-burden is removed in benches about 30 feet high, and the ore, thus laid bare, is quarried.

The cost of removing the over-burden varies with the nature of the ground and with the facilities for getting proper dumping facilities. The following statement shows the average cost over a whole year in the "Joya" mine, which is worked by the open-cast system. The greater part of the material removed is decomposed porphyry, and, as a rule, fairly hard.

COST OF REMOVING OVERBURDEN AT THE "JOYA" MINE PER CUBIC YARD IN THE SOLID (CALCULATED ON THE TOTAL QUANTITY REMOVED DURING 1891.)

Labor.—Superintendence	$0·009	
Excavation	0·032	
Loading into wagons	0·049	
Mule drivers	0·005	
Unloading wagons and repairing roads	0·016	
Various	0·001	$0·112
Materials.—Explosives		
Baskets (used for loading wagons)		
Railway material		
Wagon material		
Oil and grease		
Various		—0·011
Shops		0·006
Stable expenses (mules)		0·013
Tools		0·002
Amortisation of railway material		0·006
Total cost per cubic yard		$0.15

The open-cast working is certainly the best system in mines where the overburden is shallow and the deposit wide. The limit at which the removal of overburden becomes unprofitable is generally put at 4 cubic yards of overburden for every ton of ore laid bare. The cost of quarrying the ore, after having laid it bare, may be taken as follows, exclusive of general charges:

COST OF QUARRYING ORE IN THE OPEN-CAST IN THE "JOYA" MINE PER TON OF 1000 KILOS (AVERAGE FOR THE YEAR 1891.)

Breaking the Ore.—Miners	$0·038	
Materials (explosives)	0·012	
Shops	0·004	
Tools	0·005	—$0·059
Loading into wagons		0·038
Weighing		0·003
Total cost per ton, put into wagons and weighed		$0·10

Examples of open-cast working are found at the Rio Tinto (south lode), Santo Domingo, Tharsis (north lode Sierra Bullones, and center lode) La Zarza, La Joya, Las Herrerias, Lagunazo, etc.

When the proportion of overburden is too great, the mine is generally worked on the pillar-and-stall system. The lode is divided off vertically in floors, 30 to 40 feet apart, and in each of these floors galleries and cross-galleries are driven, intersecting one another at right angles, leaving large pillars of mineral to support the roof between the floors. The roof is generally left about 12 to 15 feet thick, and the square pillars have sides of 15 to 20 feet, the galleries being of the same width as the pillars, and about 20 feet high. It is evident that by adopting this system of working, a large quantity of ore is left in the mine; taking floors, 35 feet apart, with a roof of 12 feet, galleries 23 feet high and 16 feet wide, and pillars with sides of 16 feet, the quantity of ore extracted by means of the galleries is only one-half of the total quantity. In several mines, considerably less than one-half is extracted. It is generally maintained, by those who adopt the pillar-and-stall system, that after honeycombing the mass, more ore may be gained by robbing pillars and roof. This is, however, a very dangerous operation in mines where the lode is nearly vertical, where the width is considerable, the ore very heavy (specific gravity about 5), and where often ten to twenty floors are formed one above another. Only in one mine (the Carpio mine) has this been done; and the result was not encouraging. Only four floors had been formed, yet, although a good deal of ore was extracted by robbing, still by far the greater part remained in the mine, and could not be got out—the comparatively great height of the galleries being a great element of danger. That the operation of robbing is a very delicate one is confirmed by the fact that most of the mining companies, after extracting all the ore they could get by means of galleries, and finding their ore reserves disappearing, have determined, instead of robbing the pillars, to remove the overburden and quarry the honeycombed mass in the open air. Instances of this are found in many places. It is needless to say that a great deal of money would have been saved if the overburden had been removed from the beginning.

Another disadvantage, in connection with the "pillar-and-stall" system is the great cost of breaking the ore. Although galleries may be driven of considerable dimensions, as long as the ore is firm, still breaking ore in galleries, especially in hard ore, is always very costly. Whilst the breaking of ore in the open-cast may cost $0.07 per ton, the breaking in galleries will cost, on the average, from $0.52 upwards. When the ore is very hard, it may be as great as $0.85. The reasons for this higher cost are too evident to need any mention. A miner will break, per shift, in galleries about ⅔ of a ton; in the open-cast he will break from 12 to 15 tons of ore—and even more in favorable cases.

Examples of pillar-and-stall workings are found at Rio Tinto, in the San Dionisio lode; at Tharsis, in part of the north lode, and formerly, in the Sierra Bullones and La Tarza Tharsis (both these lodes are now open-cast); at Lagunazo, in the eastern portion of the lode, at Sotiel-Coronado, Pena de Hierro, Lapilla, Aznalcollar, Caridad, etc.

The Cabezas del Pasto mine is worked on a different system which allows all the ore to be extracted, without any danger, and at a low cost; and there seems to be no reason why the system should not be adopted in all places where the pillar-and-stall is now used, and where the height of overburden excludes the open-cast system. The mineral deposit at this mine is about 500 feet long, with a width varying from 20 to 75 feet, the average being about 32 feet. The gossan goes down about 100 feet; and it was, therefore, impossible to work the mine by open-cast. The lode is nearly vertical, as shown in Fig. 1, which presents a cross-section, approximately in the center of the mass.

After fairly ascertaining the bearing and extent of the lode, an extraction shaft and a pumping shaft were sunk in positions outside of the lode, as shown in Fig. 2. The dimensions of these shafts were 10 feet by 5 feet and 11 feet by 5 feet. The extraction shaft was divided by a partition in the center, so as to accommodate two cages. They were originally sunk to a depth of 230 feet, and subsequently deepened to 350 feet. The lode was then divided in floors, about 65 feet apart. From the extraction-shaft galleries were driven, at every floor, cross-cutting the lode entirely. When these galleries reached the ore, narrow galleries (A Fig. 2) were driven east and west, following the hanging-wall (the extraction shaft being in that wall) along all the sinuosities of the lode, and accurately determining its shape. From these galleries, again, cross-cuts B were driven through the lode at every 33 feet. After thus learning the exact shape of the lode, a "side-tie" C was driven in the country-rock, alongside the lode and at an average distance of about 15 feet, and from this side-tie cross-cuts were driven towards the lode at regular intervals of 33 feet. The side-tie was kept nearly straight, and was used as an extraction-gallery a tramway of 2-foot gauge, with rails of 30 pounds to the yard, being laid in it. There were various reasons why the gallery A, along the wall of the lode, was not utilized as an extraction-gallery; the two principal ones being its crookedness, and the fact that it became surrounded by "stowing" or "gobbing," which necessitated constant timbering to keep it open. On one of the levels it was, indeed, attempted to make this gallery serve for extraction; but it was found very difficult and expensive, and quite unsuitable.

Both walls of the lode are slate, in which all galleries had to be closely timbered.

When the cross-cuts from the gallery along the hanging-wall had reached the foot-wall, they were filled with stone, carefully piled up, and new cross-cuts, D, were then driven alongside the first ones; these were again filled up, and again new ones, E, were made, and so on, until a complete slice of ore had been removed over the whole length and width of the deposit. All the galleries and cross-cuts had a uniform size of 6 by 6 feet, so that the height of the first slice removed was 6 feet. When this had been accomplished, the gallery A, along the hanging-wall, was filled up and a new gallery was driven right above it. From this new gallery cross-cuts were again driven through the mass, and filled up the same way as below, but with one important difference; while the first slice of 6 feet had to be broken out of the solid body of ore, the slice next above was now undercut over its whole area; in fact, it was resting on the packing. This made the blasting very much cheaper; so that, whereas the contract-price given to the miners in the first slice averaged $0.50 per ton of ore, it was only $0.25 in the slice next above. Again, in the first slice the first cross-cuts in the solid ore cost $0.76 per ton of ore, and the secondary cross-cuts, which were really widening out the first ones, only cost $0.42 per ton. These figures show the enormous advantage of having free sides for the working-faces—an advantage, by the way, which is never got in working by pillar-and-stall. After the second slice has been removed, a third was taken away in the same manner, and so on, until the whole lift of 65 feet was removed. The working was not limited, however, to one lift or level, but three were attacked simultaneously in the same manner; and, at the present day, the second, third, and fourth levels are in active work, and the fifth is in preparation. Fig. 3 shows, in vertical longitudinal section, the condition of the workings, July 1, 1891.

It might be expected that some difficulty would be experienced when workings of one floor reach the stowing of the floor above. In practice, however, it is found that the stowing gets so tightly packed as to be quite firm, and, with a little additional care, it is comparatively easy to mine below it. No galleries nor cross-cuts were made more than 6 feet high and 6 feet wide, and no new cross-cut was started before the adjoining one had been properly filled in.

During the filling in of the gallery A, on the hanging wall, a chute was built up in rough stone, above the cross-cut, from the side-tie. Through this chute the ore from the second slice was thrown down to the cross-cut. When the second slice had been removed, and the next gallery filled in, these chutes were carried up, and so on; and these always served for sending the ore down to the cross-cuts and thence to the side-tie, where the ore was loaded into wooden hutches holding about ½ ton each, and subsequently trammed to the extraction-shaft.

The material used for stowing is quartzite. This is quarried on the top of a hill, about 700 yards from the lode. The stone is lowered by means of an inclined plane to the level of the mouths of two special shafts (marked No. 7 and No. 1 in Fig. 2), sunk for the purpose of delivering stone to the workings, and extending, at present, to the third level, with loading-platforms at each floor. The stone, loaded in hutches, similar to those used for the ore, is lowered in these shafts by means of double drums with brakes, the full wagon going down pulling up the empty one. The stone required in the fourth level is landed in the third level and trammed through the extraction-gallery of this level. This extraction-level is connected with the workings below by means of winzes; the stone is tipped in the winzes and falls almost at the foot of the working to be filled up. As the slices are removed, these winzes get filled up also, and therefore gradually disappear, while the ore-chutes always get longer. Each level is thus supplied with stone from the floor above, and the stone need never be raised by hand. All the winzes for throwing down stone are made in the hanging-wall; they are about 3 feet square and very securely timbered.

A good deal of small stuff is produced in the quarry. At various times trials were made to use these smalls in the filling up, as it seemed a pity to throw them away. It was found, however, not economical to do this, as the smalls were more expensive to handle in the mine than the big stones, and also because stowing done with smalls settles down far too much, and loosens the ore above to a dangerous extent, making a very treacherous roof in the workings higher up.

The stowing with large stone is so firm that no subsidence of the ground over the mine can be noticed, although a very large quantity of ore has already been removed, as may be seen from the longitudinal section, Fig. 3.

This system has now been in operation for eight years, during which a total of 230,000 tons has been extracted. Only one man has been killed by falls of the roof during all this period, which shows that the system is not a dangerous one. All the cross-cuts are kept narrow (6 feet); very few props are used, and even these few are generally taken away before stowing.

The average quantity of ore broken by a miner in this mine is 3 tons per shift of ten hours, as against ½ ton under the pillar-and-stall system, the difference being due to the ore being always under-cut and requiring little blasting. (See Fig. 4.)

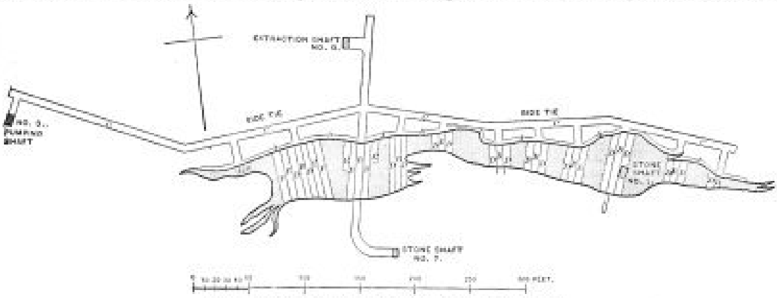


FIG. 2. CABEZAS DEL PASTO—PLAN OF THIRD LEVEL.

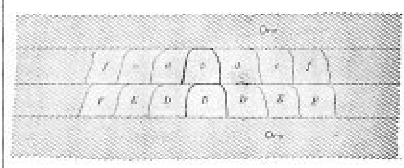


FIG. 4.

The average cost of work in 1891 was for different parts of the system, as follows:

First cross-cuts, B, in the solid ore	$0·76
Cross-cuts D, E, F, etc.	0·42
First cross-cuts, b, in next slice	0·28
Following cross-cuts, d, e, f, etc.	0·26

This shows the increased economy in breaking when the ore is under-cut.

The cost of extraction for the year 1890 was as follows:

COST PER TON APART FROM GENERAL EXPENSES.

Labor.—	Superintendence,	$0·0128	
	Breaking the ore,	0·2372	
	Loading into wagons and tramming,	0·0501	
	Engine-men, etc.,	0·0362	
	Stowing,	0·1569	
	Timbering,	0·0152	
	Unwatering,	0·0048	
	Various,	0·0078	—$0·521
Shops.—	Carpenter shop,	0·0091	
	Smithy,	0·0148	— 0·024
Materials.—	Explosives,	0·0136	
	Coal,	0·0053	
	Timber,	0·0331	
	Steel,	0·0022	
	Caskets,	0·0074	
	Grease,	0·0008	
	Various,	0·0031	—0·132
Tools,		0·0091	
Depreciation of machinery,		0·0273	
Depreciation of wagons and rails,		0·0035	—0·040
Total per ton,			$0·717

The cost of stowing per cubic yard may be detailed as follows, one cubic yard corresponding to about 2·7 tons of ore:

COST PER CUBIC YARD FOR 1890.

Superintendence,	$0·0114
Quarrying stone, inclusive of explosives,	0·0556
Throwing small stuff over dumps,	0·0540
Transport of stone to shafts and lowering down in shafts,	0·0931
Underground transport from shafts to winzes and topping,	0·0664
Underground transport from winzes to workings,	0·0720
Building up in workings,	0·0390
Various,	0·0164
Total per cubic yard,	$0·40

For the better appreciation of these cost-sheets, I may here give the average daily wages earned by workmen in the district:

WAGES EARNED PER DAY.

	Reals.	Dollars.
Foreman of the mine,	24	1·00
Engine-drivers,	20	0·87
Stokers,	10	0·43
Carpenters,	20	0·87
Smiths,	20	0·87
Masons,	16	0·70
Miners,	12 to 16	0·52 to 0·70
Trammers,	12	0·52
Ordinary laborers,	10	0·43
Boys and girls,	6 to 8	0·26 to 0·35
Cost of coal,	150	6·54
Cost of firewood,	45	2·00
Cost of six-foot props, each,	10	0·43

The following is the cost of a ton of ore, mined by the pillar-and-stall system, where other conditions are the same as above:

COST OF PILLAR-AND-STALL SYSTEM PER TON OF ORE.

Labor.—	Superintendence	$0·0128	
	Breaking the ore	0·6540	
	Loading into wagons and tramming	0·0501	
	Engine men, etc	0·0362	
	Timbering	0·0152	
	Unwatering	0·0048	
	Various	0·0078	—$0·781
Shops			0·024
Materials			0·132
Tools			0·009
Depreciation			0·031
Total per ton			$0·977

The cheaper working over the pillar-and-stall system is entirely on account of the cheaper breaking of the ore, the difference being about $0·26 per ton.

The system here described was started by Mr. C. Roepell, M. E., and subsequently carried on by the writer and Mr. P. E. Carr, M. E. It can be applied in all large masses and wide lodes, and is a safe and economical mode of getting all the ore.

The Cabezas del Pasto mine is one of the mines worked by the Bede Metal and Chemical Company, Limited, of Newcastle-on-Tyne.

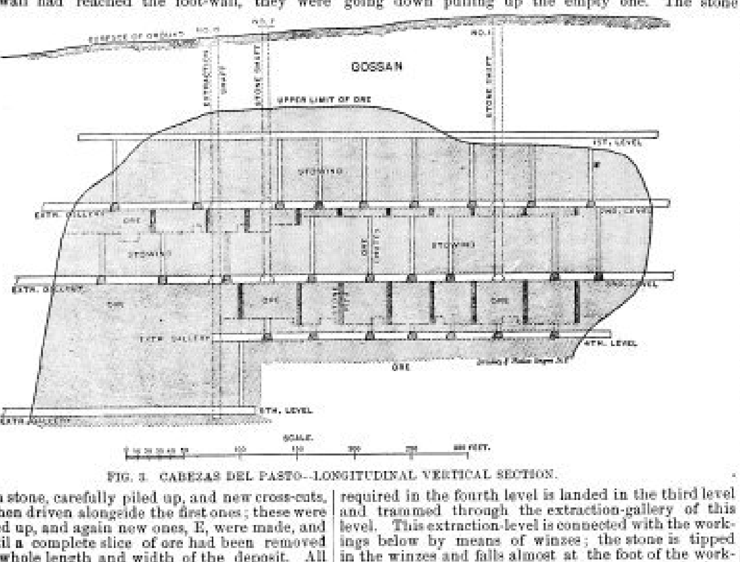


FIG. 3. CABEZAS DEL PASTO—LONGITUDINAL VERTICAL SECTION.

A HAND-TELESCOPE FOR STADIA-WORK.

BY ROBERT H. RICHARDS, BOSTON, MASS.

[From the Transactions of the American Institute of Mining Engineers.]

If one holds up a prism, or wedge of glass, with narrow angle, say 1° to 2°, and compares the transmitted image with the image seen above or below the prism, the former will be found to be thrown to one side by an amount varying with the angle of the wedge. Speaking of the two rays as the direct ray and the bent ray, we may say that when the bisecting plane of the prism is at right angles to the line of sight, the angle between the direct ray and the bent ray will be constant for any given prism.

Fig. 1.

If now we place a prism or wedge of glass in such a position that it half-covers the objective of a telescope, we shall obtain on looking through it two images of every object seen—one image by the direct ray, which comes through the uncovered half of the objective, the other which comes through the prism, and is the image by the bent ray. The angle of divergence of these two rays will be constant and unalterable, whether the telescope is directed to a near object, with its eye-piece at increased distance from its objective, or upon a distant object, with eye-piece nearer to the objective. That is to say, if the "throw" or apparent dislocation of the image is one foot in one hundred feet it will be two feet in two hundred, ten feet in a thousand, and so on.

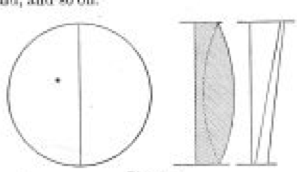


Fig. 2.

The usual form of stadia-telescope has at the focal point of the objective two spider-lines, placed at a definite distance apart and intended, let us say, to represent a throw of one foot in one hundred feet. But as the distance between lines remains the same, while the distance from the objective to the webs differs with every variation in the distance of observed objects, it follows that the angle between the lines of sight which these two spider-lines define cannot be constant, but must vary with every increase or decrease of distance between the instrument and the object viewed.

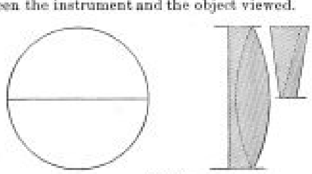


Fig. 3.

If in Fig. 1 we represent three positions of the spider-lines by W_1, W_2, W_3, and three objects corresponding to those positions by O_1, O_2, O_3, at near, medium, and distant positions, we see at a glance from the figure that there is no constant angle represented by the spider-lines, and that the only way to graduate a rod for the practice of stadia-measurement by this method is to determine values for one foot at a sufficient number of distances, and to provide the rod with a graded scale accordingly.

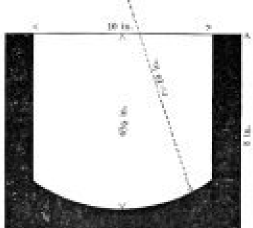


Fig. 4.

The prismatic stadia-telescope, on the other hand, has a constant angle for all distances and all focal lengths; and when the factor has once been obtained, it may be used to graduate a rod with uniform scale from end to end.

Again, the usual stadia-instrument involves two points of observation. The operator adjusts the lower [spid]er-line on the zero of the rod and then observes the reading of the upper line on the rod. There are, therefore, two personal equations in the operation of taking readings. With the prismatic stadia-telescope, on the other hand, both observations are made at once, just as the sailor, in taking the altitude of the sun at sea, brings the sun's image to the horizon and observes the contact. Only one personal equation is thus involved.

The spider-line stadia-telescope cannot be used by simply holding it in the hand, but requires a firm support; for, if it were used in the hand, the first line would wander from the zero on the rod before the reading of the second line had been taken. The prismatic stadia-telescope, on the contrary, can be used in the hand just as a sextant is. Nevertheless, as the readings to be made with it are much finer than those of the sextant, a support will be preferred for most purposes.

The one great advantage of the spider-line over the prismatic telescope is, that it uses the full light of the whole objective at all times, while the prismatic has only half-light. This objection to the latter is completely removed when the spacing target-rod is used; and it is fairly well met by the employment of self-reading rods, to which reference will be made below.

In adapting the prismatic stadia-telescope to the needs of the surveyor, several important matters have to be determined, relating to the prism and also to the telescope and the rod.

In my experiments I have combined a telescope of 30 diameters magnifying-power with a prism of one foot throw to 100 feet, and also with a prism of one foot throw to 150 feet. I shall speak of these two combinations respectively as 30 *d* : 100 and 30 *d* : 150. I have also combined a telescope of 20 diameters magnifying-power with three prisms, throwing respectively 1 foot in 50 feet; 1 foot in 100 feet; and 1 foot in 150 feet; and I shall speak of these combinations as 20 *d* : 50; 20 *d* : 100; and 20 *d* : 150. Finally I have combined a telescope of 10 diameters magnifying-power with prisms of 1 foot to 50 and 1 foot to 100; and I shall call these combinations 10 *d* : 50 and 10 *d* : 100.

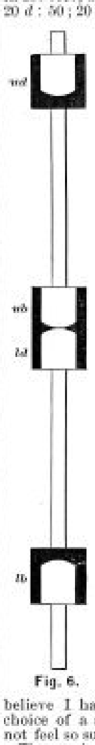


Fig. 6.

The first fact I encountered in these experiments was, that 10 *d* : 50 and 10 *d* : 100 can be used with uncorrected prisms, since the amount of color does not seriously injure the observation; while no prism not thoroughly achromatic was found satisfactory for either the 20 *d* or the 30 *d* telescope.

Fig. 2 represents what appears to me to be the rational and proper mode of combining the prism and the objective; while Fig. 3 shows an improper combination. In Fig. 2 the bent rays are exact counterpart of the direct rays, while in the adjustment of Fig. 3 this is not the case.

Choice of a Prism.—For hand-use a wide prism is preferred, say 1 foot displacement in 50 feet distance. For a fixed telescope 1 : 100 or 1 : 150 would be preferred, according to the distances to be sighted and the length of the rod to be used. A prism throwing 1 : 150 will permit readings at 1500 feet on an 11-foot rod, while a 1 : 100 prism will read only to 1000 feet on the same rod. On the other hand, where a standard steel tape with sliding targets is used instead of a rod, we may say that the wider-angle prism will give more accurate work than the narrower.

Choice of a Telescope.—Since a large field is not needed, we have to deal with two considerations only: the lightness of the instrument and its power. If the former consideration governs the choice, I would recommend a light 10 *d* or a light 20 *d* telescope; if the latter, I would recommend a 20 *d* or 30 *d* telescope.

Choice of Rods.—In this direction I believe I have settled the question as regards the choice of a spacing rod with sliding targets; but I do not feel so sure with respect to the self-reading rods.

The spacing-rod represented in Figs. 4 to 9 is so pre-eminently superior to every other which I have tried that I strongly recommend it.

This target stands out strong and bright under any circumstances. It can be read against a dark background in the woods and also against a light sky background on a hilltop.

In Fig. 5 the rod is represented as seen by the eye. Fig. 6 shows it as seen by the prismatic stadia-telescope. In this figure *ud*, *ld* are the upper and lower images by the direct ray, and *ub*, *lb* are the upper and lower images by the bent ray. The observer of course neglects *ud* and *lb* and uses for his contact *ub* and *ld*. The important advantages of this form of contact are shown in the subsequent figures.

Fig. 7 represents the targets approaching contact; Fig. 9 shows the images lapping, in which case there is a bright lens-shaped image, indicating the amount of lap. Upon its appearance the assistant is signalled

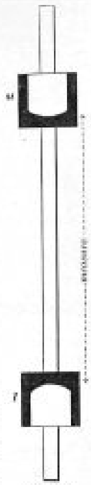


Fig. 5.

to draw the targets slowly apart; and the instant the white lens become invisible the reading, Fig. 8, is taken. The disappearance of this white lens gives a close and positive reading. The results stated below were obtained with this reading.

A target of the size shown in Fig. 4 can be read easily at 2000 feet distance with a 20 *d* telescope, in an even atmosphere. A much smaller target will suffice for short sights. The design of Fig. 4 has more strong points in its favor than any other yet tried by me.

The spacing-targets, Figs. 4 to 9, may be used on a steel tape if the following conditions are observed: The tape must be held at right angles to the line of sight. If the right angle is at one of the targets, it will be found easier to reproduce them at a point half-way between the targets. For distances much greater than 2000 feet a larger target or a higher-power telescope, or both, will be needed.

Fig. 10 represents a tape, as used by me on a 1970-foot sight with the above targets and a 20 *d* telescope.

Self-reading Targets.—Three forms which have been experimented upon are represented in Figs. 11, 12, and 13.

Fig. 11 gives good results with a 10 *d* : 50 combination for short distances. It may be graduated, as shown, with 2-foot unit or with 5-foot or 10-foot unit. In the latter case, it would be used for long distances with a 20 *d* : 100 combination up to 30 *d* : 150 combination; but the individual feet would have to be divided by the eye. The skeleton second image on it reads 68 feet.

Fig. 12 may be graduated with 1-foot, 2-foot, 5-foot, or 10-foot units, according as a short distance or a long-distance rod is wanted. The skeleton-reading of the second image upon it indicates 265 feet. Possibly, for certain distances, this graduation may be found easier to read than that of Fig. 11.

Fig. 13 represents a target-rod with an optical vernier. The space from 0 to 100 feet on the rod is graduated into 11 parts, while the spaces from 100 to 200, also from 200 to 300, and so on down, are graduated into 10 parts. Moreover, the space from 0 to 100, which we may call the vernier, is graduated on the opposite

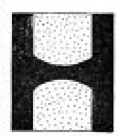


Fig. 7.

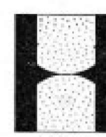


Fig. 8.

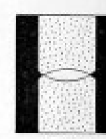


Fig. 9.

side to the other readings, so that the second imag can bring it down and give a vernier-reading between the two images. The partial skeleton second image gives a reading of 423 feet, no dividing by the eye being required. By this system an 11-foot rod may be made for a 30 *d* : 100 combination, which will actually give readings of individual feet at 1000 feet distance.

The vernier-reading is the most fascinating idea I have met in my investigations. Whether it is really practical can only be decided in the field. The images which are important for the reading are half-light images, and therefore dim, while with the other two forms of target a full-light reading is obtained.

Limits of Error.—Partly by reason of the limited time at my command for experiments, and partly because every time I went out to get definite records of practice, I made some discovery which led to an improvement in the apparatus, I can only promise at this time to give detailed figures at an early day as a supplement to this paper. The figures I am now prepared to publish were taken with a curved spacing-target of the design shown in Figs. 5 to 9.

With a 20 *d* : 150 combination, holding the rod at 100 feet distance, I obtained five separate readings of the distance in feet between the targets, which were 0·653; 0·654; 0·653; 0·653; 0·653. With a 30 *d* : 150 combination I made these four successive readings at 100 feet distance: 0.675; 0·675; 0·675; 0·675; all with the spacing-target described in Figs. 4 to 9.

If I had made an error of 0·001 foot upon the rod, this would correspond to an error of 0·15 per cent. or 0·15 foot in 100 feet. But I did not make this error in four readings with 30 *d* : 150, and only made it once in five successive readings by the 20 *d* : 150 combination. If the prism had been a 1 : 100 prism, the error referred to would have been 0·1 foot in 100. If the prism had been a 1 : 50, the error would have been ·05 foot in 100 feet. I cannot imagine a reason why the percentage-error at 1000 feet or 2000 feet when the atmosphere is steady, should be any greater than it is at 100 feet. From the above considerations, I believe I am safe in saying that the error of the prismatic stadia is well inside of 0·1 per cent.

I hope to present, in the near future, some figures actually obtained for both short and long distances.

If one desires to determine the distance to a point without the trouble of sending an assistant there, it may be done with a pair of Wollaston camera-lucidas, as shown in Fig. 14, in which W_1 W_2 are the two cameras.

If the Wollastons both give 90°, then the requisite

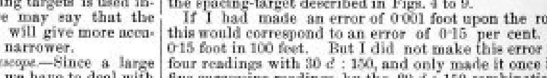


Fig. 10.

deviation from 90° may be obtained by inserting a prism, P, as shown. If, however, the two Wollaston angles add up to say 177° to 178°, then the apex-angle will be 2° or 3°, and will answer without the addition of another prism. After the two observers, E_1 E_2, have found their places, so that their respective images coincide, then they can measure the base-line between them by a prismatic stadia-telescope; and knowing the factor of the Wollastons, three feet or four feet to the hundred, the distance to the unknown point may be determined approximately by multiplying the observed distance between E, and E, by the factor, 3 feet to 100; 30 feet to 1000; 300 feet to 10,000; and so on.

In making my designs and in testing my instruments, I have been helped materially by Captain A. H. Russell and Messrs. J. Hays Gardiner, W. H. Weston, Franklin Knight, Luis T. Verges, and W. S. Hutchinson, friends to whom I wish to make acknowledgment.

Fig. 11. Fig. 12. Fig. 13.

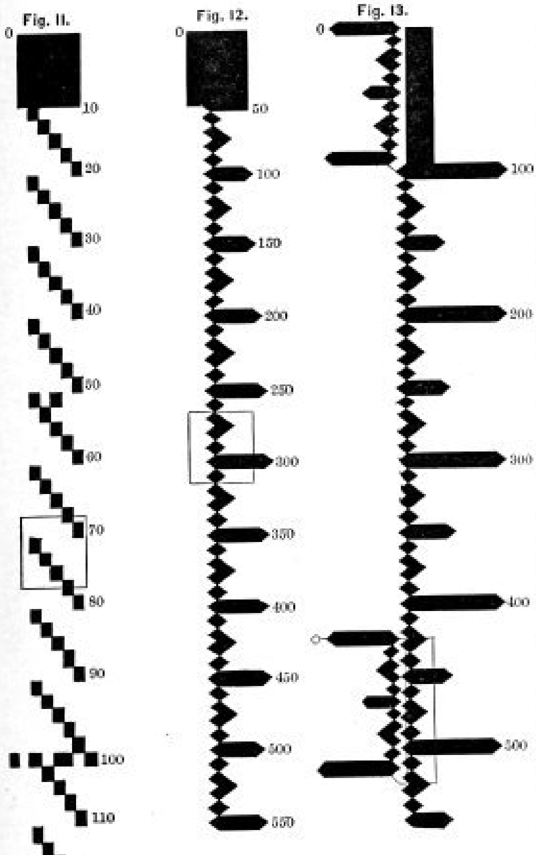
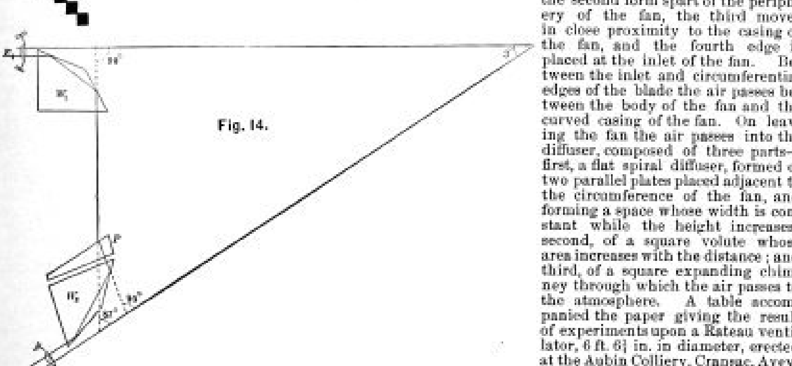


Fig. 14.



Chandler & Taylor Company, of Indianapolis, Indiana, report that they are now working on a complete new line of saw-mill machinery which they expect to have ready for the market by early summer. Their standard mill has already been completed and has been favorably commented on by all who have seen the mill. The design is neat, the working parts are heavy and the proportions and convenience are at once apparent and leaves nothing to be desired. The Heacock patent variable belt feet works will be used on all mills, which will largely increase their output.

We will inform our readers farther as soon as complete catalogues are issued of these machines which the makers will be glad to send on application.

Messrs. Copeland and Bacon, the widely known builders of Hoisting Engines and Mining Plants, whose general offices are at 85 Liberty St., New York, and who for several years have had a branch store at 535 Arch St., Philadelphia, have opened another branch store at No. 62 South Canal St., Chicago, for the convenience of western purchasers.

THE PROGRESS IN MINING.

Reviews of Important Papers Relating to Mining in the Proceedings of the Mining and Scientific Societies, and in the Mining Journals of Europe, United States, and Canada.

Coal Cutting Machinery. Mr. John B. Atkinson, of Earlington, Ky., contributes a short article in a recent issue of the Transactions of the Engineering Association of the South on his experiences with coal cutting machinery.

While electricity is making rapid advances in its application to mining work, Mr. Atkinson doubts if it will ever displace compressed air as a motor for coal cutters. He points out that while constant feed rotary machines may be successful in seams with an even plain holing they are costly where the holing contains iron or sulphur balls. We think this is an opinion pretty generally held by mining men. In the latter case, Mr. Atkinson found that a pick machine (the Harrison) was the best. He considers that machines are too cumbrous for thin veins but that in a vein of ordinary thickness they can be profitably used. Ordinary labor can be used, and two weeks' experience will convert a farm hand into a fair runner. The machine does the hardest part of a miner's work, does it quicker, gets a greater percentage of lump coal, and saves 50% of the cost of powder. With 60 rooms of work at Earlington these machines can produce 250 tons of lump coal per day, whereas by manual labor 100 rooms would be required for the same output. This is a consideration as a smaller number of mules are necessary, and the general underground cost would be less.

A New Ventilator. At a recent meeting of the North of England Institute of Mining Engineers, Mr. M. Walton Brown read a paper descriptive of the "Rateau Ventilator," which, he stated was so designed that air might pass through it at a high speed, and without interruption. The wheel is mounted upon the shaft, and is fitted with thirty blades of a special form. Each vane has four edges, one of which is fixed upon the face of the wheel, the second form apart of the periphery of the fan, the third moves in close proximity to the casing of the fan, and the fourth edge is placed at the inlet of the fan. Between the inlet and circumferential edges of the blade the air passes between the body of the fan and the curved casing of the fan. On leaving the fan the air passes into the diffuser, composed of three parts—first, a flat spiral diffuser, formed of two parallel plates placed adjacent to the circumference of the fan, and forming a space whose width is constant while the height increases; second, of a square volute whose area increases with the distance; and third, of a square expanding chimney through which the air passes to the atmosphere. A table accompanied the paper giving the result of experiments upon a Rateau ventilator, 6 ft. 6¾ in. in diameter, erected at the Aubin Colliery, Cransac, Aveyron.

Deep Boring at Schladebach, Prussia. We are indebted to the *Colliery Guardian* (Eng.) for the following article on this subject.

At the closing *seance* in 1891 of the Societe Industrielle de Mulhouse, M. Charles Zundle gave some particulars gathered from two reports sent to the society by the German Mine Department, of the deepest borehole which has yet been put down, viz., that at Schladebach, near Kotschau, in Merseburg, Prussia, which attained the great depth of 1,748 meters, or 956 fathoms.

The boring was begun in August, 1880, by the Royal Division of Prussian Mines, and finished in the Autumn of 1886, having occupied 1,247 actual working days, with a mean daily advance of 1·4 m. (4 ft. 7 in.) and at a total cost of 212,304 marks ($50,912.00) or, say, $38.08 per yard of boring. A 25-horse power portable engine sufficed for the motive power necessary to work the boring rods and also the pumps, a tower 27 m. (89 ft.) high, permitting of 20 meters of tube lining being raised or lowered at a time.

The initial diameter of the hole was 280 mm. (11 in.) After 20 m. of sand, gravel and marl, passed through by the system of *Schappenbohrung*, or tube boring, the variegated sandstone was struck, which was attacked by the *Hohlfreifallinstrument*, or free-fall apparatus, a cast-steel drill with end in the form of a cross with guides, water flowing down outside the tabular rods and rising up the inside. At the depth of 57 m. (31 fathoms), the lining could not be got to descend further, so an attempt was made to go on without lining; but the *débris* detached from the sides of the hole rendered it necessary to put in a tube lining of 230 mm. (9 in.) diameter. At 164 m. (90 fathoms) strata of gypsum and anhydrite were encountered, and also water charged with sea salt. At the depth of 175 m. (95 fathoms) the free-fall apparatus was abandoned for rotary boring by means of a soft iron crown, of 210 mm. (8¼ in.) diameter, set with borts or carbonate diamonds, producing cylindrical cores of 140 mm., or nearly 6 in. diameter. In the dolomitic limestone it was found impossible to detach one of these cores; and the crown became fixed so fast that it became necessary to draw up the rods and bore into the core with a small crown, in order to detach it, a work that occupied three weeks.

After several accidents and difficulties—such as the rods bending and having to be cut and lifted, a crown sticking in the bottom of the hole and having to be perforated and ground up by the free-fall apparatus, or a tool falling by accident into the hole and necessitating the cutting of the rods at great depths—the depth of 1,070 m. (585 fathoms) was reached, the diameter of the hole having been reduced seven times. Between this depth and that of 1,724 m. (943 fathoms) the hole was continued with a diameter of 48 mm. (2 in.) yielding cores of 23 mm. or less than 1 in. diameter. The old red sandstone had been passed through between 327 and 1,630 m., when the Devonian rocks were traversed without, however, encountering a seam of coal, which might have been met with at that geological depth. A stratum of cuprose schist, struck at 326 m., was not considered rich enough to warrant its being worked.

Nevertheless, the hole was continued, with a purely scientific object, and at the beginning of 1886 a lighter tubing, of 33 mm. (1⅓ in.) diameter, was put in, in which boring was carried on with a crown of 31 mm. (1¼ in). giving cores of 12 mm. (½ in. bare) only. But, finally, after successive accidents—such as breakage of the rod and fall of the crown, and breakage of the screw of the core-extracting apparatus—at the depth above mentioned it was found necessary to stop the work, which could only have been continued at a great expenditure of time and money. The following are the rocks passed through with their depths and thicknesses:

	Thickness Feet.	Depth Feet.
Vegetable earth	1·97	1·97
Sand	14·01	15·98
Clay	58·28	74·26
Variegated sandstone	465·65	539·91
Gypsum and anhydrite	52·61	592·52
Permian limestone (Zechstein)	152·18	744·70
Gypsum	34·16	778·86
Anhydrite	292·71	1071·57
Cuprose schist	2·87	1074·44
Old red sandstone	4274·87	5349·31
Devonian rocks	388·57	5737·88
	5737·88	

Careful thermometric observations were made as the work proceeded, and naturally delayed its progress considerably. From a depth of 3937 feet they were continued regularly every 98·4 feet, and before the tube lining was put in, so as to avoid any disturbing influence from conduction, while to counteract that of water currents, the thermometer was immersed in a fixed column of water between two clay plugs, and left there for sixteen hours. To prevent the glass from being broken by the great pressure, it was enclosed in an iron case; and there were always three superposed thermometers from which a mean of the readings was taken. The observations of the first 3937 feet were taken subsequently. The observations went to show that the increase of temperature does not diminish with depth, as had heretofore been imagined, but follows a constant arithmetical progression. The last reading taken viz., at 1·716 m. (938 fathoms) was 45·3 degs. Reaumur, or 56·6 degs. Cent. or 134 degs. Fahr., which shows an increase of 1 deg. Reaumur for every 46·09 m., equivalent to 1 deg. Cent. for every 36·87 m. At this rate potassium, the fusion point of which is 48 degs. Reaumur = 60 degs. Cent. = 140 degs. Fahr. would melt at a depth of 1,845 m. (1,000 fathoms), and grey foundry pig (1,240 degs. Reaumur = 1,550 Cent.) at 50·775 m., or about thirty-five miles, while the greatest temperature of blast furnaces, which according to Scherer is 2,230 degs. Reaumur (4·037 degs. Cent.) would be attained at a depth of 104,708 m., or a little over 14 geographical miles.

M. Zundel concluded his interesting communication by calling upon the Societe Industrielle to urge the putting down of a deep borehole in Alsace-Lorraine, or the deepening of two Hasenrain and Dollfus holes, in order to prove the existence of coal or Bituminous shales yielding petroleum, or even to demonstrate practically that a source of heat and power exists beneath our feet, that shall maintain warmth in our bodies, and keep our mills and factories going, when all the coal deposits shall be exhausted.

The Practical Working of Coal-Cutting Machines. At the meeting of the Manchester Geological Society, held last week, Mr. Richard Sutcliffe read a paper on the "Practical Working of Coal-cutting Machines," of which the *Colliery Guardian* (Eng.) gives the following summary: "In the course of his remarks Mr. Sutcliffe said that he quite agreed with Mr. G. Blake Walker, of the Wharncliffe Silkstone Colliery, who was the largest user of coal-cutting machines in England, when he said that actual experience points to 100 yards per eight hours shift as being a satisfactory performance with coal-cutting machines when the ordinary conditions of work in a coal face were in force. The writer had found that the most convenient machine, and a better one for all-round work than any, was one having a cylinder at each end, with the cutting wheel in or near the middle. By this arrangement as comparatively light machine would keep the rails without extra fittings in working, and was capable of cutting either coal or fire clay, and the power could be varied to suit the material to be cut, by making it to run from 3 to 1 to 12 to 1 between the crank shaft and cutting disc, and its total length need not exceed 7 ft. To get anything like good results from the best machines, when cutting 3 ft. deep or more, the *debris* should be kept removed, as the fore or cutting portion of the wheel brought it from the groove or cut, otherwise it would be taken back in part by the back portion of the wheel, until it becomes jambed. As the attendant might have many things to look after, as well as the removal of this *debris*, it was often neglected, and therefore much of the power wasted. This fact must suggest to the contemplative mind the desirability of making a coal-cutting machine capable of dealing with its refuse automatically, so as to prevent its return into the groove. The fixing of the chisels or cutters in the periphery of the rotating disc had a great influence on the working of a machine in cutting hard material. The proper way was to fix the cutters radial in the disc, and hook them near their edges, sufficiently forward to cut, and then, as a cutter shank wore loose, it got less, instead of more work to do. Even the sharpening of the cutters had an important effect on the working of a machine, and a set of twenty was sometimes blunted in as low as 10 yards, and sometimes would cut as much as a thousand yards, even when properly edged and tempered, according to the material to be cut. If the holing was fairly free from iron pyrites, or such-like impurities, the set of cutters should do from 50 to 100 when each cutter was doing its share in either coal or fire-clay. A good coal-cutting machine should be strong and simple in construction, with few working parts; it should have sufficient base and weight to keep on the rails when working without extra fittings; it should be able to cut either way, and be easily reversed, and should automatically remove the *debris*, so as to prevent it getting into the groove, and it should not exceed 3 ft. in width, nor 7 ft. in length. Where coal had to be blown down after being cut it was best to make a deep holing, but where it fell from gravitation it was sometimes advisable to take a lighter or shallow cut, which enabled the machine to cut a greater distance, and the fillers to fill out a greater length, each in the shift, allowing the gates to be farther apart; but whether the cut were deep or shallow, it was undesirable to dress down the face more than was necessary to the machine to pass, as it saved labor, and made less small, when allowed to remain for next fall. At Gartness Colliery, near Airdrie, in Scotland, where machines had worked successfully for many years in a 30-inch seam, with good roof and strong floor, they made the gob roads 14 yards apart. The corves were filled in the gob road at about 17 cents per ton, and the filler had to throw the coal when it got out of his reach, filling 6 yards at each side of the gate. The cutting was done by one contractor at 9 cents per ton, and the filling was done by another. In Yorkshire the system was to take the cars into and along the face, necessitating the use of small cars in thin seams, but allowing the gob roads to be made at any desired distance apart, and accordingly they were made at from 12 to 50 yards apart to suit the ideas of those adopting them, and it often took from two shifts upwards to fill out the coals. This necessitated irregular working of the machines, without any regular quantity of work being laid out for them per shift, and it was not nearly so methodical a system as the Scotch. It also compelled the filler to take up the floor clay instead of confining his energy to the filling out of the coal, which could not very well be done but while the pit was drawing, and the floor clay could be removed at any time. In some cases the machines were made to cut all in one direction, having to be taken back through the gob roads every time it cut through the length of the face, but almost all the recent installations were made to cut back and forwards. His (the writer's) opinion was that money spent in taking them through the gob road, except for repairs, was simply wasted. The best mode of working seemed to be to sub-divide the labor into something like the following divisions: Holers, blowers, and timberers, fillers and packers, and rippers. The holers would include a man to drive the machine, one man to lay the way in front of the machine, and a youth to clear away the *debris* from the cut. The fillers to devote the whole of their time in filling out the coals. The blowers would include men to bore the holes, timber up the face, and blow down the coal. The packers to take up the floor clay, and rip and pack the gob roads. The whole of those about the machine should be under the control of a capable man—more especially at the commencement—who understood machinery and mining in a general way. He might have it on contract or it could be left to the section under him, but he should have complete control of the men, without interference of subordinate officials, whose prejudices and jealousies could only hamper and impede the work. Energy, perseverance, and system would work machines in any mine with a fairly good top, but of course their proper place was in thin seams, where holing forms the greatest part of the labor, and where properly worked they should benefit both the miner and the mineowner; the former, in doing the most laborious part of the work, and the latter, by increasing the output, reducing cost of getting and in reducing the proportion of small coal made in getting. Mr. G. B. Walker gives the saving effected in the reduction of cost of getting at from 6 cents per ton in a 3 ft. seam, to 21 cents in an 18 in. seam, and that effected by the value of the yield of coal, as compared with hand labor, at from 13·4 cents in the 3 ft. to 21 cents in the seam 18 in. thick, per ton, making together a total saving of from 19·4 cents in the 3 ft. to 42 cents per ton in the 18 in. seams. In concluding his paper, Mr. Sutcliffe said that the boring type of machine had obtained a strong footing in America, but compressed air was the motive power in both countries, with few exceptions, and in the mining districts of the United States machine mining was steadily increasing, there being scarcely any coal-producing territory of the Union where machines were not being, or had not been used with more or less success.

The Miner's Safety Lamp and Improvements by The Double Chamber.

A correspondent in a recent number of the *Colliery Guardian* (England) writes: Out of the vast number of people interested directly or indirectly in the improving and perfecting of the miner's safety lamp, comparatively few have interested themselves to understand its fundamental principle. The history of the safety lamp with enumeration of its development, would undoubtedly, if written, be interesting from more points of view than one, and provided one possessed the necessary time and data for compiling, there is here material of great value. The primitive Davy lamp was not destined to reign for very long. Its dim and murky light, its proneness to get blown out with currents that it had to contend with in the mine, together with its unsafeness, were features that made the work of supplanting it easy. The acute feeling of relief that accompanied the advent of the Clanny can be conceived only by those who have had experience with the Davy.

Without making further mention of the Clanny, and passing over a host of other forms of lamps, which, from their very number, form a splendid monument of the patient endeavors and labors of inventors in trying to solve the problem, we eventually come to the Mueseler lamp, which, in its first days, created a good deal of stir and enthusiasm, and bade fair to satisfy scientific men and miners. But it would appear that the size of the inside tube and its position are such that tilting the lamp to an angle of but 20 degs. from perpendicular or even less is in most cases sufficient to deviate the feeding current from the flame to such an extent that it will die out. The Mueseler lamp, however, must be credited with having introduced a new principle. Without doubt, the tube in the Mueseler is one of the features necessary in the construction of an absolutely safe lamp, but it should be modified to some extent. It should be altogether larger, say 1½ in. at the base and tapered to ¾ in. at the top, a bell-mouth to be formed at the base in order to deflect the incoming current that it may pass down close along the inner side of the glass, and thus be brought to impinge directly upon the flame. Thus nearly all the oxygen of the air passing through the lamp will be available, although it will not, of course, be all consumed. The unconsumed portion, together with the products of combustion—carbon dioxide and steam and the diluent nitrogen—all at a considerably elevated temperature, will intermix and pass up through the tube with considerable velocity into the gauze beyond. And now by preventing any further ingress of air, or, more precisely, of oxygen, into this mixture, it will be quite impossible for any inflammable gases which may have passed into the tube with these products to be consumed in the gauze beyond the tube. The chance of its ignition will be noted further on. As stated, the foul products will be considerably heated and very much rarified, and we know that although combustion may be carried on with great freedom in an atmosphere of normal density at some given temperature, we can by sufficiently attenuating that same atmosphere, prevent combustion entirely at that same temperature or even at a higher one. Thus the rarefaction of the gases will further reduce the chances of combustion beyond the tube. But the principle, the importance of which I wish to note, is that the products, after once passing through the Mueseler tube, should be kept strictly intact from the outside atmosphere (thus preventing any increase in the amount of oxygen present) until the products emerge again through the shield at the bonnet. Now if the greater part of the gauze be so shielded up that the outside atmosphere cannot intermix with the combustion products and any inflammable gases mixed with them as they pass through the Mueseler tube and until they again pass out through the bonnet at the top then the ventilating of the lamp will be more or less of a circular column of heated gases co-axial with the tube. The gauze of the lamp will thus be constantly immersed in an atmosphere of foul gases surrounded as it were, by thick walls of carbon dioxide and foul air—the ventilating current, in fact, having to force its way through a chamber containing a non-supporter of combustion. The result of this is that, although ignited gas may be forced through the tube as previously explained, the flame cannot possibly live for any length of time in the atmosphere that now surrounds it. It therefore dies out. Thus far, theory and facts lead to this conclusion, that a lamp of this description will always extinguish except in an atmosphere containing a percentage of fire-damp less than that necessary to form a mixture of the least explosive properties. In case the percentage of inflammable gas mixed with the incoming air be a little less than is required to form an explosive mixture, say 5 to 6 per cent. and is more than sufficient to form a cap on the flame, a faint combustion may be carried on (though unstable) at the base mouth of the tube. This cannot possibly be any source of danger, even though it is continued all day, as it is quite clear of the gauze, and will not produce more heat than that which the lamp can easily radiate; the temperature of no part of the lamp will therefore be dangerously high. It should be stated that these features appear to have been combined in a lamp patented by Mr. Thomas Thomas, of Ynishir, South Wales.

Mr. A. H. Osterloh, Jr., an energetic and progressive young man, has entered into the Mine, Mill and Railway Supply business at No. 89 Water St., Pittsburgh, Pa., under the title of The Osterloh Supply Co. He will handle first class new and second hand machinery of all kinds, and is prepared to contract for the erection of complete colliery plants. He is also prepared to furnish first-class supplies and tools promptly and at reasonable prices. It will pay to send to the Osterloh Supply Co. for circulars and catalogues.

MISSOURI COAL.

The Coal Production—The Coal Market—The Uses and Adaptabilities of the Coals—The Available Tonnage and Duration of Supply—The Value of Coal and Coal Lands.

(From the Preliminary Report on Coal of the State Geological Survey.)

The total production of coal in Missouri for the year ending June 30, 1891, was 2,650,028 tons, valued at 3,480,867 dollars. According to Bulletin No. 10 of the Eleventh Census, Missouri ranks second as a coal producer among the States west of the Mississippi River, Iowa being first with a production of a little over four million tons. Colorado is ranked next after Missouri, her production being 2,544,144 tons, and Kansas is fourth with a production of about 2,200,000 tons per annum. After these no other of the western states approach Missouri in the amounts of coal produced. According to the same Bulletin Missouri ranks ninth as a coal producer among the States of the Union, Pennsylvania leading off with the magnificent figure of over 80,000,000 tons. Illinois being next with about 12,000,000 ton, Ohio third, with nearly 10,000,000 tons, West Virginia next with over 6,000,000 tons and then Iowa, Alabama, Maryland, and Indiana preceding Missouri in the order given.

The amount of coal produced in the State is, thus, both absolutely and relatively large. Its value is greater than that of any one other mineral product in the raw state, the production of lead for the year ending June 30, 1891, according to the State Mine Inspector's figures, being valued at $2,411,399, that of zinc at $2,673,073, and of iron at $331,065.

According to the list of coal mine operators appended to this report there are, in all, 385 individuals and corporations engaged in mining coal. Of these, one organization mines *about a fourth* of the total amount produced each year; ten companies mine together nearly two-thirds of the total amount and sixty individuals and companies mine together about five-sixths of the total, leaving for 325 individuals and companies the production of one-sixth.

The principal coal producers, in the order of the amounts of their products, are: The Rich Hill Coal and Mining Company, the Western Coal and Mining company, and the Lexington Coal and Mining Company, these three being under one management, with mines in Bates and Lafayette Counties; the Kansas and Texas Coal Company, with mines in Macon, Ray, and Linn Counties; the Keith and Perry Coal Company, with mines in Henry and Bates Counties; the Richmond Coal Company with mines in Ray County; Loomis & Snively, with mines in Macon County; the Mendota Coal Company, with mines in Putnam County; the Inter-State Coal and Mining Company, with mines in Randolph County, and the Randolph Coal Company, with mines in Randolph County.

The conditions affecting the market of the coals west of the Mississippi River are, in some respects, different from those in the eastern part of the country. The Western Bituminous coal field is surrounded on all sides by large expanses of country destitute of merchantable coal.* These great areas with their constantly increasing population and needs, must, under natural conditions, draw their supplies of coal largely from the mines of Iowa, Missouri, Kansas, Arkansas, Indian Territory and Texas. The area of workable coal is also restricted in Kansas, Arkansas, Indian Territory and Texas, only a small portion of the coal measure areas there being productive. East of these areas their coals are brought into competition with the coals of Illinois, Indiana, Kentucky, and Ohio in the North, and with those of Tennessee and Alabama in the South; even the Anthracites of eastern Pennsylvania are sold within the very limits of these western coal fields, on account of their special adaptabilities. The natural facilities for transportation provided by the Ohio and Mississippi Rivers enable the coals of western Pennsylvania and of Ohio to compete very successfully with the geographically much nearer western coals, especially along the lower Mississippi. Further, through the distribution of railway lines and adjustments of rates, Illinois coals force the competition line much farther west than would seem possible from geographic considerations. Thus the territory affected by this competition to the east, is large, and it will probably always be considerable, though subject to variations.

Towards the west, however, there stretches a great area of country in Nebraska, Kansas, Indian Territory, and Texas, which is not only destitute of coal, but which, has, further, a sparse supply of timber to answer as a substitute for such mineral fuel. This is especially the case in Kansas, and its effects upon the Missouri coal industry is important. West of this coal-barren area are the deposits of Dakota, Wyoming, Colorado, and New Mexico, which are to a certain extent competitors in the market and which may become more so in the future. It is not to be anticipated, however, that this competition with the coals of Missouri and adjacent states will reach very far east, for the latter coals are generally superior in quality to those farther west, which are largely lignitic, and the supply of superior coals in Colorado and New Mexico appears to be not more than is needed to satisfy the home needs and the more imperative demands for coal still farther west.

Thus the coal-barren area surrounding the Western

*In eastern Texas and Southeastern Arkansas are large areas underlain by lignites, or brown coals. These have been in the past, only of limited local use. Recent investigations, by the Geological Survey of Texas, have shown that these lignites are equal in character to those which are widely used in Europe. They will probably become merchantable in the future. That they will be extensively substituted for Bituminous coals in the most important uses of the latter, is, however, an expectation which does not seem at present warranted.

Bituminous Coal Fields may be looked upon as a most promising market for the future, especially that to the west where the population is destined to increase rapidly in the next few years, with a proportionate increase in coal consumption.

In addition to the foreign market however, there is in Missouri a good home market; one which is destined to increase greatly in the future and which will always be a steady consumer of coal and the most substantial supporter of the coal industry. The coal fields of Missouri are not located in a mountainous, rugged, or sterile country; on the contrary there are in a country of moderate elevation, with gentle undulating surface, where bluffs and steep declivities occur only along the largest streams; a country with a most fertile soil in a well advanced stage of cultivation. It is already well populated, a network of railways traverses it, small towns are numerous, and cities occur at short intervals. These conditions furnish consumers for the coal at the very mouth of the mine, they cause small operations to be numerous and to be profitably prosecuted, and they further permit the mining of coal for local uses under conditions which would not be profitable for the general market. In addition, these conditions furnish opportunities for obtaining labor, and inducements for retaining it, which are entirely absent in many coal mining regions.

The railways of the State constitute, without doubt, the largest class of consumers of coal. Hence the greatest single use to which coal is put is for the production of steam in locomotives; but, for manufacturing purposes, a large amount of coal is also used in steam production. Domestic consumption in stoves and furnaces ranks next in importance. For the production of illuminating gas a few coals of the State have been roughly experimented with, but not with generally satisfactory results, and very little of the coal product is used for this purpose. Thus coal from the vicinity of Moberly has been used there at the gas works, and, when well purified, the gas from it was excellent, but the cost of purifying it from sulphur was too great. The coal mined at the Hamilton Coal Co.'s shaft in Caldwell County has been tested for gas production and is reported to have yielded an abundance of gas, but it would not coke in the retorts, and, therefore, could not be profitably used. The coal mined at Trenton, in Grundy County, has also been tested with similar results. In Henry County are several coals which have been used for gas production, with reported favorable results. The thick coal bed south of Lewis station is such a coal, and also that from the Pitcher mine south of Clinton. These coals have been used, not only in the immediate vicinity of the mines, but have been shipped to remote points in the State for this special purpose. The coal mined at Minden, Barton County, also gives promise of being a gas producer, inasmuch as coal from the same bed mined at Cherokee and other points farther west in Kansas, is largely used for that purpose.

No coal in the State, to the writer's knowledge, is used for coke manufacture. Partial tests have been made of a few coals, but the results were not encouraging. The coal from the Excelsior Coal and Coke Company's shaft, at Higginsville, in Lafayette County, was thus experimented with. The product was of fair quality for domestic use, but was too weak and contained too much sulphur for furnace use.

Concerning the adaptabilities of Missouri coals we know, therefore, little even in a general way, and practically nothing in a detailed and authoritative way. As steam producers we know that they are extensively used, but what their relative evaporative powers are as compared with each other we can say nothing at present; and we are equally in the dark as to how they compare, in this respect, with the coals of other states with which they are brought into competition. We know that the same coal burnt in different furnaces will yield very different results, and *vice versa*, that the same furnace fired with different coals produces different amounts of steam; yet we are unable to say of the various Missouri coals in just what furnaces the best results may be attained with each. We know that some coals are better for steaming purposes, some for domestic purposes than are others; but which are the best domestic and which the best steaming coals of Missouri we cannot say. Gas coals and coke are imported into this State from Pennsylvania and are sold here at necessarily high prices. It is by no means improbable that there exist coals in the State which could be used more economically for the purposes for which these coals are imported. It is, therefore, in the interest of both the owners of coal lands and the producers of coal, as well as of the consumers, that the adaptabilities of the Missouri coals be first definitely established and then that the various coals be applied to those uses for which they are best suited.

Estimates have been made in publications of past years of the probable amount of coal in the State. Such estimates have been made by assuming an average thickness of coal for the whole area of the coal measures and then multiplying this thickness into such area. This method does not commend itself for further use, and, in general, we are of the opinion that the attempt to make such an estimate in the past was altogether premature and would still be so now. We are not in a position to make as much as an approximate estimate in this direction, even were we to leave out of the question entirely the considerations affecting the availability of the coal in the present and in the future. The data necessary for such an estimate are the number of coal beds, their respective thicknesses, the area underlain by each bed, and the depth of each beneath the surface. Some of the principal causes restricting the distribution and availability of Missouri coals have been described in the preceding chapter of this report. To properly make such an estimate it is necessary that we define the nature and extent of such limiting causes, and this can only be done by the most detailed local work.

The question of the distribution and of the amount of coal in the State, is one which the state as a whole, as well as the individual property owner cannot afford to neglect. Coal is, probably, of all others, the most substantial of a State's mineral possessions. Every industry is dependent upon it and it is the main spring of our Nineteenth Century civilization. In Great Britain, from the results of carefully executed geological surveys, estimates have been made by special commissions of the amount of coal in the United Kingdom, over one foot in thickness and situated within a depth of 4,000 ft. beneath the surface.

An acre of ground contains for each foot of coal underlying it about 1,700 tons. With two feet of coal the tonnage per acre is 3,400 tons. With the methods of mining pursued generally in the State, certainly not less than 2,500 tons of these 3,400 tons could be marketed. This would be 1,600,000 tons per square mile, and, thus, the product from a two-foot bed of coal, over an area of two square miles, would more than equal the present annual production for the whole State. Or, in other words, at the present rate of production, there is annually exhausted in the State an area of less than two square miles, and probably much less, inasmuch as the coal under a large part of the mining territory is three and four feet thick. The total area of the coal measures in the State, as already stated, is about 23,000 square miles. If only one-tenth of this area be underlain by available coal two feet thick, the supply will be sufficient to furnish coal at the present rate of production for over a thousand years. It is allowable to assume that a much larger area of available coal exists but, on the other hand, the rate of production is constantly increasing and will doubtless continue to do so for many years to come. Hence estimates of duration of supply can never be anything more than approximate and provisional. With the present indefiniteness as to the amount of coal present, even an approximate estimate cannot be presented. What is above given is offered merely as a suggestion.

The total value of the coal in the State must remain indeterminable until the question of the amount of the coal is settled. With a coal bed two feet thick the value of the 2,500 tons of available coal per acre, at $1.30 per ton, is $3,250. The value of the product of a square mile of such coal is $2,080,000. If we allow a profit of ten cents per ton, the net value of the coal from an acre of such land is $250, and for forty acres of such land it is $10,000. The value of the coal contents of such land, based upon the present market prices of the same substance, is thus many times what the land is valued at for farming purposes. Coal, however, is a possession which is not convertible until excavated and transported to market, and, until this is done, it represents just so much capital lying idle in the ground. Moreover, the coal of any one track cannot be opened upon, excavated and thus converted into ready money in a short time; but the work will proceed slowly and the returns will come in gradually from year to year. Thus, if a man own a property of forty acres, of which, according to our calculation, the net value of the coal is $10,000, and if he does not receive any of this $10,000 until the expiration of fifteen years, then the present value of his land is a sum, which at compound interest at current rates, will amount to $10,000 in fifteen years; this at six per cent. interest will be about $4,160, or about $100 per acre. The exact time when a man may receive the full net value of the coal contents of his land depends upon many indefinite factors, such as the growth of facilities of transportation, the demand for the product, etc. It is thus impossible to give any one value per acre which will apply to all coal lands, even though their coal contents and the conditions under which it occurs be similar. Considering the conditions affecting the coal market already described, and, considering further, the undoubted prospect of a great growth of coal consumption in this and adjoining states, it would seem, however, a well assured fact that any and every large body of coal land may be made a profitable producer of coal during the course of a few years. Coal rights covering many square miles of land in the State have been purchased at the rate of a few dollars per acre, the amount seldom exceeding $5. In the case of a single large property, only a portion may be operated at any one time, but a moderate production from this portion, on a very small margin of profit per ton, will yield many times 6 per cent. on the amount of the original cost, not only of the area actually worked, but of a large surrounding area also. Thus, the original cost of the coal rights over ten square miles, at $5 per acre, is $32,000. If the bed be only two feet thick, and if the coal underlying only 40 acres be removed per year, and sold at a profit of ten cents per ton, the income would be $10,000, as above calculated, or about 30 per cent. of the total original investment. On the basis of these figures it is plain that the results of a few years work, and the exhaustion of a very small fraction of the entire track, will suffice to return to the investor the total amount of the first cost of the coal land. The net receipts after this will continue to be large and will be clear profit.

Thus, the coal lands of Missouri would seem to be promising fields for investment, even at rates much higher than have been so far maintained. The statistics of shipments show that the tendency is towards large operations by companies controlling thousands of acres of lands. Pursued on this large scale mining can be prosecuted undoubtedly much more economically and larger markets can be reached. The coal can also be sold on a smaller margin of profit, which is a benefit to the consumer. The small operator is sometimes, if not generally, the sufferer through such conditions; and, further, the small land-owner is often, through lack of local competition, induced to part with his land, or its mining rights, to the adjacent large owner and operator at extremely low figures. Once the value of these coal lands well established and their extent defined, however, wide interest will be excited and strong organizations will be led into keener competition for the possession of these lands than has heretofore been the case, we may, therefore, look forward, in the march of events, to a large increase in the coal industry of the State, to profitable returns to those who invest their money sagaciously in coal lands and in the support of the dependent industry, and to an enhancement of the value of such lands now largely held and used purely for agricultural ends by private citizens of the State.

WHY DIP IS MORE LIKELY TO BE REGULAR THAN STRIKE WITH FISSURE VEINS.

BY ALBERT WILLIAMS, JR., M. E.

Faults may throw a vein out of plane as to either dip or strike, or both; perhaps more frequently the former. But, barring the effects of faulting, experience has shown that most fissure veins are tolerably uniform in their downward trend, while more or less wavy in their horizontal course, and that the dip often remains constant even where the average strike may be distorted by large scallopings. Reference here is not to the outcrop, which may be apparently twisted from the real course by the manner in which the topographical contours cut the plane of the veins, but to the flexures shown underground, where no such cause misleads observation. The splitting of veins into offshoots and the irregularities where two parts of a vein widen apart to inclose a horse, also occur in such ways as to affect both dip and strike, or either; but again the effect is more commonly to deflect the strike than the dip. While there are few positive laws thus far established regarding ore deposits (about the safest deduction of all being that what we do not know about them far exceeds what we do), the characteristics just referred to seem to be sufficiently frequent to have some significance; and though this frequency may not be enough to lead to anything that could be fairly called a law, yet even if it is established in a preponderance of cases only—and this at least may be conceded—it has a direct bearing upon the choice of plan to be adopted in mining where not much is known in advance as to the character of the ground to be opened. Probabilities are certainly better than nothing to work upon.

If, then, it is really true that the dip of fissure veins is likely to be more reliable in point of uniformity than their strike, the question naturally comes up, Why should this be so?

The most satisfactory answer seems to be that a large proportion of the veins are on the lines of *fault* fissures. This is pointed to by the occurrence of smooth walls, slickensides and clay selvages, which perhaps might also be accounted for by assuming small movements of the ground up and down during a long time, where the throw is not large enough to be dignified by the name of fault, but when these marks are very pronounced and there is found besides in the vein crushed rock indicating violent disturbance, the testimony becomes stronger, and when, as sometimes (though rarely) happens, the amount of throw can be measured and disjointed rock formations actually matched, then the evidence becomes conclusive. As to such veins as most probably were filled by hot ascending solutions, on the solfataric theory, there are parallel examples in the case of existing thermal springs (whether metalliferous or not), for these are often found in lines along the tops of evident fault fissures. Now, faulting means a movement more in an up-and-down direction than in any other. This being so, it is easy to understand why, when a rupture of rock masses has taken place, one being heaved up or the other slid down, or both walls moving in opposite ways or in the same direction, but with different degrees of motion, the fracture along the line in which the force was applied should have been more or less straight, while in other directions the result might have been a warped surface, since there the line of least resistance would be determined rather by the character of the ground than by the direction of effort, that is, where the impulse was most intense the break would be a clean one, whereas sidewise it might be irregular. Indeed, if it is conceivable that, in faulting, the up-and-down surfaces might have split off in waves, the continuance or renewal of the movement would cause the walls to act upon each other like huge planing machines, or rather like two slabs which the stone-dresser is surfacing, thus grinding off the inequalities with irresistible power and leaving the wall faces smooth and slickensided, with broken rock in the vein and clay gouges along the edges, just as in fact they are seen in the distinctly typical fissure veins.—*From the Engineering and Mining Journal.*

The Lidgerwood Manufacturing Company have issued from their New York headquarters, 96 Liberty Street, a forty page pamphlet, the third of their Sketch Book series, bearing the title "Open Pit Mining." It is profusely illustrated with dainty pen and ink sketches and full of valuable and interesting facts regarding the application of the company's celebrated Locke-Miller and Harris-Miller suspension cableways to open pit mining, quarrying and construction work.

Several views are shown of the Tilly Foster Iron Mines, Tilly Foster, N. Y., the concentrating works at Edison's Ogden Ore Mills, Ogden, N. J., and the Dunnellon Phosphate Company's mines, Dunnellon, Fla., with the suspension cableways erected by the Lidgerwood Manufacturing Company at these well known localities, also views of cableways used for building the Sodom Dam, at Brewsters, N. Y., and the Austin Dam, Austin, Tex. The last named cableway is the largest ever erected, having a span of 1350 feet. The book contains as well some very strong testimonials which will be read with interest by engineers and contractors. "Open Pit Mining" is intended for gratuitous distribution.

The Lidgerwood Manufacturing Company now own or control over a dozen patents on cableways, notably those of T. S. Miller, M. W. Locke, N. C. Harris, and C. M. North.

Correspondence

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ *Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.*

Speed of Fans.

Editor Colliery Engineer:

SIR:—I submit the following in reply to "C. A.," of Broadford, Pa., who asks the following question in the April issue:

"The barometer reads 29·5°, where a fan is making 40 revolutions per minute, if the barometer suddenly drop to 28·5° will the fan travel faster or otherwise, the power remaining the same?" As the pressure varies directly as the density, and as the density is decreased by the sudden drop in the barometer the fan will travel faster, that is in the proportion as 28·5° : 29·5° :: 40 : x, or 41·4 revolutions per minute at a reading of 28·5°.

Yours, etc.,
T. K.

Mt. Olive, Ill., April 12th.

Ventilation.

Editor Colliery Engineer:

SIR:—I notice in your April issue that in his answer to Question No. 2, asked by "Alberto," of Wall, All'y Co., Pa., "T. K." makes a mistake regarding the water-gauge 2,000′ farther in the mine. If the water-gauge registered 0·5 at entrance, the distance being 4,000′ in and 4,000′ return = 8,000′, then the water-gauge 2,000′ farther in, and 2,000′ back again, making an additional 4,000′ would be found by proportion.

Thus:

8 : 4 :: 0·5 : x, or 0·25 = the pressure 2,000′ farther in the mine.

In finding the pressure at any distance, everything else being equal, the rule is, if the length is doubled the pressure is also doubled, and one-half the length requires one-half the pressure.

Yours, etc.,
J. N.

Trotter Mine, Pa., April 11th.

Mensuration.

Editor Colliery Engineer:

SIR:—I submit the following in answer to "L. P. H.," of Avoca, Pa., in the April issue: As the kettle was to hold 7 gallons less than a score, the contents would equal 13 gallons. In 13 gallons there are 282 × 13 = 3,666 cubic inches. Then as the diameters are as 5 is to 3, we can solve as follows:

$$(5^2 + 3^2) + (5 + 3) \times \frac{12}{3} = 196, \text{ and}$$

$$196 \times {\cdot}7854 = 153{\cdot}9384.$$

By proportion we find the required diameters thus,—

$$153{\cdot}9384 : 3666 :: 5^2 : 595{\cdot}30801733,$$

Then

$$\sqrt{595{\cdot}30801733} = 24{\cdot}4002 \text{ inches, the greater diameter.}$$

Also

$$5 : 3 :: 24{\cdot}4002 : x, \text{ or } 14{\cdot}6401 \text{ inches, the smaller diameter.}$$

I would have worked it out in full, but did not want to use too much of your space.

Yours, etc.,
BRYCHAN.

Nanticoke, Pa., April 20th.

Mensuration.

Editor Colliery Engineer:

SIR:—Please insert the following question for answer in your Correspondence Department:

On the Fourth of July a pole was erected,
Composed of six pieces and nicely connected.
Two feet and six inches it measured around
On the place where it stood on the top of the ground.
The form was a cone in surface complete;
The height of the same was twice sixty feet.
What length of inch riband procured at the shop
Will wind round the pole from bottom to top,
And have it lay smooth and plain to be seen
By leaving a space of five inches between.

Yours, etc.,
BRYCHAN.

Nanticoke, Pa., April 20th.

Trigonometry.

Editor Colliery Engineer:

SIR:—In the December, 1891, issue of THE COLLIERY ENGINEER "R. L. T.," of Reynoldsville, Pa., asks a question which I do not think has been answered as yet, therefore I offer the following solution:

Will some of your readers kindly explain how the decimal is found for any number of degrees such as 35°? Is it by multiplying by the sine of one degree? ·017452 × 35° is not correct.

Being under the impression that "R. L. T." is situated like myself, and has to plod along the best he can, I venture to submit the following formula as I understand it in Davis' Legendre:

The sine of one degree is found thus: As there are 180° in a semi-circle, and the radius being 1, we have

3·141592+ ÷ 180 = ·017453+, the sine of the first degree, then

·017453+ × 2 = ·03489+, sine of the second degree carried out to five decimal places.

Now by Davis' rule we find the sine of the third degree thus:

·01745 : ·03489 — ·01745 :: ·03489 + ·01745 : sine of third degree.

We will illustrate this by the following example:

Sine 1° : sine 2° — sine 1° :: sine 2° + sine 1° : x, or substituting their values

·01745 : ·01744 :: ·03489 : x, or ·03486,

then,

·03486 + ·01745 = ·05231, sine of the third degree. The slight difference is caused by not carrying out the decimals further.

Yours, etc.,
BRYCHAN.

Nanticoke, Pa., April 20th.

Speed of Fans.

Editor Colliery Engineer:

SIR:—Please publish the following in reply to question by "C. A.," of Broadford, Pa., in your April issue: The barometer reads 29·5° where a fan is making 40 revolutions per minute, if the barometer suddenly falls to 28·5° would the fan travel faster (owing to diminished density) or otherwise, the power remaining the same? 28·5 : 29·5 :: 40 : x, or 41·4.

Yours, etc.,
T. K.

Belleville, Ill., May 5th.

Mensuration.

Editor Colliery Engineer:

SIR:—Please insert the following in answer to the "Kettle Problem" in your last issue: The kettle is to contain 13 gallons × 282 cubic inches = 3666 cubic inches. The depth is 12 inches and the diameters are in the ratio of 5 to 3, then the areas for the different ends will be in proportion to the ratios squared. The square of 5 is 25 and of 3 is 9 making a total of 34 parts, 9 for small and 25 for large end. Now if we divide 3666 by 12 we have 305·5 area for one end which multiplied by 2 and divided by 34 gives one part. We now multiply this by 9 which gives area of small end then

305·5 × 2 = 611 ÷ 34 = 17·970588 × 9 = 161·735292. Then subtracting 161·735292 from 611, we have 449·264708 area for large end. These areas divided by ·7854 = the squares of their diameters, the square roots of which will be the required diameters. Therefore

161·735292 ÷ ·7854 = $\sqrt{205{\cdot}93}$ diameter squared, the square root of which = 14·35 + and

449·264708 ÷ ·7854 = $\sqrt{572{\cdot}0202}$ the square root of which = 23·9169, now if we divide 14·35 by 3 and multiply by 5 we have 23·9165, being only $\frac{4}{10000}$ over the mark.

Now to prove from the areas that the kettle holds the quantity let us multiply each end by one-half the depth and 161·735292 × 6 = 970·411752 and 449·264708 × 6 = 2695·588248 = 3666 cubic inches ÷ 282 = 13 gallons.

Yours, etc.,
G. S. FORSYTHE.

Delaney, Cambria County, Pa., May 9th.

Mensuration.

Editor Colliery Engineer:

SIR:—In Nesbit's Mensuration there is a question similar to "L. P. H.'s" kettle question which appeared in your April issue. It is not worked out but the answers given for the diameters are 24·400163 inches and 14·640098 inches respectively. In working it out, however, I make the diameters 20·760 inches and 12·456 inches. What causes the difference? I cannot imagine unless it is in the value of the score. I compute a score to equal 20. By the rule my diameters give the whole quantity of inches in 13 gallons counting 282 cu. inches to the gallon.

The rule to find the contents of a frustum of a sphere, which is similar to the "Tinker's Kettle," is "To the sum of the squares of the radii of the two ends, add one-third of the square of the height, and this sum being multiplied by the height and the product again by 1·5708 will give the contents." In this instance we will let 10 x equal the large diameter and 6 x the small. The radius equals one-half the diameter, then the formula is.

$$(5\,x)^2 + (3\,x)^2 + \frac{12^2}{3} \times 12 \times 1{\cdot}5708 = 282 \times 13, \text{ collecting}$$

$$(34\,x^2 + 48)\ 18{\cdot}8496 = 3666 \text{ cu. ins.}$$

Therefore, x = 2·0760, which multiplied by 10 and 6 gives the large and small diameters respectively.

Yours, etc.,
W. J.

Dunlo, Cambria Co., Pa., May 2d.

Mensuration.

Editor Colliery Engineer:

SIR:—I send the following solution to question by "L. P. H.," of Avoca, Pa., in the April issue:

The rule for finding the contents of a conical frustum is as follows where the two end diameters are D and d and the height is H and C = contents:

$$C = \frac{D^3 - d^3}{D - d} \times {\cdot}7854 \times \frac{H}{3}$$

In the example we have $d = \frac{3}{5}$ of D; H = 12 and C = 3666 cubic inches and we have to find D.

Reducing we get $\frac{D^3 - d^3}{D - d} = \frac{3666}{3{\cdot}1416} = 1167$ nearly.

Calling D = x we get

$$\frac{x^3 - \left(\frac{3}{5}\ x\right)^3}{x - \frac{3}{5}\,x} = 1167\ ;\ \frac{490\,x^3}{250\,x} = 1167\ \therefore\ 1{\cdot}96\,x^2 = 1167.$$

Hence $x^2 = 595{\cdot}4$ and $x = \sqrt{595{\cdot}4} = 24{\cdot}4$ inches the larger diameter of which $\frac{3}{5} = 14{\cdot}64$.

Yours, etc.,
W. H. BOOTH.

Willesden Junction,
London, N. W. England, May 3d.

Ventilation.

Editor Colliery Engineer:

SIR:—As "X. Y.," of Nanaimo, B. C., does not understand my solution of "R. R. S.'s" question in September issue, I will try to oblige him by further explanation and show him where I get my formula. It is not always necessary to go to an author for one. It must be evident to any one who understands anything about friction of air in mines that the water-gauge (1·85 inches) or 9·62 pounds pressure is the frictional resistance due to the passage of the current, not for the first section of the air-way alone, but all four combined and that each contributes its part of pressure; and the relative amount due to each section will be as its rubbing surface divided by its area cubed. Now I will try and show you as plainly as I can where I get my formula. By using the equation $k\ s\ q^2 = p\ a^3$; and as we want to find p we must divide $p\ a^3$ by a^3, to get p or what is the same divide $k\ s\ q^2$ by a^3, because $k\ s\ q^2 = p\ a^3$, but in the question k and q are the same in each of the sections of the air-way those factors cancel each other so we can leave them out, and we then have

$$\frac{k\ s\ q^2}{a^3} = \frac{p\ a^3}{a^3} = \text{the relative pressure.}$$

The next formula I used was made from the same equation as above where it is found if air-ways passing the same or equal quantities with the same pressure their rubbing surfaces will vary as the cubes of their areas as can be seen thus, $k\ s\ q^2 = p\ a^3$, because after canceling we have s on the one side and a^3 on the other, hence s varies as a^3.

"X. Y." says he has tried Fairley's formula where a road of various dimensions can be reduced to a typical air-way that will offer the same resistance to the passage of the current and cannot find anything like the same pressure, viz., 16 lbs., I think he has evidently made a mistake in the working of the question as may be seen by applying Fairley's formula, which is

$$\frac{a'^3}{o'} \times \frac{s}{a^3} = l' \text{ for the typical airway.}$$

A′ and o' representing the area and perimeter of the assumed or typical air-way respectively.

Let us assume such an air-way 4 × 5 whose area will = 20 sq. ft. and its perimeter 18 feet,

Then

$$\frac{20'^3}{18'} = 444{\cdot}44$$

1st air-way, or section,

Lengths.

$$\frac{s}{a^3} = \frac{28000}{48^3} \times 444{\cdot}44 = 112{\cdot}53$$

2d air-way, or section,

$$\frac{s^3}{a} = \frac{27500}{31\frac{1}{2}^3} \times 444{\cdot}44 = 392{\cdot}44$$

3d air-way, or section,

$$\frac{s}{a^3} = \frac{30000}{35^3} \times 444{\cdot}44 = 373{\cdot}15$$

4th air-way, or section,

$$\frac{s}{a^3} = \frac{34000}{24^3} \times 444{\cdot}44 = 1085{\cdot}54$$

Total length of typical air-way = 1963·66 ft.

Then,

$$\frac{k\ s\ v^2}{a} = p = \frac{\overset{k}{{\cdot}0217} \times \overset{l}{1963{\cdot}66} \times \overset{o}{18} \times \overset{v}{648{\cdot}1^2}}{20}$$

= 16·1 lbs. pressure.

So we see that by Fairley's formula we obtain the same pressure as I found it to be before, and if "X. Y." will apply this formula to the quantity, which I gave as the answer, viz., 9·998 cubic feet, he will find it will work back to the given pressure nearly (9·62) and I think that either of the formulæ I used is easier than Fairley's, and not so difficult to understand.

Yours, etc.,
T. S. C.

Gardner, Ill., May 17th.

A Problem in the Development of Coal Lands.

Editor Colliery Engineer :

SIR:—In answer to "H. J.," of Charleston, W. Va., in the April issue, I would say that to answer his problem in detail would require considerable space. I will endeavor, however, to answer his questions so that he can draw a conclusion as to which field of coal would be the cheapest to develop.

We will first consider the coal above water level and note some of the advantages and disadvantages. As I am not informed as to the rise of the ground I would say for the benefit of "H. J." that the cost per yard for putting in a drift and timbering the same, would be $6.00 per yard without taking into consideration the cost of timbering. The opening to be 6½ feet high, 6 feet wide on top and 8 feet wide on bottom. This cost will be on the mine until the coal will be fit for market; probably twenty yards. We will say twenty yards for our calculation. Then we have:

20 × $6.00	$ 120.00
Cost of grading	1,500.00
600 ties at 10 cents each	60.00
15 tons steel rails at $30	450.00
Labor for laying the same	60.00
Splice bars, spikes, and bolts about	15.00
Rollers and brackets about	40.00
Total,	2,245.00

I haven't given the cost of rope as I don't know what size would be used, but a rope ¾ inches diameter would be the proper size for the above calculations. I will not make an estimate of the friction drum and connections, but will suppose the cost to equal the head gearing, etc., of the shaft. Steel rails to be 20 lbs. to the yard and incline to have three rails all the way except the pass-bye, which will require four rails. The ties should be long enough to reach under all the rails as they hold the road in better shape than if they were short, besides the saving of timber. If you have no timber on the tract of land the ties will cost more than 10 cents each. In a drift mine there is no trouble to get the water out of the mine, whereas in a shaft or slope mine it will be necessary to use pumps. The coal could be handled on the incline with two day hands less than with the shaft.

We will now make an estimate of the shaft work. As the shaft will be 60′ to the coal it will require 70′ to be sunk in order to give sump room. The average cost of sinking a shaft 10′ × 14′ including tools, timber, blasting material, carpenter and blacksmith work, etc., is $120 per foot, then

$$70' \times \$120 = \$8,400.$$

As there will be 100,000 gals. of water to be lifted per day it will be necessary to calculate size of pump required to perform the work, and as it will require a pump to perform the work in ⅓ of a day to allow time for packing, repairs, etc., we will calculate the size of pump to lift water in 8 hours: 8 × 60 = 480 min.

Then by using imperial gallons we have

$$100{,}000 \div 480 = 208\tfrac{1}{3} \text{ gals. per min.}$$

$$\frac{208\frac{1}{3}}{2\frac{1}{2} \times 20 \times {\cdot}034} = 11 + \text{ inches } = \text{ diameter of water end.}$$

In one imperial gallon there are 277·274 inches; length of stroke 2½ ft.; number of strokes per min., 20. Again using the U. S. standard gallon we have

$$208 \times 231 = \frac{48048}{20 \text{ (No. of strokes)}} = \frac{2402{\cdot}4}{30 \text{(length of stroke)}} = 80{\cdot}08.$$

$$\sqrt{\frac{80{\cdot}08}{{\cdot}7854}} = 10 + \text{ inches } = \text{ water end of pump.}$$

A pump of that size would cost from $1200 to $2000, or on an average of $1600, you will then need pipes and fittings, boilers, engines to hoist coal, boiler house, engine house, etc., which would not be required for the drift mine.

In case of a stoppage for want of a market for coal, or from strikes, etc., the drift mine would cost merely nothing but the shaft would require a fireman, pumper, and machinist, or engineer, besides the boiler coal used to pump the water out besides the cost of packing, lubricants, etc. A slope mine could be driven for less than the sinking of the shaft, but the coal could not be handled any faster and all other labor would be on a par with the shaft work. If a slope was put in it should be on an angle of 15° or 20°. To make it any steeper will require a carriage to convey the cars to the surface. The cost per yard for driving a slope would be about $18 for labor and standing the timber. I haven't the time to give the question the consideration it should have or I would answer more fully and perhaps some of your able correspondents will have answered the same question. If any of your correspondents wish to criticise or correct this answer, I hope they will do it in a gentlemanly way.

By discussing all such questions in the proper way in your valuable journal, we can get all, or nearly all, the good there is in a question and may get the ideas of some of our brightest correspondents, thereby making the Correspondence Department more interesting and learning some good lessons ourselves.

Yours, etc.,

PEACE.

Dunbar, Pa., April 20th.

P. S.—Would say for the benefit of "H. J." that if he adopts the drift mine and lays an incline road to the same that he may take a few hints from the following:

A good rate of speed on an incline is 8 miles per hour or 704 ft. per min. At this rate it will require 2 min. 7 sec. to make the trip, or three minutes to make the trip and give ample time to hitch and unhitch the cars. The work should be laid out so that it could be done in 8 hours.

$$\frac{600 \text{ tons}}{8 \text{ hours}} = 75 \text{ tons per hour. } \frac{75 \text{ tons}}{60 \text{ min.}} = 1\tfrac{1}{4} \text{ tons per min.}$$

1¼ tons × 3 min. = 3¾ tons per trip. The reason I took 8 hours for the time was to give allowance for breakage or accidents.

P.

Mensuration.

Editor Colliery Engineer :

SIR:—Please insert the following in answer to question by "L. P. H.," of Avoca, Pa., in the April issue: The diameters of the flat-bottomed kettle being in the proportion as 5 is to 3, make it in shape the frustum of a cone. There being 282 cubic inches in an ale gallon, the cubic contents of the kettle would be as follows:

$$282 \times 13 = 3666 \text{ cubic inches,}$$

and

$$\frac{3666}{12} = 305{\cdot}5,$$

then

$$\sqrt{\frac{305{\cdot}5}{{\cdot}7854}} = 19{\cdot}72$$

the mean diameter. Adding the top and bottom diameters; also the given proportions, we obtain the following:

$$\frac{19{\cdot}72 + 19{\cdot}72}{5 + 3} = 4{\cdot}93$$

and

$$4{\cdot}93 \times 3 = 14{\cdot}79 \text{ top diameter,}$$

also,

$$4{\cdot}93 \times 5 = 24{\cdot}65 \text{ bottom diameter.}$$

The following is a proof that the diameters are as 5 is to 3,

$$5 : 3 :: 24{\cdot}65 : 14{\cdot}79$$
$$3 : 5 :: 14{\cdot}79 : 24{\cdot}65$$

Yours, etc.,

TRACKMAN.

Mt. Pleasant, Pa., May 25th.

Specific Gravity of Gases.

Editor Colliery Engineer :

SIR:—In the May issue of THE COLLIERY ENGINEER I notice several replys to question asked by "Miner", of Uniontown, Pa., none of them agreeing. I will therefore offer the following solution to his question. He wants a rule whereby the specific gravity of any gas may be found. In the first place the specific gravity of any gas is its weight as compared volume for volume with dry air, air being taken as 1 or unity. And it requires 13·06 cubic feet of dry air to weigh one pound, then as the weight of any gas compared volume for volume with 13·06 will be the specific gravity of the gas. To illustrate the above more fully we will take the following gas for solution:

Hydrogen requires 188·53 cu. ft. per 1 pound, then 13·06 ÷ 188·53 = ·0692 specific gravity of hydrogen.

Carbon requires 15·75 cu. ft. per 1 lb., therefore the specific gravity of carbon is 13·06 ÷ 15·75 = ·8292.

Carbonic oxide requires 13·50 cu. ft. per 1 lb., therefore carbonic oxide is 13·06 ÷ 13·50 = ·9673.

Carbonic acid requires 8·59 cu. ft. per 1 lb., therefore the specific gravity is 13·06 ÷ 8·59 = 1·52.

Methane requires 26·61 cu. ft. per 1 lb., therefore the specific gravity is 13·06 ÷ 26·61 = ·559.

Yours, etc.,

T. K.

Mt. Olive, Ill., May 23d.

The Siphon.

Editor Colliery Engineer :

SIR:—In your April issue "S. U. P." asks a number of questions regarding siphons, among which is "How can a siphon be prevented from cutting off?" In reply would say, if the pipe is 2″ thick, remove a length from the discharge end and replace it with 1½″ pipe, the siphon will then run as long as there is water to supply it.

Yours, etc.,

WM. KELLER.

Irvona, Pa., May 28th.

Ventilation.

Editor Colliery Engineer :

SIR:—I notice that "N. S.," of Dagus Mines, Pa., in answering question by "A. B.," of Hanna City, Ill., gives the perimeter as 21·7′. I calculate it to be 18·3758′ and 5·817′ diameter by his rule for working the question. T. S. Cummings, of Gardner, Ill., also, objects to "N. S.'s method of finding diameter, but says he is glad that it can be worked several ways. Now, I am not satisfied with any of the answers given so far, and would like "W.," of Hornsby, Ill., to work his calculations out more in detail so that they could be better understood.

Yours, etc.,

SAGER.

Pine Knot, Whitley Co., Ky., May 28th.

"Watercracks" in Steel.

Editor Colliery Engineer :

SIR:—Please insert the following in answer to question by "Burleigh," of Nanaimo, B.C., in the May issue:

When the drills are ready to be tempered they should be dipped blood-red hot in the following mixture: 2 ounces of charcoal, 2 ounces of bone-dust, and one pint of machinery oil *thoroughly* mixed. Then made blood red hot again and tempered in the usual manner. The water used should not be too cold, as this is often a cause of "watercracks."

Yours, etc.,

JAMES T. JENKINS.

Plymouth, Pa., June 3d.

Something About Graphite.

We occasionally hear of some one complaining of graphite or graphite productions. Now and then such a person, without further investigation, will write to some mechanical paper condemning its use in places where, *if the graphite is pure and properly prepared*, it should be of the greatest benefit.

The nature of graphite, sometimes called plumbago or black-lead, is not generally understood. Eminent writers on friction have declared that it is the best natural lubricant known, and scientific and mechanical papers have advocated its use for many purposes. Incompetent, if not unscrupulous parties, have attempted to meet the demand by putting on the market graphite productions that are totally unfit for the uses specified.

Graphite is one of the forms of carbon. It is not affected by heat or cold, or any known chemical. As it comes from the mine, however, it contains from 50 to 80 per cent. of silica, sulphur, and other impurities, and the process of completely freeing the graphite from impurities requires very expensive machinery and the most skillful manipulation. Only manufacturers having such facilities can hope to produce an absolutely pure article. The impurities in much of the graphite now in the market take on the appearance of graphite by contact, and such impurities are sometimes undetected even by the expert, unless chemical tests are employed. This is especially true of amorphous graphite, commonly called black-lead, which is graphite without any particular form, and usually mixed with clay.

Pure graphite, and even black lead, is useful in many ways as will be shown by a perusal of the catalogue of the Jos. Dixon Crucible Co., of Jersey City, N. J.

To be useful in the highest degree, the graphite should be carefully selected with a view to the use intended. Graphite suitable for lead pencils is not the most suitable for lubricating, although it has lubricating qualities. Again graphite suitable for stove polish would not answer for crucibles, although it might be equally pure and stand the heat equally well. It varies greatly in its construction and usefulness, and the best results are only brought about through experience, knowledge and proper mechanical facilities.

The Jos. Dixon Co. are miners as well as importers of graphite in all its forms, and they do not use any graphite that they do not either mine or prepare. They not only have every facility in the way of machinery and chemists, but also the records and experience gained in sixty-five years in the business. They therefore know and guarantee the purity of their productions, and buyers of the Dixon products can feel assured not only of the purity of the graphite used, but also that the *proper* graphite has been used.

We have received from the Lidgerwood Manufacturing Company, of 96 Liberty Street, New York, a copy of "Open Pit Mining," which is a beautiful pamphlet of forty pages, illustrating by engravings from pen and ink sketches the use of Lidgerwood Improved Suspension Cableways in open pit mines. Among other sketches are a number illustrating the method of handling the ore at the Tilly Foster Mine, in New York, and the method of handling phosphate at phosphate mines in the South.

As an example of the possibilities of their method of handling material, the cableway in use at Austin, Texas, for the construction of the famous Austin dam, is shown. This is the largest hoisting and conveying cableway ever built. It has a clear span of 1350 feet; the main cable is 2½ inches in diameter, and the load carried is seven tons.

Among the other interesting illustrations are several showing the Lidgerwood cableways in use at Thomas A. Edison's famous Ogden Ore Mill, at Ogden, N. J.

The success that the Lidgerwood Company has met with in their business is entirely due to the superior quality and convenience of their machinery, and is attested by the fact that during the year 1890 they sold 1105 engines and 588 boilers.

"A Practical Consideration of Compressed Air," by William L. Saunders, C. E., of 10 Park Place, New York, is one of the most interesting and valuable treatises on the subject we have yet read. Mr. Saunders has given the subject of compressed air as a means of transmitting power, years of study, and has had a vast amount of practical experience in the matter. His work is therefore one that contains in a condensed form many valuable hints regarding the means necessary to obtain the greatest efficiency from compressed air, and he corrects some popular errors on the subject. The work is reprinted from the *Journal of the Franklin Institute* for May, and contains several illustrations that make clear the ideas expressed. It was originally delivered as a lecture before the Institute in December, 1891, and is now published in pamphlet shape, so as to be within the reach of all persons interested.

We have received a copy of the *Monthly Record*, Vol. 1, No. 5, published by the Edison General Electric Co., at the Edison Building, New York City. It is a very pretty 8-page journal printed on fine calendered paper, and is illustrated by half-tone engravings of superior merit. While naturally intended as an advertisement of the Edison General Electric Co., it contains a great deal of useful and interesting matter regarding the transmission of power by electricity. It is well edited, and is just such a production as would be expected from such an enterprising and progressive corporation as the Edison Co.

NEW MINING COMPANIES.

Names and Post-Office Addresses of the New Mining Companies Incorporated in the United States Since Our Last Issue.

Elkhorn Mountain Gold Mining Co.,	Portland, Oregon.
The Kootenay Lake Reduction Co.,	New Haven, Conn.
Katahin Mining Company,	Spokane, Wash.
The American Flag Mining and Tunnel Company,	Fremont, Colo.
Columbian Mining and Milling Co.,	Reading, Vermont.
McAntire and McKee Mining Co.,	Joplin, Mo.
Jack Mining Co.,	Carterville, Mo.
McKinney Coal and Coke Co.,	Marietta, Ohio.
McKinley Iron Co.,	Duluth, Minn.
The North Dakota Coal and Power Co.,	Mandan, N. D.
The Miller Mining and Tunneling Co.,	Aspen, Colorado.
The Fortunatus Gold and Silver Mining Co.,	Denver, Colo.
The Colorado Enterprise Leasing and Mining Co.,	Denver, Colo.
The Captain Inca Mining Co.,	Pueblo, Colo.
The Cut Diamond Mining and Milling Co.,	Colorado Springs, Colo.
The Creede Camp Mining Stock Exchange Co.,	Amethyst, Colo.
The Home Run Mining Co.	Del Norte, Colo.
The Mountain Chief Gold Mining and Milling Co.,	Fremont, Colo.
The White Star Mining Co.,	Buffalo, Wyo.
The Refugio Mining Co.,	Chicago, Ill.
Gold Brick Mining Co.,	Portland, Oregon.
The Rochester Cosolidated Mining and Milling Co.,	Ouray, Colo.
The White Elephant Gold Mining Co.,	Fremont, Colo.
The Shenandoah Mining and Milling Co.,	Denver, Colo.
The Star of the East Mining Co.	Fremont, Colo.
The Colorado Oil and Gas Co.,	Denver, Colo.
The Copper Rock Gold Mint Mining Co.,	Denver, Colo.
The Rock Island Gold Mining and Milling Co.,	Colorado Springs, Colo.
The Juniata Mining and Milling Co.,	Denver, Colo.
The Burton Gold and Silver Mining Co.,	Denver, Colo.
The Grand View Mining, Milling and Developing Co.,	Del Norte, Colo.
The Rhyolite Mining and Milling Co.,	Denver, Colo.
The Garfield Coal Mining Co.,	Denver, Colo.
The Relief Mining and Milling Co.,	Fort Collins, Colo.
The Gold Link Mining and Milling Co.,	Denver, Colo.
The Tecumseh Mining and Milling Co.,	Denver, Colo.
Rocky Ridge Coal Co.	New Whatcom, Wash.
The Silver Queen Mining Co.,	Kettle Falls, Wash.
Merrit Nickel Mining Co.	Duluth, Minn.
Stiles Gold Quartz Mining Co.,	San Francisco, Cal.
The Guadalupe Mining and Milling Co.,	Chicago, Ill.
Middlesex Marble Co.,	Portland, Maine.
Tennessee Oil, Gas and Mineral Co.,	New York City, N. Y.
Bon Accord Placers, Limited,	Cavendish, Montana.
Portable Improvement Co.,	Camden, N. J.
Sussex Slate Co.	Newton, N. J.
The Mackinly Mining Co.,	Jersey City, N. J.
The Diamond Portland Cement Co.,	Middlebranch, Ohio.
The Evangeline Gold Mining and Milling Co.,	Chicago, Ill.
The Bonner Oil and Gas Co.,	Hartford City, W. Va.
Pride of the Mountain Mining Co.	Everett, Wash.
Chicago Improvement Co.,	Chicago, Ill.
United States Asphaltum and Development Co.,	East St. Louis, Ill.
The Tower Lode Mining Co.,	Kingham, Kas.
The Englevale Coal Mining and Development Co.,	Englevale, Kansas.
Whitaker Phosphate Co.,	Kansas City, Kas.
Cymbia Coal Co.,	Philadelphia, Pa.
The Pacific Gold and Silver Extraction Co.,	Los Angeles, Cal.
The Black Bear Mining Co.,	Telluride, Colo.
The Anchorian-Leland Mining and Milling Co.,	Colorado Springs, Colo.
The Equity Mining, Milling and Development Co.,	Denver, Colo.
The Mineral Development Co.,	Denver, Colo.
The June Mining and Milling Co.,	Denver, Colo.
The American Girl Mining Co.,	Denver, Colo.
The Woody and Silver Creek Mining and Milling Co.,	Aspen, Colo.
The Amethyst Mining Co.,	Denver, Colo.
The Mica Monarch Mining Co.,	Denver, Colo.
The Empress of Aspen Mining Co.,	Manitou, Colo.
The Needles Reduction Co.,	Denver, Colo.
The Crystal Mining and Milling Co.,	Fremont, Colo.
Rochester Medina Stone Co.,	Albion, N. Y.
Elko Mining, Milling, and Manufacturing Co.,	Randolph, N. Y.
Mechanical Gold Extractor Co.,	Jersey City, N. J.
The Evangeline Gold Mining Co.,	Jersey City, N. J.
The North Star Iron Co.,	Baltimore, Md.
Elk Ridge Coal and Coke Co.,	Elkhorn, W. Va.
Oswego Lead and Zinc Co.,	Chicago, Ill.
Empire Granite Co.,	Barre, Vt.
Eureka Mica Mining Co.,	Nashua, N. H.
The Boulder Creek Mining Co.,	Boulder Creek, Idaho.
The A. O. Jones Brick and Terra Cotta Co.,	Zanesville, Ohio.
South Fork Mining and Milling Co.,	Kalispell, Mont.
Mill Side Mining Co.,	Butte, Mont.
The Lee Gold Mining Co.,	New Brunswick, N. J.
Union Jack Mining Co.,	Spokane, Wash.
Isabella Mining Co.,	St. Louis, Mo.
Daisy Hill Mining Co.,	San Francisco, Cal.
Blue Ridge Coal Co.,	Scranton, Pa.
The McLaughlin Oil Co.,	Allegheny, Pa.
The Elizaville Natural Gas Co.,	Lebanon, Ind.
Tenta Duras Mining and Milling Co.,	Cherokee, Iowa.
Jewell Metallic Paint Co.,	San Francisco, Cal.
The Chicago and Creede Consolidated Mining and Milling Co.,	Creede, Colo.
The Free Coinage Mining and Milling Co.,	Denver, Colo.
The Princess Gold Mining Co.,	Colorado Springs, Colo.
The Colorado and Mexico Exploration and Development Co.	Denver, Colo.
The Miller Mining and Tunneling Co.,	Aspen, Colo.
The Oolitic Stone and Lime Co.,	Romona, Ind.
The Goodman Mine.	San Francisco, Cal.
The Des Moines Gold Mining Co.,	Colorado Springs, Colo.
The Riall-Collins Tunnel Co.,	Jimtown, Colo.
The Little Don Mining and Tunnel Co.,	Fremont, Colo.
Boulder Electric Power Co.,	Creighton, Neb.
American Verde Antique Marble Co.,	Milwaukee, Wis.
Bland Mining and Tunnel Co.,	Philipsburg, Mont.
Allegheny Iron Mining and Milling Co.,	Duluth, Minn.
The Steubenville Oil and Gas Co.,	Steubenville, Ohio.
The Falcon Gold Mining and Milling Co.,	Salida, Colo.
The T. E. T. Mining and Milling Co.,	Colorado Springs, Colo.
The Copper Rock Gold Mining Co.,	Denver, Colo.
The Lucky Tunnel Mining Co.	Pueblo, Colo.
International Mining Co.,	Spokane, Wash.
The Inter-State Development Co.,	Cheyenne, Wyo.
The Cheyenne Mining Co.,	Cheyenne, Wyo.
Citizens' Natural Gas Co., of Greencastle, Indiana,	Greencastle, Ind.
Yellow Run Coal Co.,	Greensburg, Pa.
Columbia Mining Co.,	Danville, Ill.
Inter-Republic Gold and Silver Mining and Milling Co.,	Las Cruces, N. M.
The Bi-Metallic Smelting Co.,	Leadville, Colo.
The Ophir Bell Mining Co.,	Aspen, Colo.
[illegible]olfax Mining and Prospecting Co.,	Denver, Colo.
The Mammoth Mountain Mining Co.,	Denver, Colo.
Mammoth Mountain Deep Mining and Tunnel Co.,	Denver, Colo.
The Bachelor Hill Mining Co.	Pueblo, Colo.
The Golden Rule Mining Co.	Denver, Colo.
The Fre: Gold Hill Consolidated Mining and Milling Co.,	Denver, Colo.
The Carson Mining Co.,	Denver, Colo.
The Iron Clad Mining and Milling Co.	Denver, Colo.
The Kootenai Placer Mining Co.,	Waneta, British Columbia.
The Seven Mile Mining and Milling Co.,	Fort Collins, Colo.
The Leghorn Mining and Manufacturing Co.,	Reading, Pa.,
Brookside Coal Co.,	Wilkes-Barre, Pa.
The Sunflower Coal and Mining Co.,	Kansas City, Kas.
Ferguson Splint Coal Co.	Ferguson, W. Va.
Berkeley Sand Co.,	Berkeley Springs, W. Va.
Out-Crop Iron Mining Co.,	St. Paul, Minn.
Trojan Mining Co.,	Tacoma, Wash.
Po-Keg E-Ma Iron and Mining Co.,	Chicago, Ill.
Menlo Gold Mining Co.,	Grass Valley, Cal.
Continental Marble Co.,	Manchester, Vt.
Capitan Mining Company of Colorado,	Jersey City, N. J.
The Golden Eagle Mining and Milling Co.,	Colorado Springs, Colo.
The Mountain Chief Mining and Milling Co.,	Denver, Colo.
The Mammon Gold Mining Co.,	Colorado Springs, Colo.
The Sweet Mining and Milling Co.,	Pueblo, Colo.
The Toronto and Montreal Mining and Milling Co.,	Denver, Colo.
The Jack Pot Mining Co.	Colorado Springs, Colo.
The Nugget Mining and Milling Co.,	Colorado Springs, Colo.
The Requa Gold and Silver Mining and Milling Co.,	Canon City, Colo.
The Decatur Mines Syndicate, Limited, London, England.	London, Eng.
The Cambria Mining Co.,	Denver, Colo.
The Stanhope Mining Co.,	Denver, Colo.
The Victor Smuggler Gold Mining Co.,	Pueblo, Colo.
The Pueblo Bell Mining and Milling Co.,	Pueblo, Colo.
The Currency Mining Co.,	Denver, Colo.
The Phil Sheridan Mining and Milling Co.,	Pueblo, Colo.
The Free Coinage Gold Mining Co.,	Colorado Springs, Colo.
The Alhambra Mining Co.,	Pueblo, Colo.
The Anequa Placer and Lode Mining Co.,	Fremont, Colo.
The Barbara-Gibson Mining and Milling Co.,	Denver, Colo.
The Windsor Mining Co.,	Denver, Colo.
The San Luis Coal and Coke Co.,	Denver, Colo.
The Gold Dust Mining and Milling Co.,	Denver, Colo.
The Monument Treasure Mining and Milling Co.,	Colorado Springs, Colo.
The Orphan Girl Consolidated Mining and Milling Co.,	Denver, Colo.
Ravenswood Oil and Gas Co.,	Ravenswood, W. Va.
American Exploring Co.,	San Francisco, Cal.
Martha Washington Placer Mining Co.	Oakland, Cal.
The Pacific Mining Co.,	Duluth, Minn.
The Kirkpatrick, Howk & Massey Stone Co.,	Joliet, Ill.
Corinth Store and Improvement Co., of W. Va.,	Baltimore, Md.
Empress Josephine Mining Co.,	New York City, N. Y.
Reed Mines Consolidated Co.,	San Francisco, Cal.
Western Star Gold and Silver Mining Co.,	San Francisco, Cal.
Osborn Gold Mill and Mining Co.	San Francisco, Cal.
Helena & Butte Co.,	Helena, Mont.
The Catherine Noble Mining Co.,	Minneapolis, Minn.
The Collett Gas and Oil Co.,	Collett, Ind.
Standard Coal and Timber Co.,	Philadelphia, Pa.
Battelle Oil Co.,	Morgantown, W. Va.
Aetna Mining Co.,	New York City, N. Y.
Diamond Developing Co.,	Cheyenne, Wyo.
Lander Coal Mining Co.,	Lander, Wyo.
Carbonate Chief Mining Co.,	Great Falls, Mont.
The Gold Geyser Mining Co.,	Cripple Creek, El Paso Co., Colo.
The Bachelor Mountain Mining and Milling Co.,	Denver, Colo.
The Mammoth Mining and Smelting Co.,	Pueblo, Colo.
The Mason Gold Mining Co.,	Colorado Springs, Colo.
The Rocky Mountain Mining and Development Co.,	Pueblo, Colo.
The Ophir Gold Mining and Milling Co.,	Denver, Colo.
Black Butte Consolidated Quicksilver Mining Co.,	Portland, Ore.
Golden King Mining Co.,	San Francisco, Cal.
The Mountain Bank Coal Co.,	New Whatcom, Wash.
The Bogie Man Mining Co.,	Kansas City, Kas.
The Curtisville Natural Gas, Oil, Light, Heat and Power Co.,	Curtisville, Ind.
The Josephine Mining Co.,	Spokane, Wash.
The Diamond R. Mining Co.,	Pueblo, Colo.
The Cripple Creek Brokerage and Investment Co.,	Cripple Creek, Colo.
The World Mining and Milling Co.,	Fremont, Colo.
The Old Dominion Mining Co.,	Richmond, Va.
The Solitaire Mining Co.,	Aspen, Colo.
The Holden Smelting and Refining Co.,	Denver, Colo.
The Colo. Cripple Creek Gold Mining Co.,	Denver, Colo.
The Lillie Gold Mining and Milling Co.,	Denver, Colo.
The Sheba Queen Mining Co.,	Denver, Colo.
The Salida Mining and Developing Co.,	Salida, Colo.
The Southern Red and Brown Stone Co.,	Sanford, N. C.
The Ten Mile Mining Co.,	Paterson, N. J.
Juneau Mining and Manufacturing Co.,	Eauclaire, Wis.
The White Cloud Copper Mining Co.,	New York City, N. Y.
Wolfe Butte Consolidated Mining Co.,	Great Falls, Mont.
The Boise County Mining Co., Limited,	Idaho City, Idaho.
Custer Mining Co., Limited,	Wallace, Idaho.
The B. V. Gold Mining Co.,	Colorado Springs, Colo.
Crystal Mills Co.,	Chester, Mass.
Rock Island Gold Mining Co.,	Rock Island, Ill.
The Graham Oil Co.,	Franklin Mills, Pa.
Enterprise Mining and Milling Ass'n.,	Riverside, Cal.
Mount George Mining Co.,	Grass Valley, Cal.
Farwell Stone Co.,	San Francisco, Cal.
The Pajaro Mining Co.	Sacramento, Cal.
The California Mining Co.,	Cripple Creek, Colo.
Cardinal Mining and Milling Co.	Denver, Colo.
The White Cross Mining and Milling Co.,	Portland, Maine.

Endless Rope Haulage Operated by Electricity.

The Leavenworth Coal Co., at Leavenworth, Kansas, is arranging to drive the endless rope haulage machinery at the foot of the shaft by electric motors. There are two separate lines of rope, one on each side of the shaft, and the length of each is about 3500 ft. Each line will be operated by a 40 H. P. Sperry electric motor. The power is at present applied to the work by a transmission rope from the surface. As the shaft is 710 feet deep and very wet, and the ropes are exposed to the influence of frost in the winter, their average life is only about eight months, while in the mine where the ropes are dry, the haulage ropes last from 3 to 4 years. By the use of the electric motors, the heavy expense of frequent renewals of the transmission ropes is overcome.

A Popular Coal Drill.

The McNelley Coal Drill, a cut of which is shown herewith, is deservedly very popular on account of its many points of excellence.

McNELLEY COAL DRILL WITH SIDE GEAR ATTACHED.

The machine complete, consists of the post, as shown in the cut, with boxing to carry the screw and auger, a steel screw for driving the auger, three steel augers, two, four, and six feet long, and side-gear for imparting the motion. The posts are made of extra strong pipe, made especially for this machine, and are made so as to telescope together, which feature is secured by letters patent. This enables the operator to lengthen or shorten the machine easily and more quickly than any post machine made; it being held at any desirable height by set-screws. The connecting parts of the posts are all made of malleable iron, strong and durable. The boxing is longer than any other used, giving it more strength, and saving wear over any other. It rests upon a slide bridge, which can be raised or lowered in the post at will. This is a valuable feature in this machine, as when the bottom is soft the post is liable to settle, and thus cause the auger to bind in the hole, often necessitating a resetting of the post. A post machine is liable to settle. In this machine all this trouble is overcome, as with the jack-screw it can at once be tightened, and the sliding bridge adjusted so as to relieve the auger from any friction, however slight. No other machine has this feature, which is also secured by letters patent.

The driving screw is made of the best steel, and also the augers which are fitted and sharpened ready for use.

This machine is adapted to all kinds of mine work, and for lifting bottom, or taking down roof, it is absolutely the best machine made, as it can be worked at any angle desired, and is so easily and quickly adjusted. For close work it is unequalled; and, the side gear can put a hole within two inches of the rib. The gear can be used on either side, or on top, or directly under the driving screw, and can be changed from one position to another instantaneously. This valuable feature is not embraced in any other machine made, and is also secured by letters patent.

The great advantages of this machine are: It will drill high or low, at any desired angle or elevation, and closer to the rib than any other, and can be more quickly and easily adjusted; is lighter and more easily moved from place to place, and can be operated by a boy as well as a man; it will do quicker and better work than any other machine made, and where in use is pronounced perfect.

It is made regularly in three lengths, as follows:

No. 0 for seams ranging from 3 ft. to 5 ft. in thickness.

No. 1 for seams ranging from 3 ft. 8 in. to 7 ft. in thickness.

No. 2 for seams ranging from 4 ft. 4 in. to 8 ft. in thickness.

Different lengths will be made on application, without delay.

The general agents for these drills are Messrs. Puchta, Pund, & Co. (Queen City Supply Co.), of Nos. 161 to 165 West Pearl St., Cincinnati, Ohio, who will be pleased to send catalogues and circulars to all inquirers.

Western Pennsylvania Mining Institute.

The next meeting of the Western Pennsylvania Mining Institute, which will be held at the Court House, in Pittsburgh, on the 28th and 29th inst., promises to be a very interesting one. The following is the programme of special papers arranged for this meeting: "The Longwall that would be Applicable to the Pittsburgh Seam," by Inspector James Blick; "Mining," by Daniel Boden, Supt. Mansfield Coal and Coke Company; "The advantages of a Slope over a Shaft for Mining Coal," by Inspector Wm. Duncan; and "The General System of Longwall," by W. S. Gresley.

The subjects for debate are as follows:

(1) Should a Miner have a Theoretical Knowledge of Mine Gases? (2) What Relative Advantages or Disadvantages has the Exhaust Fan over the Blower Fan for Ventilating Purposes? (3) In the Absence of a Physician, what Remedy is the Best to Apply for the Relief of a Miner (*a*) Burnt by an Explosion of Gas; (*b*) Rendered Insensible by Inhaling Fire-damp; (*c*) Overcome by Inhaling Black-Damp? (4) What kind of Timber is Best for Timbering the Entrance of a Mine; also What kind is Best for Propping Working places, the Cost to be Considered? (5) Does the Present Mine Law Need Revising?

This programme is one that promises to be very interesting and instructive, and should induce a large attendance of the members and others interested in coal mining.

UTILIZATION OF ELECTRICALLY TRANSMITTED POWER AT THE WORLD'S FAIR.

The potentialities of electricity become wider and more numerous as the days pass, and seems like a horizon continually receding before the advancing student and inventor. Each new day a new development is made manifest, and the public now omits its expressions of astonishment at the perusal of the wonderful evolutions of the only recently appreciated force. The electric light was received first with incredulity and surprise, while now, even an advance of 100 per cent. would call forth nothing more than a faint expression of approval, as if what had been done was only what had been expected.

Electricity, as a power, utilizable for almost every purpose to which steam has been applied, is of a later date. It sprang into favor as soon as the possibility of its economical transmission was proved. The problem has been economically and successfully solved. Manufacturers mindful of greater profits, derivable from a reduction in the expenditure for power, are adopting the ever ready motor to the exclusion of the steam engine. The long lines of shafting with the inseparable evils of copious lubrication and costly friction, heavy and expensive belting in complex systems and large and small pulleys innumerable are slowly being discarded. One of the largest engine and mining machine manufactories in this country has recently been equipped with motors, the claims of which to greater economy, reliability, and perfect safety being fully conceded; and the greatest electrical manufactory in the world, that of the Edison General Electric Company at Schenectady, employing over 5,000 men, and covering with its fifty-three buildings an area of nearly twelve acres in extent, is entirely operated by electricity generated in, and transmitted from a central power house in which are the only boilers and steam engines in the entire works.

The immense advantages which the use of electrical power offers, the freedom from dirt, oil, smells, and the many shortcomings incidental to steam power, of which loss in transmission is perhaps greatest, appeal strongly to the public, and the consequent increase in the demand on Central Stations throughout the country, for electrical power, is causing them to strengthen their facilities in order to cope with the constantly increasing load.

The engineers of the Construction Department of the World's Fair have recognized the many benefits to be derived from the use of electricity and from the first decided upon employing it to run the machinery used in the work of construction, as being the only perfect agent to perform the work as expeditiously as the shortness of the time at their dispo-al demanded. They have installed in the Fair Grounds a perfect electrical power transmission plant—one in which the conditions are of a peculiar nature on account of the long distances separating the apparatus, and the fact that this machinery is being constantly shifted from place to place as it is required. The lines had therefore, to be erected to satisfy any call for power from any particular spot in the grounds.

The buildings of the Fair, which are to be wonders of the World for the time being, are built of wood covered with stuff which will give to them the appearance of imposing marble edifices. The frame-work of the buildings is of iron. The major part of the machinery, therefore, consists of saw-mills to cut the lumber, and hoists for raising into their lofty positions the immense girders, trusses, and ponderous beams. In addition there are moulding machines, planing machines, and pulverizers for the clay. The presence of the electric motors for operating the saw mills ensures the absence of fire, from the danger of which the employment of steam-engines is no guarantee.

The entire plant consists of the generators, the line and the motors, together, with the various accessory appliances needed for the successful and economical operation of the electrical apparatus. The current of 500 volts is generated from two 100 K. W. compound wound Edison Generators, of the Edison street railway type, belted direct to two high speed engines. The duplication of the generating apparatus was decided upon in order that the machines should be continually supplied with power, and the chances of a total breakdown, obviated, one generator being capable of supplying the entire demand for a short time in case the other should be disabled. The "temporary" station in which the dynamos and engines are located, are so substantially constructed that the term is almost a misnomer. The same may be said of the pole line carrying the wires and making a complete circuit of that portion of the grounds in which the motors are located. It is of first-class construction, and of the best material. The high standard of insulation of the wires is always maintained, each circuit being subjected to rigid daily inspection and tests.

In the Manufacture and Liberal Arts Building—the largest structure in the Exposition, which covers an area of thirty acres, one of the saw-mill plants is erected. This consists of a saw sharpener, band and cut-off saws, a rip saw, and a boring machine. This compact outfit is run by a 12 K. W. Edison shunt wound machine belted to a line shaft. In the United States Government Building is another saw-mill plant run by a 15 Kilowatt Edison motor. There is still another in the Mines and Mining Building, and one in the Horticultural Building. In this last named building is an electric hoist operated by a 20 K. W. Edison motor fastened to the same frame as the base of the hoist. The hoist is of the double-drum form with two winch heads and can be used to raise two separate weights at once, while at the same time the winch heads can be used to drag material into position. It is now used to raise the immense trusses and purlins of the dome of this building, and has proved eminently satisfactory. In the Transportation Building a huge derrick has been erected for raising the trusses into position. It can be rolled to any requisite point and has a 20 Kilowatt Edison Motor erected in its base frame. In this building as well as in the Agricultural Building, are other electrically operated saw-mill plants.

The Exposition Building, facing towards the lagoon, and ornamented on the exterior with Corinthian pilasters 42 feet high, has another saw mill plant. This building has been especially arranged with a view to electrical illumination at night, which in effect will be unequalled.

Here, too, is the large clay pulverizer, belted to a 12 K. W. Edison Motor, which drives it at a speed of 1,200 revolutions a minute. In the Machinery Hall, the Illinois St te Building, the Fisheries Building, and Woman's Building are other mills and planers.

Each motor is operated by means of an ordinary starting switch and rheostat, and main line switches in series with each motor. Protection is afforded by suitable fusible cut-outs, and the motors are also sheltered from dust, dirt, rain, and accident as far as possible. These machines are let to the contractors by the Exposition Managers, the charge for their use being based upon the average daily maximum load, gauged by suitable measuring instruments. As promised by the Engineers, the result of the adoption of electricity has proved entirely satisfactory, and the advocates of the portable steam engine and boiler have been compelled to acknowledge defeat. The motors have responded to every call made upon them even to the extent of sustaining a heavy overload for a short time.

The entire plant is leased from the Edison Company and is to be returned in the same good condition as received on the 1st of January, 1893.

This transmission plant is a most important one, although only temporary, on account of its magnitude, the long distances separating the various plants, and the fact that the line is easy of access from any point within the grounds. The motors are scattered over an area a mile north and south by half a mile wide. The absolute freedom from accident or failure of any kind which the plant has enjoyed, proves that this means of power transmission is as reliable as, if not more so, than any known method.

OBITUARY.

Theodore S. Mize.

Theodore S. Mize, the genial, whole-souled and talented Eastern representative of *The Black Diamond* is dead, at the early age of thirty-eight. He was a man of most amiable disposition, and had the peculiar faculty of winning the friendship and esteem of every person thrown in contact with him.

He was an able writer, and one of the best informed men regarding the current status of the coal trade in the country. His integrity and good judgment commanded the respect of every coal man with whom he was thrown in contact, and all were ready to give him their confidences because they knew he was worthy of them and never abused the trust placed in him. In his writings he occasionally, of necessity, touched on technical matters, and when this was the case, he wrote not as a careless novice, but as one who studied the conditions, and sought information from those who were versed in the technicalities. The result was that his writings on trade topics, a subject he was most familiar with, were never spoiled by ridiculous technical errors.

There was hardly an operator or coal dealer of prominence in the East who did not know him and appreciate his pleasant disposition and noble character. Words fail to portray the sorrow caused by his early death, and the sympathy we feel toward the editorial force of our contemporary, which has lost a faithful coworker and a friend endeared by the possession of a character composed of all the attributes that go to make a gentleman.

PERSONALS

Mr. James Clayton, of the Clayton Air Compressor Works, New York, was among the passengers on the Cunard Steamer "Aurania," which sailed May 28th for Liverpool. Mr. Clayton will spend a well-earned vacation of about three months traveling through England and France, and while in the former country will for a time be the guest of his brother, Mr. Thomas G. Clayton, the superintendent of the Midland Railway. Before his departure, Mr. Clayton was presented with a handsome gold watch by his employes.

The Langcliffe Colliery, located at Avoca, Pa., was recently sold to Messrs. Brooks and Mears, of Scranton. The new organization will be known as The Langcliffe Coal Company and officers have been elected as follows: President, Reese G. Brooks; Treasurer, John A. Mears; Secretary, T. R. Brooks.

Mr. John Sweeney, of Treskow, Pa., has been made foreman of the Lehigh and Wilkes-Barre Coal Co.'s large stripping at that place.

Mr. Wm. L. Saunders, Secretary of the Ingersoll-Sergeant Drill Co., of New York, is certainly a versatile personage. He is a civil engineer, and one that ranks very high in his profession. He is the author of several valuable pamphlets on air compression and the use of compressed air, and also on quarrying, shaft sinking, and tunneling. He personally manages the extensive business of the Ingersoll-Sergeant Co., and also personally designs and compiles the elaborate and beautiful catalogues issued by that company. His most recent venture is in the field of politics, as he has recently been elected Mayor of North Plainfield, N. J., his place of residence. His energy and sound business judgement are such that it is safe to say that Mayor Saunders' administration will be both an economical and a progressive one.

Mr. Wm. Young, father of Major James Young, Superintendent of the Pennsylvania Coal Company's collieries in the Lackawanna Valley, died at his residence in Dunmore, Pa., on the night of the 20th ult., aged 70 years. Mr. Young was a native of Scotland, from which country he emigrated in 1843. With his wife and first-born child, James, he settled in Carbondale, where he resided until 1851, when he located in Dunmore, where he continuously resided up to the time of his death. Up till within a few months of his death he was employed about the collieries in various capacities, but for most of his life as a skilled miner. He was offered official positions several times, but always declined them, preferring to work as a miner, rather than to take charge of men. The cause of his death was due to a general breaking down which began with a severe attack of "Grippe" two years ago. He is survived by his wife, now 70 years old, and thirteen children, of whom Supt. Young is the eldest. Mr. Young was a man, who, through all his long life in one locality, always retained the respect of his neighbors, owing to his integrity, and many good qualities as a man.

Mr. H. C. Zacharias, late superintendent of the collieries of the Silver Brook Coal Co., at Silver Brook, Pa., has been appointed General Manager of the Peerless Coal & Coke Co., whose coal lands are at Vivian, McDowell Co., West Va. Mr. Zacharias is now at work opening out the colliery, and with his engineering skill, backed by a broad gauged management, he will soon have one of the most extensive and well arranged mines in the Pocahontas field.

Mr. Monroe Schreffler, division superintendent of the Philadelphia & Reading Coal & Iron Co.'s collieries between Big Mine Run and Treverton, Pa., has had the division formerly under the supervision of Mr. John L. Williams added to his old one. This change makes Mr. Schreffler's division include all the collieries operated by the P. & R. C. & I. Co., between the Mahanoy Tunnel and Treverton. In point of production and number of collieries, his new district is the largest in the world under the superintendency of one official.

Mr. Frank A. Hill, superintendent of the Dunbar Furnace Co.'s plant at Dunbar, Pa., has been promoted to the position of President and General Manager of the company. Mr. Hill has made a record in the Connellsville region by his business ability and professional skill, exercised under the most trying conditions, that marks him as one of the ablest men in the business, and the Dunbar Furnace Co. attests its appreciation of his services by this promotion. We sincerely wish him a continuance of his past success without a repetition of the troubles he went through as superintendent.

Mr. R. M. Haseltine, Chief Inspector of Mines of Ohio, has assumed the responsibility of making Ohio's mineral exhibit at the Chicago Exposition. Mr. Haseltine held the matter under advisement for some time, and formally accepted the undertaking last month. He is now considering the plan of exhibit and the amount of space required. The great variety of the mineral wealth of Ohio and the desire to give each product a creditable showing is quite an undertaking. He should have the hearty co-operation of all engaged in the production of minerals in the State, and he will be greatly assisted in the work if they will correspond with him in regard to the size and character of the samples they desire to furnish.

Mr. W. J. Watkins, well known in the Schuylkill coal field, where he was for several years employed as inside foreman of Suffolk Colliery, near Mahanoy City, and who made a record for bravery and good judgment as Lieutenant of the Coal and Iron Police force during the Mollie Maguire troubles some years ago is now located at New Whatcom, Wash., as superintendent of the Blue Canyon Coal Mining Co. During the past three years he has traveled from southern Oregon to Herendeen Bay, on the Behring Sea, examining and reporting on coal properties for the Oregon Improvement Co. On the first of September of last year he accepted his present position. He has purchased a fine farm of 170 acres at New Whatcom, which he has well stocked, and on which he has three large barns and a very comfortable residence.

Mr. Jonah A. Davis, fire-boss in the Boston Mine of the D. & H. Coal Co., near Edwardsville, Pa., was instantly killed on the 2d ult. by a trip of cars running over him. Mr. Davis had been a prominent resident of Edwardsville for twenty years, and was highly respected for his upright character and close attention to his duties.

Mr. George Johns, of the firm of Geo. H. Myers & Co., after 12 years active service as superintendent of the Yorktown Collieries, at Audenreid, Pa., has retired to enjoy a rest well earned, after many years of active service in both the Schuylkill and Lehigh regions. Mr. Johns ranked as one of the ablest colliery managers in the Anthracite field, and under his superintendency the Yorktown Collieries have been made one of the best paying investments in the Lehigh region. Col. D. P. Brown, superintendent of the Lehigh Valley Coal Co.'s Collieries in the Mahanoy and Shenandoah Valleys of the Schuylkill region, succeded Mr. Johns on the first inst. Under the intelligent and progressive management of Col. Brown, who is a man of long and successful experience, the record of the Yorktown Collieries will not fall from the high position to which Mr. Johns had raised it.

Mr. J. A. Haskell, President of the Mahoning Railway, and General Manager of the Adrian Coal Co.'s Helvetia Mines, in Jefferson County, Pa., will on July 1st become Vice-President of the Hercules Powder Co., of Wilmington, Del., and will remove to that city.

Hon. John W. Parker, of Mahanoy City, Pa., at one time a very prominent labor leader, died at his residence in Mahanoy City last month. Mr. Parker was a man of superior intelligence, and was the founder and editor of the *Anthracite Monitor*, a one-time prominent labor paper published, at Tamaqua, Pa., and later was the founder and editor of the *Tri-Weekly Record*, a profitable and influential journal now published by his son. Mr. Parker's first literary work was done while working at his trade as a blacksmith at a colliery near Tamaqua, and his productions were signed "The Buckville Blacksmith," a sobriquet by which he was widely known, until he became more prominent as a labor leader, when his conservative counsel, strict integrity, and wisdom of speech and writings, won for him the title of "Honest John Parker."

Mr. Parker was a labor leader but not a demagogue. When his counsel was followed the workingmen always profited, and when at times the policy he advocated was thrown aside for that of demagogues, disastrous results were always the outcome.

He was not a professional politician, but was honored in politics by being elected to the Pennsylvania Senate, from the Twenty-ninth Senatorial District in 1878, on the Greenback-Labor ticket. The district was strongly Democratic, and his opponent, Hon. W. L. Torbert, was a very popular man. He served but one term, and never sought office afterwards, but was appointed by Governor Beaver a trustee of the State Hospital for Injured Persons at Ashland, Pa.

The Colliery Engineer.

AN ILLUSTRATED JOURNAL OF

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THOS. J. FOSTER,
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ALEX. DICK, MINING ENGINEER, ASSISTANT EDITOR.
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NOTICE.

The editorial rooms and business offices of The Colliery Engineer Company, have been removed from the fourth floor of the Coal Exchange Building to Rooms 14, 15, 16, 17 and 18 on the third floor of the same building, with the entrance at Room 17. The School of Mines will occupy, in addition to its old quarters, the rooms formerly occupied by the editorial and business rooms, and the instructors can be found there.

THE NECESSITY FOR TECHNICAL EDUCATION.

NEVER in the history of American mining, was the necessity for technical education on the part of all persons connected with the industry more apparent than at the present time. The extraction of a limited portion of the mineral in the ground at a heavy expense, and with great liability to accident will not be tolerated in these days of enlightenment and progress. While the development of the mining industry of the United States has advanced with most prodigious strides during the past few years, the methods of development and working have naturally also advanced to a higher and more successful plane. This advancement will continue. Every day new difficulties and obstacles present themselves to the mine [illegible]l and working miner. They must be overcome, [illegible]here is but one way to overcome them. That way is by the application of intelligence and skill.

Competition has been a strong incentive to this raising of the standard of intelligence on the part of mining officials and miners; and as this competition, not only between different districts producing the same mineral, but between different mines in the same district, increases, there will be greater necessity for increased technical ability.

That region, which, by reason of natural advantages possessed by it, or the superior skill of the men employed therein, can produce a mineral at the least expense is naturally the one that prospers most. The first of these advantages cannot be regulated by man, but the second and equally important one depends upon the personal exertions of each man employed, to store up in his mind the principles regulating the forces of Nature, which, when intelligently directed, are most potent for good, and which when ignorantly dealt with frequently cause disaster.

Even where the advantages bestowed by nature are greatest, brains are necessary for success, and many regions with less natural advantages, but with intelligent and skilled labor working under intelligent supervision, are more prosperous than those possessing great natural advantages and less skilled labor.

Employers as a rule have learned by experience that by the employment of skilled labor, the production is increased and there is infinitely less danger to life and property, than when ignorant labor is employed. Several of the State legislatures have also recognized this fact, and have wisely passed laws compelling mine officials to prove, by strict examinations, that they possess sufficient technical ability to superintend and direct the work of miners in a safe manner. Similar laws will eventually be enacted by other States, and it is safe to predict that within ten years, there will not be a State in the Union, in which mining is a prominent industry, that will not require mining officials to show their ability by qualifying before a board of examiners.

Therefore it is evident that the mining official who desires to advance must keep up with the times, by systematically studying the principles involved in the art of mining that he may be able to apply his knowledge in such a way as to produce better results than his neighbor. If he will do this, advancement is sure and speedy. If he does not do it, he is sure to retrograde, and by ignorance of certain principles in an emergency, he may be directly responsible for great loss of property and possibly of life.

Ambition to rise above the position in which he is placed by force of circumstances is inherent in the American miner, and it is commendable. Family ties and affections are just as strong among American workmen as among any other class of men, and they naturally desire a higher position in life for their children than they themselves hold, and they should be ready to grasp any means by which this ascension in wealth and the social scale can be secured. Education is the most potent lever to effect this rise, and systematic study is the only proper way to secure the necessary education.

There is also a moral obligation resting on both mine officials and miners to secure a technical education. It is their moral duty to not only protect their own lives, but the lives of their fellow workmen as well. This they cannot do, if they do not study the principles regulating the mighty forces of Nature, so as to direct them aright, and make them assistants rather than cruel and death-dealing masters.

The miner or mine official who neglects his opportunities to study these principles is untrue to himself, for he not only toils more than is necessary, but he is a constant menace to his own life and that of his fellow-workmen, because his ignorance may be the primal cause of a disastrous accident.

WHAT IS THEORY?

THERE is no word in the English language more abused than "theory." It is a word that is as a rule used in an entirely wrong sense. The majority of men believe it to mean something entirely opposite to *practice*, when in reality it is closely allied to it. There never was a practical man who was not a theorist. If he did not understand the theories involved in his business, he could not put them in practice.

The meaning usually given to the word *theory* properly belongs to *hypothesis*. A theory is an exposition, or explanation, of the general principles of a science, and not an improved supposition advanced merely for argument as an hypothesis is. The introduction of organization among the facts or data of a science is theory. Thus, the practical and well proven facts and data observed by different men at different times, in the production of certain results, when collected and organized, form the theories that explain what forces produced those results, and how much each force was exerted. Thus, we know that the pressure required to produce a certain current of air in a mine depends upon the resistance due to friction and also upon the sectional area of the air course. We know also from experiment that the resistance due to friction is so much per square foot of rubbing surface, and this amount is known as a fixed quantity or co-efficient. We also know that the friction increases with the square of the velocity, which is a fact that has been proved by both calculation and experiments. Now, having these facts firmly established, we combine or organize them and find that the pressure required to produce a certain current is equal to the product of the co-efficient multiplied by the number of square feet of rubbing surface, and the square of the velocity of the air current, divided by the number of square feet in the sectional area of the air course. This is theory. Establishing the current by producing the required pressure is practice. Or, it is a theory that a box four feet long, by four feet wide and four feet high, contains sixty-four cubic feet. If a carpenter who is told to construct a square box to contain sixty-four cubic feet does not know and understand this theory he cannot build the box, and is therefore not a practical man. The miner or mine foreman who is told to produce a certain amount of ventilation in a mine, to do it quickly, successfully and economically, must understand the theory of ventilation. If he doesn't he can't fulfill his duties, and he is not a practical man.

HOW A WORKINGMAN CAN EDUCATE HIMSELF.

THERE are three ways by which a workingman can educate and fit himself for advancement. The first is by purchasing text-books and studying them at home; the second is by attending a night school; and the third and best way is by taking a course in a good school in which tuition is by correspondence, and each student studies when and where he pleases, and recites his lessons when learned, by writing out the answers and mailing them to the instructors at the headquarters of the school.

The first method is one that rarely proves successful though some very eminent men secured their educations in this way. In the first place the choice of text-books is a difficult one. Some excel in one branch, some in another, and a few, owing to the authors giving hypotheses for theories are worthless. In the second place the cost of all the text-books necessary to pursue the study of any science is necessarily high. The author of each, assuming that the student has been educated to a certain standard, begins with formulæ and statements that are Greek to the uneducated man. Before he can understand the books specially designed to teach the principles of a science, he must have at least a good common school education. Few workingmen are fortunate enough to possess this advantage, and the result is that if they desire to study a science they must start with elementary school books and gradually work their way up. In doing this, unless they are carefully directed and advised by competent persons, they lose a great deal of valuable time studying branches or parts of the school books that have no relation to the subject they desire to master; and, by misconstruing the language of a single rule or principle they find themselves hopelessly entangled in a mass of formulæ, and they give up, completely discouraged. Their time and money having been spent in a great measure, for nothing. As we stated before, some few men have educated themselves in this way, but they were exceptions to the general rule. Few men have the natural talents that Hugh Miller and Henry Wilson possessed, and few men can hope to educate themselves as they did.

The plan of securing an education by attending night school, while possessing many excellent features, is not free from disadvantages that make it almost impracticable. In the first place, it is difficult to establish a night school, and when it is established it is impossible to secure a teacher, who combines practical knowledge with ability as a teacher, for the limited compensation, offered. In many cases the teacher, from lack of experience in the sciences taught, confuses hypothesis with theory, and thus lays a faulty foundation for future study. It must also be borne in mind that while the workingmen are in point of education, children, they are not children when natural responsibilities are concerned. They must labor to support themselves and families, and in the natural course of their labor, they must at times neglect the school, owing to other engagements, or they find that when night comes they are too tired to supplement the day's muscular toil with several hours of mental labor. The result is that the classes in the night school are composed of men, some of whom, being naturally bright and with few family cares, are able to push forward rapidly, while others, owing to no fault of their own, are slower. This causes the first class, to be retarded in their studies, or it causes the second class to be pushed forward without a clear understanding of the principles gone over.

There is but one way in which a night school can be successful. It must be located where the number of students is sufficiently large to enable the employment of a competent instructor. Every student must be regular in his attendance and must have an equal educational start to keep up with his associates. Bad weather, illness, business or social engagements, must not prevent attendance, or the student will fall behind and will be unable to catch up. To comply with these requirements is hard enough when the pupils are children without responsibilities, but when the pupils are men with heavy responsibilities it is impossible to fulfill them and make this system a success.

By the correspondence system of tuition the difficulties of the two former systems are overcome. When the student joins he is taken in hand by a competent instructor and he is drilled in the very elements of the science he desires to learn. He is not advanced beyond the elementary lessons until he fully understands them. He is not limited in time, and takes such opportunities for study as are most convenient for him. As he finishes one lesson he is led by easy steps to the next. His text-books are furnished him free, and they are specially prepared with the idea of making them as simple, clear, and brief as possible, so that the student works only on such principles as bear on the particular science he desires to master. If two men start the course on the same day, and one is either naturally brighter, or has more time to study than the other, the second is not expected to keep up with the first. If the first finishes a lesson in a day or two, and the second requires a week, he is given a week, or longer, if necessary. He is under no obligation to keep up with the first student. All that is required of him is that he sticks at the lesson until he thoroughly understands it, and is able to answer the questions given him. In this way he is made as proficient as the first. Distance of residence from the headquarters of the school does not affect its work. A man may live three thousand or even ten thousand miles away from it, and enjoy equal facilities with those living in the same town. The school, naturally having a very large number of students, gathered from all sections of the Continent, can afford to make its terms reasonable and at the same time employ a large force of able specialists as instructors. The system of studying the lessons, and then answering the questions by writing them out, drills the student in composition, and trains him for experience with an examining board. It improves his penmanship and spelling, and drills him in the art of letter writing. In case he does not understand a principle or formula, he does not have to pass it over or show other students his inability to comprehend a principle that may have seemed easy to them. A short note to the school asking for explanation is treated confidentially and all necessary explanation is given. No student can join the school and not receive its full benefit, unless he purposely neglects the advantages given him in his scholarship. The system is not a new one. It has been in successful operation for years both in America and in Europe, and is conceded by all who understand the plan to be the only successful medium by which an education can be secured by men of limited means who cannot afford to neglect their daily toil.

THE SUCCESS OF THE COLLIERY ENGINEER SCHOOL OF MINES.

THE necessity for some practical means whereby the standard of technical education among mine officials and miners, could be raised has been for years apparent to the management of THE COLLIERY ENGINEER. While the necessity was thus apparent, the means of meeting it, and successfully filling the want was not so clear, and much time and thought was bestowed on it. The outcome of all this was the establishment, on November 1st, of last year, of THE COLLIERY ENGINEER SCHOOL OF MINES. It was expected that a school in which the elementary principles of the sciences connected with mining, would be taught by correspondence, would be popular enough to warrant us in calculating on from two hundred to three hundred students in the first year of its existence, and that with that number of students it would pay to furnish a simple elementary course of lessons, which would enable the student to pass successfully an examination for a mine foreman's certificate of competency. As soon as the organization of the school was announced, and its plan of operation was explained, it became exceedingly popular, and many requests were made to have its scope so widened as to give the students a complete practical education in the principles of mining. As the number of students increased, we saw our way clear to comply with this idea, and the scope of the school was accordingly enlarged. This naturally made it even more popular, and as a result there are now over seven hundred and fifty students enrolled. They reside in various parts of the Continent, and there is hardly a mining district from Mexico to Nova Scotia, or from the Atlantic to the Pacific that has not representatives in the School. The list of students embraces all classes, from executive officers of companies and superintendents down to day laborers, and also includes a number of prominent mine inspectors. Every student who has fairly entered the course has voluntarily expressed his gratification with its plan and features. Hundreds of letters have been received from students, in which their approval of the course is expressed in the highest terms, and there has not been a single complaint against it. The plan and treatment accorded students has been so highly appreciated that we find that each student advocates the advantages of the school among his associates.

This gratifying state of affairs has made necessary an enlargement of the force of instructors, and of quarters, and has enabled us to carry the student further along in the various sciences connected with the art of mining than was at first contemplated.

Among the new features added are facilities for those of the students who desire to come to Scranton, to have practical work in surveying and mapping, and to enjoy a number of practical illustrated lectures on mining topics. Other features equally as advantageous to all students, are detailed in the new prospectus, which is a handsome volume of sixty-five pages, and which will be sent free to all enquirers. It explains in detail the work of the School, and the advantages offered to every man, who can read and write, to secure a complete mining education at a small outlay of money, that will enable him to fill any mining position. The only requirement is that students can read and write, no matter how poorly. This prospectus contains many valuable hints to miners, and also a large number of testimonials from students in the School. Those who wish to take advantage of the course, and do not, for various reasons, desire to have their names published in the list of students, will always have their wishes respected.

EDITORIAL NOTES.

NOTWITHSTANDING the exertions being made by interested parties to break the combination of the Anthracite coal roads, President McLeod and his subordinate officials are quietly going on with the work of opening up new markets for the coal, and of advancing prices gradually until they shall reach a point, that while not oppressive, will guarantee to the miner fair wages and more steady work, and to the operator a fair profit on his invested capital. Notwithstanding this work has been in progress for some time, we can authoritatively state that up to present writing neither Messrs. Pulitzer, of the N. Y. *World*, or Bennett of the *Herald*, have been compelled to raffle off their cook-stoves on account of their inability to purchase fuel for them.

FOR the benefit of mine owners, superintendents, inspectors, and others, who do not desire to take a course in THE COLLIERY ENGINEER SCHOOL OF MINES, but who do desire to possess the lesson papers used, which constitute a text-book of over 1,000 pages, we have arranged to sell the complete set of papers at the same price as a complete scholarship. The papers embracing the text used in partial scholarships will be sold at the same price as the corresponding scholarship. These papers will only be sold subject to the same conditions as are required of students, and cash must invariably accompany the order. They will not be sold on installments.

IN the nominations of Judge John Dean, of Hollidaysburgh, for Judge of the Supreme Court, and of Genl. Wm. Lilly, of Mauch Chunk, for Congressman at Large, the Republican party of Pennsylvania has diverged from the usual plan and given the great coal industry of the State the recognition it deserves. The nominations are practically equivalent to election, and we will shortly have on the supreme bench, a man who not only ranks high as an able jurist, but one who also has a thorough knowledge of the coal business; and we will also have as a representative in Congress, an able, practical business man whose integrity is unquestioned, and whose experience in the practical working of collieries, and whose knowledge of the necessities of the coal trade in the way of legislation is equal to that of any other man in the State.

IN our April issue, in "Easy Lessons for Beginners," the answer to Question 39, under the heading, "Surface Arrangements" unintentionally omitted the Diescher Washer, manufactured by the Scaife Foundry and Machine Co., Limited, Pittsburgh, Pa., from the list of best jigs.

This washer has proven its superiority by actual work in many portions of the country, and its simple construction and method of operation commend it to all practical men.

It is a rigidly constructed jig, having a stationary screen four feet square with a reciprocating plunger placed directly below the screen, and an automatic slate box or discharge at the front end of the screen. The location of the plunger or piston immediately under, and of equal size, with the screen, ensures a uniform action of the water over the entire screen surface, while the construction and arrangement of the slate discharge effect the continuous and most efficient separation and discharge of the coal and impurities respectively.

The Anthracite Trade.

The Anthracite trade, while dull, is in excellent condition. It is now between seasons, and not much demand is expected. The demand and consumption during the Spring was large, and as a result, stocks are very low. Restriction now restricts, and prices, which have been again advanced 25 cents per ton on Western shipments, and 15 cents per ton on chestnut coal for shipments Eastward beyond the Capes, are rigidly adhered to. There has been no change in prices to line trade. The Summer and Fall trades promise to be active, and good prices will be obtained for coal. The prices realized for coal last month were such as to fix the rate of wages paid the Schuylkill miners, for the last half of May, at 6 per cent. below the basis, an increase of one per cent. over the wages paid in the first half, and an increase of three per cent. over the wages paid immediately before the Reading deal was consummated. While the increase is not a large one, it is a welcome one to the miners, and is evidence to them that the new order of things means greater prosperity in the future than they have enjoyed in the past days of restriction that didn't restrict, and circular prices that were not adhered to.

The output for June has been fixed at 3,000,000 tons, which amount is expected to meet the requirements of the market. Suits to secure legal interference in the Reading, Lehigh Valley, and Jersey Central combine are multiplying, but they do not seem to cause much uneasiness on the part of the Reading managers. The latest suit has been begun by Lehigh Valley stockholders in Northampton County, Penn'a. It is evident to all familiar with the history of the Anthracite trade, that the only means by which it can be lifted out of an unprofitable condition, is by some such means as contemplated by the combination of the coal roads. To continue in the old way means only loss to operators and miners, and enormous profits to retail dealers in the large cities, who for years have been getting all the plums. If the journals that claim to oppose the deal in the interest of the poorer class of consumers will display as much activity in exposing the true sources of extortion under their very noses, by showing up the methods of the average

ANTHRACITE COAL STATISTICS.

Statement of shipments of Anthracite coal for month of April, 1892, compared with the corresponding period last year. Compiled from the returns furnished by the Mine Operators.

	April, 1892.	April, 1891.	Difference.		For Year 1892.	For Year 1891.	Difference.	
From Wyoming Region,	1,696,450·02	1,452,520·08	Inc.	243,929·14	6,465,837·01	5,672,258·07	Inc.	793,578·14
From Lehigh Region,	433,031·03	488,778·04	Dec.	55,747·01	1,751,627·08	1,762,307·05	Dec.	10,679·17
From Schuylkill Region,	815,022·13	872,395·04	Dec.	57,372·11	3,826,728·10	3,410,750·19	Inc.	415,977·11
Total	2,944,505·18	2,813,695·16	Inc.	130,810·02	12,044,192·19	10,845,316·11	Inc.	1,198,876·08

The stock of coal on hand at tide-water shipping points, April 30, 1892, was 714,842 tons; on March 31 1892, 821,023 tons, decrease 106,181 tons.

retail dealer, they will more nearly consummate the end they profess to desire and will to a small extent, at least, become something more than journalistic fakirs.

The Bituminous Trade.

The Bituminous trade is dull and featureless. Contracts made early in the season are being filled and large quantities of coal are being moved from the mines. New orders are few, and are for comparatively small amounts. Prices are weak and fluctuating.

The Coke Trade.

The iron trade continuing exceedingly dull, and prospects for the future not being bright, makes the demand for coke very light. In the Connellsville region only about two-thirds of the ovens are in blast, and they are not running full time. In fact, there has been no change of any importance since our last report, and prices remain the same.

SUMMER TOURS.

The Latest Publication of the Pennsylvania Railroad.

The 1st of June is a date looked forward to by the thousands who make their preliminary plans for summer outings, and their main guide is the Summer Excursion book issued yearly by the Pennsylvania Railroad Company, which regularly appears on that date. Advance copies for the season of 1892 are fresh from the press and certainly excel anything of like character ever published by this progressive railroad company.

It is not only a compendium of all the rates prevailing over its own and connecting lines to the principal resorts of the land, but it is equally as valuable as a guide-book, with full and explicit information as to how trips may be made, and as to what desirable variations may be utilized to enhance their pleasure and profit. Nearly five hundred resorts, ranging from Prince Edward Island to the mountains of Western North Carolina, from the southern extremity of New Jersey to the wild lakes of Canada, from the mineral springs of Virginia to the great inland lakes, are described at length, and over fifteen hundred routes, representing a stock of fifteen hundred special forms of tickets, are set out clearly and intelligibly within its pages.

In arranging these routes care has been observed in making them read over lines that present the greatest number of interesting points, and in every case there is a wide field for choice. They also provide for a return trip by a different direction, so that the tourist may find his outing a continual succession of changing scenes.

It is so comprehensive that one could hardly ask for a ticket to an Eastern resort of any prominence and fail to find it ready-made by a variety of routes. One hundred and thirty railroad and steamboat lines are represented in the coupons of these tickets, every one of them connecting directly or remotely with the Pennsylvania system.

The cover to this handsome edition represents one of the famous Pennsylvania Railroad Observation Cars artistically executed. The illustrations are the finest style of half-tone work, on as high a grade as the popular magazine productions.

Application of Electricity to Mining Operations.

It is a mistaken idea to suppose that the number of electric plants at mines is so small as to keep the application of electricity as a means of transmitting power still in the experimental stage. It is also a mistake to imagine that the application, of electric power is confined only to two uses, haulage and coal cutting. While it is true that these two branches of the work have received the most prominence in literature treating on applications of electricity to mining it was simply because they were the ones that most needed the application of an improved method of transmitting power. However, while the electricians and mining engineers were wrestling with the problems that presented themselves when these branches were under consideration, they did not neglect the others, some of which were very simple propositions, while others presented just as large a field for the application of inventive faculties as either of the two first mentioned branches. The Thomson-Houston Electric Co. was the first to enter the field of mining on a large scale, and after securing the best available engineering talent, they expended large sums of money, and an amount of patience and perseverence that seems almost incredible, to secure the best designs of electric machinery capable of performing the work in a perfect manner, and their enterprise has been rewarded, by the possession of patents that enable them to turn out machinery designed for haulage either by locomotive or rope, and for coal cutting either by chipping or scraping, solenoid drills or rotating drills. They have also succeeded in sucessfully applying electric motors to hoisting machinery, ventilating machinery, triplex, duplex, and centrifugal pumps, diamond drills, etc., etc. They have also produced the VanDepoele electric percussion drill for rock work, that is so arranged on a universal joint tripod or adjustable tunnel columns, that it can be operated in any position.

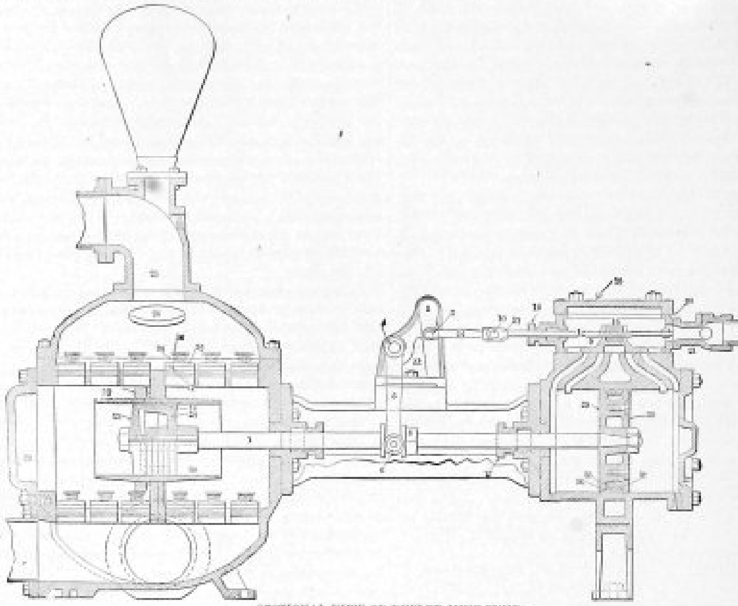
Plants embracing all types of the machinery mentioned run by Thomson-Houston motors, and supplied with power generated with Thomson-Houston dynamos are in operation in mines in all parts of the country, and a number of them are superbly illustrated in the handsome catalogue just issued by the Thomson-VanDepole Electric Mining Co., which controls all the mining work of the Thomson-Houston Co. This catalogue is composed of 200 pages containing fine illustrations and a large amount of interesting [illegible]luable text. We advise all our readers who [illegible]t already secured a copy of this work to send [illegible] once.

STEAM PUMPS.

We herewith present sectional views of The Laidlaw and Dunn Co.'s Duplex Mine Pump and Duplex Boiler Feeder. These pumps have won an enviable record for efficiency and durability, and are specially constructed in a manner to ensure a continuance of their high reputation, and the consequent large volume of business being done by their manufacturers.

These pumps are made with removable and interchangeable brass water cylinders and plungers, with bronze piston and plunger rods to resist the action of acidulated mine water. The cast brass cylinders are heavy enough to be bored out several times, before it cup leathers, or metallic packing, in accordance with the kind of water to be pumped.

The boiler feed pumps manufactured by the Laidlaw & Dunn Co., are also fitted with heavy removable cast brass interchangeble water cylinders showing the flanged ends. They are held in by the water cylinder heads. The advantage of having pumps constructed in this manner, lies in the fact that when the water cylinder becomes worn, it is not necessary to send the pump to the repair shop to be rebored, because, by simply taking off the water cylinder heads, the old or worn cylinder can be removed, and a new brass cylinder can be pushed into its place in a few minutes. This advantage will be apreciated by all steam users.



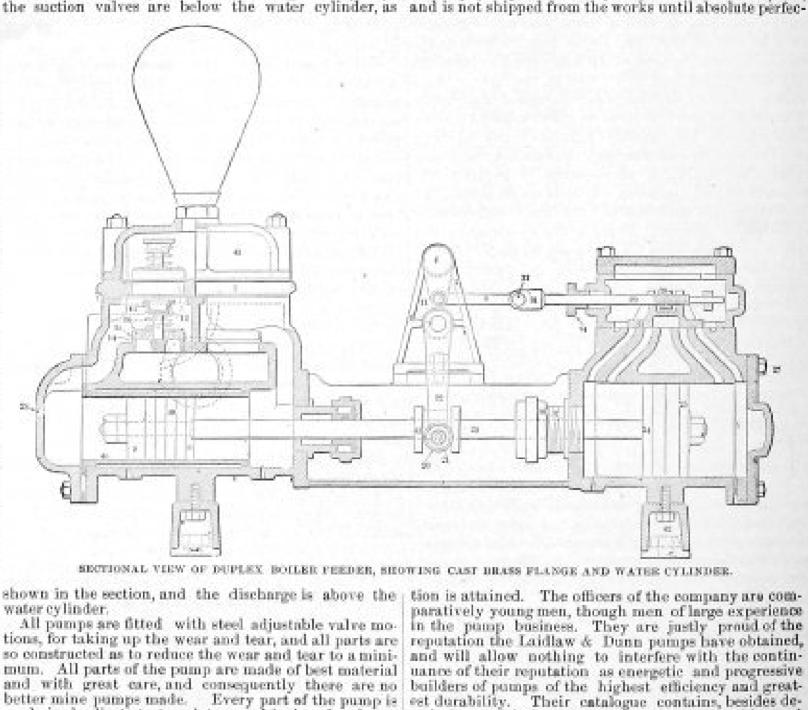
SECTIONAL VIEW OF DUPLEX MINE PUMP.

is necessary to renew them. They are fitted to the main body of the water end with ground joints, and are held in place by a heavy flange. They are also fitted with brass valve seats, which are screwed into the valve deck with a fine tapering thread. The valve stems are of best brass, and screw into the valve seats in a similar manner.

The water ends of these pumps are provided with large hand hole plates, so that every valve in the suction and discharge of the pump can be removed without dismantling the pump. On the large mine pumps the suction valves are below the water cylinder, as

The smaller sizes of these pumps are all fitted with brass followers in the packing glands. The bearings are large and long, thus ensuring least wear and tear. They are also fitted with steel adjustable valve motions, brass valve seats, brass stems and springs, and composition or brass valves, as may be desired. They are guaranteed for hot or cold water. As in the mine pumps, all parts of these pumps are interchangeable. They are made of the best material, and the best workmanship is used in their construction.

Every pump is carefully inspected in all its parts, and is not shipped from the works until absolute perfec-



SECTIONAL VIEW OF DUPLEX BOILER FEEDER, SHOWING CAST BRASS FLANGE AND WATER CYLINDER.

shown in the section, and the discharge is above the water cylinder.

All pumps are fitted with steel adjustable valve motions, for taking up the wear and tear, and all parts are so constructed as to reduce the wear and tear to a minimum. All parts of the pump are made of best material and with great care, and consequently there are no better mine pumps made. Every part of the pump is made in duplicate to templates, and is therefore interchangeable, and can be duplicated without any trouble. The ports in the water end are made large, so that, if necessary, the pump can be run at a high speed. The water plungers are packed with square packing,

tion is attained. The officers of the company are comparatively young men, though men of large experience in the pump business. They are justly proud of the reputation the Laidlaw & Dunn pumps have obtained, and will allow nothing to interfere with the continuance of their reputation as energetic and progressive builders of pumps of the highest efficiency and greatest durability. Their catalogue contains, besides descriptions of their various styles of pumps, tables and data of value to all pump users. It will be sent free to all colliery owners or colliery officials. The address of the manufacturers is The Laidlaw & Dunn Pump Co., Cincinnati, Ohio.

COLLIERY IMPROVEMENTS.

Colliery Owners, Superintendents, Mining Engineers, Contractors, and others are respectfully requested to inform us as early as possible of all improvements contemplated at their mines. We desire to make this department as complete as possible.—*Editor.*

*** The Coahuila Coal Company, Hondo, Coahuila, Mexico, has the following improvements in course of construction under the supervision of Mr. E. G. Tuttle, Superintendent:

At their new mine they are sinking a three-compartment shaft, which is 10 ft. 10 in. x 21 ft. 4 in. Each compartment will be 6 ft. x 8 ft. in the clear.

At their Hondo mine, they are erecting a new tipple with Mitchell dump alongside of their 600 ton washer. This new tipple will weigh and screen the coal before it passes to the washer.

They have also erected a 22" by 20" air compressor at the same mine to furnish power for a Harrison Coal Cutter.

*** The Leavenworth Coal Company, of Leavenworth, Kansas, Mr. J. E. Carr, General Manager, is erecting one 115 H. P. generator, and one 60 H. P. generator to operate 6 Sperry mining machines, a 25 H. P. power pump, with a capacity of 80 gals. per minute and a lift of 710 ft., and two 40 H. P. motors to drive their inside endless rope haulage machinery. They will also use other smaller motors for various purposes around the mines. The electric machinery is all being erected by the Sperry Electric Mining Machine Co., of Chicago.

*** Messrs. John Ingle & Co., of Evansville, Ind., are making sweeping improvements at their Ingleside colliery at Evansville, and propose to have the most complete coal handling appliances in the State. They have ordered new first motion Brazil winding engines of latest type, from Messrs. Crawford & M'Crimmon, of Brazil, Ind., and are putting in new boilers, pumps, etc. They will also begin the erection of a new tower at once and put in a new outfit of screens of the most approved construction. They are also sinking a prospecting shaft from the present level, which has reached a depth of 100 feet from the surface.

*** A number of improvements will shortly be introduced at the Milnesville colliery under the superintendency of Mr. J. I. Hollenback, of Hazleton, Pa. A new locomotive has been added to the plant, and an electric light plant will be added, so that the work on the extensive strippings can be prosecuted both night and day.

*** The Mill Creek Coal Co., New Boston, Schuylkill County, Pa., will shortly sink a new slope 900 ft. long in the Buck Mountain seam to the basin, and will open the overlying seams by tunnels. They will also erect a new breaker to prepare the coal from this new opening. All the improvements contemplated will be under the supervision of Mr. T. D. Jones, general superintendent.

*** The Reynoldsville Coal Co., of Reynoldsville, Pa., is opening a new mine near Sandy Valley, Jefferson County, Pa.

The D. L. & W. R. R. Co. have made preparations to sink shafts and erect two breakers in the vicinity of the Badman and Gomer farms in the suburbs of Nanticoke, Pa. They will be fitted up with the latest and most improved machinery for the preparations of coal for market, and will be called the "Bliss" and "Auchincloss" after Directors of the Company.

*** The Vesta Coal Co., under the superintendency of Mr. R. A. Drum, has a large force of men at work opening up a new mine at Allenport, Washington County, Pa., near the old American Mine, which they are now operating to its full capacity. The narrow work in the new mine is being pushed forward as rapidly as possible. The entire structural work of the tipple, etc., will be of iron, and it will be one of the finest on the Monongahela River. A rope haulage plant is being placed in the new works which will handle the coal from both the old and the new mines. Both mines will be ventilated by a 25-foot fan, which is nearing completion at the old mine.

The Vesta Coal Company is composed of members of the Jones & Laughlin Iron and Steel Company, and the products of the two mines will be largely used at the mills and furnaces of that company at Pittsburgh. At the new iron tipple, a large crusher will be operated for crushing the coal, which will be loaded in barges and taken to the coke ovens near the furnaces. It will be so arranged that when the river is too low, the coal can be loaded on cars and run down by rail. This plant promises to be one of the largest and steadiest running mines in the upper pool of the Monongahela.

New Mine Inspection Districts in Ohio.

Chief Mine Inspector R. M. Haseltine, of Ohio, has redistricted the State for inspection purposes, in compliance with the law as amended at the last session of the Legislature. The state will now consist of seven districts, instead of five, as formerly. The first district comprises the counties of Hocking, Vinton, Jackson, and Scioto, containing seventy-nine mines that employ more than ten men and forty a less number.

The second district is composed of Washington, Athens, Meigs, Gallia, and Lawrence, containing sixty large and thirty-eight small mines.

The third district, embracing the counties of Muskingum, Perry, Morgan, and Noble, contains seventy large and eighty small mines.

The fourth district, composed of Monroe, Belmont, Guernsey, Coshocton, and Holmes, embraces sixty large and eighty small mines.

The fifth district covers Harrison, Jefferson, Carrol, and the southern portion of Columbiana, and contains thirty-seven large and sixty-seven small mines. This district was made smaller than the others in order to allow more time to each, owing to the number of mines in it which generate fire-damp.

The sixth embraces Tuscarawas, Stark, and Wayne, and has sixty-three large and one hundred and nineteen small mines.

The seventh, Summit Medina, Portage, Mahoning, Trumbull, and the northern portion of Columbiana, containing fifty-four large and seventy-seven small mines.

The records in the Mining Department show nine hundred and twelve mines in operation. Of these four hundred and twenty-three employ more than ten men and four hundred and eighty nine, a less number. The average to the district would be sixty large and seventy small ones. In making the division, three small mines were considered the equivalent of one large one and the districts will contain 92, 93, 87, 61, 100, and 79 average mines respectively.

Engineering Association of the South.

The regular April meeting of the Engineering Association of the South was held at the Association headquarters in the Cumberland Publishing House, Nashville, Tenn., on the evening of the 14th inst.

Vice-President F. P. Clute, of South Pittsburgh, Tenn., presided, with the following gentlemen in attendance: Messrs. Hunter McDonald, J. Biddle, J. S. Walker, H. M. Robert, W. N. McDonald, R. L. Johnson, C. E. Bright, W. B. Ross, William Leftwick, William Whorley, and Frank Ross. In the absence of the Secretary Mr. W. B. Ross was appointed Secretary *pro tem.*

The minutes of the last meeting were read and approved.

Messrs. Hunter McDonald, and J. S. Walker, the tellers appointed to canvass the ballots for membership reported the election of the following gentlemen: As members: William W. Carson, Prof. of Civil Engineering, University of Tennesse, Knoxville, Tenn.; Henry L. Collier, partner and engineer of the Lithonia Granite Quarries, Atlanta, Ga.; Chas. E. Hamlin, Engineer and Manager Southern Office of the King Iron Bridge Co., Chattanooga, Tenn.; Benjamin M. Hall, member of firm of Hall Bros., Civil and Mining Engineers, Atlanta, Ga.; Arthur G. King, Practicing Engineer Atlanta, Ga.; Henry M. Robert, Lieutenant Colonel of Engineers, U. S. A., in charge of Cumberland and Tennessee Rivers Improvement, Nashville, Tenn.

As Juniors: Philip H. Porter, Post Graduate Student and Fellow in Engineering, Vanderbilt University, Nashville, Tenn.; Arch T. B. Somerville, Engineer for the King Iron Bridge Co.; Chattanooga, Tenn.

A communication was read from President A. V. Gude, Atlanta, Ga., stating his intention to be present at the Fifth International Congress of Internal Navigation to be held at Paris, France, beginning July 21, 1892. On motion President Gude was appointed a representative of this association at the coming congress, and the Secretary was directed to forward a notice of his appointment to Mr. Gude and to the Secretaire General at Paris.

The paper of the evening entitled "Municipal Engineering in Chattanooga," by Mr. James A. Fairleigh of Chattanooga, was then read by the Secretary *pro tem*, in the absence of the author.

The paper presented the system of organization and control of the department of public works and engineering of the city, giving also the amounts of appropriation and expenditures in the city during the past two years, together with the amount of asphalt, granite block, brick, and block asphalt streets in use, with the cost of same and an exhibit of the mileage and cost of the sewers of the city, of which there are nine miles of brick and thirty-three miles of pipe sewers. The paper was discussed by Vice-President, F. P. Clute, of South Pittsburgh, Tenn., Col. H. M. Robert, of Nashville, Tenn., and Mr. Hunter McDonald, of Atlanta, Ga.

The Illinois Mining Institute.

The newly organized Illinois Mining Institute seems to have made an auspicious beginning at its first quarterly meeting held at Springfield, Illinois last month. The attendance was large, and there were fifty-seven applications for membership. Mr. J. C. Simpson, General Manager of the Consolidated Coal Co., of St. Louis, is president of the organization, and Hon. John S. Lord, Chief of Bureau of Statistics, Springfield, is secretary. Papers were read by the president, Mr. Simpson, on "The Purposes of the Organization;" by Inspector Walton Rutlege, on "The Water-Gauge;" by Thos. Stockett, chief engineer of The Consolidated Coal Co., on "Coal-Cleaning Apparatus;" by Inspector Hudson, on "Mine Inspection;" by Mr. Murray on "The Mine Manager;" by Mr. Rollo on "Fire-damp in Illinois Mines;" and by Mr. Ramsay, of the Braceville Coal Co., on "Drainage in Wet Longwall Mines." The reading and discussion of these papers occupied the greater part of two days, and the published proceedings of the meeting will doubtless afford interesting and instructive reading to all engaged in mining coal.

The Roslyn Disaster.

The explosion that occurred at the Northern Pacific Coal Company's Roslyn No 2 Mine, on the 10th ult., was the most disastrous accident that ever occurred in the Pacific Coast coal industry.

The mine is the largest one of a group of three mines known as Roslyn Nos. 1, 2, and 3, and is located in Kittitas County, near the center of the State of Washington. Its capacity is 2,000 tons per day. It has two openings for the drawing of coal (independent of the traveling way for men and mules), called respectively, the Water Level and the Main Rope Entry. The mine is a very extensive one, and consists of a dip entry, first level, second level, third level, fourth level, third east, second east, and first east; the latter being worked out, but used as an intake for a separate split of air. The second east was also used as a separate intake. The water level and manway were also used as intakes, making four in all. Ventilation was produced by a ten-foot cyclone fan, and the Inspector's report for 1891 shows that the quantity of air displaced by the fan was 57,600 cubic feet per minute.

On the day of the explosion, gas was reported in the sixth west entry and in the sixth east. All this gas was removed by Foreman John Shaw before the men were allowed to commence work. At noon the mine was reported free of gas, and the air current circulating was about 45,000 cubic feet. The explosion occurred at 1.45 P. M., and 43 men were killed. All the men were working with naked lights, except in the sixth east gangway, where three men were using safety-lamps. The cause of the explosion is not known positively, but Mr. John Kangley, the general manager of the company supposes that a sudden outburst of gas occurred which suddenly filled the workings and was ignited by some man's lamp.

The mine was supposed to be in an excellent condition and the ventilation was considered by the workmen and the mine inspector as first-class.

Taking into consideration the excellent ventilation, the comparative freedom from gas in the past, the analysis of the coal, and the fact that one small pump effected the drainage, the following deductions as to the conditions existing previous to the accident can be drawn:

(1). The mine was a dry one.

(2). The coal contained 39·29 per cent. of volatile hydro-carbons.

(3). There was a strong current of fresh air sweeping through the workings.

(4). The explosion extended over a very large portion of the mine.

These deductions show that all the elements necessary to cause an explosion of dust, ignited by gas, were present. It is a settled fact that the dust of coal containing as much as 25 % of volatile hydro-carbons is exceedingly explosive, and the presence of a small percentage of gas increases the danger.

Owing to the location of the mine and the badly mixed and untechnical press dispatches, intelligible detailed accounts of the explosion are unobtainable, but by taking the facts of the explosion, and the last published report of the State Mine Inspector into consideration, we are justified in the opinion that coal-dust was a more potent factor in the explosion than gas.

Fatal Mine Explosion.

An explosion of gas in the lower lift of the West End Coal Co.'s Colliery, at Mocanaqua, Luzerne Co., Pa., on the morning of the 31st ult., resulted in the death of two men, John Pretheroe, mine foreman, and John Walters, a miner, and the fatal injury of three others, Wm. Hooper and two Poles, names unknown. Besides these six others were more or less seriously burned.

No person is able to tell the exact cause of the explosion, as mine foreman Pretheroe, whose lamp ignited the gas, was instantly killed. It is supposed that a body of gas had accumulated in some spot not visited by Pretheroe earlier in the morning, as was his custom, and owing to the comparative freedom of the mine from gas, he took chances. He carried a safety-lamp, either of the Davy or Clanny type, and it is supposed that either the gas ignited in the lamp and burst it, or that the lamp was accidently broken, and ignited the gas. At this colliery the foremen acted as fire-bosses in connection with their other duties, and in this instance Foreman Pretheroe neglected the usual precaution of an examination previous to the entry of the miners, and he paid the penalty for his neglect with his life.

One of the neatest specimens of typography that we have ever received in the shape of a catalogue, is the New General Catalogue of the Henry R. Worthington pumps. It is beautifully illustrated, as are all the Worthington Company's catalogues, and should be in the library of every operator and colliery official. Several new special catalogues are in preparation that will show Worthington pumps of many different designs, for special work. The particularly high standard of excellence of the Worthington pump, together with the enterprise of the company in securing every real improvement in pump construction, make these catalogues a medium through which pump users can be kept posted regarding the most modern types of steam pumps.

The H. C. Frick Coke Co. is having made a complete model of its Standard mine and coke works on a scale of one twentieth of an inch to the foot. The model will be an exact reproduction of the shaft and inside workings and coke plant. It will show the headings and rooms, inside haulage machinery, the shaft timbering, hoisting machinery, transfer trucks, coke ovens, larries, etc., etc. The machinery will all work just as the larger machinery does at the mine. Coal will be hoisted and handled, and the coke ovens will be in blast, but instead of burning coal they will be fired by gas, and asbestos blocks will represent the coke in process of burning. It will be an unique and interesting exhibit.

Messrs. J. E. Carr & Son, of Leavenworth, Kansas, in a recent letter inform us that they have just shipped six of their patent cable gripe to the Pana Coal Co., of Pana, Ill., and that with the assistance of their advertisement in THE COLLIERY ENGINEER they are selling large numbers of them to collieries in all parts of the United States and British Provinces. The experience of Messrs. Carr & Son, can be duplicated by all manufacturers of mining machinery, if the same means are used to secure business, viz., by manufacturing first-class goods, and then by making their goods known to purchasers through the columns of THE COLLIERY ENGINEER.

We have received from the Goulds Manufacturing Company, of Seneca Falls, N. Y., advance sheets from their handsome special catalogue of "Efficient Power Pumps and their Application." The pages received contain a large amount of valuable data regarding the merits of Gould's Triplex Power Pumps, one of which is in successful operation at the Pancoast Colliery, near this city. Its motive power is electricity, and the operators of the colliery are highly pleased with it. The Goulds pumps are constructed to run by either electric or steam power, and we advise our readers to look into these many superior points, by sending for and reading their catalogue.

THE BABCOCK & WILCOX AS A COLLIERY BOILER.

We illustrate in this issue a boiler recently erected by The Babcock & Wilcox Co., for the Summit Branch Railroad Company at Williamstown, Pennsylvania, and reference to our advertising columns will show to what extent these boilers have already been introduced into collieries. The reasons for adopting these boilers are economy of fuel, durability, small cost of repairs, and the fact that excessively high pressures may be carried with perfect safety. Where steam has to be carried long distances, as it does at many collieries, this latter reason is often times an all-important one.

The question of economy is one that until within a comparatively short time has not been thought worthy of much attention at Anthracite mines. Now however that the finer grades of coal are being utilized operators are finding out that the coal they burn is valuable to sell, and lately at many collieries the boilers are charged on the books at the regular market price for all coal burned. Where this is done it is easy to see that the old practice of plain cylinder boilers is a very expensive one. As a matter of curiosity we have made some estimates as to the probable saving that could be effected by a change from cylinder boilers to the more improved type. The mine inspectors report about 8,000 boilers in the Anthracite Districts of Pennsylvania. If these average only 30 h. p. each, there is a total of 240,000 h. p. Suppose the running time averages 12 hours per day for 200 days per year and that the saving in coal is only 2 pounds per h. p. per hour. The total annual saving will then be 528,000 tons of coal worth on board cars an average of about $1.00 per ton, or $528,000.00 per annum.

The economy secured by the use of the improved type of boilers, however, covers a good deal more ground that the market value of the coal saved. It means a reduction in the number of men required to handle the coal and ashes. It also includes wonderful saving in wear and tear. To fire the 8,000 boilers referred to not less than 1,000 men are required, while the same h. p. in Babcock & Wilcox Boilers can be fired by at most 400 men. This great reduction in the number of employes is due to the smaller amount of fuel handled, and to the fact that the boilers are usually put in larger sizes, one 125 h. p. boiler taking the place of four cylinder boilers. If the saving in labor be 600 men at $300.00 per year, the aggregate economy in labor and fuel will amount to considerably over $700,000.00 per annum, or about $3.00 per h.p. per annum. If the Babcock & Wilcox Boilers cost when set from $4.00 to $8.00 per h. p. more than the plain cylinder type, the difference will be paid back in from two to four years, after which the saving is a continual source of profit to the operator. In addition he has a boiler that will last many times as long as the cylinder boiler, and carry high pressure steam with safety. We are glad to know that so many collieries have already taken this view of the matter. It is a branch of colliery engineering that has had entirely too little attention paid to it in the past.

Gettysburg.

The New York Commercial Advertiser says in a recent editorial:

"There is no spot in this country so attractive to those who have patriotic emotions, and who honor heroic deeds, as the quiet little town in Southern Pennsylvania, known as Gettysburg, which the great battle of the Civil War has made historic for all time. Unlike Waterloo, this field is marked by monuments which tell every detail of the struggle. Nearly four hundred of them mark the spots where the Federal forces fought and won everlasting glory. Many of these monuments are genuine works of art. In fact, this famous battlefield is a *grand out-door National Gallery of Art*—heroic Art. Nothing like it can be seen on either hemisphere. Twenty miles of roads have been laid out on the field, and a million dollars' worth of bronze and marble may be seen in a day. As an object for Summer Excursions there is no such spot on the Continent. The scenery about Gettysburg is beautiful and full of repose. Its hotels are good, its people hospitable and appreciative, and the Reading Railroad has made the journey thither comfortable and even luxurious.

A Convenient and Accurate Transit.

The transits manufactured by Mr. Herman Pfister, 195 West Fifth St., Cincinnati, Ohio, are models of convenience, accuracy and good workmanship. They are all made under the personal supervision of Mr. Pfister, who carefully tests and adjusts every instrument, before it leaves the shop. Among the special features of this transit may be mentioned the following:

The telescope plunges both ways over the compass box, even when extended its greatest length. The graduation of the compass box and sliding plates are especially distinct and easy to read. The shifting plate for moving the head of the transit on the tripod is entirely independent of the leveling screws. The leveling plates and screws are not detachable from the instrument proper, and are packed in a walnut case, exposing nothing but the tripod to dust and dampness. The vertical angle is read from a full circle, and not from an arc only. The eye piece as well as the object glass is adjusted by rack and pinion movement; and there are spring tangent movements for both upper and lower plates. The instrument is constructed in such a manner that is not easily put out of adjustment, but if such a thing should happen it is readily and easily adjusted. The prices for the different types of instruments are reasonable, and catalogues will be sent free on application.

The new catalogue, just issued by the Lunkenheimer Brass Manufacturing Co., of Cincinnati, is a book that should be in the hands of every mine owner, and colliery official, or other person using steam power. It is a beautiful illustrated volume, bound in flexible cloth, and illustrates the many types and styles of brass and iron valves, fittings, etc., etc., for steam, water, gas, or oil, manufactured by the Lunkenheimer Co. This company was founded over thirty years ago by the late Frederick Lunkenheimer, who won a high reputation for the excellence and efficiency of his brass and iron specialties, and his sons who have succeeded him have demonstrated the fact that they can perpetuate this reputation, and are doing it by turning out only first-class goods at reasonable prices. Every product of their large works bears the name "Lunkenheimer" stamped prominently on it, and every valve, gauge, lubricator, etc., is tested before it leaves the factory to ensure its bearing out the reputation ensured it by the name it bears.

A New Culm Separator.

Mr. James Pollock, mechanical engineer, of Wilkes-Barre, Pa., has been granted a patent on a culm separator that promises to be very successful in practical operation. It consists of a water tight tank about eight or nine feet deep, having a rectangular form five feet by fourteen feet at top with sides converging to a small square opening at the bottom. In this opening at the bottom a gate valve is located which can be opened and closed at will, through which the sediment can be removed. The tank is filled with water to within a few inches of the top, and seven inches under the surface of the water is located a perforated plate of one-eighth of an inch round the mesh. In its operation the coal or culm enters the tank at one end and is conveyed over the surface of the perforated plate and under the surface of the water, washing the material as it moves through, allowing all the particles which are too small for burning purposes to drop to the bottom where it can be drawn off through the gate without materially affecting the water in the tank. The material washed is conveyed through the water until it approaches the opposite end of the tank, at which point the perforated plate is inclined upward with the conveyor, carrying the material out of the water and depositing it into a chute, which carries it to a screen to be meshed into marketable sizes. This arrangement enables the water to remain in the tank and to continue washing the coal without an overflow. The sediment, which settles under the perforation, is drawn off through the gate valve at the bottom into a car and deposited on the dirt bank.

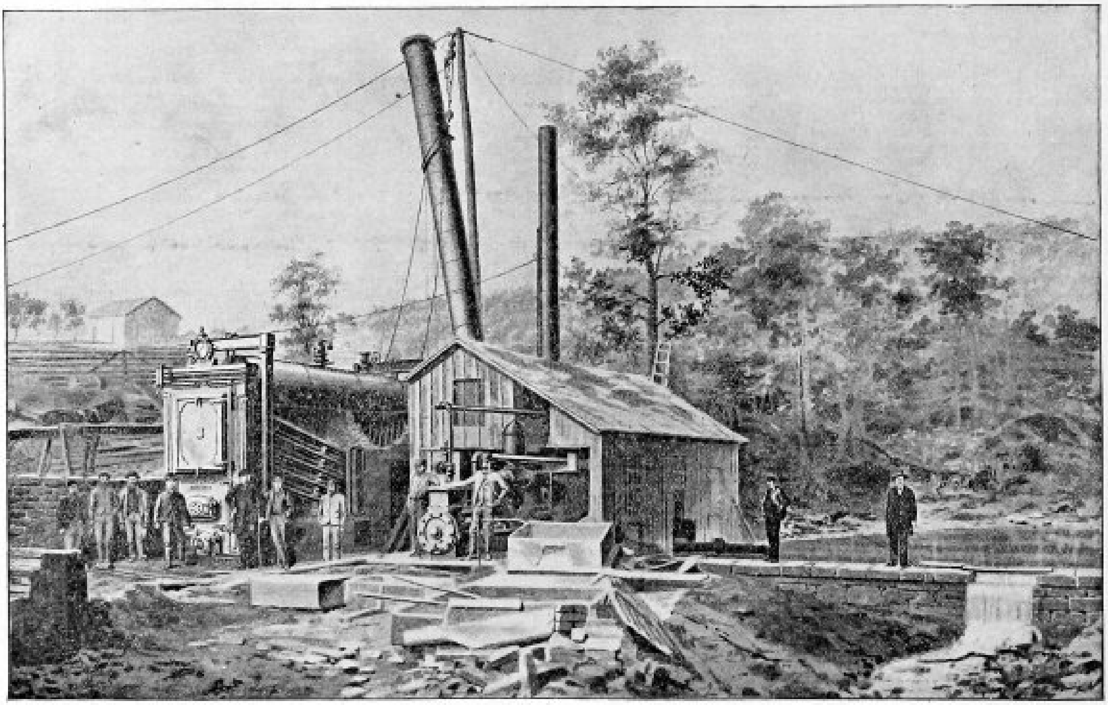
The idea was originally intended for washing the small dirty coal in breakers, but the capacity of the machine is large and it has been found to be suitable for washing the material in culm banks, for which purpose it seems very well adapted.

The American Institute of Mining Engineers.

The Sixty-second Meeting of the American Institute of Mining Engineers, which was announced for June 21st has been postponed for one week, and will begin Tuesday evening, June 28th.

This change of date has been made in consequence of the offer of the manager of the magnificent Hotel Champlain, situated at Bluff Point, about three miles south of Plattsburgh, to open the hotel in advance of the regular summer season, for the special entertainment of the Institute, provided the date of June 28th could be substituted for the earlier date first announced, at which time it would be impossible to have the hotel open. The superior comfort and enjoyment assured to members by this arrangement need not be argued to any one knowing, by reputation or personal experience the Hotel Champlain. Headquarters will therefore be established and sessions will be held in this hotel. The usual rate of $5 per day will be reduced to $3.50 for members and guests of the Institute, and the reduced rate will be continued until July 6th for the benefit of such as may desire to remain at Bluff Point over the Fourth of July.

This meeting promises to be one of exceptional interest and pleasure. Communications and inquiries concerning local arrangements may be addressed to A. L. Inman, Esq., Plattsburgh, N. Y., Acting Chairman of the Local Committee.



THE BABCOCK AND WILCOX BOILER AT WILLIAMSTOWN, PA.

EASY LESSONS FOR BEGINNERS IN THE STUDY OF THE ART OF MINING AND THE SCIENCES RELATED TO IT.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the theory of mining and to learn how to answer the questions in ventilation, mine surveying, and mechanics which are asked at the examinations for mine manager's and mine foreman's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine manager's and mine foreman's certificates and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and the calculations are worked out at length for the benefit of those who are not familiar with figures.

PENMANSHIP.

The capital Y consists of a capital loop similar to that employed in making the letter V, a right curve which is connected with the loop by a short turn, and an extended inverted loop which has its straight line made one space longer at the top than usual. The inverted loop should extend below the line two-thirds of the height of the capital loop above the line. It is shown in the right proportions in the first letter at the left of Fig. 46. The second letter from the left is faulty in that the right curve is on the wrong slant and the

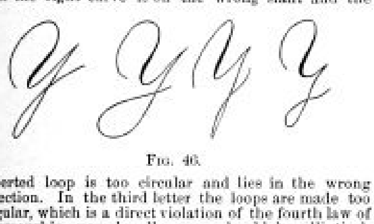


Fig. 46.

inverted loop is too circular and lies in the wrong direction. In the third letter the loops are made too angular, which is a direct violation of the fourth law of Penmanship, namely, all curves should be elliptical. In the fourth letter the right curve is too short which destroys the symmetry of the whole letter; also, the inverted loop is out of proportion to the rest of the letter, and it is terminated below where the line would be.

The first letter in Fig. 47 shows the capital Z written in conformity with the four laws of Penmanship. It consists of a capital loop, an inverted loop and a small loop, which is made in joining the inverted loop with the capital loop. As in the letter Y the inverted loop, is two-thirds the length of the capital loop, or if the whole length of the letter was divided into five parts, the capital loop would be three parts high and the inverted loop two parts. In letter 2 the capital loop is too angular, and the inverted loop is

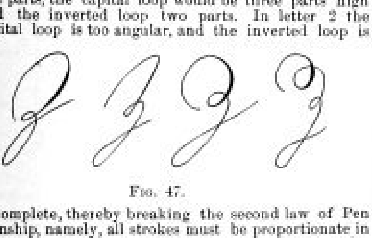


Fig. 47.

incomplete, thereby breaking the second law of Penmanship, namely, all strokes must be proportionate in distance. The capital loop of the third letter is circular instead of elliptical, and shows how any divergencies from the correct elliptical arrangement produce deformities. This is a common error to be guarded against in writing both letters Y and Z. In the fourth letter the capital loop is drawn too far to the left producing a manifest deformity. Also the inverted loop is contracted and out of all proportion to the rest of the letter.

GEOLOGY

In its Relation to Coal, Iron, Oil, Gas, and Ores.

70. What is the ore of iron?

The several ores are all varieties of the compound of iron with oxygen. They are called hematite, limonite, or magnetite.

71. Where are they found?

In the sedimentary rocks between the strata, like coal; and often very thick.

72. How were these beds formed, like coal?

Not exactly like coal but yet very similar, in that water and vegetable and organic matter have had a great deal to do with the deposit.

73. What is the process?

We judge only by what is going on now. Taste the waters of a bog as they ooze from the soil. The taste is inky. The water is colorless. A chemist would tell you that there is iron in it. Where did it come from? I will tell you. Where are the iron bogs seen? Anywhere and everywhere. Do you remember my saying that pyrites was a very common mineral? It is everywhere. In coal, in clay, in sandstone and in nearly all the rocks. Water is a great and powerful solvent. It can leach out of any rock some of the matter it contains. Well, it will dissolve, or wash away pyrites which naturally accumulate in the marshes.

74. But we do not find pyrites there?

No you do not for the moment, wet pyrites comes out into the air it rusts (that is it takes oxygen from the air) and you will notice a scum floating on top of the water. That is iron rust. Bye and bye the rust sinks to the bottom and as more of it is washed in here, a layer of iron mineral is formed.

75. Why it is just like coal formation.

Yes, this bog iron ore forms in pools like coal but there is a difference. It seems that organic matter is important in this work. Decaying plants and animals seem to hasten the process which otherwise would be slow.

76. Are all the varieties of iron formed in the same way?

Practically the same. The varieties differ in the amount of oxygen contained with the iron. This difference causes some iron ores to be reddish, like ochre, and others metallic.

77. Are iron springs the same thing you have been describing?

Yes, they are. You will see them near the place where coal-beds come up to daylight. Indeed one way to find some coal blossom is to be on the lookout for these iron springs or iron bogs.

78. You told us of the effect of heat on coal, does it ever change the iron ores?

Wherever a bed of iron ore has been heated by having lava near it or where it has been squeezed badly in the disturbances of the rocks, the soft limonite iron ore was changed into the hard shiny "magnetite" or "hematite."

79. In what geological formations does iron ore occur?

Most of the English iron ore comes from the coal measures. Alabama iron ore is also from near the coal seams. The Silurian contains much of the iron ore.

80. Does an iron bed have fossils in it as in a coal seam?

Yes, but the fossils are always of fresh water plants and shells.

81. How much iron is there in the ores?

Magnetite is nearly three-fourths pure iron; hematite or specular ore has nearly as much; bog ore has a little over one-half iron.

82. Where are these ores mined?

In almost every state of the Union. Some ores are purer than others, but the Lake Superior region, Cornwall of Pennsylvania, and Virginia, are turning out large amounts of iron ore. Michigan stands first in mining nearly 6,000,000 long tons of an average value of $2.70 per ton. Alabama and Pennsylvania come next with 1,500,000 each.

83. Do all kinds of iron ore produce the same kind of iron?

No. The red hematite is the most desirable iron ore.

84. How much iron ore have we in the United States?

We produced 14,518,500 long tons last year. The consumption is 15,733,465 (according to the census). Each long ton of ore is equal to about 1200 pounds of pig iron.

85. Have any figures been given as to how long the iron ore supply will last?

It is predicted that we have only sufficient iron ore, now discovered, to furnish the United States, for 110 years assuming that the consumption doubles every 13 years as it has done during the last 10 years.

86. How thick are the iron ore beds?

Like coal, they may be found up to 50 feet thick, though the purest seams are only about 4 feet. Like coal, also, the seam is underlaid by clay

87. From what you say of iron and coal, the plants and animals must play a very important part in Nature?

They do, and though we are exhausting the coal beds and iron mines, they return to the earth again. When we burn up coal, it goes up into a gas, that is called carbonic acid gas, what miners call choke-damp. That gas feeds the plants now living and they take the carbon out of the gas, put it into the grass or wood which soon decays and goes through the same process. So it is with iron, when it rusts it falls into the soil and is washed back into some pool and we have iron ore again.

88. Does anything else depend upon the plants?

Yes, natural gas and petroleum. They are the products of decay of wood and vegetation. Some claim that petroleum, or mineral oil, was made by the decay of organic matter, perhaps of animals.

89. Why is that so thought?

Because big caves have been found containing bitumen, the solid remnant of petroleum and with fossils. In one place there has even been a cave solidly full of fishes that have been changed into oily tar. At least the geologists are all agreed that petroleum was made from organic matter that lived in *salt* water.

90. What is the objection to the belief that the oil came from trees and plants?

Because petroleum rarely occurs in strata that have been heated.

91. What is natural gas?

It is a gas accumulated in the subterranean chambers. It was discovered while drilling for oil wells. All oil wells may yield gas, but gas wells do not give petroleum.

92. How was it produced?

Do you remember Q. 8 in which it was shown that the movements of the rocks in the earth heated and changed the character of the coals from peat or lignite to Bituminous and from the soft coals to the hard coals? In this process, the most of the carbon remained in the coal as the table in Q. 2 showed, while the oxygen and some hydrogen forming water was carried off while the remainder of the hydrogen and some of the carbon, combined as a gas or in different gases (see page 287 July, 1892, number of The Colliery Engineer), escaped into the strata where it was collected in the pores or in cavities.

93. Is the natural gas, then a remnant of the coal changes?

Yes, it is, and is found in the vicinity of the coal regions. A few geologists believe that fishes furnished the oil.

94. Does the gas cover a large territory?

It is found in a greater area than that of oil. And by the finding of new wells the district is extending. There are 500 gas-wells in the oil country and its vicinity and these produce 100,000,000 cubic feet per day.

95. At what depth is gas found?

The depth is 2200 feet or so, though of course it varies.

96. Is there any connection between the gas and oil?

Yes, Mr. C. Asburner who is the authority says they are the same in a Geological sense. (See also p. 145, February, 1892, number, also the illustrations.)

97. Where does the gas occur, geologically speaking?

It is found in the flat or nearly flat beds of three different sets of strata. The most productive wells are in the Devonian sands. (See Q. 18 Geology). It is found in the lower Silurian limestones. It is in the Bradford and Sheffield sands and 1500 feet below the Pittsburgh coal. In no case, however, does it occur where the rocks are broken up badly or where the strata are not porous. We find oil and gas in the Cretaceous in Colorado.

Fig. 14.

98. Why is the oil in a given stratum?

Because the rock B is porous and has a floor A of clay. If now the rocks above are so badly cracked as to allow the oil to flow in from above, the oil will accumulate in just the same way as the artesian well waters do, Fig. 14. When a hole is drilled to the porous stratum, the oil, gas, or artesian water, according to the region, will flow out.

99. Does the natural gas occur in the same way?

The stratum is there overlaid by a roof or cover of impervious material like clay, and the rocks below are broken or porous enough to let the gas rise as high as it can.

[TO BE CONTINUED.]

METHODS OF MINING.

Shaft Sinking—Tunneling—Systems of Working Coal and Metals—Timbering in Mines.

68. What is the best method of supporting the roof besides timbering?

The important one is by filling the excavation with rock waste.

69. What is this method called?

The name varies with the other conditions. For example, coal, clay, and ore may be mined by "Longwall", which you shall see, is one variety. Then the iron mines of Lake Superior and many lead mines in the old country are worked by a method called "caving," or one called "filling." Then in silver vein mining, the methods include a kind of filling. So no one name can be given to it.

70. What is the idea?

In "Longwall" and in "caving" the idea is to break and "hew" ore over as large a face as it is safe and then to let the roof cave behind the miner as much as it would. No effort is made to support it. These methods require a bad roof and a brittle hanging wall.

71. Suppose the roof is strong?

If the roof or hanging wall is strong and will not break, then these methods will not do. Unless the roof caves you cannot work by "Longwall" with any degree of safety.

72. What is the "filling" method?

That is where the roof is too firm to break and cave and rock is quarried above and lowered into the mine to fill up the rooms as fast as the ore is mined out. It is cheap and very safe.

73. What is the method in silver mines?

It is not often that the vein carrying an ore of silver has only silver minerals in it. For then the silver would be as plentiful as coal, for example. But a vein which is about four feet wide will have in it a streak or two which may not be over a few inches thick. All the rest of the four feet is filled with quartz, or spar; and they are worthless. Now, we shall see that in vein mines then, only a little of the mineral is taken away and hoisted to the surface, while all the rest is left. Sometimes it is all shot off and broken to be left on the stulls (see Question 39), for support between the walls. Or sometimes if the vein does not happen to have enough of this waste rock to fill up the rooms that are mined out, the hanging wall is shot down to help fill up.

74. Then the only idea is to so use the waste rock as to save timbers?

Yes, even in the pillar and bord method, you throw the waste rock behind you and try to pack it into a place so as to hold up the roof. The waste is called gob in coal mines and gangue in metal mines.

75. What are the methods of mining and upon what do they depend in making a choice?

The choice between the various methods of mining depends upon the thickness of the vein, the dip of it and the strength of the roof and ore. A hard ore, whether thick or thin may be mined by any method almost, but a soft ore can only be mined by caving or by square setts (see Q 64). Otherwise the method of mining depends upon the dip and the thickness of the vein. A very steep vein, and thin, can be mined only by overhand method—the underhand method is no longer used. A very steep vein, that is also thick, may be mined by "filling" and by square setts. A vein of moderate dip and medium thickness may be mined by the bord and pillar. A quite flat vein of not over 6 feet thick can be mined by "Longwall," while a vein over 6 feet thick and flat may be mined by bord and pillar. Panel working is used for coal seams that have much gas.

76. Is the vein worked all over at the same time?

Oh no. It must be "blocked out". That is the vein is divided into sections, or lifts. And one lift is worked at a time. After the shaft has reached the vein, or where a slope is on the vein, gangways are driven along and in the vein for some distance. In coal mines they are always in pairs. One is the return air-way and the other is a haulage way. In metal mines they do not drive any return air-ways, so there is only one gallery, which they call a drift.

77. How far apart are these galleries?

If the dip is steep, they are about 100 feet apart. If the vein is quite flat they are several hundred.

78. What fixes the distance between them?

The thicker the vein, the nearer together these may be. In large steep iron mines, the drifts are about 60 feet apart. In thin coal seams that are quite flat, the gangways are as much as 600 feet apart.

79. What is the distance between these called?

The part of the vein between the two drifts is called a "stope" in metal mines and a "lift" in coal mines. So stopes are from 60 to 100 feet high and lifts are 300 to 600 feet.

80. How many of these lifts or stopes are laid out?

If you run out the galleries very long, you need not block out more than two lifts at a time. For you will have enough of vein to work out for a long time. Of course you work on both sides of the entry. If the drifts are not run out very long then you must sink the shaft or slope deep enough to drive several galleries on each side.

81. Why do you drive them so long or so numerous?

To open up enough of the vein to have "reserves" for changes in the market demand. When the price is good you will be ready to turn out a great deal. So in veins. As you may know under "Geology" questions, the metal-ore changes very much in value and in purity. By opening up much of the vein, you will have a variety of ores to supply the market with as the demand varies.

82. How long are the galleries driven?

That depends upon the kind of haulage systems to be used. Tramming would not pay if it was over 500 feet. But if you put in a tail rope or an endless rope or even a locomotive you can make the gallery even a mile long. But a mile is as long as will surely pay to haul the coal unless the shaft is very deep. It may be cheaper to sink another shaft further on, than to haul all the coal a mile, or more, to one shaft. When a mine becomes large the entry may not be large enough to allow all the coal to be raised from the ground a mile on each side. Then the operator must sink a new shaft or entry to help out the first one.

83. What is the size of these galleries?

They are made only large enough for the purposes they are to serve. In coal mines they may be wide enough for two tracks and a space for a man to travel along without being struck by the cars. Sometimes the gangway has a row of center props to hold up the cap of the timbers and so support the roof. But this is an exceedingly dangerous and barbarous practice because of the numerous accidents that come from it. A gangway has to do service for a block of vein that is one lift of 300 to 600 feet high by perhaps a mile long.

In metal mines the width of the gangway is only enough for a car track. Usually the width of the gangway, or drift, is fixed by the distance between the walls of the vein. A drift here only does service for one stope of 60 to 100 feet high and rarely over 1000 feet long.

Along metal mine drifts the haulage, or tramming is by hand; while along coal mine gangways, cable rope or even locomotives may be the source of power.

The height of gangways in coal mines is fixed by the thickness of the seam. It can hardly be less than 4 feet for mules or men and need not be over 7 feet. If the roof is good it may not be objectionable to rip into it to get height sufficient for tramming. If the roof is poor it is not usually cut into. In some few cases the floor may be cut away. Generally, however it is best to avoid cutting either roof or floor, if one can. In metal veins the height of the drift is about 6 feet 6 inches because there is no objection to cutting into the vein matter.

84. Is a vein or seam ready for attack when it is divided in this way?

Yes. To review, we have reached the vein or seam and driven out a number of galleries, quite horizontal, which have between them blocks of mineral ready for mining. A metal mine has several stopes opened out, (see Q. 81) but coal operators do not run out more than one lift at a time, because the coal is so even in nature and value that "reserves" are not needed and besides the keeping up of several galleries is expensive. So the next lower lift is not started until the one above is exhausted.

[TO BE CONTINUED.]

POWER IN MINING.

The Elementary Principles of Mechanics—Steam—Boilers—Engines—The Machinery Employed in Mines.

How does the fusee or conical drum work?

It is an arrangement for making the work of the engine as uniform as possible. It is used single where the object is merely to equalize the engine work. In Fig. 14 is a side view of a conical drum, from the small end of the drum the rope A and its load is hanging. Then the leverage is the radius of the small end: if the rope weighs q pounds per foot, the cage and car weighs c and the load weighs W, then the weight hanging from the small end, down the full length, D, of the shaft is $c + W + q D$.

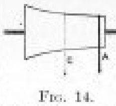


FIG. 14.

This multiplied by the lever arm, r, gives the moment of the weight. To make this constant then this product must be constant for any position of the cage in the shaft. But the length of rope is decreasing. To balance that, the lever arm must increase so that when the cage is at a point half way down the shaft we have

$$(c + W + q D) \text{ times } r = (c + W + q \tfrac{1}{2} D) \times R.$$

So, R, the radius of the drum at that time (C, Fig. 14) is known, when the weight of your cage, load, and rope are fixed upon.

64. What then should be the size of the drum for a one inch rope with a cage and car of 2,500 pounds?

A one-inch steel rope weighs about 1·6 pounds per foot. Assume a shaft 600 feet deep, then the rope, weighs, q D, 960 pounds. A car usually holds about twice the coal that it weighs. So that the weight to be hoisted is 2,500 + W + 960 pounds. Now the smallest allowable diameter to a drum is 40 times the diameter of the rope. That is the drum cannot be less than 40 inches across at its small end. This makes the radius of the drum 20 inches.

(3460 + W) × 20 must balance the rotational power of the steam on the crank arm. At the other end of the drum, the lever arm of the weight is R, from it are hanging only the cage car and load, or 2,500 + W, so

$$(3460 + W)\ 20 = (2{,}500 + W)\ R$$

and if W is a ton of 2,000 lbs., R becomes 24·3 inches The deeper the shaft, the larger R must be for a balance.

65. How would you proceed to calculate the power of a hoisting engine?

Always calculate the least power the steam has on the crank arm for the engine may stop on any point of its revolution, see Question 34, and it must be capable of starting from that same position. As a single cylinder would be unreliable the double cylinder is used as in Question 56. Then you must calculate the smallest power of the double crank arrangement as in the table given below.

66. Please explain the table.

The first column has the amount of cut-off which the engine valves are set to. For example a cut-off of

TABLE OF ROTATIONAL POWER OF STEAM UPON THE CRANK PIN.

(Including 7% clearance and excluding compression.)

Ratio of apparent expansion.	$l = 4\frac{1}{2}\ r$		$l = 5\frac{1}{2}\ r$		$l = 7\ r$	
0, no cut-off.	·5615	·3974	·5600	·3974	·5589	0·3974
⅞, cut-off.	·4964	·3553	·4606	·3288	·4586	·3096
¾, cut-off.	·4380	·2172	·4365	·2499	·4353	·2350
⅝, cut-off.	·4256	·1878	·4193	·1923	·4124	·1966
½, cut-off.	·3926	·2469	·3818	·1473	·3736	·1542

Co-efficient given is to be multiplied by $P k^2 s$

½ means that the steam only enters for ½ of the stroke when the supply valve is closed until the piston reaches the end of its stroke to return.

The other columns are in pairs. The first pair are for a connecting rod 4½ times as long as the crank, the second where it is 5½ times, and the third pair where it is 7 times the crank length. The first column of each pair gives the greatest steam power that the crank arm receives while the second column gives the least power and the one you must figure for.

The co-efficient is the same, for any boiler pressure or size of cylinder. So you must multiply that found in the table by $P k^2 s$ where P is the pressure of the steam as it enters the cylinder, k is the diameter of the cylinder in inches and s is the length of the stroke in feet.

For example, a ½ cut-off engine, 80 pounds of steam, duplex cylinders 16 × 20 having a connecting rod of 70 inches long will give a co-efficient from the table of 0·4124 as a maximum and of 0·1966 as a minimum (the connecting rod is 7 times the length of the crank, 10 inches.) These two give us therefore

$$0{\cdot}1966 \times 80 \times 256 \times 1{\cdot}666 = 6710 \text{ pounds.}$$

$$0{\cdot}4124 \times 80 \times 256 \times 1{\cdot}666 = 14076 \text{ pounds.}$$

On a conical drum directly connected having (as in Question 64) radii of 20 inches and 24·3 inches, the engine could in the weakest position raise a weight, W, = 566 lbs. from the small end and of 820·8 lbs. from the large end, because (reducing 20 inches to feet)

$$6710 = (3460 + W)\ 1{\cdot}666$$

Whence

$$W = 566 \text{ and } 6710 = (2500 + W)\ 2{\cdot}02$$

Whence

$$W = 820{\cdot}8$$

67. That is a small load is it not?

Yes, the case results in a small load, but it shows forcibly the influence which the dead weight of the rope, cage, and car has in the effective work of the engine. These should all be very light and then properly proportioned to the weights to be carried.

68. What would be the difference if there were two such conical drums on the same shaft arranged so that while one is hoisting the other is lowering?

The result in that case would be very beneficial. Assume just the case mentioned. Then, while the (3460 + W) has a lever arm of 1.666 feet, the load (2500) is hanging from the 2·02 radius of the drum to turn the drum with the effort of the engine and thus assist it. This leaves for the engine to do only (3460 × W) 1·666 − 5050 = 716 + 1·666 W.

So that the engine could start, even from its weakest position, a weight of 3,600 pounds. So you can see the benefit of a balance like some of those mentioned in Question 58.

69. How is it with reels?

They are only used for flat ropes, where the first coil winds on the small axle of the reel and after that each successive turn winds the rope on its predecessor. The result is that the lever arm of the weight at the start is small, but increases with each revolution of the reel until at the top, the weight is winding on a big circle. It is practically the same as with a conical drum. (See also page 115, of December, 1891, number of THE COLLIERY ENGINEER.)

70. Is that the object of the flat rope?

Partially so. It saves a long drum, and is safer to wind. But it gives trouble by slipping off its coil and down between the other coils and the arms, where it wedges tight and often breaks.

71. Are engines measured in any other way?

Oh yes, you will hear them spoken of as so and so many horse power. Long ago Watts set a number of horses to lifting weights by means of pulleys and averaging up their work, he found that a horse could raise 150 *pounds* at the rate of 220 *feet* a minute. It was also found that with other machines a single horse would lift, each minute, 1,000 pounds at a speed of 33 feet a minute. Tested by various appliances, the result was always the same that the weight lifted multiplied by the speed was 33,000. So 33,000 foot-pounds was called the work or power of a horse. Any machine or appliance that gives 33,000 foot pounds in a minute is said to give one horse power, sometimes written H.P. No matter how slow, or how fast, the product of the speed and weight measures the work. A given engine, machine, or animal may, by suitable arrangements hoist fast, but the load is correspondingly less. Remember what was said in Question 23. What held true of the "balance" of moments is also true of the equilibrium of work. The general principle is known as that of the conservation of energy.

72. How does this apply to the example in Question 19?

There 50 pounds at B balanced 150 pounds at C. The work done by the lever was to raise the weight. Now if that weight is lifted 2 inches or ⅙ of a foot, the work done is ⅙ times 150, which is 25 foot pounds; expressed as ft. lbs. To perform this work, the force of 50 pounds at the other end had to pass through ½ foot. The measure of the work of the force is 25 ft. lbs.

73. Is the foot pound, (ft. lb.) the unit of measure of work?

Yes, it is called also a dynamic unit. (See page 163, of the February, '92, number.) In this unit all work is expressed, sometimes the work is also measured in time; for example, the work done would be the same no matter how long it took you to raise the weight. If you did it in a minute, you are stronger than one who required 3 minutes to lift it. So in comparing power it is necessary to refer the work to some unit of time—a minute is the standard.

74. Will you cite some instances of powers?

The average man on a windlass can, in a minute, do 5,300 ft. lbs. of work, a horse on a canal averages 28,000 ft. lbs. per minute, a mule hauling cars gives the same work.

A trammer is capable of about 3,240 ft. lbs. per minute. A water-wheel may give out as much work as is equal to the weight of water used multiplied by the height of the fall.

[TO BE CONTINUED.]

ANALYSES OF COAL, ORES, ETC.

Instructions in Sampling and in Making Analyses to Ascertain the Quality and Value of Coal, Ores, &c., &c.

The Amount of Carbonic Acid in Air.—This may be found, approximately, by putting into a glass stoppered bottle, one-half an ounce of dilute lime-water, tinted with phenolphthalein, and if on opening the bottle in the room, the color remains as it was, there is less than ¼ of one per cent. of the choke-damp. If the color disappears rapidly, there is more carbonic acid than 1 in 400 of air.

The only other method that is simple consists in filling a bottle that will hold about a gallon (its volume must be carefully measured) with the air to be tested. Pour into it 100 c. c.* of lime water and shake up for some time; add phenolphthalein and it will color the solution so long as there is any hydrated lime present. Now add of a standard solution of oxalic acid till the color is gone and note how much solution it requires. Every 1 c. c. of the solution corresponds to 0·012125 grain of carbonic acid.

So that if it required 108 c. c. of the solution there were 1·31 grains of carbonic acid.

Now take another 100 c. c. of the same lime water as used before, and add the same amount of phenolphthalein. Also proceed as above to add of the standard oxalic acid solution till the color is gone. Note the amount and calculate as before. Suppose it required 70 c. c. of the solution. Then that corresponds to 0·848 grain of carbonic acid.

The difference between the two readings, (0·462), gives the amount of carbonic acid in grains which when multiplied by 48·4 gives the number of cubic inches of the gas in the given bottle. For greater accuracy this should be reduced to the zero of temperature and normal pressure of 30 inches of barometer.

Having now the number of cubic inches of gas in the known volume of the bottle it is a simple matter to

*All measuring flasks and burettes (dropping tubes) are divided up into French measure instead of English measure. A c. c. is a cubic centimeter, that is, a cube whose sides are the one-hundredth of a meter in length. A meter is 39·37 inches long. So a cubic centimeter is 0·0610 cubic inches.

determine the percentage of gas in the given sample of air.

Assaying of Ores.—Just as the analysis of coal proceeds in miniature as does a coke oven to ascertain the fixed and volatile compounds, so assaying similarly treats ores to ascertain their behavior in the smelting furnace as well as the amount of silver, lead, etc., that they will produce when melted. We distinguish the terms analysis and assay from one another by embracing in the latter term all methods which require the high heat of a furnace. Analysis is a term the chemists use for the wet processes, or those involving filtering and the use of liquids.

An ore contains several metals of iron, silver, lead, copper, etc., the amounts of which may be determined by the dry (or fire) method, or, with greater accuracy, by wet methods. The former is preferred because it is quicker, and resembles the smelting process. There are in the main two fire methods, one employing a crucible and the other a scorifier shown in Figs. 7 and 7*a*. These receptacles are both of clay but the crucible is coarser and heavier than the scorifier which is a soft smooth fire-clay receptacle, not as deep but broader. The crucible is of sand, in form round or triangular, and of sizes from those 2 inches high holding, perhaps, 2 ounces to those holding a gallon. These crucibles are sometimes called "Hessians."

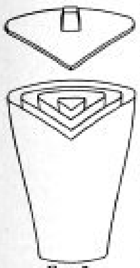


Fig. 7.

Fig. 7*a*.

In the crucible the operation of assaying follows the principle of smelting the contents to metal which is then weighed. In the scorifier the operation is rather one of roasting—that is driving off all the volatile substances. It is broad and shallow exposing a large surface of the molten contents to the action of the air. All the operations of assaying the metallic value of an ore are conducted in one or other of these dishes.

The assayer must be provided with a suitable furnace within which to perform the fusion. Fig. 8 shows the three veiws of the best form of assay furnace. It is made of common brick, with fire brick lining at the places, exposed to the flame. As seen, it is merely a brick shaft having a fire grate, *c* near the bottom opposite to which is a door, *a*, for feeding coal, an opening for the "muffle" and a vent *d* connecting with the chimney. The draught ought to be strong—at least 10 feet of chimney; soft coal may be used. Upon the ledges marked *b*, *b*, the "muffle" rests. This furnace can be built for \$25.00.

Fig. 8*a*.

A muffle is a fire clay cylinder about 14″ long and having a cross-section the shape of a capital ⌂, Fig. 8*a*. One end is open and faces the front while the other is closed except for a small vent. The crucible or scorifier is placed inside of the muffle which is kept red hot by the flames of the coal burned below. A muffle 8 inches wide × 14 inches long is the best size for all around work and will allow 3—2½-inch scorifiers to stand side by side. A muffle with care will give a month's service.

When the muffle, *m m*, is placed on the supports and in position there should be at least a 3-inch ledge in front, the space between the muffle and the brick is stopped up with a cement made of fire-clay 4 parts, sand 1 part, and some water.

The tools required by the assayer are: 1 pair crucible tongs, Fig. 9.

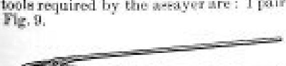


Fig. 9.

2 pairs of scorifier tongs, Fig. 10.

Fig. 10.

2 pairs of cupel tongs, Fig. 11.

Fig. 11.

1 small shovel scraper, Fig. 12.

Fig. 12.

The latter is an emergency tool for sprinkling sand upon the muffle floor when a scorifier has been upset or eaten through; and also for scraping off the fused mass as soon as possible.

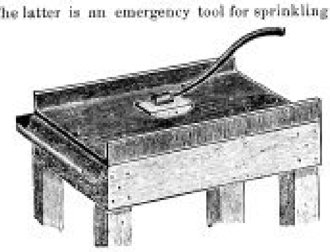
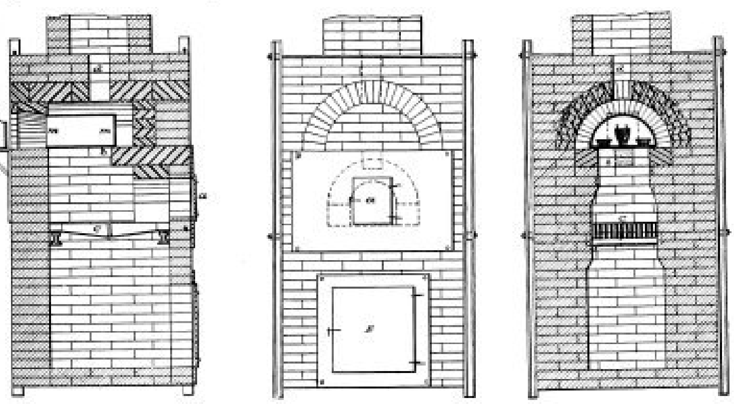


Fig. 8*b*.



Longitudinal Section. *Rear Elevation.* *Cross Section.*

Fig. 8.

For grinding ores, a mortar and pestle might be used but the most rapid crusher is the combination of a large heavy cast-iron plate 18 x 24 inches 1 inch thick and a cast iron grinder about 5 inches square and about 3 inches thick, Fig. 8*b*. The lower face of the box is convex. A handle is set into an eye at the top. The ore to be ground is broken into small pieces and then the grinder, held by the left hand and the handle by the right, is rubbed over the smooth surface of the plate and pulverizes the ore quickly and easily.

The ore is always sifted through a sieve with 100 holes to the inch. The sieve in two parts is preferable, that is a tin box about 8 inches diameter, into which fits a tin cylinder with a sieve bottom. The ore is thus sifted through the sieve into the box below without dust or loss, Fig. 13.

Fig. 13.

The assayer should also have an iron mould receiving scorifications. This is a heavy casting into which are several cup-shaped cavities, Fig. 14.

Fig. 14.

With a supply of the articles mentioned the assayer is ready for business, though there are several other articles to be purchased. These will be suitably discussed in place.

[to be continued.]

VENTILATION IN MINES.

Including a Description of the Gases Met With in Mines and the Atmospherical Conditions Necessary to be Known to Understand the Laws of Ventilation.

47. Suppose the case of a furnace in a 400-foot shaft and the mine drag is 2 inches gauge, how hot must it raise the air?

2 inches gauge = 10·368 pounds pressure between the two columns of 400 feet each. The difference in weight per cubic foot must therefore be 0·02592. Air at 60° F. weighs 0·0766 pound. So the light air must weigh 0·0507 pound per cubic foot. To attain this the air must be at a temperature of 320° F.

48. Is that the same method of figuring as with a fan?

Yes, you know the difference is only one of pressure, not of temperature. For example, in the formula given in Q. 45, *t* is 60° Fahrenheit usually. Then W becomes 0·002553 B and the difference between the weights of a cubic foot of downcast and a cubic foot of upcast air would be equal to 0·000186 times *g*, the gauge reading. A fan producing an exhaust equal to 2 inches (it is also called a depression of the water-gauge of 2 inches), makes the upcast air lighter than that in the downcast by 0·000372 pound per cubic foot.

49. Is the difference in the weights of the air in the two shafts the only cause producing draught and ventilation?

Yes, that is all. The product of the depth of the shaft by the difference between the two weights is called the motive column,—that which causes the draught.

50. Is not there a natural method of ventilating, which requires no machinery?

Yes, by having the two outlets at different levels and depending upon the difference in weights of the warm mine air and the air outside, but it is not reliable nor safe. This plan is only used in the metal mines, and not in the coal mines.

51. Does it furnish as good ventilation?

No. The current is not always in the same direction; and in mines having bad gas this would be dangerous. One time the air from outside would come down the entry and then go along the workings to the upcast. At another season the air would be in the opposite direction and go along the workings first. In the spring and autumn there would be no current.

52. Would it make any difference which way the air moved?

Yes, it would, because at one time the goaf gases would be swept into the mine by the current; at another they would go out and give no trouble.

53. Is the air good in metal mines?

There are no coal gases to spoil the air, but then there is very little fresh air taken into the mine. The air in the metal mines is more impure than in coal mines because no current is supplied and the dead air is not washed out.

54. What do you mean by dead air?

Air is composed of two gases, called oxygen and nitrogen. If air contains no oxygen it cannot support life and nothing can live in it. It is dead air.

55. Is there much oxygen in it?

Under any conditions and in any place you gather it, pure air has 21 parts of oxygen and 79 parts of nitrogen.

56. What is oxygen?

It is a colorless, tasteless gas that is essential to the burning of fuel and to life of any animal.

57. What is nitrogen?

That is a gas that simply has no influence upon life, one way or the other. It appears to act only as a dilutant—to prevent the air being too rich.

58. Then air is good or bad according as it has much or little oxygen in it?

Yes, that is true to a certain extent. But the air may be bad if it has other gases in it. When you step into a room you say its air is bad when you may mean that there are other gases in the room besides oxygen and nitrogen.

59. What are the other gases?

There is always some carbonic acid (choke-damp) and there may be some sulphureted hydrogen. In coal mines there is also more or less marsh gas (fire-damp).

60. What is carbonic acid?

It is a gas that weighs more than air and is the product of all decomposition. We breathe it out from our lungs, so do animals. Timber and coal, while rotting, give out the same gas. It is the gas that comes out of the stove from burning fuel. You will always find it near the floor or in the bottom of old workings. As this gas is very poisonous, no one should go into it. Only a small amount of it in the air will poison a person. You never feel it if you are breathing it until it is too late to help yourself. It makes you very weak and finally kills. Old workings should, therefore, never be entered until they have been tried by a candle. If the candle or lamp will not burn in it, keep out of the place until the place is ventilated. If you want to test the air in another way, do this: Fill a bottle outside with water. Go into the room, turn the bottle upside down and as the water runs out, the gas will bubble up into it. Cork the bottle and when you get up above, pour into the bottle some clear lime water. If the fluid becomes milky, then carbonic acid is present.

61. Will carbonic acid only gather near the floor?

Yes, so long as it is undisturbed. If a current of air be swept through the place the carbonic acid will float off with the air.

62. What is sulphureted hydrogen?

A heavy gas that has a rotten egg odor and is very poisonous. It comes from the pyrites, or mundic, that you find sparkling in the coal, like gold, some call it fool's gold. This gas cannot be produced unless there is also some heat. So if ever you smell it, be sure that you do not breathe it long and also be careful that the goaf or room in which it is be thoroughly ventilated. If it is not ventilated, the heat may start a fire in the slack.

63. Is this also found near the floor?

Yes, the two I have mentioned are the only two heavy gases produced in a mine.

64. What are the light gases?

Some say there is formed a little carbonic oxide that you call "white damp" but the main gas of collieries is the fire-damp.

65. What is fire-damp?

If you remember Q. 8 under Geology, I spoke of the miasma of swamps, that is called marsh gas. The marsh gas collected in swamps, some later, gathered in the rocks and is now called natural gas and some stayed in, or near the coal and is called fire-damp. This fire damp also comes off from the burning of coal and produces the chimney smoke. (See page 66, October, 1891, number.)

66. Is there much of it in coal?

Underground, it is found in big caves or chambers that suddenly burst into the mine; it collects in the pores of the coal or in crevices. The amount can never be estimated. It is always found in the coal mine, and is always feared because you never know when a great deal of it might be thrown out.

67. Is it poisonous?

Yes, it is not wise to breathe it but there is a still more serious objection to it. It explodes.

68. Where is it most often found?

Near the roof, and always at the upper portion of any cave or nook. Just under the platform it collects, too, so that it must be watched for everywhere.

69. How may we know of its presence?

Sometimes it comes out from the coal continually with a low hiss as a "blower." At other times, there is no sound at all. The several ways of testing for fire-damp is by the way a candle or lamp flame behaves in it. If there is very little gas, the flame does not show it but as the amount is large, the flame will become long and the cap of blue grows long too. When the flame is all blue and can hardly be seen, there is a very dangerous amount of gas in the air. When you find the lamp flame shows blue, *don't blow it out*, but first lower it slowly toward the floor and leave the room. (See page 163, February number).

70. What does the blue cap mean?

That there is enough gas in the air to take fire and almost enough to explode.

71. What causes the production of gas?

It is always escaping from the coal. A little would not be very serious, but it is the sudden production of gas that we fear. The falling or sqeezing of a part of the roof, the creeping of the floor, the crushing of a weak pillar or the falling of the barometer outside will force a great deal of gas into the workings.

72. Is there no means of preventing this?

None whatever. There is no prevention, but there is a cure, and only one—a very strong ventilating current.

73. Is not the use of the safety-lamp a good cure?

It is a partial cure. That is, a mine not using safety-lamps is very likely to have more accidents than one using them. But still, even in the latter case, the only remedy is to have a very powerful pressure and plenty of good air.

74. Why is the safety-lamp not good?

Because, first, none has yet been invented that gives a good light and also prevents the air current from blowing the flame against the iron wire gauze. Secondly, because there is no lamp that can be locked so that a miner can not open it. Thirdly, because the miners themselves will insist upon prying it or breaking it open. The first trouble has been nearly perfectly remedied. The second has not been and the third will not be until the fool-killer's work is done. I do not blame a miner for wanting a good light to watch the roof and to protect himself against falls but too many open the lamp to light a pipe. A perfectly secure lock on the lamp or a light so arranged as to go out if pried open are the only safe-guards against the men who risk the mine and all their fellow laborers for the pleasure of an hour's smoke.

[TO BE CONTINUED.]

SURFACE APPLIANCES.

The Preparation of Coal and Ores for Market.

71. Why must the ore be broken so fine?

The lead, zinc, or silver minerals occur in such small crystals and all scattered through it. So the rock must be broken up fine enough to release all the material. This will give you clean broken quartz or galena free from quartz. Coal is not broken any finer than the demands of the market require, but here we must separate, by crushing, the different minerals from one another.

72. Then does the size of the minerals in the rock fix the fineness of the crushing?

Precisely, and this is accomplished better as the rock is softer. Quartz is so very hard that we can not get a perfect separation. The loss of mineral sticking to the lumps of quartz is what makes the process less perfect than coal washing.

73. Is the sizing done in the same way as in coal?

Yes, the broken mineral is raised by an elevator to a hopper in the top of the mill or else, if the site allows it, the mineral goes down a chute to the screens (see Q. 30). In any event, the broken stuff is now screened just as I explained in Q. 32. Only the screens are not cylindrical, Fig. 5, but conical, Fig. 6.

74. What is the advantage?

The screens must be inclined so as to deliver the coal freely at the bottom. Now, a cylindrical screen can not get this without bevel gearing or a chain of some sort. This additional machinery is wasteful of power and is expensive. A conical screen may have its shaft level and, so, can be directly connected with the line shaft. But in the metal mines we use conical altogether.

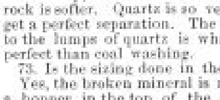


FIG. 5.

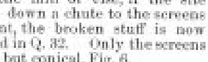


FIG. 6.

75. Then is the rest of the process the same as with coal?

Yes, but a little more complex, as explained in Q. 54. The screens give a more, or less, imperfect sizing of the stuff. Each screen delivers to its own jig and each jig treats a certain sized stuff. The jig, Fig. 1, (April number) will clean the stuff which is continuously delivered on the sieve B. The heavy stuff collects on the bottom of the sieve while the light is forced to the top. Here, however, it is the waste which is the lightest and which is washed off at the tail board. So the quartz is cleaned off from the metallic ores, while the heavy is collected, at A, Fig. 1.

76. Do not you separate the lead ore from the zinc ore, and that from silver?

Oh, yes. This is done by repeated operations in this way. As pyrites is heavier than slate, and slate heavier than coal, you could, if you wanted to, not only separate the clean coal but also, afterwards, separate the slate from the pyrites by similar operations. But the last two do not pay so of course no attempt is made to separate them. The same is true with those you mentioned. Quartz is lighter than pyrites, and pyrites does not weigh as much as zinc blende: Zinc blende, or black jack, is lighter than lead ores (galena, for example) and galena is lighter than silver ores. Now, as explained in Q. 42, the more water, you use, the more stuff it will carry off. So we could use a great deal so as to carry off all but the silver ores, or we could carry off all the material that is lighter than the lead. Then afterwards we could separate the lead from

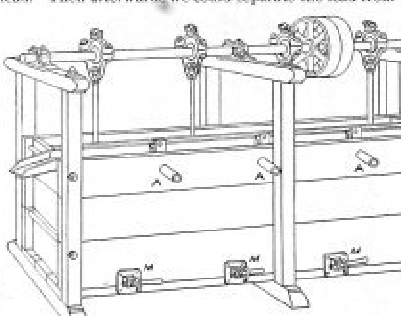


FIG. 7.

the silver and also in other machines, the zinc blende from the pyrites. That is what they do in the old country. Separate all the minerals from each other because they are all salable. Here, it would hardly pay. So we draw the line at the lead ore.

77. Then you mean that you arrange the jig so as to collect all the lead and the silver on B, Fig. 1, and wash off the tail board all that is lighter than the lead?

Yes. But remember these are not perfect machines so that we can not collect *all* the lead and silver for some does escape. Some floats off, being exceedingly fine, while more is lost by sticking to the quartz and pyrites. Most of it is caught, though.

78. Are the lead and silver discharged at A, Fig. 1, like the pyrites from coal?

Very much like that. There are many schemes for removing the "concentrates," as they are called as soon as they are made. The tailings are washed off into the jig next alongside as was mentioned in Q. 53. In that they are again treated and some lead is recovered, but of course it is not much. Sometimes even the third jig gets some of the lead.

79. How is it that the third or even the second jig can get any thing out of the tailings which are already washed?

Because usually the pistons of the others are set a little slower so as to get what had escaped with the quicker piston of the first jig.

80. Does any of the zinc ever collect in the first?

No, generally the object is to get very clean lead. The second jig has considerable zinc blende, or "jack" but little pyrites. The third will have hardly any galena, less zinc, and much pyrites. The fourth jig has a bad mixture of them all. That which escapes off the tail board or the fourth, is very poor, but has some valuable mineral in it. In Fig. 7 is an illustration of the four jigs with their discharges shown at A for the coarse and at M the fine concentrates.

81. Is this variety of jig used for any variety of ores?

Practically any mixture of mineral may be concentrated by jigging, provided there is sufficient difference in the specific gravities of the various minerals. The effectiveness of the separation depends upon the cleanness with which the various minerals break. If the ore can not be crushed perfectly enough to free the galena from the blende and the pyrites, there must be some of the valuable material lost because of its adherence to large particles of the quartz or spar, which washes away.

82. What becomes of the tailings?

They are re-treated by being subjected to another, and finer crushing to further liberate the adhering particles of valuable mineral after which washing is effected upon another variety of machines similar in principle to those aleady mentioned.

[TO BE CONTINUED.]

The Ingersoll-Sergeant Drill Co., of No. 10 Park Place, New York, has opened a branch office under the firm name of Parker, Melcher, and Ingraham, at 100 to 104 West Washington St., Chicago, Ill., where a complete outfit of machinery manufactured by the company, such as Air Compressors, Channelers, Rock Drills, and all Mining, Tunneling, and Quarrying Machinery with duplicate parts will be kept in stock.

Economy at the Steam Plant.

There is no portion of an American colliery where there is more waste and consequently more money lost than at the steam plant. Many operators and superintendents pay no attention to this waste, as they think it is entirely a waste of fuel, which is naturally cheap at the mine. But this is not the only waste, though it is bad enough, because every ton of fuel burned has a market value, and all burned in excess of actual need is loss. The waste also includes long lines of steam pipe of larger size than actually needed, and either more boilers than are needed, or loss from delays caused be lack of steam power at the point of utilization, even though the boiler plant is large enough. The waste is entirely due to the condensation of the steam between the boilers and the point of utilization. There is no excuse for this waste, because there is an efficieny remedy, and one that is really not expensive when properly considered. This remedy is a good non-conducting steam pipe covering which can be easily and quickly applied to the pipe, such as the Carey Standard Asbestos Removable Covering. It is one of the most perfect sectional removable coverings made, and is unexelled in its efficiency and convenience.

It is composed of Asbestos fiber and a very light cementing compound, thoroughly intermixed, after which it is moulded into sections 3 ft. long, and to fit any size pipe from ½ to 12 inches in diameter. It has a firm and hard exterior, while the interior is filled with minute air cells, which confines the air within the body of the covering. This is the most practical way of accomplishing the best results of an air space or air-chamber and forms the best non conductor and heat-retainer known. It is first wrapped with woolen felt cemented to the outer surface, and then covered with a heavy canvas, the whole forming a most excellent covering, complete and ready for use. It combines all the qualities essential in a good pipe covering. It retains heat, excludes cold, prevents condensation of steam, is light and durable. It is both fire and water proof, and is easy to apply. It will not corrode, eat, or injure iron surfaces, nor will it shrink or warp out of shape, and thereby leave openings for the escape of the heat. It is also absolutely indestructible by heat. As it is necessary at all collieries working below water level, to carry steam to pumps, and other machinery, often situated many hundreds of feet from the boilers, a good pipe covering is not only a good investment, but is an actual necessity. For by its use dry steam can be conveyed to the pump or other engine with sufficient expansive power to do the work required, and the covering by keeping the heat where it belongs, in the steam pipe, will protect timbers from rot, and the roof from disintegration.

A few of the advantages resulting from the use of this covering may be summarized as follows:

You can convey steam or hot water to any point no matter how far distant from the boilers.

You work dry steam in your engine cylinders and thus avoid all risks of accidents or breakdowns.

You save wear and tear on your boilers, etc., by avoiding the necessity of excessive firing to keep up the requisite amount of steam.

Your grates will not require renewing as frequently as formerly.

Your engine will run nice and smooth and give better results in developing power.

The cost of keeping your steam plant in good repair will be decreased.

It increases the efficiency, insures the safety, and decreases the expense of operation of any steam plant.

This covering is manufactured by the Philip Carey Manufacturing Co., 117 to 125 Gilbert Avenue, Cincinnati, Ohio, who also manufacture special coverings for ells, tees, crosses, and globe valves, though an asbestos cement, which they make is also frequently used for covering fittings, as it makes a very neat and complete finish. It will pay all steam users to write to the manufacturers for catalogue and descriptive circulars.

Important to Prospectors for Coal or other Minerals.

The diamond bit rock drill that furnishes a core of the material through which it bores, is naturally the best machine for prospectors' use, and is the only machine that will furnish information on which positive statements can be based. Most types of diamond drills, however are expensive and require steam, compressed air, or electricity to work them, and the question of, power is a serious one when the prospectors means are limited, or when the hole to be bored is not very deep, and the land owner or prospector does not care to expend a large sum of money for the desired information. To meet the requirements of such persons, the Hasenzahl Portable Diamond Bit Rock Drill, for hand or other power, was designed. It is simple, durable, cheap, and portable, and can be operated by any person of ordinary intelligence. It has been in use in all parts of the continent for several years and has everywhere given perfect satisfaction. The inventor and manufacturer, Mr. Wm. Hasenzahl, 135 West Second St., Cincinnati, Ohio, will cheerfully send descriptive circulars containing complete descriptions of the drill, with price-list, and testimonials from users to any person desiring to purchase a drill, with a capacity up to 500 ft. of depth of hole. Mr. Hasenzahl, has also associated with him an expert geologist and chemist of national reputation, and they are prepared to take contracts for prospecting any kind of mineral lands, and for furnishing chemical analyses and assays of any cores.

How to Live

How an Athlete Trains.

The objects which the athlete usually has in view when he begins to train are:

First—To get rid of all tissue, the loss of which will not impair the strength—in a word, the "dead weight" of the body.

Second—To improve the "wind."

Third—To develop the particular sets of muscles to be used in the actual contest, to the highest degree possible.

The first step toward the removal of fat is in a judicious regulation of the diet. The athlete, particularly if he is inclined to take on weight rapidly, diminishes the amount of fat-producing foods. He avoids fat meat, sugar, starch, and butter, and limits his liquid food to a minimum. His bill of fare consists chiefly of lean meat or mutton, varied by poultry, eggs, or fish, stewed vegetables, greens and fruit and jelly or bread pudding for dessert. The bread used should be about twenty-four hours old. For drink weak coffee or tea, the latter iced, and with a little lemon juice added, is best.

Such a diet in itself will ordinarily reduce the weight somewhat, but, by exercising and rubbing, the fat is removed more quickly. If the athlete is so heavy that he must train off a good deal, he wears a heavy "sweater," or jersey, while exercising, in order to induce perspiration. He must then be very careful not to drink much, else he will regain in a few minutes the weight it took hours of hard work to get rid of.

By "wind" we mean the power of the heart and lungs to do their work properly in spite of continued exertion. Everyone is familiar with the distressful feeling occasioned by unusual and violent exercise. This distress arises simply from the inability of the lungs to supply the proper amount of oxygen to refresh the blood and to get rid of the poisonous carbonic acid gas, the production of which is greatly increased by muscular work, and from the inability of the heart to circulate the blood freely.

It is necessary for the athlete therefore, no matter in what branch of sport he intends to compete, to take as part of his training, exercise that will develop the power of these organs. Running is by all means the best method of developing the wind, and for this reason is practiced not only by the runners themselves, but by oarsmen, boxers, and football players as well.

To develop any particular set of muscles, those muscles must be given a great deal of work. The athlete begins by exercise well within his powers, and then, by gradually increasing the demands made upon the muscles, they become accustomed easily to preform work that before would have been impossible.

He is expected to keep regular hours, to get sleep enough without becoming lazy, to avoid unusual excitement, to get plenty of pure air and sunlight, and is if he is a smoker, to give up tobacco.

A word as to the alleged dangers of training. "Athletes die young," is a warning I have often heard. Of course they do, if after training they plunge into all manner of excesses. But it isn't athletics that kills them.—*Philadelphia Record.*

The Best Exercise.

A celebrated London physician told the great Dr. Punshon, of oratorical fame, that he could extend his life ten years at least by walking a short distance every day.

Looked at from its *physical side* alone, walking is the prince of gymnastics of any kind. We do not mean, however, that rush of fury, that artificial pace which the characteristic impatience of the times has introduced, but the regular, gentle motion of a natural gait, calling many muscles into play, giving the body just occupation enough to leave the mind perfectly free for thought, aerating the blood through expanded lungs, causing the million pores of the skin to breath forth their moisture, the whole organism to glow with health, and discharge its many functions with comparative ease and lightness.

Take that exercise, and you return home with a keen zest for food or work or play, or whatever awaits you, the weary, jaded feeling gone. At night you retire to unbroken dreams, to sleep, deep and refreshing as an infant's.

If some Koch or Brown-Sequard were to discover an elixir half as virtuous as a regular walk every day in the open May air, he would become the blessed of thousands of thousands of grateful hearts. His concoctions would command their own price, and his name would encircle the civilized world; yet here is Nature's own remedy, and, like all else provided by her, free of cost and only needing a persevering trial to insure its own reward.

Again: Walking is not only healthy physically, but mentally. The distractions of the city cease as you move out to the rural scenes surrounding it. Nature instructs you that it was God who made the country, and only man made the town. Her hidden beauties, never seen by the man who rushes through them in an express train, are discovered in rich and rare splendor all around. Distant hills draw near, undulating valleys reveal their lovely hearts. Trees are companions; the grass beneath our feet is instinct with every form of life. We go back, amid the music of the birds and the rushing of the brooks and the murmuring of the winds, to quiet seclusion and peaceful thought.

Thus it is that men's best, grandest, purest moments come to them when they take their walks abroad; but whether, like Dr. Johnson, you prefer the busy city streets, or, like ourselves, the country retreat, your exercise will still be profitable to the entire being.—*New York Ledger.*

Overeating vs. Overwork.

An abuse that tends to the injury of brain-workers is excessive eating. A writer in the *Medical Mirror* recalls to mind several active brain-workers who suddenly broke down, and fancied that it was due to brain fatigue, when, as a matter of fact, it was due to overstuffing of their stomachs. The bodily furnace connected with their mental machinery became clogged up with carbon in various shapes and forms, and as a result disease came, and before the cases were fully appreciated a demoralized condition of the nervous systems was manifested, and they laid the flattering unction to their souls that they had indulged in mental overwork. Hard work, mental or physical, rarely ever kills. If a mild amount of physical exercise be taken, and a judicious amount of food be furnished, the bowels kept open in the proper manner, the surface protected with proper clothing, and the individual cultivates a philosophical nature and absolutely permits nothing to annoy or fret him, the chances are that he can do an almost unlimited amount of work for an indefinite length of time, bearing in mind always that when weariness comes he must rest, and not take stimulants and work upon false capital. The secret of successful work lies in the direction of selecting nutritious food, taken in proper quantities, the adopting of regular methods of work, and the rule of resting when pronounced fatigue presents itself, determining absolutely not to permit worry.

The Treatment of Croup.

To begin with, croup is that terror of all parents whose children are subject to this malady. The mother who has once been roused by the hoarse barking cough so unmistakable in its warning is never likely to forget the thrill of terror which seemed to make her very heart stop beating. No matter whether it be true or false croup, the alarm at the moment is the same, and in neither case is there any time to be lost. If the cough does not seem very tight, and is not accompanied by strangling, begin giving syrup of ipecac in doses of fifteen drops every twenty minutes. Continue this until the child's breathing is relieved, or until he vomits. But should he awake with symptoms of choking and great difficulty of breathing, administer at once a teaspoonful of the ipecac into which has been stirred a good pinch of powdered alum. Should this not cause vomiting in fifteen minutes, repeat the dose, and assist its action by making the child drink a cupful of warm water. Place him in as hot a bath as he can bear—about 100 degrees—and keep him there *at least* ten minutes, spreading blankets over the tub to prevent the water cooling. He should be supported in a reclining position, so that as much of his body as possible may be under water. When he is taken out roll him at once in heated blankets, and put him to bed in a warm but well-ventilated room. He may sometimes be relieved by inhaling steam. If possible get a doctor immediately.

Take great care the day after croup that the child is not exposed to cold. There used to be a comforting theory current that no child ever had croup after midnight, but, alas! time and experience have proved this a pleasant fallacy.—*Harper's Bazar.*

An Easy Way of Giving Cod Liver Oil.

Cod liver oil is a substance that is largely and very properly used in treating lymphatic conditions in delicate and rickety children. It is both a foodstuff (on account of its oil) and a medicine (through the iodine and other elements which it contains). Unfortunately its disagreeable taste prevents its administration, and this taste can be only partially concealed by mixing it with syrup of coffee, Malaga wine, orange juice, or by giving, as soon as it has been taken, a mint drop or some other aromatic preparation.

A process that is quite efficacious, but that is difficult to realize in children, consists in moistening the mouth with a little strong wine, in bolting down the oil, and in ending up with a glass of the same wine, which carries down the remaining portions of the oil.

Attention, however, has now been called to a means which seems to be a good one, and which had already been used by druggists in making emulsions of cod liver oil. It consists in mixing the oil with an equal amount of medicinal lime water. In this way an odorless liquid is obtained, of milky appearance, very like a syrup, to which can be added any aromatic essence, such as mint, lemon or anise-seed as a corrective. Cod liver oil, saponified in this way, has a taste that is almost agreeable, does not adhere to the walls of the mouth, and does not give rise to the rancid and repugnant after-taste that is so disagreeable in the plain oil. The preparation can be kept for a long time, can be easily assimilated by delicate stomachs, and has, furthermore, the advantage of being relatively low in price.

Useful Information

Musical Instruments.

Apollo was the old god of music, and his favorite instrument, the lyre, was invented by Mercury. When the latter was four hours old he found the shell of a tortoise, and made it into a lyre with nine strings, in honor of the nine Muses. This instrument Mercury gave to Apollo, who became a wonderful player upon it. The lyre was used by the Greeks in olden times, and from it was fashioned the harp.

The old time viol was the first instrument of its kind, and furnished the plan for the modern violin, which, however, is seven hundred years old. It is said that Charles II. introduced it into England. One of the finest makers of violins was Stradivarius, of Cremona, who existed in the early part of the eighteenth century. Violins made by him are worth thousands of dollars now, and highly esteemed by collectors and performers.

The flute is very old in its origin, but the flute of to-day is different from that of the ancients. It has been improved upon from time to time, and the old people would probably fail to recognize it now. The flageolet, which is somewhat similar, is credited to Juvigny, about 1581.

The first trumpet was a sea-shell and was used by very old nations. Trumpets were well known in the days when Homer lived, and a Jewish feast of trumpets is spoken of in the Bible, nearly 1500 B. C. Alexander the Great is said to have used a speaking trumpet 335 B. C.

The harp, which was suggested by the lute, is ascribed to Jubal, 3875 B. C., and was King David's favorite instrument. The harp was used by the Welsh and Saxons, and also by the ancient people of Ireland. One of the oldest harps in existence is in the Dublin College Museum, and originally belonged to Brian Boroihme, King of Ireland.—*From Harper's Young People.*

Ventilation.

The healthy atmosphere in a room is one in which the air is changed to the extent of 3000 cubic feet per hour per adult inmate. The air admitted need not be cold; warmed air, so long as it is fresh, is of course preferable to cold air in winter, but in some way the air must be brought in if we are to continue in health. There are various ways of doing this. One is by admitting cold air so that it is directed upward toward the ceiling, where the air of the room is at the highest temperature; the cold stream is then heated in its passage as it falls to the lower level for breathing. But in large rooms, to utilize at its best this current, there should be in the skirting outlets communicati g with a heated upcast flue, which will draw away the heavy air near the door. In cases where there is heating by hot water coils, the cold air may be brought in at or near the floor level and passed through the hot water coils—the outlet for vitiated air being in or near the ceiling—to a heated up-cast flue. In larger rooms or buildings for public assemblies it may be necessary with either of these systems to use a fan, either to propel fresh air into the room or to draw away the vitiated air.

The great desideratum in the admission of fresh air is to cut it up into very fine streams something in the way water is cut up in passing through the fine rose of a watering can. It has been found that air admitted through a tube or orifice of equal sectional area throughout enters as a cold draught; but if the inlet be through a series of small truncated cones, the smaller section outward, the larger inward, with a wire gauze on the inside, the current is so cut up and diffused that the draught is not felt. By analogy, a mass of water entering through a narrow canal drives all before it and cuts a channel for itself, but the same quantity passing over a large surface of ground gently irrigates it. Another important point is not to let the passage of the air be at too great a velocity, the gentler the flow the better.—*Contemporary Review.*

A Bridge of Salt.

The natural wonders of Death Valley have probably been more minutely and extensively described by professional writers than any other spot they never saw, but one wonder there has in some way escaped these untraveled scribes. In 1883 some borax works were built on the east side of the valley, a couple of miles or so above the mouth of Furnace Creek canyon. The road thence to the railroad led down the east side of the valley for several miles, and then had to cross over to the west side because no drinking water can be had on the east side below Furnace Creek. Moreover, the land on the west side lies much better for a road. But how to get the wagons across the valley was a problem. From end to end the center of the valley is one long salt marsh, and in some places it is so soft and wet that even a man would need snow-shoes to insure his safety. Elsewhere, however, the ooze has been crusted over. This crust is in places very thin and treacherous, and only in one locality does it seem to be firm. Wherever this crust has been cut through a thin, slimy salt mud has been found to be of unmeasurable depth—unmeasurable with any line or pole. Dr. C. Hart Merriam's corps of scientists cut through in one place and easily shoved a pole down fifteen feet. There is no guessing how much deeper the slime was.

However, a road must be had, and so the workmen went about over the marsh where the crust seemed to be thickest and sounded it with sledge-hammers. They found the crust was a mixture of salt and sand, and eventually a route was decided upon. The road was then to be graded, and probably for the first time in the world a road the length of this one was graded exclusively with sledge-hammers.

Here was a stretch of solid salt some eight miles across. In a sense it was level—there were no hills or valleys. In another sense there was scarce a level square inch on the whole bed, for the salt crust had probably, through the influences of heat from above and of moisture from below, been torn and twisted and thrown up into the most jagged peaks, pyramids and crisscrossed ridges imaginable. They were not high—none more than four feet—but there was not level space even for a man's foot between them. Every step made was on a ragged point or edge of some kind. The nearest approach to anything like that I have ever seen was on the ice on Lake Erie, where two fields had been jammed together by the wind and held so by the frost. The ragged ice masses were somewhat like these salt masses. They were larger, but they were not so sharp or in any way so difficult to cross.

Judging that the crust would sustain the weight of the wagons the workmen swung the sledge-hammers day after day until they had beaten down these pinnacles into a smooth way six feet wide. It was perhaps the most laborious engineering work ever done in the country, for the climate and the location, far from civilized habitations, combined to retard the efforts of the workmen. The roadway, when completed, led over what may be properly called a naturally formed bridge of salt eight miles long—the only bridge of the kind in the world.

As one enters the easterly end of this road two unmarked graves are seen in the salt crust near the track. They are graves of unknown men who died there from the heat, and, after the fashion of the country, were buried where they fell. They were covered over with pieces of salt broken from the pinnacles near by. The crust was too hard to warrant digging into it. One must travel a long time to find two more graves like these, if, indeed, two more can be found in the world.—*New York Sun.*

A Relic of the War.

The following is a copy of a bill, written in lead pencil on coarse yellowish "war paper," for second-hand crockeryware sold at auction in Raleigh, North Carolina, January 7, 1864. The war was still nearly a year and a half from its close, so some idea may be gained of what prices rose to in the last days of the Confederacy.

2 Waiters, each $4 00	88 00
1 Sifter	5 50
2 Stone crocks, each $2 25	4 50
6 Cups and saucers	78 00
6 Teacups and saucers	65 00
12 Plates, each $6 25	75 00
1 Glass mug	6 25
2 Steak dishes, each $15 00	30 00
2 Steak dishes, each $23 00	46 00
Teapot, bowl and cruet	85 00
2 Pickle dishes, each $4 50	9 00
6 Salt-stands, each $2 00	12 00
1 Soup tureen	38 00
1 Gravy dish	10 00
1 Gravy dish (cracked)	2 00
5 Dinner plates, each $6 25	31 25
2 Vegetable dishes, each $18 25	36 50
Total	$540 00

—*From Harper's Weekly.*

Practical Uses of Geology.

Though the practical value of geology has been, and still is, well demonstrated, there is a certain class of well meaning persons who, from want of due consideration or lack of information, fail to see any direct benefits from the study of stones. Appended are a few hints regarding the worth and results of geology. As a statement, geology is the sum of all the sciences, the foundation, the support, the very anchor that holds the rest, for it treats of our own earth, of its birth, rise, progress and the present state. Properly studied, it embodies the complete story of life, the great history of creation, the narrative of our very existence, the record of our own planet, our present home. To be a competent geologist, one must study everything useful and economical to explain causes and effects, reasons and results. As he journeys he involuntarily studies thoroughly the country he passes through—the botany, entomology, chemistry, zoology, mineralogy, and compares them with the silent wonders he saw sculptured in the rock that lived, flourished, and died thousands of years ago. Astronomy is consulted as to the formation of this earth and its companions and visitors. From the little diatom, resplendent under microscope, to the huge reptiles 75 feet long, in stony silence petrified, the boundless, natural realm of mysteries opens wide its gates. All have a wonderful tale to tell—a story often beyond the grasp of man's puny intellect. But proofs are constantly carried around with you of the uses of mineralogy and geology. The metal buttons on your clothes, the knife in your pocket, your keys, not to mention the countless array of hardware everywhere, owe their cheapness to work of the persevering follower of science. This assertion is true. It cannot be denied. There are belts and lodes of mineral in the earth that have certain limits, sure and certain manner of occurrence and regular deposition. Here the mineralogist and geologist steps in and defines them, toiling away until the rocks tell their own story of hidden treasure. By deductions, the geologist locates mineral belts, natural gas, oil, marble and minerals. It is not to be forgotten that his theories have to be tried in the crucible of experience.—*Mining Industry.*

ELECTRICAL PROGRESS

The Electric Current and the Human Body.

A recent discussion in an engineering society on the trolley brings up again the subject of what currents are dangerous. Notwithstanding the amount of matter published regarding the resistance of the human body and the current which would kill, the subject still seems to be greatly misunderstood by many, partly because numerous persons interested are not sufficiently well posted in electrical matters to understand the statements made, and partly because such statements often appear contradictory, making the whole subject look mysterious. There are, for instance, about as many figures given for the resistance of the human body as there are authorities for such statements. Furthermore, the question is often asked, "How many volts will kill?" It is stated by some that 30 or 40 volts will kill a horse, while others ask how it is that Tesla is not killed when he takes many thousand volts if 3,000 volts has been known to kill in a number of cases. The writer himself, on top of one of the Alpine peaks in a storm, has had lightning pass through his body to an extent sufficient to make a loud cracking noise and to produce long blue streams of sparks from the fingers, representing probably many millions of volts, without any effect on the body other than to induce him to descend without delay. Others report having taken "the full current of a 1,000 volt alternating current machine through their body" without fatal effects, while in still other cases flesh has been burned to the bone without proving fatal. These apparently contradictory statements make it seem to many that little is known about this subject. This is not the case, however. Although there is room for more definite knowledge, a good deal is known; it requires only to be properly stated. It reminds one of the old story of the color of the chameleon; all three of the observers were right in their observations but wrong in their conclusions. Regarding the resistance of the body it is well known that this resides chiefly in the skin. If the skin is very dry and thick, as on some workmen's hands, it is almost an insulator; while if it is moistened with perspiration, or water, or better yet with caustic potash, which penetrates the pores as it dissolves the fatty substances, the resistance of the skin becomes very low. The condition of the skin and the size of the electrode in contact with it are therefore the most important factors in measuring the resistance of the body, if the electrodes were placed in incisions made through the skin the resistance would doubtless be exceedingly low. A horse is easily shocked through shoes because the nails penetrate into the moist part of the hoof, thus making a good contact through the insulating horny substance; besides this, his hoofs are often wet with mud. The current necessary to kill depends very much on the contact with the moist parts of the body and it therefore cannot be said that a certain number of volts will or will not kill. Furthermore, the quantity of the current actual traversing the body is also an important factor. In Tesla's machine the quantity of the current is small and insufficient, as the body is capable of taking care of it rapidly enough to prevent danger. The source of the current must therefore be great enough to develop a sufficient quantity of current as distinguished from the voltage alone. In all electric light and power circuits there is always sufficient quantity. It would appear from this that the number of amperes might be a better gauge than the number of volts, but the time is also of importance, as the same current is no doubt more dangerous if it continues to pass for a longer time. One author states that one tenth of an ampere for one second is sufficient to kill. This, though more rational than merely the number of volts, is still not sufficiently definite, as in many cases a great enough number of amperes has been taken locally to burn and char the flesh without producing death. It appears, therefore, as Prof. Houston pointed out, that a current, to cause death, must pass across the body; that is, through some vital part, of an arm or a leg. A comparatively large current passing in at the hand and out at the shoulder would not necessarily cause death directly, but if it passes through to the other hand, thereby passing through the heart, it would doubtless prove fatal. To summarize, it is therefore not rational to speak in general of the definite resistance *per se* of the human body, not to say that more than a definite number number of volts is fatal, except between very wide limits. The nature of the contacts must first be considered, then the number of amperes, and the duration, and finally the question of the current through the body in relation to the vital parts. The voltage must then be great enough to send that current through that particular resistance of the body, according to Ohm's law, and the source must generate a sufficient quantity of electricity to keep this current flowing. Finally, there appears to be also a counter electromotive force in the body, which must be considered, and there is besides doubtless a difference between the alternating and direct currents. A direct current probably decomposes the tissues by electrolysis and a high potential discharge may act in the form of rupture of the tissues.—*Electrical World.*

Weaving by Electricity.

That decentralization in industry which some economists expect to grow out of the development of electricity as a motive power seems to be already in progress at St. Etienne, France, according to a recent report of our department of state. The industry at that place is the manufacture of silk ribbon, and most of the large output of some $24,000,000 a year is the product of house industry. Generally the weavers own their own looms and operate them by hand in their own homes. There are 18,000 looms thus distributed about, while the steam-power factories have only 5,000 looms. Now the city of St. Etienne intends to set up a large electric-power plant and distribute power to the looms of the house weavers and supply light as well. The cost of the undertaking and the conversion of the hand looms into power looms will be borne in the first instance by the city, and a charge will be imposed of seven cents a day per loom for the use of current and motor. The plan is regarded with great favor by the hand weavers. That they have been able so long to stand against the factory system with its cheaper processes of production is to be explained apparently by the fact that their ribbons had obtained such a reputation for superiority in the general market as to be able to overcome the drawbacks of higher cost of production and prices. No doubt the supply of cheap power to the house looms will now firmly establish the weavers in their industrial independence. The experiment is a most interesting one and before very long will be given a trial, without question, in many parts of the United States.—*Electric Power.*

Electricity as an Aid to Moral Suasion.

It appears that electricity is not confined to electrocution as a means of punishment as it has been found to be effective in cases of minor criminals at the Newark City Home.

This institution is a temporary retreat for the incorrigible youth of Newark, for many of whom, by reason of long practice, the rod and switch have lost their terrors.

Dr. Whitehorne, of Verona, is the regular physician of the place, and is credited with the adoption of a medical battery for administering reproof.

A boy named Rafferty, tried to stab one of his companions during the play hour one day and the Superintendent determined to try the electrical punishment on him. He was taken into the Superintendent's private room which was darkened to befit the solemnity of the occasion, and Rafferty was requested to remove his coat and roll up his sleeves. The Doctor was in attendance and adjusted his battery which gave forth an ominous buzzing sound.

The proceedings so far were unusual, and the boy commenced to get frightened. One electrode was placed at the back of his neck, and the other, in the form of a brush with wire bristles, was rubbed over the boy's arm. With a yell of terror the boy broke away from the chair and stood shivering in an agony of apprehension. He was forced back, however, and the Superintendent continued dusting the wire electrode over the boy's arm and face. The current was increased and the boy after being nearly paralyzed with fear, was finally released in an exceedingly limp condition and a very penitent frame of mind. For several days he remained in a spiritless condition, and after he recovered, not understanding the nature of the punishment, he spread the report that he had been pricked with bunches of red hot needles and subjected to the most awful tortures.

The method proves itself effective, however, as in no case where it has been tried, has the offender given cause to require a second application. The authorities of the institution consider it an entire success in subduing the vicious tendencies of their youthful charges.—*Electricity.*

MECHANICAL NOTES

Rolling Rails.

The process of rolling railroad rails of Bessemer steel, as practiced in Germany, says *Machinery* is declared to be one of the most perfect mechanical operations in the world. The steel is cast in blocks which contain sufficient material for two or three rails, these blocks, while still red hot, being carried to the preparatory rolling mills, by horses which have been trained to work in the midst of this fire and noise; here they are kept hot, in special furnaces, and are rolled into longer blocks having a square cross-section. After being thus prepared, they are taken to the rail rolling mills, which consist of two complete rolling mills, with all the appurtenances in one apartment, and the blocks which come from the preparatory mills are heated again and then passed between the rollers, of which there are three placed one above the other, so that the rails are rolled during the backward as well as the forward motion without requiring a change in the direction of rotation of the rollers. The rails have to pass back and forth between the rolls 13 or 14 times, and each time that they come from the rollers they are caught by the workmen on the short, bent ends of long levers which run on rollers on movable carriers. Each time the rail passes from between the rollers it is longer, and its cross section narrower than after the former rolling, until it finally stretches itself out like a gigantic fiery snake. It is then taken to a circular saw, which cuts through the glowing metal with perfect ease, dividing the long bar into two or three rails. The cold ring is now put under presses, by means of which the slightest irregularities are removed, and then the holes are bored, the end surfaces evened, etc.

The Great Bells of the World.

The Russians and the Chinese are behind the rest of the civilized world in many things, but bell-founding is not among the number, for the bells manufactured by both nations are not only the largest, but among the best of those made by any nation. It is said that before the great fire by which Napoleon was driven out of Moscow, there were in the churches of that city 1,706 bells, each of which exceeded 15,000 pounds in weight. The capital of Pekin, China, has a bell 18 feet high and 15 feet in diameter, and weighing 120,000 pounds. The giant bell of the world is in Moscow; it is poetically denominated the King of Bells is 19 feet 3 inches high, and its circumference around the rim is 60 feet and 9 inches. Its weight can, of course, only be estimated, but, by the least calculation, it is 443,732 pounds, and its value as old metal exceeds $300,000, not considering the gold and silver, of which there is a considerable quantity, which enter into its composition. This bell, when sung required forty men to ring it, the clapper being swung by means of two long ropes, with twenty men at each. It is now cracked and useless and rests upon its rim on the ground. The great bell at St. Ivan's in Moscow, is 40 feet, 9 inches in circumference, its thickness just above the rim is sixteen inches, and its weight is computed at 127,830 pounds. The great bell of Vienna weighs 40,200 pounds. After these are many smaller, yet of considerable size. A bell of Olmutz, Bohemia, and a bell in Rouen, France, are about equal in size to the Vienna bell; the bell of St. Paul's, London, weighs 38,470 pounds; the bell of Westminster, 30,350; that of St. Peter's, in Rome, 18,600. Several of these bells are sounded only on important occasions. The St. Paul bell, the Vienna bell and the bell of St. Ivan's are tolled only at the death of royalty; the bell of St. Peter's tolls at the death of a Pope.

ENGINEERING

The Squadron of Christopher Columbus.

At a time when preparations are making in Europe and America to celebrate with brilliancy the fourth centenary of the discovery of the new world, everything relating to Christopher Columbus and his memorable voyages assumes a great interest and has a right to attract the attention of the public. We propose to make known to day some studies that have recently been made on the little vessels, the *caravels*, by means of which one of the greatest navigators ever known discovered the new continent.

The *Revue Maritime Autrichienne*, of Pola, has recently published a very interesting article giving the result of all the investigations that have lately been made, particularly in Spain; for the purpose of ascertaining what was the exact type and maritime value of the three ships that the illustrious admiral of Castile commanded in his search for the new world, starting from Huelvas on the 3d of August, 1492.

We know that these vessels were called caravels; but the result of the latest researches has taught us that this term was applied to no particular class of vessels. The Spaniards used the word *Carabela*, borrowed from the Francic language and derived from the Greek word *karabi*, to designate ships very unlike one another in construction and sails.

The investigations have brought together all the data that the writings of the admiral (especially his log-book), the sketches made upon his published maps by his pilot, Juan de la Cosa, and the ancient publications on this subject, were capable of furnishing; and they have given Rafael Manleon, the marine painter, the means of making an aquarelle representing Columbus' three ships.

The three ships were named the *Santa Maria*, the *Nina* and the *Pinta*. The first of these had the following dimensions: Length of keel, 62 feet; between perpendiculars, 75 feet; greatest width, 23 feet; depth 14½ feet; burden, from 120 to 130 tons. As the crew never exceeded 90 men, the ship was capable of carrying quite a large supply of food and water. The admiral's log mentions that his pinnace was 30 feet in length, but the same document speaks only superficially of the armament. It mentions, for example, that on the 26th of December the admiral fired *una lombarda y una espingarda*. The latter of there arms is well known; the former was a gun of small caliber that originated in Lombardy.

The suit of sails of the *Santa Maria* was that of a small three masted-vessel, with five sails only: a jib, foresail, mainsail, topsail, and a lateen. The mainmast was provided with a top, which the sketch represents as round and basket shaped, and which was capable of affording shelter to firers of grenades. The general form of the hull was that of the round ships of the period. There was a large poop and a small forecastle. The free board was very low amidships, and the deck was here open.

The nautical qualities of the *Santa Maria* were excellent, as the admiral's log proves: "This ship behaved very well in bad weather, and had the speed of a good sailer." The same was the case with the two other ships, and the log often mentions a speed of 15 Italian miles an hour equivalent to 11 nautical miles—a very good speed for vessels sailing as consorts. The *Revue Autrichienne* cites, moreover, as an example of the high speed reached by ships of this epoch, a journey of 600 Italian miles made in 36 hours by a caravel commanded by Vincente Lago, which visited in succession the Canaries, Madeira, Port Santo, and Gambia in 1444.

The dimensions of the two other ships commanded by Columbus are not indicated. The *Victoria* celebrated for having made the tour of the world for the first time had a capacity of but 85 tons.

The *Nina* resembled the *Santa Maria*. The *Pinta* carried lateen sails on her three masts, at least at the beginning of the voyage; but the admiral's log tells us that at the first stop (at the Canaries) this set of sails was replaced by square ones, in order that the ship might be placed in the same condition as the two others.

These three ships sailing as consorts, flew the flag of Castile at the mainmast and that of the admiral at the mizzen. The first was divided into four squares, two red and two white. The latter each bore a lion and the others a castle. These were the arms of Castile. Those of Arragon were excluded by the orders of Queen Isabella, the government of that country having refused to participate in the expenses of the expedition. The admiral's flag was a white pennant with a green cross between two crowned letters F and I—the initials of the names of Ferdinand and Isabella, who had given these arms to Columbus. A cross was painted on the sails of the ships, according to the custom adopted by the Spanish and Portugese in order to distinguish their vessels from those of the infidels. Such is a summary of the data furnished by the article in the *Revue Maritime* of Pola.

There still exists in the museum of Madrid a picture of the first voyage of Chistopher Columbus. It is due to the artist Brugada, and represents the admiral's fleet coming into sight of San Salvador on the 12th of October, 1492.—*La Nature.*

Great Dam in Australia.

Official details of the great dam at Beetaloo, Australia, corrects some of the previously published statements and figures, and the immensity of such a piece of engineering work may well challenge a comparison with anything of the kind in that part of the world. The structure is of concrete, 110 feet high from the bed of the creek to the top of the dam and 580 feet long, being curved in the plan of a radius of about 1400 feet; the width of the top is fourteen feet, the profile of the section being designed in accordance with Rankine's rules and the width of the section at the foundation 110 feet; the crest of the bywash, which is 200 feet wide, is five feet below the crest of the dam, and the reservoir behind the dam at its full one and one fourth miles long, with an average width of eight chains. The capacity under these conditions, is 800,000,000 gallons, for the supply of a district covering an area of 1700 square miles, including eight separate townships, etc. The quantity of concrete used was 60,000 cubic yards, the net time occupied in construction being about two and one-half years. Special machinery was used for mixing the concrete and depositing it in place, and the whole work is regarded as a most creditable achievement.

PULLEY BLOCK.

No. 471,519. Philip Freund, Brooklyn, N. Y. *Patented March 22d, 1892.* The casing is formed in two parts which are duplicates. The halves are fastened together by rivets or bolts at B and H, and by a center pin R. The central part of each side is drawn inward, forming circular shoulders L. The sheave K is a ring having a groove N around its outside for the rope, and having two grooves Q

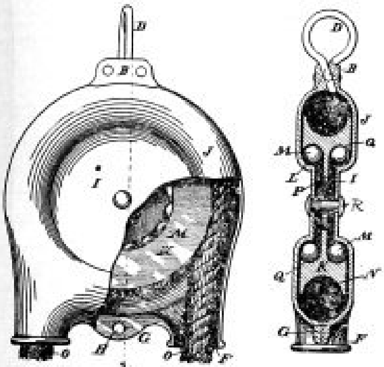
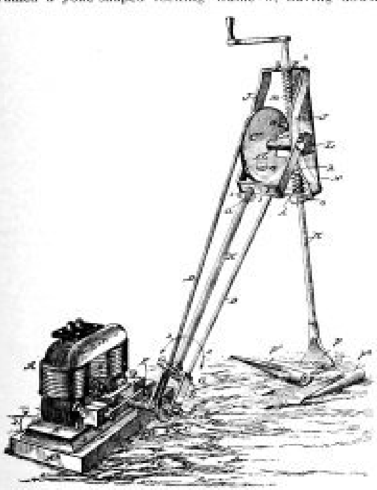


Fig. 1 Fig. 2

as shown, to receive two sets of balls M. These balls roll on the shoulders L of the casings and thus form circular ball bearings for the sheave. The casings may be castings, or they may be pressed into shape from sheet metal, thus making a light, cheap and serviceable pulley block. Friction is reduced to the lowest possible limit. The sheave can not bind in the casing, as the balls confine it laterally as well as centrally.

ELECTRIC MINE DRILL.

No. 472,444. John Fish, South Bend, Ind. *Patented April 5th, 1892.* This is a new mining machine, which may be used as a pick or drill, in any position where electricity is available. A is the electric motor, of any type. B is its armature, whose shaft is extended outside the motor far enough to receive the pulley C, that carries the driving belt D. The electric motor is mounted upon a base A^1 and this is mounted upon and secured to a sub-base A^2 by a strong pivot having a vertical axis that permits the motor to be swiveled as shown by the arrows 1 1. This permits the drilling to be done in any direction without changing the position of the sub-base of the motor. Upon the extended armature-shaft is hung the forked frame E, whose branches are arranged upon opposite sides of the driving-pulley C, and are retained upon the said shaft by means of collars F F. The frame E has parallel guide pins G for the belt D, and said frame is rigidly attached to the long arm H, that carries at the outer end the drilling mechanism. The forked frame I is attached to the arm H by a swivel joint so that it can be turned in any direction. At the upper ends of the forked frame I is fulcrumed a yoke-shaped rocking frame J, having down-

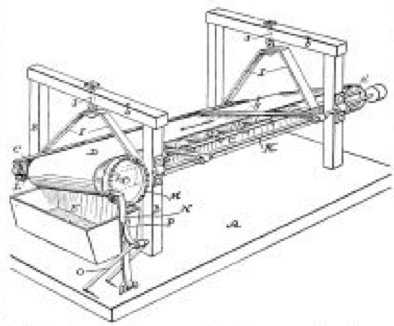


wardly-curved side bars. This frame is fulcrumed upon a pin or shaft that extends through both the branches of the forked frame and the yoke shaped frame. The large pulley C' is set to one side of the frame I in line with the arm H by means of a sleeve *d* and carries upon its inner face one or more laterally-projecting pins or tappet-lugs *e*.

In the rocking frame J, in suitable bearings in its ends there reciprocates the drill-rod K, whose angle may be changed by the adjustment of the frame about its fulcrum as shown by arrows 4 4. This drill-rod has attached to it a collar or anvil *k*, and between this collar and the end of the frame J is a spiral spring *l*, encompassing the drill-rod. On the opposite side of the collar and sliding on the drill-rod is a hammer-block L, and between this hammer-block and the opposite end of the frame is a long spiral spring *m*. Now as the pulley in this rocking frame revolves its pins or lugs force back the hammer-block against the long spring *m*, compressing the latter until the pin passes the block, and the spring forcibly drives the hammer-block against the anvil or collar on the drill rod and imparts thereto a blow, which is repeated in such rapid succession as to give a very effective cutting action to the drill-point or tool-carrier at the end of the rod.

ORE CONCENTRATOR.

No. 471,319. James Tulloch, Angels Camp, Cal. *Patented March 22d, 1892.* The pulp mixed with water is fed upon the endless belt or apron D. This is made of rubber, canvas, or other suitable material. It is supported on carrying rollers C^2, a tail roller C^1, and a head roller C, all of which are carried in a swinging frame C C. The frame, together with the rollers and the belt, is suspended by hangers I and eye bolts J to the cross sticks *b*, of the main frame. Vibratory motion is imparted to it by the cranks K and rods *k*. The head roll is provided with a ratchet M on the end of its spindle, and a pawl N is arranged to engage the ratchet and turn it one tooth at every swing of the frame. It is claimed that a decided advantage is gained by suspending the belt, etc., from the over-head frame work instead of supporting it on rocking ports, as commonly done.



This motion is advantageous, in better spreading the material over the surface of the belt, and in keeping it worked away from the sides thereof and toward the center, resulting in a more perfect concentration.

MINING MACHINE.

No 472,177. Charles O. Palmer, Cleveland, Ohio, *Patented April 5th, 1892.* The cutter wheel 43 is made like a spur gear, the back of each tooth being shaped to act as a gear tooth, and the face of each tooth is shaped to act as a cutter, or is provided with detachable cutters. The cutter wheel is driven by a pinion 28 which is keyed to the same spindle that carries the grooved pulley 32, the arms of the wheel are flush with the under edge of the rim, and are of less thickness than the rim, the carrying arm 27 is off set downward just inside of the rim of the wheel, so that the portion which enters the kerf made by the cutters will lay below the top edge of the wheel rim. The inner end of the arm has a hub which turns in the boss 25 of the machine frame and is retained in place by a ring or collar 30.

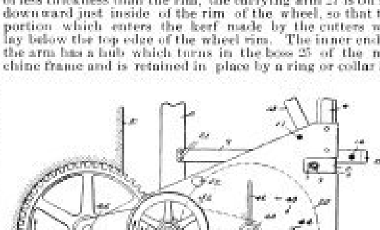
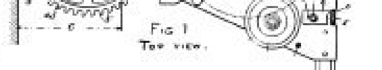


Fig 1
Top view.

Fig 2



End view

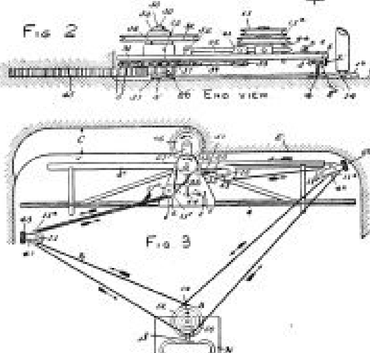


Fig 3

A sprocket wheel 37 is attached to the hub of the arm, and serves to swing the arm and cutter wheel around the center pin 35. It is connected by a chain 39 to a sprocket pinion 38, which is turned by a four-armed handle 42. The cutter arm is swung into or out of the cut by turning 42, and it is fastened in position by a stop pin 44, which may be inserted in holes 45 in the top plate of the machine. The machine slides on a stationary frame composed of two rails 4 and 4' suitably braced together as in Fig. 3. It bears on three points only—one being the head 31 of the center pin 35, and the other two points are the clamps 2. The machine is fed along the ways by the same rope which drives the cutters. The arrangement of driving rope is shown in Fig. 3. The motor N, S, drives a double pulley 10 and 12, of different diameters. The pulling strand of rope from the machine pulley 32 to the motor—runs on the small pulley 10, while the slack or returning strand runs off the larger pulley 12. Both strands run beyond the motor, around guide pulleys to a sheave 15, which is hitched to the machine.

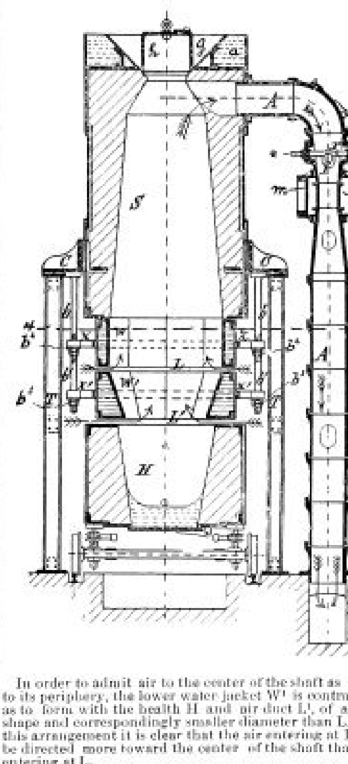
The two lines or "runs" of the driving-rope, which extend from the driving wheels 10 and 12, respectively, to and around the driven pulley 32, constitute the "driving circuit," while the opposite lines or runs, extending from said driving wheels to the pulley 15, constitute the "feed-circuit" of the driving system. The operation of the differential wheels 10 and 12 when operated in the proper direction, as indicated by the arrows in Fig. 5, is to pay off the rope to the driving-circuit faster than it takes back the rope from said circuit, the difference being taken from the feed-circuit, thereby shortening the same. The lengthening of the one circuit and the shortening of the other is compensated by the drawing forward of the mining-machine on its track toward the right hand in Fig. 5, the rate of said movement depending of course on the relative sizes of the two wheels 10 and 12, which sizes may be made of a proportion suitable for any required rate of feed.

CUPOLA FURNACE.

No. 468,306. Carl Sahler, Cologne, Germany. *Patented February 2d, 1892.* This smelting-furnace, which is operated by the suction of a steam jet or a ventilator, is used for smelting ores and resmelting the resultant metallic products.

The furnace consists of the shaft S and the water-cooling jackets W and W', the portable and adjustable hearth H, and the exhaust A with the steam-jet I. The shaft S is provided at its top with hopper *g* and bell *h*, surrounded by a water-jacket or other suitable casing *a*. The shaft S is carried freely by means of the columns T and the supporting-ring C, or the ring C is supported upon double T-standards.

The water-cooling jackets W and W' are carried by bands Z and Z', which are supported by bolts *b b'*, secured to the ring C. By means of the nuts b^2 b^3 the water-cooling jackets W and W' may be raised and lowered. By this arrangement two ring-shaped adjustable air-ducts L and L' are formed, one between the hearth H and the lower cooling-jackets W and the other between the two jackets W and W'. As soon as the jet I is in operation in the exhaust A air enters the ducts L and L' to assist the combustion.



In order to admit air to the center of the shaft as well as to its periphery, the lower water jacket W^1 is contracted so as to form with the health H and air duct L^1, of annular shape and correspondingly smaller diameter than L. From this arrangement it is clear that the air entering at L^1 must be directed more toward the center of the shaft than that entering at L.

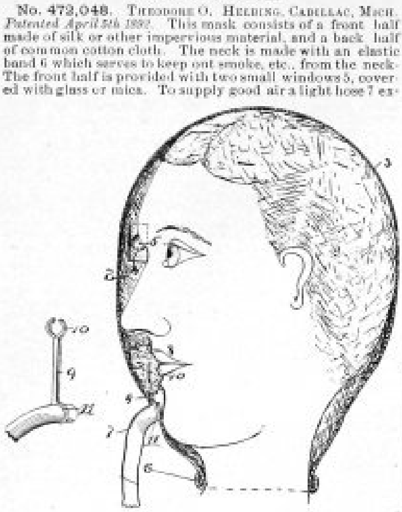
In smelting more or less pulverized ores the part R of the air-injector is apt to become clogged, and therefore it must be readily interchangeable during the working. The removable pipe section R is surrounded by the casing *m*, having closed ends, as shown, to form a tight joint and hold the parts in position, as the section R is removable.

In order to prevent overheating of the steam-pipe *r* in the exhaust, the steam is admitted at both ends *e* and e^1, and thus the whole pipe is continually filled with steam. The jet-pipe *r* is made in one piece, and is removable and interchangeable. The jet *r* is regulated by means of nuts *m* and m^1.

In order to make the furnace serviceable for distant and mountainous regions, it is made to be taken apart in pieces of not over two hundred pounds weight, so as to be transported on the backs of mules. For this purpose the sheet metal of the casing is not riveted together, but is put together with bolts, and further, the water-cooling jackets W and W^1 are each made of eight sections of water boxes, and the exhaust A is made of a series of sleeves which fit each other, while the standards T are made of two U-shaped beams screwed together and provided with base and cap pieces.

FIREMAN'S MASK.

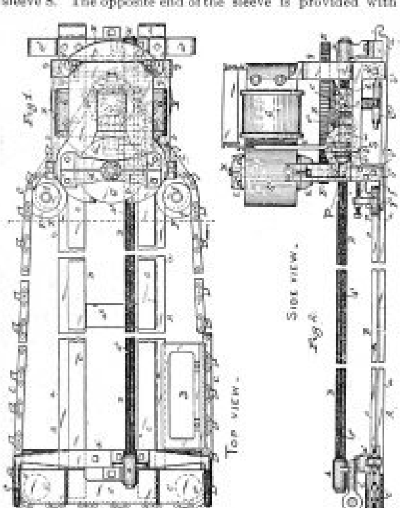
No. 472,048. Theodore O. Helding, Cadillac, Mich. *Patented April 5th 1892.* This mask consists of a front half made of silk or other impervious material, and a back half of common cotton cloth. The neck is made with an elastic band 6 which serves to keep out smoke, etc., from the neck. The front half is provided with two small windows 5, covered with glass or mica. To supply good air a light hose 7 ex-



tends nearly to the floor where there is usually a layer of air free from smoke or fumes. The top end of the hose is provided with a spring clip 9 shown separately in detail, which serves to hold a sponge against the mouth and nostrils of the fireman—thus enabling him to breathe in a room where the smoke would otherwise suffocate him.

MINING MACHINE.

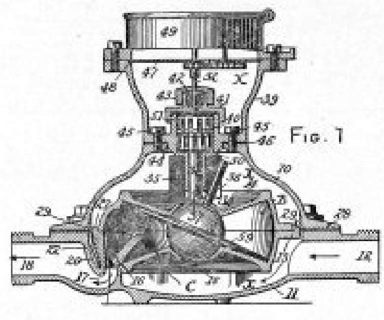
No. 472,503. Adam Kiel and Anton R. Westerdahl, Pittsburgh, Pa. *Patented April 5th, 1892.* This machine employs an endless chain having cutters attached to each alternate link. The front end of the frame is composed of two flat bars C' which serve to support the chain links while they are engaged in cutting coal. The chain is driven by a sprocket wheel C' on the lower end of the shaft of the large spur gear E. Power is supplied by an electric motor G' and G which is mounted on standards attached to the main slide or carriage b. The driving pinion E' is on the lower end of the armature shaft, and gears directly into the wheel E. The sides of the chain are supported on rollers F which have a wide flange on the lower edge to furnish a good bearing. The stationary frame A is composed of flat bars a, united by cross bars a^1, a^2 and a^3. This frame lays directly upon the floor. The feed screw D is journalled in brackets d d' which are bolted to the cross bars as shown. The screw is grooved as shown, to suit the feather in the driving sleeve 8. The lower end of the armature shaft carries a worm which drives a worm wheel P which runs loosely on the screw D, and has clutch jaws on one side to engage similar jaws on the sleeve 8. The opposite end of the sleeve is provided with

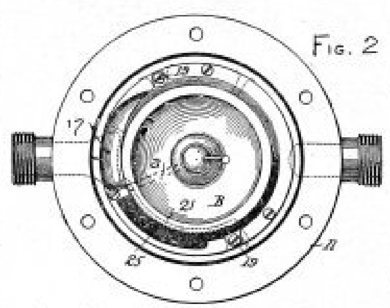


jaws to engage the jaws on the hub of the bevel pinion e^2 which is driven by e^1. The sleeve is moved into engagement with P or e^2, by the hand lever t. The wheels P and e^2 run in opposite directions, at different speeds, and one is used for feeding the cutter chain into the cut, and the other for backing out. The screw turns in a nut k, on the side of the bearing of the main sprocket wheel and spur gear E. The sliding frame or carriage B is composed of two flat bars c, united by cross bars C' and the motor frame b. The side bars C slide through suitable slots in the front cross bar a'. An additional support 3 is used to support the chain on the running in side, to prevent the cutters from jumping or gouging, and thus breaking the chain.

WATER METER.

No. 471,295. John Thomson and Frank Lambert, Brooklyn, N. Y. *Patented March 22d, 1892.* The measuring chamber of this meter is made in two sections B and C and is bored truly spherical, so that the disc 30 will fit water tight in all positions. The heads are made conical, and are shaped to form a bearing for the ball 37 to which the disc 30 is attached. The ball has a pin 36 projecting upward, which engages a small crank 35, and through it drives the gearing that moves the register in the upper part of the case. The measuring chamber is divided into two chambers by a partition a, shown by dotted lines in Fig. 2. This view shows the upper part of the case 10 removed. The disc 30 is slotted to allow the partition to pass through it, and the partition is located between the supply port 25 and the discharge port 17. The disc does not revolve as the crank 35 turns, but merely rocks or wabbles in its bearings, sufficiently to sweep through the entire space between the upper and lower heads. The disc touches each head on a line only, and as it wabbles this line of contact shifts, being exactly with the crank, on the lower head, and exactly opposite the crank on the upper head. The space in the chamber always grows larger behind the line of contact, and smaller in front of it.

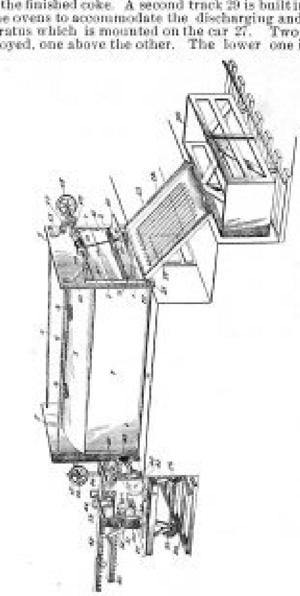




At each revolution of the crank the disc expels a volume of water equal to twice the contents of the chamber less twice the bulk of the disc and ball. The water enters at 12, passes under the chamber 15, and rises through the port 25, and enters the chamber by a wedge-shaped opening similar to the exhaust port 16. The action of the disc is continuous and the displacement is perfectly uniform.

COKE OVEN.

No. 472,115. Wm. T. Gates and George H. Sharp, Fairchance, Penna. *Patented April 5th, 1892.* The oven is made with a straight flat bottom, flat sides and ends, and an arched top having the usual vents, 4, 4. Each end of the oven is provided with three flat doors, 10, 11, and 12, and a small windlass is provided to lift them. The discharge end of the oven is provided with a screen 25, over which the coke passes to the car 26, to remove ashes, etc., from the finished coke. A second track 29 is built in the rear of the ovens to accommodate the discharging and leveling apparatus which is mounted on the car 27. Two rams are employed, one above the other. The lower one is used to



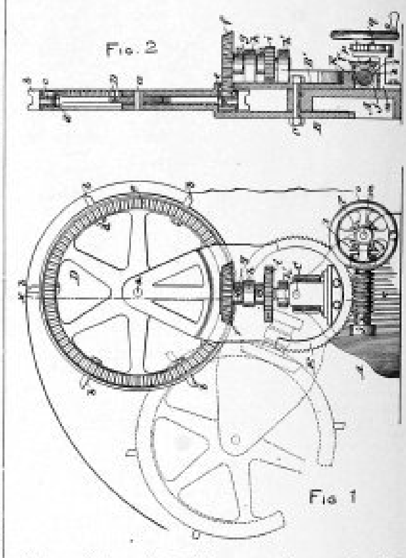
push out the finished coke from the oven to the car, and the upper one is worked back and forth to level the charge. Both rams are provided at their front ends with large T shaped heads nearly as wide as the ovens. Both bars are provided with teeth on the under side, and are propelled by pinions driven by the cranks and gearing shown. Either the upper or lower ram bar may be thrown into or out of gear with the driving pinions by the handlever 48. The doors being divided, either of the rams may be used without opening the whole end of the oven. The admission of too much air is thus prevented.

MINING MACHINE.

No. 469,608. James Taylor, Edwards, Ill. *Patented February 23d, 1892.* The stationary frame A of the machine is secured to any suitable fixed support. Two arms B B' are connected with the frame A by the pivot bolt C. The arms extend forward and between their free ends is journaled a cutting-wheel D on the pin a. The arms B B' are offset within the rim of the wheel, so that the combined thickness of the arms and the central portion of the wheel is equal to the width of the rim of the wheel, thus permitting the arms to enter into the cutting made by the wheel.

The wheel D is furnished with removable cutters b on its periphery, which are provided with shanks c, extending through the rim of the wheel, and receiving nuts d, which are turned down on the wheel-rim, clamping the cutters securely in place.

The wheel D on its upper face is furnished with a toothed rim e, which is engaged by a beveled pinion f, mounted on a shaft g, journaled in bearings h h', and secured to the arm B'. The shaft g is provided with the spur-wheel i for receiving power from an electric or other suitable motor mounted upon the arm B and moving with the said arm.



The arm B' is provided with a segmental worm-wheel E, and in journal-boxes j on the frame A is journaled a worm k, which engages the worm-wheel E. The worm-shaft is prolonged beyond one of its bearings and provided with a motor-wheel l, which is engaged by a corresponding wheel l', on the vertical shaft m, journaled in the bracket n, secured to the frame A. The shaft m is provided with the hand-wheel o, by which it may be turned, and with a ratchet-wheel p, which is engaged by the pawl q, pivoted on the bracket n.

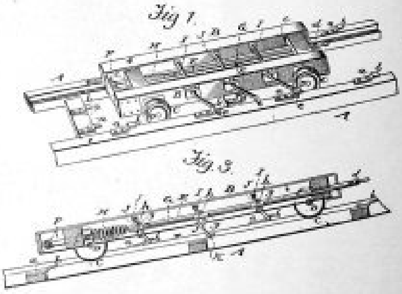
Motion being imparted to the shaft g from any suitable source of power, the wheel D is revolved, and as it is revolved the arms B B' are moved forward by turning the worm k, thus carrying the wheel D up to its work. The cutters b readily remove the coal as the wheel advances, and the wheel is constantly held up to its work by the action of the worm and by the pawl-and-ratchet mechanism above described.

The cutters b are preferably notched at the center, as shown in Fig. 2. They are readily removed for sharpening after loosening the nuts d.

Owing to the construction of the arms which carry the wheel D, the said wheels may cut a groove in the body of the coal equal in depth to nearly the diameter of the wheel. The frame A may be secured to any convenient support, or it may be fastened to the floor of the mine by means of a jack-screw.

CAR FOR INCLINED RAILWAYS.

No. 467,945. Jacob Messner, Calumet, Mich. *Patented February 2, 1892.* The draw rods E extend through both ends of the car and are cushioned by spiral springs F on their rear ends. Several rock shafts I having crank-shaped ends, extend across the body of the car, above the draw rods. Each rod or rock shaft I is provided with a slotted



arm g, which engages a pin h, on the draw rods. As long as there is any tension on the draw rods they are pulled forward and the pins h move the arms g and turn the rock shaft I sufficiently to lift the bent ends i clear of the catches k which are fastened to the stringers or cross ties as shown. As soon as the hauling rope breaks or the tension is slacked off, the spiral spring H pulls back the draw rods and drops the hooked ends of the rock shafts, which engage the catches shown and stop the car.

The Colliery Engineer.

AN ILLUSTRATED JOURNAL OF

Coal and Metal Mining and Kindred Interests.

VOL. XII.—NO. 12. SCRANTON, PA., JULY, 1892. WITH WHICH IS COMBINED THE MINING HERALD

AN ELEMENTARY TREATISE ON THE PRINCIPLES OF COAL MINING.

For the Use of Candidates for Mine-Foremen's Certificates, Mining-Students, Mine-Foremen, Mine-Superintendents, Mining-Engineers, Etc.

BY A. A. ATKINSON.

New Brancepeth Colliery, Durham, Eng.

The Robbing of Pillars.

The working off of pillars economically, safely, and without any great loss of coal is a subject worthy of great consideration, and when we consider how many different methods are in vogue in the collieries of Northumberland and Durham, we cannot help being struck with the idea that some of these methods are based upon wrong principles, and are neither economical for the owners, nor safe for the workmen, it is, however, of no use making such general statements as these, as although the system employed may exhibit grave defects, at the same time they are not easily removed, and we should submit that it is only by becoming practically acquainted with many different methods, and carefully observing for ourselves the various peculiarities to be seen in them, that we may hope to be able to lay down reliable rules for working off the pillars, or the "broken working," as this removal of pillars or second working is usually termed in Durham and Northumberland, and we must remember that owing to the great variety of circumstances under which coal is found, that no single rule can be given to apply to all.

In writing this the author has observed the following subdivision of the subject:

1. General remarks upon broken workings including a few observations upon creep, pressure, etc.
2. Particular descriptions of methods now in use or of those that have been employed in the working away of pillars.
3. Cost of broken workings as compared with whole workings.
4. History.
5. Appendix.

It is only in the bord and pillar (stoop and room in Scotland) system of working coal that the second or broken working occurs (except perhaps to a slight extent in the Longwall system where posts and pillars are left on each side of the gateways and which are removed after the district is finished) and as the north of England may be said to be the birthplace of this system of working coal and of removing the pillars, it is there where we find the system at the present day pursued in the most perfect manner, and that district will therefore be more particularly referred to in this paper.

In the days when coal mining was in its infancy in the North of England, very small pillars of coal were formed of minimum dimensions to support the roof and to prevent heaving or lifting of the floor of the seam during the working of the whole, and these pillars were abandoned in the mines when the boundaries were reached in the whole. This was a serious loss of coal to the owner of the minerals, to the owner of the colliery, and also to the country, but it was before the method we now know as the "broken working" was suggested, or tried and mineral owners in many cases actually stipulated for the leaving of pillars of coal of certain dimensions for the purpose of supporting the surface land, and to allow as much as possible of the royalty in the whole to be worked. The leases often provided "That the tenant shall leave good and sufficient stoops and pillars to uphold the roof," etc. It frequently happened however that the pillars were left too small for the superincumbent pressure and when they began to deteriorate and the floor to soften the mine would become practically unworkable, and the surface in many instances more damaged than if all the coal had been extracted.

Many of the pillars which were abandoned in these old pits have in recent years been worked out, and the author knows of some collieries in the county of Durham where this is being done at the present day in the Hutton Seam which contains valuable household coals.

The method of safely working off the pillars having been found to answer it soon became extensively practiced, and landowners are now very careful to have the colliery leases drawn up to provide for the working out of the pillars and secure as large a percentage of the available coal in the royalty as possible, consistent with safety, and to cautiously guard against improper modes of working the coal.

In opening out a colliery the determining of the dimensions of the pillars to be formed by the whole working is a subject demanding the most careful consideration and ought to be decided only by those thoroughly conversant with mining who are able to weigh well the various peculiarities of the coal seam, surface conditions, and various other points; for the future success of the colliery may to a large extent depend upon a judicious determination of the size of the pillars.

The first point to consider is, what is the least size of pillars consistent with sufficient strength to support the roof and prevent any heaving or lifting of the floor, and when this is determined it may be found advisable, for reasons enumerated later on, to consider, what dimensions over and above the safe or minimum dimensions the pillars are to be made. To determine the least size of the pillars consistent with safety, it is necessary to take into account the depth of the seams from the surface, because with the depth the pressure of the superincumbent strata which the pillars will have to support increases, consequently it is essential to increase the size of the pillars with an increase in depth. For instance, at a depth of 100 fathoms, pillars left 30 yds. x 14 yds. might be found to be large enough, but at a depth of 200 fathoms, pillars of the same dimensions would in all probability be found quite inadequate, and with this increase in depth it would be necessary to increase the size of the pillars to 40 or 45 yds. x 22 yds.

It is also necessary to consider the nature and strength of the stone forming the roof and particularly the floor, the reasons for this will be given when we explain the term "creep," and also the hardness or softness and thickness of the coal seam. No hard and fast rule can be laid down whereby we can calculate even approximately the dimensions of the pillars owing to the varying conditions under which coal seams occur; a rule which answered to the requirements of one district might be very misleading and inapplicable to another, therefore it will be seen that experience is alone worthy of confidence in deciding such weighty matters, and in a district where there are other collieries working the same seams under similar conditions the methods and particulars of working ought to be carefully examined and the merits and demerits weighed, so as to assist in arriving at the most suitable dimensions in each case. The table on following page has been culled from the writings some years ago of one of the Government Inspectors of Mines in the North of England.

At most of the collieries in the North of England the dimensions of the pillars are made much larger, and consequently a larger percentage of coal left than is given by the table. Take for instance the size given for pillars at the depth of 100 fathoms, viz.: 22 yds. x 9 yds. Very few if any of the collieries in Durham at or near that depth will be forming pillars of less dimensions than 30 yds. x 14 yds. and some as large as 50 yds. x 30 yds. At depths varying from 200 fathoms to 300 fathoms in the eastern district of the same county the pillars are in most of them as large as 60 yds. square.

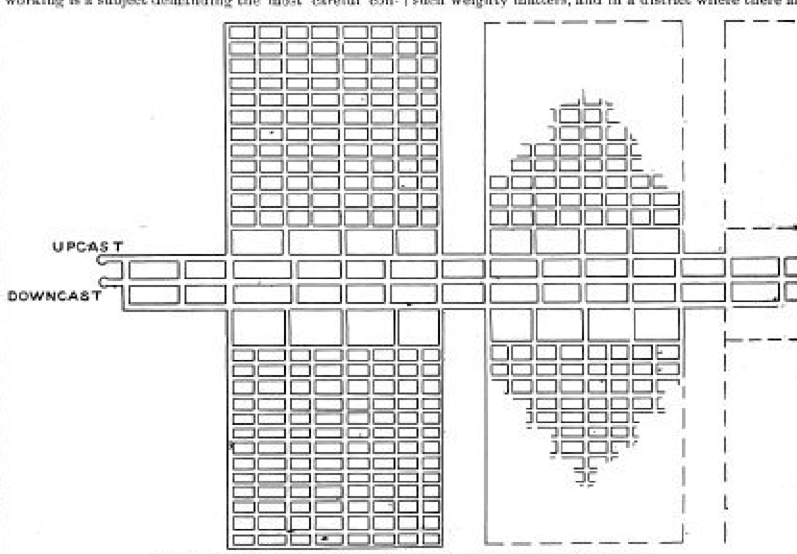


FIG 1.—ILLUSTRATING THE PANEL SYSTEM WITH BARRIER PILLARS.
(Scale, 500 ft. = 1 inch.)

Mr. G. G. Andre, in his work on "coal mining" in writing on the "Dimensions of the Pillars and Stalls" says, "the pillars are regarded, not as supports to the roof, but as masses of coal prepared for subsequent removal. Hence enormous dimensions are given to the pillars, and by this means the evils of thrust and creep are entirely avoided. As there is nothing but convenience to limit the size of the pillars when viewed as masses to be wholly worked away, in deep pits it is customary to take out by the preliminary workings that is, by the driving of the bords and headways, only from one-fifth to one-fourth of the coal, leaving pillars 30 yards long by 18 or 24 yards broad, and even 40 yards long by 30 yards broad."

We will now show in the same way the advantages and disadvantages of

LARGE PILLARS.

ADVANTAGES.	DISADVANTAGES.
(a) Fair percentage of round in the pillars.	Small proportion of whole workings.
(b) Lessened hewing or getting cost over the total area.	More broken workings to maintain.
(c) Less cost of maintaining brokens.	Greater amount of straight, narrow, or yardage work.

Such is an imperfect sketch of the considerations that must be kept in view when laying out pillars, and although some of the above may not exist at all collieries as advantages or disadvantages, yet generally speaking they will be found to be tolerably accurate. At one large and deep colliery for instance, where there is no narrow or yardage work of course this would not be an advantage for small pillars, nor a disadvantage for large ones. The inapplicability of the small or large percentage of round coal has already been cited.

Another considerable disadvantage with large pillars in seams where fire-damp is given off, is the distance that it is necessary to carry the air to the working faces by means of brattice rendering it sometimes an extremely difficult matter to keep them in a fit and proper condition for the men to work in, especially when they are about up the distance to be driven and near holing.

SCALE FOR FIRST WORKING, WITH DESIGN OF AFTERWARDS TAKING OUT THE PILLARS; THE WIDTH OF PRINCIPAL WORKINGS BEING FIVE YARDS, AND CROSS HOLINGS, TWO YARDS.

Fathoms deep.	Size of Pillars.	Proportion left in Pillars.	Fathoms deep.	Size of Pillars.	Proportion left in Pillars.
	yards.			yards.	
20	20 x 5	·41	180	26 x 14	·69
40	20 x 6	·50	200	26 x 16	·71
60	22 x 7	·52	220	28 x 18	·73
80	22 x 8	·57	240	28 x 20	·75
100	22 x 9	·59	260	30 x 21	·77
120	22 x 12	·61	280	30 x 22½	·78
140	24 x 12	·63	300	30 x 24	·79
160	24 x 14	·66	*M. Wearmth.	40 x 29	·80

*The Monkwearmouth colliery, at the depth of nearly 300 fathoms, has been worked with five yards openings, whilst the block of coal is left 40 yards x 29 yards.

It is particularly to be observed that to work cheaply in the "whole" is to a great extent opposed to an economical "broken" or second working, and for the following reasons:

First. That to get a large quantity of coal in the first working of course leaves less for the "broken," and while in the first case we get a large amount of coal for a certain length of wagon-way, engine plane, or other haulage road, in the "broken" we get a proportionally smaller quantity for the same wagon-way, etc., and consequently all charges connected with upholding the same will be very heavy upon the "broken" on account of the smaller quantity of coal to be worked.

Second. When too much coal has been taken away when working the "whole," the "broken" workings are difficult to maintain in an efficient working condition, and are very liable to "creep," that is, the floor lifts, and consequently consume a larger quantity of timber etc., than they would have done had the pillars been left larger.

Third. The coal got under the above circumstances is generally of a soft nature giving a small percentage of round, and often so crushed that large portions are left underground.

It will be seen from the preceding that if the first working is cheap the second working will in all probability be expensive, and it is therefore readily seen what a very difficult point it is for the mining engineer to decide as to the cheapest method of working his pit so that the cost of the "broken" added to the cost of the "whole" or first working, will amount to a minimum total cost over a given area of coal field.

If the excavations made during the first working are of such an extent as not to leave sufficient coal to be a support for the roof or a preventative against the bottom or floor of the seam, rising up, the second working is always very expensive, and the coal very much crushed, yet if the excavations bear such a proportion to the coal left that the weight of the superincumbent strata is not able to render the coal softer and easily worked, the customary saving in a lessened hewing or getting price may not be expected; another important consideration to be looked at demanding that the pillars should not be too large so that the coal in the "broken" should be softer than in the "whole" is that no blasting in the coal is allowed in the broken workings of many seams.

At this juncture a weighty question arises as follows: In the case of house coal would it not be cheaper to leave large pillars and so get a good percentage of round in the "broken," than getting a good percentage in the "whole" workings, but very poor in the "broken," as is the case when small pillars are left?

It is also necessary that the following question should be kept in view: Would the increased percentage of round coal in the "broken" workings more than balance the probable extra cost of getting or hewing?

In some cases we have also to look at the necessity of getting a large supply of coal at once incident upon the opening out of a new colliery or in a current going colliery upon the arrival of increased trade, in which cases it is often necessary to have many bords or rooms going at once, and in order to do this, little pillars are left.

We may put this intricate subject before our readers in this light:

SMALL PILLARS.

ADVANTAGES.	DISADVANTAGES.
(a) Large proportion of coal in the whole with a good percentage of round coal.	Low percentage of round coal in the broken owing to the pillars being crushed.
(b) The brokens being smaller or containing less coal for the same area were there larger pillars left, are soon exhausted.	Large cost of hewing or getting over the total workings.
(c) Small amount of straight or narrow work, where yard prices are paid.	Increased cost of maintaining the broken workings.
(d) More coal to be got on short notice then could be in the case of large pillars.	More to be paid for removing falls when the roof is fallen, and more liability to creep.

Besides which there are other considerations for and against the leaving of small pillars, but which it is hardly necessary to mention, at the same time it may be remarked that it depends largely upon what the coal is used for, as to the size it is advisable to leave the pillars; for instance the pillars in a gas or coking seam need not be of such a size as in a house or steam coal seam.

Mr. Buddle's plan of leaving panels separated by barriers, as shown in Fig. 1, recommends itself for these reasons, that it enables the "brokens" to stand better as regards pressure; if the creep does occur in one panel it is prevented by the barriers from extending to any others; and also as the barriers are worked off with the "broken", it gives a better percentage of round coal in the "broken".

We can, with the assistance of the preceding, and data as to costs of working over a given area, arrive pretty nearly at the cheapest method.

We will now dismiss the question as to the size of pillars, and say a few words on the ventilation of broken workings.

Anyone who is a practical miner knows well enough that "broken" workings are rarely as well ventilated as the "whole" workings of a colliery, and the reason is that in the first place the return air-ways from a "broken" are rarely maintained in such good condition as those from a district working in the "whole mine," in consequence of the workings being in an uneasy state; and secondly, because the places are more open and cannot be ventilated by means of brattice (at least the "juds" or working lifts and "loose end" places cannot) as bords and walls in the whole workings; and thirdly, more places exist at which air can escape from the working place; and fourthly, the air spreads itself to a great extent into the goaf or gob; and lastly, the removal of the pillars causes the top stone to fall, and the thill or floor to creep, so throwing open reservoirs of gas which often baffle the best ventilation. At a large colliery in South Durham, for instance, when the "broken" working was commenced in one of the seams, the roof fell and gas issued to such an extent as to render foul 38,000 cubic feet of air in the district.

The workings in a "broken" district from these causes are often badly ventilated, and the near proximity of the goaf, which may be considered in fiery seams as a large reservoir of gas and as this sometimes gives the gas off into the workings, it increases the difficulty of ventilating, and interferes with the general comfort of the workmen.

The usual method of ventilating a "broken" district is at the present time only to force the air along the goaf edge, so as to exert a sufficient amount of pressure on it to prevent the gas from escaping in such volumes as to prevent the working off of the pillars, or in other words "to keep the goaf edge clean" by a current of air sweeping along it and carrying off any gas that may exude from the goaf of greater pressure than that of the air.

In one fiery seam in Durham, we are told, however, that it was the regular custom to ventilate the goaf and have currents of air passing through it.

In Greenwell's work on "Mine Engineering" there is a plate which would appear to represent the ventilation of a goaf, yet that this system is both inapplicable and undesirable can easily be seen.

The idea has long existed that gas might be drained from the goaves near the broken workings by means of pipes open at some part of the goaf above the rest, and into which pipes the gas would flow or be exhausted by means of a fan to the surfrce. Messrs. Lyell and Faraday, in their report to the Government on Haswell explosion, proposed this method, and a paper by Mr. Fowler on the subject about twenty years ago, is a further evidence that the idea even then had not been forsaken. There can be little doubt but that these contrivances might be of some use, but when the expense is considered, it is plain that except under particular circumstances, they are practically inapplicable.

Instead, however, of adopting Mr. Fowler's process of exhausting the air from the mine, it has been proposed that it should be forced in and let the only outlet be the mouth of a tube, the other end of which is an arched chamber situated in the highest part of the goaf, by this means fresh air would be forced in at the edge of the goaf, and expel the gas through the tube and out to the surface, but to this would apply the objections of the late Mr. Dunn, H. M. Inspector, and others, that it would partially destroy the ventilation of the mine, but it need only be in operation when the pit is not working.

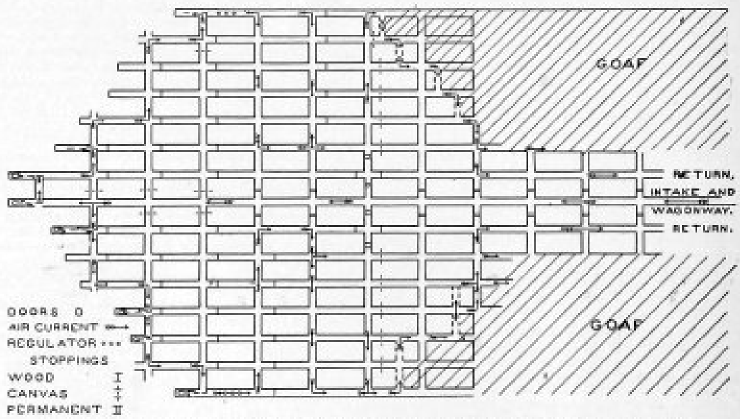


FIG. 2.—ILLUSTRATING METHOD OF FOLLOWING UP "WHOLE" WITH "BROKEN" AND THE VENTILATION OF THE GOAF-EDGE.

(Scale, 250 ft. = 1 inch.)

Mr. Buddle in his evidence on the explosion that occurred at Wallsend Colliery in June, 1835, says with reference to ventilating the goaf in pillar workings: "These wastes are not ventilated and a great quantity of foul air is necessarily engendered there, and at these situations a current of air is directed to pass the face or front of the void to carry off the gas emitted from it to the gas drift." And again before a Parliamentary Commitee in 1835 he says: "We proceed to take off the pillars of coal, always working to the windward, that is to say against the stream of air in order that whatever gas may be made, may be immediately carried off from the people working there."

It will thus be seen that the system of ventilating a "broken" is to keep the air pressing on to the goaf, but not into and through it. This is shown in Fig. 2, the ventilation of which is indicated by the arrows.

[TO BE CONCLUDED.]

We are pleased to note that the enterprise and fair dealing of the Ottumwa Iron Works, of Ottumwa, Iowa, in furnishing first-class haulage and hoisting machinery at reasonable prices has been rewarded by a strong demand for their machinery from all parts of the country. During the month of June they have shipped or have on their books the following orders:

1 Pair Geared Hoisting Engines 16" x 24" for Colorado.
1 Pair Geared Hoisting Engines 16" x 24" for Penna.
2 Pair Geared Hoisting Engines 10" x 12" for Iowa.
1 Pair Geared Hoisting Engines 12" x 16" for Kansas.
1 Pair Direct Acting Hoisting Engines 20" x 32" for Missouri.
1 Pair Tail Rope Hoisting Engines 15" x 18" for Tennessee.
1 Pair Tail Rope Hoisting Engines 12" x 16" for Ind. Ty.

Such a showing for one month is positive evidence of the favor in which their engines are held, and we advise parties contemplating the erection of hoisting or haulage engines to write them for bids, particulars of construction, etc.

REGULATORS.

BY S. M. ROBERTS.

Having noticed within the past eighteen months the difference of opinion among the readers of THE COLLIERY ENGINEER in regard to the theory of finding the area of regulators, I wish to express my opinion on the subject.

The difference of opinion among your readers has been as to which of the following formulæ is the correct one

$$\frac{k\,s\,v^2}{p} = a, \text{ or } \frac{k\,s\,v^2\,q}{n} = a.$$

Now, I don't think either of the above formulæ can be applied to find the area of a regulator. They are to find the area of an air-way "that has lateral resistance." While a regulator has no lateral resistance, all the power being expended in velocity.

Therefore we must apply some formula in which the power is expended in giving rise to velocity to find the size of a regulator, to pass a certain quantity under a given pressure.

The formula used by most authorities for the flow of fluids through a thin plate is:

$$\frac{V}{\cdot 61\ \sqrt{2\,g\,h}} = a, \quad (1)$$

where

V = quantity in cubic feet per second.

·61 = co-efficient of contraction into co-efficient of velocity.

g = gravity = 32·2.

h = head of fluid.

a = area in thin plate.

To illustrate the theory I am about to demonstrate, I will use Figs. 1, 2, 3, and 4.

Suppose we have two air-ways, Fig. 1, A B, and Fig. 2, D E; A B having a greater resistance than D E, and a quantity equal to q passing through A B (per minute) under a pressure (in air column) equal to B C. Again, suppose we have any given quantity passing through D E under a pressure (in air column) equal to F D. Then the power expended in D E will be equal to B C — F G. Then, suppose we have a hole in a thin plate equal to O under a pressure equal to F G; and capable of passing a quantity equal to that passing in the air-way D E.

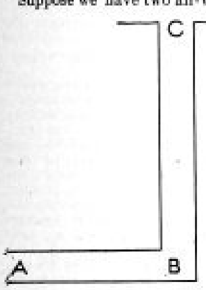


FIG. 1.

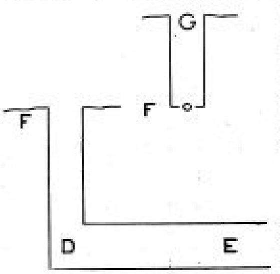


FIG. 2.

Then the same power will be expended in D E plus O as is expended in B A.

Now, suppose we take O, Fig. 2, and place it as a regulator, O, Fig. 4, then will the power expended in D E, Fig. 4, be equal to that in A B, Fig. 4, also A B, Fig. 1.

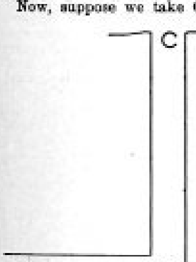


FIG. 3.

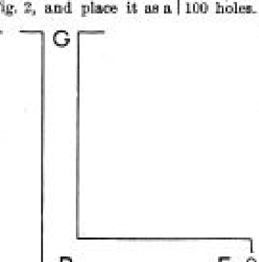


FIG. 4.

Therefore the resistance is the same (each resistance due to the column D G.)

Now we have sufficient data to base a formula:

Let H denote B C, Fig. 1.

Let h denote D F, Fig. 2.

Let h_0 denote F G, Fig. 2.

Then,

$$H - h = h_0 \quad (2)$$

Substituting the value of h_0 in (1), we have

$$\frac{V}{\cdot 61\ \sqrt{2\,g\,(H - h)}} = a \ (3) \text{ or area of regulator.}$$

To make this a little easier to understand, I will solve a problem given in a recent issue:

QUESTION.—"An air-way 6′ × 6′ × 1500′ is passing 12000 cu. ft. per minute. What size regulator should be placed in an air-way 7′ × 8′ × 600′ so as to pass the same quantity."

Let k = co-efficient of friction in air column for a velocity of one foot per minute = ·00000026881.

s = rubbing surface for air-way No. 1.

a = area in square feet for air-way No. 1.

v^2 = square of velocity for air-way No. 1.

A = area for air-way No. 2.

V_0^2 = square of velocity, air-way No. 2.

S = rubbing surface, air-way No. 2.

q = quantity = 12,000.

Then,

$$\frac{k\,s\,v^2}{a} = H = B\,C, \text{ Fig. 1.}$$

and

$$\frac{k\,S\,V_0^2}{A} = h = D\,F, \text{ Fig. 2.}$$

Substituting figures

$$\frac{\cdot 00000026881 \times 24 \times 1{,}500 \times \left(\frac{12{,}000}{36}\right)^2}{36} =$$

29·86 + = H = B C, Fig. 1, and

$$\frac{\cdot 00000026881 \times 30 \times 600 \times \left(\frac{12{,}000}{56}\right)^2}{56} =$$

3·94 + = h = D F, Fig 2.

Hence,

$$29{\cdot}86 - 3{\cdot}94 = 25{\cdot}92 = h_0 = F\,G, \text{ Fig. (3).}$$

Then substituting the value of h_0 in (1), we have

$$\frac{200}{\cdot 61\ \sqrt{64{\cdot}4 \times 25{\cdot}9}} = 8{\cdot}93 \text{ square feet of}$$

area of regulator.

(3) may be thus reduced

$$\frac{\cdot 204\ V}{\sqrt{\frac{k\,s\,v^2}{a} - \frac{k\,S\,V_0^2}{A}}} = \text{area of regulator.}$$

V_0^2 and v^2 = square of velocity in feet per minute.

V = Quantity to pass through regulator in cubic feet per second.

To give myself greater satisfaction, of the above theory, I tried an experiment on a regulator, and obtained the following result:

(1). With ·1-inch water gauge a velocity of 1,150 feet per minute.

(2). With ·26-inch water-gauge I obtained a velocity of 1,910 ft. per minute.

(3). With ·25-inch water-gauge I obtained a velocity of 1,790 ft. per minute.

(4). With a water-gauge of ·09 inches I obtained a velocity of 1,060 ft. per minute.

NOTE.—The thermometer was held in the middle of orifice while measuring the velocity.

BLASTING BY ELECTRICITY.

The use of electricity for firing blasts, either of common black blasting powder or dynamite, commends itself to all practical men having sufficient work to justify the small first outlay for the necessary apparatus: first, because it is absolutely safe, and secondly, because by firing a number of holes at *exactly* the same instant of time, the entire and combined strength of the explosive is fully secured.

The apparatus necessary for electric blasting consists of enough insulated copper wire to reach from the battery to the blast, a few feet of connecting wire, some electrical exploders or caps, and a magneto machine.

The "Pull Up" Blasting Machine is a first-class one, and is largely used in work where a large number of shots are to be fired at once. The three principal sizes are Nos. 3, 4 and 5. No. 3 has a capacity from 20 to 30 holes; No. 4, from 40 to 50 holes; and No. 5 from 75 to 100 holes.

In this Blasting Machine between the field pieces there is fitted to revolve an armature wound to a very high resistance. The rapid revolving of the armature by pulling up the operating bar, generates an electric current of high electro-motive power, which, at the moment of its maximum intensity, is sent out to the outside circuit, in which are the exploders, the explosion of which is instantly accomplished.

These machines are operated by a very easy and simple motion, which works smoothly and without any strain upon the parts. The operating bar, after being pulled up to fire, will fall back into its place of its own weight, and is ready to be used again. All parts are made strong and durable.

These machines are warranted to fire the number of holes claimed at a distance of 500 to 1,000 feet.

For blasting purposes, where the number of holes range from 5 to 8, the No. 1 "Victor" Machine is a cheap and good one. It weighs but 15 lbs. and its dimensions are 7½ in. × 7 in. × 4½ in. For tunneling and ordinary shaft sinking it meets all requirements.

The Smith Blasting Machine is a magneto-electric instrument of small size, weighing only about twenty-two pounds, occupying considerably less than one-half a cubic foot of space.

It is constructed on the Wheatstone and Siemen's principle, having a magnet of the horseshoe character, of iron, wound about with coils of insulated copper wire; between the poles of the magnet there is fitted to revolve an armature of cylindrical construction, carrying in its body other insulated wire coiled longitudinally, as to the cylinder.

The rapid revolution of the armature, by suitable means, generates and sustains in the machine an accumulative current of voltaic electricity of great power, which at the moment of its maximum intensity is, practicably, switched off to the outside circuit in which are the exploders, and in the interior of each exploder, the ignition is instantly accomplished. These machines are made in two principal sizes. No. 3, and No. 4. The first has a capacity of from 10 to 20 holes, and the second from 20 to 40 holes.

The Crescent Blasting Machine is the simplest in construction, and requires no skill on the part of the operator. It discharges a uniform current of electricity at every operation. There is no violence or rapid movement required when making the blast, and the parts are not liable to break or get out of order. It is also made in two principal sizes. The "C" machine having a capacity for 20 holes; and the "D" machine having a capacity for fifty holes.

Each machine should be supplied with enough leading wire to make two leaders of sufficient length to reach from the blast to a safe distance for the person who operates the machine, to stand. Cotton covered wire is generally used, and gutta percha covered wire is also used to a small extent. However, the most convenient leading wire is the "Improved Cable manufactured by the Aetna Powder Company, of Chicago.

A small quantity of pure copper wire for connecting the exploders in the various holes is also necessary. If the exploder wires are picked up after each blast, they can be twisted together, and used in place of connecting wire. Each outfit should also have convenient reels on which to wrap the leading wire and connecting wire when not in use.

The electrical exploders, or caps, are a very important factor. In fact without them electric blasting would be impossible. To insure success and safety *only the best quality should be used*, and exploders made by different manufacturers should never be used in the same blast, as they may be of unequal electrical resistance.

A very important and useful addition to the blasting apparatus is a roll of insulating tape. That made of okonite and sold by the Aetna Powder Co., of Chicago, is the best. It is a useful and convenient article for covering bare wire joints in blasting, either on dry ground or under water. Its composition is okonite, a superior insulating compound. It makes a waterproof joint, and can be applied instantly. The heat of the hand will cause it to stick fast to the bare wire, and it cannot be removed except by cutting it off. It is put up in half-pound packages, in widths of ½ and ¾ inches. It costs but a trifle, and should be generally used by all blasters for covering bare connections.

To use this tape the cloth, which is only placed upon it to separate the layers, and prevent the compound from sticking together, must be removed.

Wrap the joint thoroughly, taking pains to have the tape overlap, then apply a little heat from a lighted match, when it will be found impossible to remove the tape without tearing it.

The application of heat is preferable, but not absolutely necessary.

The following general rules must be observed to ensure the greatest safety and success in electric blasting:

Drill as many holes as you want to fire at one time. The distance between the holes should be about the same as the depth of the holes; thus, if the holes are 10 feet deep they should be about 10 feet apart and 10 feet back from the face of the rock. Place the electrical exploders in the center of the explosive to be used, and let the wires extend some ten or twelve inches above the mouth of the hole loaded.

Tamp the holes carefully with dry sand or fine earth.

Care should be taken when tamping not to injure or cut the insulation on the wires, as bare portions of the wire or bare joints should never be allowed to touch the ground; particularly so if the ground is wet. Many blasts have failed by allowing bare connections to come in contact with the ground and it is sometimes advisable to cover the joints with insulating tape.

When all the holes to be fired at one time are loaded and tamped, separate the ends of the two wires in each hole, and, by the use of connecting wire, join one wire of the first hole with one of the second, the remaining free wire of the second with one of the third, and so on to the last hole, making a continuous connection between the holes and leaving a free wire at each end hole.

Connecting wire should be of same size as the exploder wires. Leading wire should be at least twice as large.

All connections of wires should be by hooking and twisting together the bare and clean ends. *Great care should be taken that the connections are clean, bright, and well twisted*; more failures occur from improper connections than from any other cause.

The charges having all been connected as directed above, the free wire of the first hole should be joined to one of the leading wires, and the free wire of the last hole with the other of the two leading wires extending to the battery. The leading wires should be long enough to reach to a point at a safe distance from the blast—say two hundred and fifty feet to five hundred feet.

Everything being ready, *and not until all are at a safe distance from the blast*, clean the free ends of the two leading wires and connect one to each of the two set screws on the battery, by passing the ends through the holes in the set screws, bringing the thumb-nuts down firmly upon the wires. Then operate the battery by using the handle as directed by the rules accompanying the type of battery used.

Great care should be taken with the exploders. The Aetna exploders which are all of quintuple force, and every one of which is guaranteed, are the best. They will explode any of the high explosives, such as blasting gelatine, gelatine dynamite, ammonia powder, or ordinary dynamite. There are no second quality Aetna exploders made.

The above data has been compiled from practical experience gained in all kinds of mining, quarrying, and excavating work, and is published more in detail and with numerous illustrations in the new catalogue of the Aetna Powder Co. of 95 to 101 Randolph St., Chicago. This catalogue will be sent free on application to all readers of THE COLLIERY ENGINEER. The explosives and blasting apparatus manufactured and for sale by this company are all of first quality, and are fully warranted.

THE COAL-DUST THEORY.

Its History from 1803 to 1892—Its Production in Mines and the Various Methods of Overcoming its Dangerous Properties

BY W. WALKER, OF NOTTS COUNTY, ENGLAND.

Within the past few years the subject of coal-dust has been brought prominently and constantly before the mining world, by means of searching enquiries into the cause of explosions, and frequent reports of minute and searching examinations of mines in which explosions have occurred, lectures on coal-dust and its irritability of flame, together with numerous experiments and demonstrations illustrating its dangerous properties, and lastly, by the report just issued by the Royal Commission appointed to enquire into the effect of coal-dust on explosions in mines.

These experiments and reports have conclusively proved that finely divided dry coal-dust is capable of feeding and materially lengthening the flame and increasing the destructive properties of an explosion of marsh gas and air.

They have also proved that fine dry coal-dust is capable of raising air containing from 2 to 3 per cent. of fire-damp to an explosive point.

Also from some of these experiments it appears that certain kinds of very dry, finely divided, highly combustible and most inflammable coal-dusts, when present in large quantities and in the close vicinity of a strong blown-out shot, may cause an explosion in the absence of appreciable marsh gas, whose intensity and destructive force may be even greater than the intensity and destructive force of an explosion of marsh gas and air.

Coal-dust, therefore, becomes a most dangerous element in the art of coal-mining, and demands most careful study and care on the part of all interested in coal mining.

It has existed in coal mines from the earliest days of coal mining; it being to a greater or less extent an unavoidable daily product of coal mining.

The quantity of coal-dust produced daily in our modern coal mines is incomparably large compared with the quantity produced during the early days of coal mining; hence the dangers of coal mining have increased.

This great difference is due to the rapid extension which coal mining has undergone during the latter part of the present century, by which mines are enlarged, greater depths reached, more men employed, the use of explosives more common, greater distances along which coal has to be brought from working places to pit-bottom, and an increased velocity of transit.

These are some of the chief causes which have tended toward an increased production of coal-dust in modern coal mines.

The first mention of coal-dust as a dangerous element in connection with coal mining occurred in the year 1803, in which year an explosion occurred at the Wallsend colliery, in the North of England, by which 13 men and boys were killed, and 20 more or less seriously injured. It was decided to investigate into the cause of this explosion, and Mr. Buddle was appointed to make the necessary examination. After making all necessary examinations in the mine, he wrote his report, which stated that the mine was dry and dusty, and that the survivors who had been the furthest from the seat of the explosion were burnt by red hot sparks of coal-dust, which had been ignited by the flame of the explosion and carried along by the force of the current.

His report proved that the injury to the workmen and the destruction to the property had been increased by the ignition of these fine particles of dry coal-dust; and yet history yields no record of experiments or discussions on this new theory of mining dangers.

No more is heard of coal-dust for a period of 25 years, when its dangerous properties are again mentioned by a Mr. R. Ball; but such report seems to have had no more effect on the mining world than Mr. Buddle's report, since it does not appear to have induced any experiments or discussions on the dangers of coal-dust.

Such silence, indifference, and neglect is not to be wondered at when it is remembered that mining engineers were very scarce in those days, and colliery managers were often made out of men from other industries than mining, so that farmers, blacksmiths, joiners, &c., were often appointed indiscriminately to take complete charge of a mine; men who knew nothing of the dangers attending the art of coal mining, whose knowledge of roof and sides and their necessary support, methods of extraction, gases produced, and found in mines, their effect on animal life, and the safe removal or dilution of these gases, was *nil*.

No wonder that a knowledge of the effect of fine dry coal-dust in the presence of an explosion of marsh gas and air, or of its effects in the presence of a strong blown-out shot has been so markedly slow.

Nothing could have retarded this new theory more than the appointment of incompetent men to such responsible positions.

Meanwhile, explosions were occurring more frequently and owing to the extension of mines the number of victims were gradually increasing with nearly every explosion; thus feelings of sympathy were raised in the hearts of intelligent and feeling men, and as successive explosions occurred, accompanied by their dreaded results, taking away the stay and the support of families, rendering children fatherless, sometimes orphans, and parents sometimes childless, it was thought desirable that more minute and searching investigations should be made into the causes of these explosions; so that when the great Haswell explosion occurred, in September, 1844, by which 95 men and boys lost their lives, two eminent men (Faraday and Lyell) were appointed to investigate into the cause of this explosion.

They entered into their work earnestly, and spent much time in the mine examining minutely everything which could give them the least trace into the cause of the explosion; they also paid great attention to the evidence given at the public enquiry, and from this evidence very little gas could have been present at the time of the explosion, quite inadequate to produce such disastrous results.

During their examinations they found deposits of coked coal-dust adhering to the bars, props, and sides of the roadways along which, the flame of the explosion had passed, varying in thickness from one-half to nearly one inch.

This coked coal-dust enabled them to come to the conclusion that as the flame of the explosion had come in contact with this fine dry dust it had decomposed it, and under such conditions each particle of dust had yielded up to the flame a part, or the whole of the gas it contained, which gas fed the flame and thus increased the destructive effects of the explosion.

They presented their report to the Home Secretary in the year 1845, and after describing the possible collections of fire-damp in a mine, the different ways by which it was disturbed by atmospheric changes, the way by which it could be effected by falls of roof, consequent on the removal of timber or otherwise, thereby reducing the areas of the reservoir in which gases could collect, also the effect of certain mixtures of fire-damp and air when brought into contact with flame.

They continued their report by stating that the whole of the flame and the destructive force of the explosion, was not, in their opinion, due to an absolute mixture of fire-damp and air, but that the extent of the flame, the intensity of the heat, and the destructive force of the explosion, had been materially increased by the fine dry particles of coal-dust, as collected on the bars, props, sides, and floor of the mine.

This valuable report was given to the mining world in 1845, and in the same year Faraday lectured at the Royal Institution in London, on the effects of coal dust in conjunction with an explosion of marsh gas and air, and thus by their report, lecture, and illustrations, Faraday and Lyell tried to force home to the mining world the intensified effects of an explosion of fire-damp in the presence of fine dry coal dust.

It would seem, from the want of recorded history, to have either been forgotten or entirely ignored, or disbelieved in by the mining community, as no more appears to have been heard of the coal-dust theory for a period of ten years.

This is, perhaps, not to be wondered at, when we consider the disbelief generally introduced when any new theory or idea is introduced or propounded. Mankind is naturally very slow to accept new theories.

The knowledge contained in these reports and lecture of Faraday and Lyell's does not appear to have traveled out of England; for in 1855, ten years later, the mining world is awakened by a report from France, by M. du Souich, who had examined a mine immediately after an explosion of fire-damp, and stated in his report what he considered a new theory on explosions, viz., "The Coal-Dust Theory." He observed during his examinations the coked coal-dust adhering to the bars, props, and sides of the roadways through which the blast had passed, and came to the same conclusion as Faraday and Lyell had done in 1845.

In the year 1861 the same French mining engineer examined two mines where explosions had occurred, and in his reports of these examinations he again advanced the coal-dust theory, and tried to show how coal-dust had materially increased the destructive force of these explosions.

The continuation of these reports on coal-dust awoke the mining world from its slumber of indifference, and induced in some a desire to prove the truth of these strange statements.

From 1864-7, a Frenchman, named M. Verpilleux, had a series of experiments carried out, which proved fine dry coal-dust to be a dangerous element in an explosion of marsh gas and air. Other Frenchmen continued these experiments, but especially a M. Vital, who in 1875, made some experiments on some fine dry coal-dust obtained from a mine where an explosion had occurred in which gases were seldom detected. His experiments were carried out with a view to ascertain the effect of coal-dust in the presence of a strong flame, resembling the flame from a blown-out shot. He was satisfied that very fine, dry, and highly inflammable coal-dust would, in the presence of a strong blown-out shot, &c., suffer decomposition and feed the flame, and thereby increase the destructive force of an explosion.

Experiments were made in England, about this time, by Mr. W. Galloway, on a large scale. From these experiments he was led to believe that coal-dust would not of itself produce an explosion; but in the year 1880, he conducted a further series of experiments, and proved that certain kinds of very fine and highly inflammable coal dust would produce an explosion when present in large quantities, and in the vicinity of a highly-charged blown-out shot.

About the same time experiments were carried out by Professor Freire Marreco and Mr. W. Cochrane, at the Elswick Collieries. These experimentalists made their experiments in a model colliery, ventilated by a model Guibal fan, by which a strong current of air was maintained, and a quantity of fine dry coal-dust thickly suspended in the air current. At this stage of the experiment a pistol was fired into the air current, which was immediately followed by so violent an explosion that the model mine was damaged and the Guibal fan broken.

These experiments were continued by Messrs. Morrison, L. Wood, and G. Gray, and by the North of England and the Chesterfield Institutes of Mining Engineers.

To further illustrate the destructive effects of very fine dry coal-dust in the presence of a blown-out shot, a series of experiments were carried out by Mr. H. Hall, Her Majesty's Inspector of Mines for the Liverpool district, in conjunction with Mr. Clarke, about the year 1875. These gentlemen had placed at their service an adit level or footrill 45 yards in length, and dipping from the entrance in direction of the dip of coal; the adit was arched with bricks, and had a sectional area of about 30 feet, and it was ventilated by a vertical shaft. At distances of 15 feet sheets of a very inflammable nature were suspended across the level, and reached two-thirds of the height of the adit, and nearly touched the floor. In these sheets small holes were made, and in these holes small quantities of powder were put. Charges of gunpowder varying from 1½-2½ lbs. were fired at intervals, and under varied circumstances, from a cannon fixed at the end of the adit level.

In the first experiment the cannon was charged with 1½ lbs. of powder, and the charge rammed with underclay or clunch. When fired it was found that the flame of the blown-out shot had reached about 15 feet; no sheet or powder had been affected by this charge.

The second experiment was with 1½ lbs. of powder, but the charge was rammed with small coal and a quantity of fine dry coal-dust spread in the vicinity of the cannon, and extending eight or nine yards from the cannon. In this experiment the flame reached 30 feet, but not 45, as proved by the firing of the inflammable sheets and powder.

In the third experiment the charge of powder was 2 lbs., and rammed with small coal, and coal-dust in the vicinity of cannon, as in second experiment. In this experiment the flame reached 45 feet, but not 60, as shown by sheets and powder.

The fourth experiment only differed from the second and third in the charge of powder, it being 2½ lbs. The flame reached 60 feet, but not 75, as proved by cloth and powder.

In the fifth experiment, the adit being wet, the floor was covered by deal boards all the length of the adit, and thickly covered with fine dry dust. The charge was 2½ lbs. of powder rammed with small coal. In this experiment the flame issued in a large volume from the mouth of the adit level, and of such intensity, that had any one been standing at the mouth of the adit it would have killed them.

The temperature of the adit was 50° F.

Water was slowly dripping from the roof and the floor was wet.

No gas could be detected at the time of these experiments.

These experiments carried out as they were, under conditions very possible in a mine, proved conclusively that the length, the intensity and the destructive force of the flames from a blown-out shot was considerably increased when fine dry coal-dust was inflamed, and the length of the flame in the third and fourth experiments was increased at least 15 feet for every additional ½ lb. of powder. This was due to the additional powder increasing the force of the explosion, thereby enabling more coal-dust to be decomposed, by which more gas was thrown into the flame, increasing its length.

Mr. Hall continued his experiments, in 1890, in a vertical shaft placed at his disposal having a depth of 200 yards. He represented a blown-out shot by the firing of a cannon, pointing upwards, from the bottom of the shaft. In his first experiments he fired the cannon in the absence of dust, and merely obtained a loud report, similar to the report of a shot fired at the bottom of a sinking shaft. He then had a quantity of very fine dry dust riddled into the shaft from the surface, after which the cannon again was fired, and the flame of the shots variously increased; whilst in some of these experiments the flame issued from the mouth of the shaft, proving conclusively the danger of very fine dry coal-dust in the presence of a rapid and powerful flame such as issues when a blown-out shot occurs.

Since the majority of these preceding experiments were carried out, the Royal Commission on Accidents in Mines spent considerable time in making experiments on coal dust from different collieries, and the outcome of all these reports and experiments was that part of G. R. 12 of the 1887 A. of P. which refers to the ramming of shots and firing of shots where dry coal-dust exists.

About the same time, and also quite recently, the Prussian Fire damp Commission spent much time in making experiments, on an elaborate scale, on the effect of fine dry coal dust in conjunction with an explosion of fire-damp, and its properties in the absence of fire-damp; the outcome of their researches being the introduction of more stringent rules.

The coal-dust theory being brought so prominently and constantly before the mining world, induced Parliament to appoint, on February 9th, 1891, a Royal Commission on explosions from coal dust in mines. The first report of this Commission has just been issued, and shows how exhaustive the Commission has been in endeavoring to ascertain the opinions of some of the most influential and interested gentlemen connected directly with mining. Such gentlemen consisting of the Chief Inspectors of Mines, Mining Engineers from various coal fields, and Professors of Science.

Twenty-three witnesses were examined by the Commission, and of this number twenty-one were examined directly on the coal-dust theory, with the following result: Thirteen of these witnesses are agreed that very fine dry coal-dust is capable of causing an explosion in the presence of a blown out shot and in the absence of fire-damp; the remaining eight witnesses, whilst not admitting coal-dust as capable of causing an explosion in the absence of marsh gas, are agreed that it is dangerous element, and capable of aggravating an explosion of fire-damp; also able to render smaller quantities of fire-damp capable of producing an explosion.

In each of these commissions fine dry coal-dust is regarded as a very dangerous element in mining. Thus the coal-dust theory has gradually been gaining ground and has been the means of explaining much of the mystery surrounding several of the explosions that have occurred during the past 10 or 15 years. At the enquiries held immediately following these explosions, evidence has repeatedly been given that fire-damp has not been detected, or otherwise only to a very limited extent on the day of explosion, and therefore quite inadequate to produce an explosion, whilst the minute and searching examinations in the mines immediately after an explosion, have often revealed a state of things which, according to the coal-dust theory, were quite competent to produce an explosion.

The Seaham explosion of 1880, by which 164 men and boys lost their lives, is generally considered to have been due to the effect of a blown-out shot in a district that contained large quantities of very fine, dry, and highly inflammable coal-dust; probably with a small percentage of fire-damp in the air.

The Altoft explosion of 1886, by which 22 men and boys were killed, was proved at the enquiry to be due to a strong blown-out shot, which had been badly planted, in a district containing large quantities of very fine dry coal dust. This explosion occurred on a principal intake air-way 500 yards from the downcast shaft and along which 40,000 cubic feet of air were passing per minute. The explosion occurred in the afternoon, when all the day shift men were out of the mine, otherwise the results would have been more disastrous.

The Elemore explosion of 1886, by which 28 men and boys lost their lives, was also proved to have been due to a strong blown-out shot, which had been badly planted in a district containing large quantities of fine dry coal-dust. This explosion also occurred on a principal intake air-way, 200 yards from the downcast shaft, and along which 37,810 cubic feet of air were passing per minute.

This explosion also occurred when the day shift had been drawn to the surface, otherwise the results would have been more appalling.

Explosions of fine dry coal-dust resulting from a heavily charged and bad planted blown out shot, and in the absence of appreciable marsh gas, may generally be distinguished from an explosion of marsh gas and air, by the first results of the explosions.

In the case of an explosion of coal-dust, the seat of the explosion is, generally speaking, not much disturbed, since the first stages of an explosion of coal-dust are the feeblest; but it gathers force as it travels; being fed by the gas from the particles of coal-dust, and produces the greatest destruction where the largest quantity of dust exists.

Pure air traveling at a high velocity will favor an explosion of coal-dust, since it contains more of the element oxygen to support the combustion of the dust.

In the case of an explosion of marsh gas and air, the seat of the explosion is often most difficult to find, since its first stages are very violent.

Pure air in large quantities renders marsh gas inexplosive.

Having briefly stated the coal-dust theory, and shown how it is possible for coal-dust to either intensify an explosion of marsh gas and air, or cause air containing only a small percentage of fire damp to become explosive, or cause an explosion itself in the absence of appreciable marsh gas, but in the vicinity of a heavily charged and badly planted blown-out shot, we must next consider how coal dust is produced in mines.

The amount of coal-dust produced in a mine will depend on the following conditions:

(1) The nature of the coal.
(2) The methods of extracting the coal.
(3) The practicability of the workmen.
(4) The condition of the rolling stock.
(5) Transit from working places to pit bottom.

The nature of coals varies very considerably: some coals being soft, tender, friable or nesh, and cannot be extracted from their natural position without producing large quantities of slack and dust. Such coals cannot be conveyed over the long distances common in modern coal mines, and at high velocities, without producing small, which eventually becomes a part of the dust of mines by the passage of men, boys, and horses to and from their working places.

Other coals are hard, strong, dense, or compact, and can be extracted and rehandled without producing much slack and dust, and admit of being conveyed over great distances much safer and quicker.

This statement is proved where two coals, the one a soft coal and the other a hard coal, are extracted at the same time and in the same mine. In the soft coal roads the production and accumulation of dust is much more rapid for a given quantity extracted than in the hard coal roads. Hence the amount of dust produced will depend to some extent on the nature of the coal worked.

(2) *The method of extraction.*

There are always certain natural directions in which coals may be worked with a maximum production of large coal and a minimum production of slack and dust. A soft, friable coal will yield a maximum of large and a minimum of dust if worked on the end, a technical term employed by colliers to indicate right angles to the slines of the coals, or to nature's marks. If such coal be worked on the face, *i.e.*, parallel to the slines, it will yield a maximum of slack and dust and a minimum of large coal. If worked on any point between end and face, long or short horn, it will produce less large than when worked on end and more large than when worked on the face.

Therefore, the best way to work a soft, tender coal is on the end, other circumstances being favorable.

A hard, strong coal will yield a maximum of large and a minimim of small if worked on the face, parallel to the slines. It will in most cases make the most small and dust when worked on points between face and end, long or short horn. Therefore, the best way to work a hard, strong coal is on the face, other circumstances being favorable.

Whilst pointing out the best methods of working coal with a maximum of large and a minimum of small and dust, it must not be forgotten that local circumstances may often decide the exact point at which coals must be extracted.

No mine of any extent can at all times so arrange the whole of its working places so as to constantly advance on the best point for producing a maximum of large and a minimum of dust. The thickness of the seam of coal will affect the production of small and dust. If the seam be thin and is required to be holed and cut deep, there will be an increase of dust. If the nature of the floor or thill be so hard that the holing has to be done in the coal itself, the amount of dust produced will be materially increased. If the coal be worked with a series of cuttings, the dust produced at these points will be very abundant, due to the incessant grinding action at such points, and should the seam be thin and large quantities of air required, then the high velocity with which it travels along contracted cuttings picks up the dust and carries it in suspension, and deposits it where the velocity is decreased, due to increased area.

The amount of dust produced will depend to some extent on the readiness or otherwise of the coals to fall when liberated, without the aid of explosives, since the shattering force of an explosive materially increases the production of dust, and the blast of the explosion floats the dust in the air in clouds.

(3) *The practicability of workmen.*

Contractors, stallmen, or workmen may increase or decrease the dust unavoidably produced according to their practicability. When the workmen are sound practical men, they will always try in Longwall working, to keep their stalls straight from end to end, free from all buttocks or projections; they will have their coals holed to a good depth, if necessary, and always keep plenty of stock in advance, so as to allow the coals to soak or leave the roof, and thus be ready to fall on the removal of sprags, thereby avoiding the use of explosives as much as possible; they will by timber and packs try to avoid weights, which, when heavy, grind the coal considerably. They will constantly supervise their workmen and prevent them from unnecessarily cleaving the coal, and will see that the coal is so loaded that with ordinary tramming it will not fall down by the way from the working place to the pit bottom. Good workmen in post and pillar working are equally careful in their endeavor to extract the coal in the best and most practical way, and will be very careful to hole and cut their coals to the very best advantage. Such men usually use the least explosives, where explosives are allowed.

In their endeavor to make a day's wages, they ever keep before them the fact that it is, generally speaking, the large round coal that makes their wages, and recognize in every ton of slack and dust produced and thrown into the goaf or gob, a direct loss to themselves, their fellow workmen, their employers, and the community at large, and thus every effort is centered on a maximum of large round coal and a minimum of slack and dust.

In the case of incompetent or negligent workmen, no regular system is observed, and such workmen and their working places are always from hand to mouth, nothing is done at the proper time, therefore nothing can be found in its proper place at proper times, viz.: props, packs, sprags, cuttings, rippings. Such incompetent workmen in thin seams, working by the post and pillar system, where, generally speaking, more explosives are employed than in Longwall working, sometimes put their holes in with such bad judgment, and charge them with the same wisdom, that when the shots are fired no coals can be found at the face, the overcharged shot hole having blown the coal to slack and dust and scattered it in all directions, and to such distances as to be beyond hopes of recovery.

In mines where a round price is paid to workmen for large and slack coal, there is every encouragement to carelessness in getting the coal. In such mines the dangers are greater and more numerous than in mines where it is the large coal that makes the workmen's wages.

(4) *Condition of rolling stock.*

The condition of the rolling stock will affect the production of dust in mines.

The trams, tubs, or wagons may be considered as the most important rolling stock, and may be either box ended, or one open end, or practically both open ends. In the latter case the tram consists of a frame with two sides, with a narrow strip of sheet-iron 6 or 8 inches wide passing along one end and attached to each side.

Each of these trams are used often in the same district.

Open ended trams are not to be recommended for mines where the gradient is perceptible and variable, because of the impracticability of always keeping the open end or ends of the trams in such position as is most suitable for retaining the coal, nevertheless, they have their advantages in low seams, and enable the loading of the coal to be done quicker and easier, and can convey a great weight of coal per tram.

If the trams or tubs be not kept in good repair, they act like a sieve, and allow the smaller pieces of coal to fall through upon the roads, and a great part of such coals becomes eventually the dust of the mines. If kept in good repair, they prevent the smaller coals from falling through, and therefore assist in keeping the roads clean.

The transit of the coal from the working places to the pit bottom produces the greater part of the dust of mines, and the amount produced will depend on the following conditions:

The size of the roadways.

The condition of the roads, crooked or straight, good or bad roads.

Methods of haulage.

If the roads leading from the working places be small and partly packed up with dirt, then owing to the scrubbing of coal either on the sides of the roadways or on the roof, small and dust must be produced, and such accumulates along the roadways.

If the roads be badly laid or crooked, trams or tubs will not ride. It is a well-known fact that a good loaded tram will not ride on a bad road, and a badly loaded tram will not ride on a good road. And whenever coals are turned out of a tram, either by accident or otherwise, the whole of coal is never put into the tram again, but small pieces are left on the roads, and the workmen, horses, or trams grind it to fine dust.

If the roads be level, the removal of the coals is much facilitated and much safer, and produces less dust than when the roads are inclined. In the latter roads lockers or sprags, used in the wheels of the trams, and heavy chains running behind the trams to further assist the ponies, produce large quantities of very fine dust.

The first part of the haulage is done by men, ponies and horses, after which the haulage is generally mechanical, such as self-acting inclines, dip engine roads, tail rope haulage, and endless ropes or chains. Sometimes large quantities of dust are produced, and at the same time the air is laden with very fine dust by a runner or a breakage on dip haulage roads, due to the drawing of cap or socket of rope, breakage of rope and underchains, breakage of coupling, breakage of a brake strap, or carelessness on the part of the men and boys on the main roads.

The endless rope haulage produces the least dust of any mechanical haulage, due to the slow regular speed at which the trams run, and the necessarily large roads required for this method of haulage. The fine particles of dust always to be seen on the surfaces of the coal in trams or tubs are picked up by the air current when strong, and especially where the trams and the air current are traveling in opposite directions, which is commonly the case. These fine particles of dust are floated by the air current until they are finally deposited on the roof, bars, props, sides and floor of the roadways.

The traveling of the men, boys, and horses to and from their working places is constantly producing dust in dry mines, which remains for some time after their passage more or less suspended in the air, and finally deposited on the bars, props, and floor of the mines.

Very fine dust is sometimes carried down the downcast shaft from the screening plant, and especially if such plant be erected near the pit top, and the direction of the wind carries the dust over the mouth of the shaft.

The dust being produced in a variety of ways, the very fine particles are suspended by the action of the air current, and coming in contact with the bars, props, sides, and floor of the mine, collect particle by particle at these points until large quantities accumulate, unless systematically removed.

It will be seen from the preceding pages that coal-dust is most abundantly produced and accumulates most rapidly on the main haulage roads of a mine, because on these roads the whole of the coal must pass in traveling from the working places to the pit bottom, and as these roads are chiefly the intake air-ways for the mine, the dust will be much dryer.

Generally speaking, the dust is also dryer in deep mines than shallow mines. This is due to the higher temperature and the more or less absence of surface water.

The very fine dust produced at the working places is fresher and purer than is found at any other part of the mine.

The return air-ways do not contain dangerously dry dust, since the air, which has become more highly charged with moisture in its passage through the working places, yields up a part of this moisture in its passage through the return, and if a return has been in use for years, as a return, very little coal-dust will be exposed to sight, the whole of it being coated over with the products of combustion from the lights employed in the mine.

The dangers attending the production and accumulation of fine dry coal-dust in the working places and roadways of a mine suggest a decreased production wherever possible, and whilst there are a large number of mines in which the dust question is closely attended to in the most practical ways, there are nevertheless mines in which little, if any, attention is paid to this dangerous element.

Its production and dangers can only be decreased and avoided by a combined effort on the part of the management of the mine and the workmen employed.

On the part of the management only good and practical workmen should be employed, and these should be supplied with sufficient material to keep their working places in the best condition, and the roads under their supervision in good repair. The trams, tubs, or wagons should be constantly maintained in good condition, the roadways large, and the roads kept in good repair, the best system of haulage introduced, and the main road arrangements on the best principles.

On the part of the workmen a stricter supervision amongst themselves is necessary, so that every care is observed in working their places to the best advantage, with a view to producing a maximum of large to a minimum of small and dust. Where explosives are allowed, the greatest care and judgment in deciding the position of shot hole, the boring of the hole, the amount of explosive employed, the nature of the material employed for ramming, and the ramming of the shot, so as to avoid a blown-out shot.

In all cases of blasting on dusty main roads, which is usually done at night time, after complying with General Rule 12 and Special Rules in force at the colliery, further precautions should be taken by causing the deputy or fireman, who is generally chosen from the most practical workmen to examine the position of every shot hole before it is charged, and if not satisfactory, have another one bored under his direction, and to charge the hole with the explosive himself, or otherwise see that it is not overcharged, and be should also see that it is rammed with suitable material, damp sloom or clay, so as to reduce the possibility of a blown-out shot to a minimum of danger.

Much has been said and written during the past few years about the more or less practical ways by which the dangers of fine, dry, coal-dust might be removed or safely overcome.

In a few words, the dangers of coal-dust may be removed or safely overcome by the careful removal of a part of the dust, accompanied by a systematic sprinkling of water on the roadways, thereby keeping the roads clean and damp.

In some mines large quantities of dust are loaded up and sent to the surface, or to a gobgate, or into the working places, to be gobbed, and the most dangerous places sprinkled with water, and then swept up. In some cases water pipes have been laid on the side of the principal roadways, and at short distances small upright pipes terminated with rose ends, screwed into the main, and from these small pipes the water is directed to the dust on the roadways. This method is not largely employed.

Mechanically-arranged water tanks have been introduced, by which a spray of water is thrown upon the roads during the motion of the tram.

The most common and most practical method of watering the roads is by means of the common water-cart having one or two plug holes in the end and sides, or lengths of perforated $1\frac{1}{2}$ to 2 inch pipes attached to the ends or sides of the water barrels, the plugs are withdrawn as required, and the water flows either in a stream or in a spray.

The watering of the roof and sides of roads, and especially the roof, partakes more of theory than practice. Very fine sprays of water have been thrown into the downcast shaft, so as to saturate the air with moisture, but such an imperfect method of laying the dust in mines is not much advocated, since it cannot carry its water to the more distant roadways, but deposits it too near the pit bottom. It is also injurious to the workmen, being constantly surrounded by air fully charged with moisture.

Impure salt has been employed in North Staffordshire, and was reported a few years ago to be giving satisfaction. It was stated that 9 tons were required for every 500 yards of roadway, and such required to be done every week for the first month, and once a month afterwards. This method does not appear to meet with much favor, probably due to cost and extra work required. The removal of a portion of the dust, together with the sprinkling of water on the roads, when carried out systematically, gives general satisfaction, and induces feelings of safety.

Much has been said about the effects of water on the roadways of a mine, and it has been generally admitted that its effect on the roadways varies very much in different mines, according to the nature of the strata, and as nearly the whole of the water falls upon the floor of the roadways, it will be the floor which is most affected. It will, therefore, require more repairs to be done to the roads, which means an increased cost for repairs, but generally speaking an increased cost is not considered when the safety of the workmen and the mine is at stake.

DEFINITIONS OF TECHNICAL TERMS.

Clunch—A kind of hard earthy fireclay.
Deal Boards—Planks.
Planted—Located.
Slips—A facing or smooth parting or joint in coal, etc.
Horn Coal—Coal marked partly *end-on* and partly *face-on*.
Post and Stall—A system of working a coal seam, much the same as *Pillar-and-stall*.
Trams—Cars.
Bar—A length of timber placed horizontally for supporting the roof.
Gob-Gate—An abandoned road used for the purpose of stowing or gobbing refuse.

THE PROGRESS IN MINING.

Reviews of Important Papers Relating to Mining in the Proceedings of the Mining and Scientific Societies, and in the Mining Journals of Europe, United States, and Canada.

Chemical Means of Preserving Wood and Timbers for use in Connection with Mines.

At a recent meeting of The North Staffordshire (Eng.) Institute of Mining and Mechanical Engineers, a paper on the above subject was read by Mr. Joseph Taylor.

Mr. Taylor commenced by remarking that winter was the best time for felling timber, as it was less liable to dry-rot than if felled at any other time.

Defective ventilation is one of the chief sources of deterioration or rapid decay of timber in mines. The chief impurity in the atmosphere of mines which exercises a prejudicial influence on the timber of the mines is carbonic acid, which with a certain temperature and humidity is highly favorable to the growth of fungus. This fungus sets up a chemical change, which causes decay of the timber and vitiates the air of the mine at the same time.

Mr. Taylor described various methods in use for the purpose of preserving timber in mines and recommended creosoting as being the most efficacious. It is especially valuable as a preservative of the softer and more porous kinds of timber when placed in wet places. Any timber used in wet roadways may be rendered twice as durable by creosoting.

Trial of Coal-Cleaning Plant at a Scotch Colliery.

By invitation of Messrs. Kesson & Campbell, the makers, a large and representative gathering of coal masters, colliery managers, and others interested in the coal trade, recently assembled at Dechmont Colliery, near Newton, Scotland to inspect the dry coal-cleaning and washing machinery just fitted up by them for the Dechmont Colliery Co., Limited. The result as regards the character of the machinery was altogether satisfactory, it being admitted on all hands that Messrs. Kesson & Campbell have been successful in bringing out a set of plant which is unsurpassed by that of any other maker in Scotland, and which will compare favorably with any other coal cleaning plant.

This colliery was the creation of the Flemington Coal Company, and for a time the pits were the deepest in Scotland, the depth to the splint coal being 212 fathoms or a quarter of a mile. The company started to draw coal about the end of 1878, but as the works proved unremunerative, they were abandoned in 1882, everything being demolished except the winding engines of No. 1 pit, the pumping engines and steam winch. In the beginning of 1890, the present company entered on the lease, fitted up the pithead frames, cleared the pits of 130 fathoms of water, and commenced to draw coal about February, 1891.

At the colliery there are two pits about 140 feet apart, which are connected by a scaffold 22 feet above the ground. Under the scaffold are eight lines of railway, on which the various kinds of coal are loaded into wagons. Before the coal reaches the wagons, however, it is thoroughly cleansed and separated—the processes in use for this purpose being those known as the "dry" and "wet," the former for treating the large and the latter the small coal.

Near the middle of the scaffold are placed three revolving tippers, which are common to the two pits, so that the car loads of coal from either pit may be run into any of them as desired, and tipped onto the distributing bands. Each of these tippers is placed at the beginning of a set of machines for "dry" cleaning and separating. Each set is for the treating of a different seam of coal, and consists of a distributing band, jigger screen, coal picking band, screen shoot, and delivery plate. These being in alignment, the coal is passed from the one to the other in the order named.

The distributing band effects the uniform distribution of the coal over the jigger screen and picking band, and the jigger screen effects the separation of the coal into large and small—the large passing over the screen on to the picking band, and the small passing through the holes in a perforated plate forming bottom of screen on to a conveying band underneath. This conveying band, which is common to all the three jigger screens, conveys the small coal from them, and delivers it into the small coal receptacle. The large coal, passed over the jigger screen to the picking band, is freed from all foreign matter, which is easily seen and picked out by hand as the band carries it along. From the picking band the coal is passed over the screen shoot on to the delivery plate, and from it into the wagon. Any small that is in the coal after passing from the picking band falls out through the screen shoot so that the large coal passes into the wagon entirely free from all foreign matter and small, and ready for the market. The small falling through the screen is delivered by a conveying band into the small coal receptacle. The foreign matter picked from the large coal is treated as follows: That to which there is no coal adhering is conveyed by a haulage to the refuse heap, while that to which there is coal adhering is conveyed by a band to a crusher, where it is broken up, and then elevated and conveyed by the small coal conveyor to the small coal receptacle. This completes the "dry" cleaning process. The small coal is lifted from the receptacle by a bucket elevator to a height of fifty feet and discharged into a revolving screen. By this screen it is separated into three sizes, the first or smallest being run through a shoot into an improved washer of the conical type with revolving arms or stirrers. The coal is washed free of all foreign matter which is elevated and delivered into a car on the scaffold level from whence it is run to the refuse heap. The washed coal (or "pearls" as they are known in the trade) is carried by a flow of water into a revolving screen of fine wire meshing over which the greater percentage of the coal passes into a large hopper with a perforated inner lining, where the water is drained off and returned to the pond to be again used, the coal being delivered dry into a wagon. A small percentage of the coal passes through the meshing of the revolving screen along with the water, but this is run through pipes to a silt recovery where the coal is separated from the water and deliverd at the boiler doors for stoking purposes.

The second size of coal from the first mentioned revolving screen is passed through a shoot into a newly improved washer of the Bash type, and is there washed free of foreign matter. The washed coal in this case is taken out of the washer almost dry by means of an arrangement of inclined perforated plates and scraper blades and delivered through a shoot into a wagon. The third size of coal from the same revolving screen is washed in a Bash machine similar to that described, but adjusted to suit the larger size of coal. The coal from this machine is conveyed by a traveling band to a revolving screen, and there separated into two different sizes and delivered into wagons on separate roads. These two Bash washers are so placed as to secure a very compact and effective arrangement of the elevators for removing the refuse and recovering the small coal. The refuse is delivered into a car on the scaffold level, from whence it is run to the refuse heap. The water used for the washers is that pumped from the pits, from which it is delivered into a storage tank. From this tank it is pumped into the Bash washers by a small Worthington pump, and, after circulating through them, overflows into the range of pipes leading to the silt recoverer. The silt recoverer consists of a tank about forty feet long, by seven feet wide at top and tapering to two feet wide at bottom, and thirteen feet deep. In this tank a bucket elevator works, made so that the buckets scrape along the bottom of the tank its entire length. The buckets lift all the matter which has subsided to the bottom of the tank, and delivers it into shoots delivering at the boiler doors. The buckets being perforated, all the water is drained out and runs back into the tank. The clear water from the silt recoverer overflows through pipes into the settling pond, from which it is lifted by a Pulsometer pump and forced into the conical washer. As already described, the water overflows from this washer, carrying with it a small percentage of the washed pearls through pipes into the silt recoverer, and thus completes the circulation of the water. The motive power of the "dry" cleaning plant is derived from a 14-in. by 21-in. vertical engine, and for the "wet" from a pair of coupled engines each 14 in. by 24 in., while the silt recoverer elevator is worked by a 6 in. by 12 in. horizontal engine. As most of the machinery works automatically the whole apparatus only requires the attention of one man.

Note on the Report of the Austrian Fire-damp Commission.

Mr. W. N. Atkinson, English Government Inspector of Mines, has prepared a paper for the North Staffordshire Institute of Mining and Mechanical Engineers, entitled "Note on the Report of the Austrian Fire-damp Commission." Mr. Atkinson has reviewed some of the experiments and conclusions of the Austrian Fire-damp Commission published in the *Annales des Mines* by Mons. Chesneau, and in the *Bulletin de la Societe Minerale* by Mons. Rene Grey. With regard to the composition and properties of fire-damp and of air currents in fiery mines, he said fire-damp from a number of blowers was analyzed, and the results showed that proto-carbureted hydrogen or methane was the only hydro-carbon usually liberated by coal. The results of the analysis did not differ essentially from those obtained by the Prussian Commission, except as to those at Obernkirchen, where an extraordinary percentage of ethane was found. Hydrogen was not found in gas from blowers in any true coal, but was found in small proportion in the Trifail lignite mines, which gas also contained a considerable amount of carbonic acid and nitrogen. Gas extracted from coal by means of boreholes differed in composition according as it was taken from newly-opened workings or from the old pillars. In the former case its composition was very similar to gas from blowers, while in the latter case there was a considerable diminution in the proption of methane and a corresponding increase of carbonic acid due to the oxidizing influence of the air. It was proved that coal completely exhausted of gas by prolonged exposure would not reabsorb as much gas as it liberated. When placed in methane at atmospheric pressure the maximum quantity of methane reabsorbed did not exceed 1·61 cubic inches for 1,543 grains. Analyses of the air-currents in mines showed that owing to the oxidizing action of the air on coal the quantity of oxygen compared with that of nitrogen was always less than its proportion in pure air. Thus in the mines of Bohemia there was on the average 79·54 per cent. of nitrogen for 20·355 of oxygen, while in pure air there was only 77·04 of nitrogen for that quantity of oxygen. With respect to the pressure of gas developed in boreholes, at Rossitz a pressure of 5 atmospheres was obtained in a borehole $24\frac{1}{4}$ ft. long, and at Ostrau-Karwin 9·2 atmospheres in boreholes $21\frac{1}{4}$ ft. maximum length. Most important experiments were made as to the influence of the getting of coal and the atmospheric conditions above and below ground. The return air from the most fiery district contained an average of 1·51 per cent. of fire-damp (and 0·103 per cent. of CO), and yielded in twenty-four hours 518·91 cubic feet of fire-damp per ton extracted.

Having spoken of the quantity of fire-damp exhaled per ton of coal, he proceeded to notice the experiments made with safety-lamps, observing that in a general way it was shown that brass wire gauzes appeared more dangerous than iron wire gauzes, and that the addition of a small quantity of dust to the moving mixture increased the danger, while a large quantity, on the contrary, diminished the danger by producing an excess of combustible gas which extinguished the flame of the lamp. The Austrian Commission concluded from the experiments that the lamps used in Ostrau-Karwin—Mueseler, Wolf and Marsaut lamps—were much safer than was generally admitted, since, when shielded, they resisted the most explosive mixtures at velocities much exceeding 32·8 ft., which was practically the highest velocity encountered in fiery mines. Details were supplied as to experiments with explosives. The latter bore chiefly on the danger of shot-firing in the presence of coal-dust, and they showed that the danger of dust was greater than was usually recognized. To combat the danger of dust, watering of the working places was recommended, which, when it could be properly done, gave very good results. In dusty mines without fire-damp high explosives should be used after complete removal of the mass of dust by sweeping or watering; if practicable, safety explosives should be used, which, when stemmed with damp sand, gave great security. If there was also a small amount of fire-damp ($\frac{1}{2}$ to 1 per cent.) the shot should also be fired by means incapable of causing flame. The Commission made several recommendations as to the classification of fire damp mines, the method of opening and working mines, and ventilation. Fans were recommended in preference to furnaces for ventilation. Furnaces should not be allowed in mines producing much fire-damp, and where used in mines producing little fire-damp, or a moderate amount only, the return air should not be allowed to come in contact with the fire. Considerable attention was given to the question of lighting, and the Mueseler, Wolf, and Marsaut lamps were mentioned as good lamps, and precautions were pointed out as to the firing of shots and the working of fiery and dusty mines. Mr. Atkinson concluded by saying: "The experiments on the circumstances which influence the liberation of fire damp are interesting, and they appear generally to confirm the opinion usually held on the subject in this country and expressed in the report of the Royal Commission on Accidents in Mines. The analyses of fire-damp present no remarkable features, except that some of them show a good deal of nitrogen and carbon dioxide. The gases evolved from coal heated to 212 degs. Fahr. often contained a certain proportion of ethane, the presence of which gas has been supposed by some persons to have an effect in increasing the inflammability of the dust from the coal containing it. The pressures observed in bore-holes were not so high as some of the pressures attained in this country in the same way, a pressure exceeding 30 atmospheres having been observed on one occasion. The observations on the effect of variations of barometrical pressure accord with general experience. The statement that barometrical pressure does not effect the liberation of carbonic acid gas appears to require qualification. It may have done so in the mines experimented on, but as a general rule I believe the liberation of this gas is influenced as much as fire-damp by changes in the atmospheric conditions. It is said that the velocity of the wind on the surface, and storms, have no influence on the liberation of fire-damp in mines artificially ventilated. But such atmospheric disturbances sometimes have the effect of reducing the amount of ventilation and so increasing the proportion of fire-damp, besides which they are usually accompanied by a sudden decrease of pressure. With regard to the safety-lamp, experiments, M. Chesneau considers they were not so searching as those of the French Commission because of the limited duration of each experiment. The French experiments were made with lighting gas, and the lamps could be kept in an explosive current for an unlimited time, and the apparatus was so constructed that the lamps could be jerked about and placed at different angles with the current. He also considers the experiments made with lamps in stationary mixtures unsatisfactory because of the small capacity of the testing chamber in which the explosive mixture could not be renewed, in consequence of which the products of combustion extinguished the lamps before a proper observation could be made. The French experiments proved that in most of the lamps placed in explosive mixtures at very low velocities, so as to get rid of the products of combustion, the gas continued to burn in the lamps for an indefinite time, and in some cases to heat the gauzes to redness. He is also of opinion that 90 seconds was too short a time in which to observe satisfactorily the "caps" formed by different proportions of gas, except in the case of the Pieler lamp. It appears that in Austria the Pieler lamp is in regular use for the dection of fire-damp. The English Royal Commission condemned it as dangerous, and in the form it was first introduced no doubt it was dangerous. Subsequent modifications have made the lamp safer, but not so safe that it can be recommended for general use. In the earlier form of lamp the alcohol was apt to overflow from the wick tube and fill the gauze with flame; to prevent this the bottom of the lamp is now filled with cotton wool to absorb the alcohol. There is some uncertainty about the exact percentage of gas indicated by caps of different lengths. The cap-lengths given by the inventor of the lamp and subsequently by Dr. Brookmann for the German Fire-damp Commission exceed those given by the French and Austrian Commissions. The lamp should not be used without being completely shielded and should not be taken where gas may be present until a previous examination with an ordinary lamp fails to detect the gas. It is only useful for detecting low percentages of gas in an air-current and not for finding gas in the goaf or in holes. It should only be used by persons of discretion and experience. The experiments with explosives bore principally upon the danger from coal-dust. It was not found possible to decide the degree of danger caused by different dusts from their chemical composition and physical properties. The only conclusion drawn is that the sensitiveness of dusts increase generally with the proportion of easily inflammable hydrocarbons (especially with the amount of ethane liberated at 212 degs. Fahr.), and with the dryness of the dust. This is a question requiring further elucidation. That the dryer a dust is the more inflammable it becomes is easily understood; what we want to know is how damp it must be to be harmless. I incline to the opinion that the physical condition of coal-dust as to dryness, purity, and fineness will be found to be more important factors than its chemical composition." The soda-dynamite recommended for use by the Austrian Commission was not approved by the French Sub Commission on Explosives. The following is an extract from their report, as translated by Messrs. Brown and Bird, for the North of England Mining Institute: "The Prussian and Austrian Commissions agree in recommending the use of mixtures of dynamite and crystallized carbonate of soda. The conclusion cannot be accepted, because these mixtures have not only a very low explosive force, but, further, the easy dehydration of the salt may lead to serious inconvenience. It has been previously mentioned that if an attempt is made to thaw cartridges of frozen dynamite in warm water, the nitro-glycerine is expelled from the pores of the silica, and exudes when the water rises to 95 degs. Fahr., and the cartridges then become dangerous. The same effect may occur as has been mentioned, during summer in magazines where the cartridges are stored; and cartridges prepared some weeks back may be thus seriously damaged. It appears difficult to recommend the use of such unstable explosives, which may cause serious accidents, even in the absence of fire-damp. It is remarkable that several other salts, easily volatilized, but more stable than carbonate of soda, were not tried, as was done by the French Commission. There is no need therefore to repeat the reasons which led the French Commission to abandon mixtures of this nature, and to replace the inert salt, by a salt explosive in itself, such as nitrate of ammonia; as the desired safety may be thus obtained, without sacrificing too great a proportion of the explosive force." The classification of mines for legislative purposes according to the amount of fire-damp they produce has never been attempted in Great Britain, and it is doubtful whether such a scheme is either practicable or desirable. The recommendations of the Commission as to precautions against a fire on the surface preventing access to the mine by both shafts is worthy of consideration. No serious catastrophe from such a cause has occurred in Great Britain, but if a fire on the surface prevented access to a mine by both shafts, and the smoke went down the downcast shaft, the loss of life might be great. The opinion of the Commission that shot-firing may still be allowed, when the greatest precautions are taken, in places where there is 2½ per cent. of fire-damp, is, in Mr. Atkinson's opinion, wrong. Such a proportion can not be detected by ordinary safety-lamps, and the only safe rule to go by is not to fire shots where any gas can be detected in that way within 20 yards of the shot. It will be observed that where dust is present in addition to 2 or 2½ per cent. of gas, the Commission would prohibit shot firing altogether.

THE USE OF ASBESTOS IN MINES.

Its Superiority Over Other Materials as a Non-Conductor, and its Structural Advantages.

Asbestos is a highly refractory fibrous mineral, having about 90% of silica and magnesia in its composition. It is insoluble in water, and will not change its mechanical (that is, fibrous) structure when wet.

The application of Asbestos in operating mines, is to insulate steam connections. The problem which confronts the mining engineer is, how to secure good results with a steam boiler at the mouth of the pit, and a pump several hundred feet under ground, or a fan several hundred yards away from the boiler, necessitating the use of long lines of steam pipe which must be covered with a non-conducting material to prevent the radiation of heat.

This pipe often runs close to the tracks in slopes and along haulage roads, or is hung perpendicularly in shafts, where it meets with the roughest usage and is often subject to the constant drip of water, sometimes strongly impregnated with sulphur.

Of what form and of what materials to make an insulator that will be of service under such trying conditions is the question that must be solved. That the pipe must be covered is scarcely a matter of debate. Assuming the pipe to be 4″ internal diameter, and the run, say 1,000 feet, the exposed iron surface will be 1,250 square feet, *i. e.* the equivalent of a flat surface 125 feet long by 10 feet broad.

Assuming, further, a steam pressure of 70 lbs. we have a body of heat at 316° Fahr., 1,250 square feet in extent constantly radiating into an atmosphere about 250 degrees cooler than itself, with results which anyone familiar with the condensation of vapors can easily predict. Theoretically, it would take over 8 tons of coal per annum to remedy the waste in each 100 lineal feet of pipe, or, at $3.00 per ton, $24.00 per 100 feet, making a total waste on the line of pipe in question of $240.00 per annum, but practically the pump could not be run, as the water of condensation would clog the cylinder and valves so as to stop the motion and injure the machinery.

With the pipes properly insulated by the application of a good non-conducting covering, all this loss can be prevented, and perfectly dry steam delivered at great distances from the boiler.

The loss from radiation under such favorable circumstances is infinitesimal, and compared with the loss or waste through friction and other causes, is not worthy of note. It is hard to obtain reliable statistics owing to the difficulty of making accurate observations from apparatus covering so much ground. In a recent test, however, of a system of piping carrying hot water under pressure at 400 degrees Fahr., the total loss, in a travel of 10,000 feet, chargeable to radiation, was placed at 3%. These tests were made by competent engineers, and with the use of every means known to science. All of the pipes in question were insulated with 1½″ in thickness of Asbestos.

Having considered the possibilities of the case, we now revert to the main question. What material, if any, will answer the purpose?

Such material to fully answer the purpose must fill the following requirements:

1. It must be a non-conductor of heat.
2. It must be unaffected by heat.
3. It must be unaffected by water.
4. It must stand rough usage.

A countless list of articles have been offered by enterprising vendors, with various devices for fire proofing, water-proofing, etc., and in turn have been discarded for some fatal defect.

The fire-proof lining has been found no protection or the water-proof cover has been broken away and the water has destroyed the coverings.

It may be interesting to review a few of these to see in what way they fall short of the standard we have just set up, *i. e.*, durability under heat, water, and rough usage.

First comes Hair Felt, the oldest form of pipe covering in use, one of the best non-conductors of heat known, because so full of air cells, but hair felt is short lived under heat, and disintegrates rapidly when wet. The various fire-proof linings used under hair felt do indeed prolong its life but do not give it real durability, and for mine work it cannot be recommended. Then there is an extended list of paper pulp and wool felt materials, usually made up in sectional or cylindrical form. Some have a thin sheet of Asbestos as a lining, placed there more for appearance than use, as a close examination will show the Asbestos to be too thin to afford much protection.

The best type of this covering is made of alternate layers of wool felt and Asbestos sheathing, laid up in cylindrical form so as to leave air spaces. But this covering while efficient and durable, under ordinary circumstances, will not stand the exposure of a mine shaft; the wool felt will char, leaving the Asbestos.

We would refer right here to the well-known effect of heat and moisture on organic substances, which is to disintegrate them rapidly. Hence these, and similar coverings, containing a large percentage of hair, wool, and other organic matter will be quickly destroyed in mines, and we therefore lay down the general proposition that no covering should be adopted for use in mines that contains organic matter in its composition.

The various forms of non-conducting cements are more durable under heat but are too easily injured by rough usage to last long in a mine. We can divide them into two classes, those containing heavy clays or earths with animal or vegetable fibers as binders, and those made from Asbestos and infusorial, or fossil earths. The former are only nominal pipe coverings, as they do not retain the heat and have no real value. The latter have merit, but are not of service in the line of work we are now contemplating.

In connection with these cements or plastic coverings, we find in use several made from mixing magnesia or plaster with Asbestos. The Asbestos acts as a binder and adds to the strength of the plastic compound, which is formed into sections or slabs, but the objection urged against the use of cement in mines holds good against this form of material; it will not be found durable.

We have just referred to various forms of non-conducting coverings and point to the fact that in each case the materials used in their make-up other than Asbestos cannot be recommended for use when exposed to great heat, continued moisture, and rough usage.

We now point to another most important fact to be observed, which is that all the durability these goods possess is found in Asbestos Fibers, which they contain. The hair, wool, paper, pulp, etc., chars under heat, while the clay, magnesia, plaster, and other similar fillings wash away under exposure to moisture or crack and break when subjected to abrasion.

It was the discovery of these facts that led to the construction of the style of pipe covering manufactured by the H. W. Johns Manufacturing Company. This meets all the demands of mine work, and we will now fully describe it.

It is an established fact that the non-conducting property of a material depends not so much on the elements of which it is composed as on their mechanical arrangement. A material which is made up in solid and compact form, so that its particles be in close contact will be a poor non-conductor of heat. If, however, this same material be loosely felted together so as to form numerous air cells between its particles or fibers it will then prove an excellent non conductor of heat, and it is such substances only which admit of such treatment that are useful as non-conductors of heat. Asbestos, for instance, is popularly known as a mill board or sheathing, and in this form is only a fair heat insulator, while in the loose or fibrous form it is one of the best non conductors of heat known.

In conformity to these well proven facts the covering we are about to describe is made solely from fibrous Asbestos.

The Asbestos is taken in its crude or natural state, and by special processes it is cleaned from all foreign substances and the long silken fibers are selected and separated and divided until they are as loose and fine as a bat of cotton.

This material has been found to answer the first stipulation as laid down earlier in this article, *i. e.*, it is a good non-conductor of heat.

It also meets the second requirement and will stand the most intense radiated heat that can be brought to bear on it, for it is entirely free from all organic substances, and hence will meet the third requirement, which is to be unaffected by water.

This material is then taken and by machines, invented by the H. W. Johns Company, it is shaped into cylindrical form, of sizes to fit pipes of any diameter and of any required thickness.

These cylinders or sections of Asbestos are then cut on one side so as to open and slip over the pipe, after which they are neatly jacketted with suitable material, and provided with bands and buckles to hold them in place.

For mine work, under favorable conditions, the jacket is a light cotton duck which is afterwards coated with a water-proof paint to keep the covering dry as possible. But in very wet places, and under trying conditions, a jacket of Asbestos and wire cloth is substituted. This is a special material formed by uniting layers of Asbestos through the meshes of wire cloth after which the material is water proofed. This forms a jacket of great strength and durability, unaffected by heat and impervious to moisture.

These jacketings are to give finish to the coverings, and also to prevent any excess of moisture in them, as moisture fills the air cells and promotes conduction of heat. The covering does not depend on the jacket either for its strength, or for its protection, as the Asbestos Fibers from which it is made have in themselves great strength and will stand very rough handling. If they are wet they dry out again without in any way injuring the covering.

We have thus far treated Asbestos only in its function as a non-conducting covering, and we can justly claim to have demonstrated its unequalled merit for this purpose.

There is certainly no material known that in any way approches to it for such a purpose.

But it is not only in this way that it is useful to the miner. There are many other ways in which it is useful and doubtless many more will be devised in the near future.

It is largely used as a piston packing in cylinders of engines and pumps, and also as a flat packing to make cylinder heads, steam chests, and all kind of flange joints.

As a fire-proofing it admits of great possibilities. Its long silken fibers can be spun and woven into a fine fabric that would make an excellent brattice-cloth, and the many light flexible and durable forms into which it can be made could, when intelligently used, greatly decrease the fire risk in mines.

We venture to predict that the present known uses of Asbestos are to its soon to be discovered possibilities, as the feeble steam of the pioneer Cornish pumps are to the present million gallon Worthingtons of to-day.

We therefore commend it to the notice of every thoughtful and progressive mining engineer.

Correspondence

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any needed correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

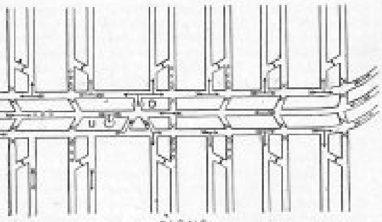
The Editor is not responsible for views expressed in this Department.

Correspondence should be in as simple language, and as free of technical signs and formulæ as possible, consistent with clear solution. Catch-questions will not be published.

Ventilation.

Editor Colliery Engineer :

SIR:—I submit the following sketch in reply to "Straggler" of Mineral Ridge, Ohio, in the May number: It is not by any means free from doors, which of course will not be in accordance with his wish, but with the plan of openings given, it is the best method of ventilation I could recommend, providing both entries have long distances to go. It will be noticed there are two intakes and one return. This could be reversed, if desired, with a very slight change at shafts bottom. By this latter method less track, etc. would be required. There are twelve doors shown but twice that number will be needed if a steady current of air must be kept up to working face, but it is not always the case that middle pillars are large enough to give space for the trips to pass through one door and the other door to be shut. Thirteen overcasts are used.



SIGNS

AIR CURRENT	OVERCAST XX
REGULATORS	UPCAST U
– DOORS	DOWNCAST D

The number and size of regulators to be used would have to be regulated according to the differences of lengths of entries from upcast and number of miners working in each split. (It would be better to regulate entries and number of miners and avoid regulators as much as possible.) If "Straggler" wishes to have his mine ventilated without doors, or nearly so, he will have to somewhat change his plan of openings.

My principal reason for replying to this question is that it may possibly induce some of your able correspondents to give their opinions as to the possibility of working mines without doors or nearly so, especially gassy mines. There is no doubt but that doors are a great source of danger and expense wherever used. I believe if the subject is taken up and discussed intelligently through the columns of THE COLLIERY ENGINEER that the time will be hastened when doors will be a rarity rather than 100 yard obstructions. Too often in the past the cost of erecting the doors only has been considered and not the expense of operating them and the dangers resulting from their use.

Yours, etc.,
JOSEPH CAIN.

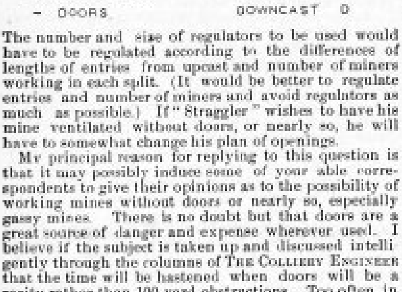
Whitwell, Marion Co., Tenn., May 30th.

P. S.—I would say that the mine could be worked entirely without doors by only having one break-through open at one time, but there does not seem to be any wisdom in that as there would not be sufficient air in the workings.

Gas Met With in Mines.

Editor Colliery Engineer :

SIR:—Please insert the following question in your next issue: A drill hole from surface to coal is 223′. A room 12′ wide is driven from No. 1 entry to drill hole, to be used as a pump room. When the fan is stopped the pump room fills with gas. Now, could this gas be



lighted at bottom of drill hole by throwing fire down, the hole being 8″ in diameter? If so, would the gas explode, and would the coal fire from the gas? When the fire was discovered how would you proceed to quench it, and when extinguished what would be the result in gases?

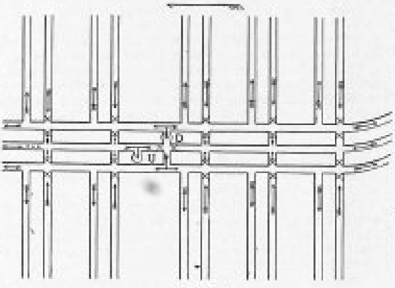
Yours, etc.,
C. H. FELLABOM.

West Newton, Pa., May 7th.

Ventilation.

Editor Colliery Engineer :

SIR:—In answer to "Straggler," of Mineral Ridge, Ohio, in the May issue, I submit the following plan:



SIGNS.

RISE OF SEAM.	REGULATOR ···
AIR CURRENT	DOWNCAST D
X AIR CROSSING	UPCAST U

In case the pitch of seam is in the opposite direction the current should be reversed in the butt headings.

Yours, etc.,
WILLIAM KELLER.

IRVONA, PA., May 23d.

Ventilation.

Editor Colliery Engineer :

SIR:—I notice that "Alberto's" question No. 4, in the March issue, has been answered by "T. K.," of Mount Olive, Ill.

I beg to submit the following in reply to "Alberto" and leave to the decision of your readers as to who is right: Taking "T. K.'s" data we have a main entry $6' \times 14' = 40'$ perimeter and two smaller entries each $6' \times 8' = 28' \times 2 = 56'$ perimeter. Now according to the first law of friction "Pressure varies directly as the rubbing surface," we have

40 : 56 :: 4 lbs. : 5·6 lbs., which would have been the pressure were it not for the second law of friction, "Pressure varies *inversely* as the sectional area." Then,

96′ : 84′ :: 5·6 lbs. : 4·9 lbs. pressure per sq. ft. sectional area of two small drifts.

Yours, etc.,
E. J.

Oglesby, Ill., June 7th.

Mathematics.

Editor Colliery Engineer :

SIR:—Please insert the following in answer to question (2) by "R. L.," of Gasford, Pa., in the May issue:

(2). A coal barge full of Bituminous coal displaces 6,625 cubic feet of water. How many tons of coal does the barge contain?

ANSWER.—In taking this question into consideration we will assume that the water in the hull of the barge is on a level with the coal; any other way of working the question would be suppositional. One cubic foot of fresh water weighs 1,000 ounces or $62\frac{1}{2}$ lbs. One cubic foot of salt water weighs 1028 ounces or 64·25 lbs.

One cubic foot of Bituminous coal varies but weighs, say, 1250 oz. or 78·12 lbs.

Now coal in its broken state as screened and sent from the mines varies in proportion likewise, say, as 62 is to 100.

Therefore in every cubic foot, 62 parts coal and 38 parts water, each would weigh:

Coal, 100 : 62 :: 1,250 oz. : 775 ounces per cu. ft.

Water, 100 : 38 :: 1,000 : 380 ounces per cu. ft.

Coal and water combined 1155 ounces per cu. ft.

Then

100 parts $\div$ 38 = $2\frac{12}{19}$ cubic feet of space to make 1 cubic foot of water.

And

$775 \times 2\frac{12}{19} = 2{,}039\frac{9}{19}$ ounces of coal space to equal 1 cubic foot of water space.

Now there are 6,625 cubic feet of water, this multiplied by $2039\frac{9}{19}$ will give ounces of coal in barge = $13{,}511{,}513\frac{3}{19}$ ounces, or

$$\frac{6{,}625 \times 2{,}039\frac{9}{19}}{2{,}240 \times 16} = 370 \text{ (nearly) tons of coal}$$

the barge contains.

Also,

$$\frac{6{,}625 \times 1{,}000}{2{,}240 \times 16} = 184\cdot84 \text{ tons of water dis-}$$

placed.

If the barge contained sea water, which is much heavier, the weight can be found in the same manner as above.

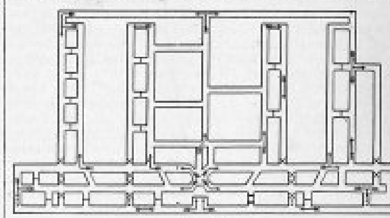
Yours, etc.,
JAMES STIRLING.

Jeanesville, Pa., June 21st.

Ventilation.

Editor Colliery Engineer :

SIR:—I herewith send plan of ventilation as requested by "C. D. R.," of Hope Church, All'y. Co., Pa., in the April number. Very little fault can be found with plan submitted by "C. D. R." Where there is one plan of ventilation as well arranged there are five inferior to it. However, I send the following in answer to Fig. 1 in hopes that it will better enable him to deal with ex-



SIGNS

AIR CURRENT	STOPPINGS =
OVERCAST X	REGULATOR ···
DOORS –	

plosive gas, if any. It will be noticed that I have seven overcasts, four more than the original plan, and two additional short break throughs. I have no doors in entries, an item of consideration, as doors are objectionable and a source of expense when used. I have placed two doors in break-throughs between main intake and main return so that if a furnace is used coal can be brought there, but if the furnace is located elsewhere they will serve as a ready means to pass in and out of air-way for inspection, etc.

"C. D. R." asks for any suggestions whereby his system of ventilation could be bettered. I would point out the following faults (Fig. 1, April issue):

(1.) Only one door separating the intake from the return whereas two should be used.

(2.) A large return air current loaded with impurities directed into main headings on north side.

(3.) An overcast used on one of the south side main headings which does not seem to be of much value as it is shown as an intake current.

(4.) No regulator where one is needed in the return from entries 1 and 2 east on north side of shaft.

(5.) No way shown to get to upcast shaft, except by going around to head of main entry.

The following are a few errors made in ventilating mine (Fig. 2, April issue):

The main intakes are nothing but doors and return air-ways. The left side main entry could be made into a true intake current by the expenditure of a few dollars in building two overcasts and the driving of a few yards of narrow work so as to make one return for each set of four entries. The value of the money spent would be soon repaid. I have no doubt but that other faults visible will be fully dealt with by others of your able correspondents.

Yours, etc.,
JOSEPH CAIN.

Whitwell, Marion Co., Tenn., April 16th.

Mechanics.

Editor Colliery Engineer :

SIR:—Please insert the following question in the Correspondence columns of your journal:

Pipe of what diameter, and boilers of what size should be used to conduct steam a distance of 400 feet, and to an elevation of 150 feet above boilers to run a fan 18 feet in diameter, 85 revolutions per minute. Size of engine 10″ cylinder by 20″ stroke.

Yours, etc.,
SUBSCRIBER.

Pocahontas, Va., June 22d.

Efficiency of Fans.

Editor Colliery Engineer :

SIR:—In looking over the back numbers of THE COLLIERY ENGINEER, I notice a question in the September issue by "M.," of Braidwood, Ill., which remains unanswered, therefore I offer the following solution:

He wants to know the efficiency of a 16′ fan making 130 revolution per minute, with a water-gauge of 3·2″. We will first find the tangential velocity of fan by multiplying the diameter

$16' \times 3\cdot1416 \times 130 = 6534\cdot5280 \div 60 = 108\cdot9$ velocity per sec.

Then,

$108\cdot9^2 \div 32 = 370\cdot6$ motive column, and

$1\cdot2 \times 12 \times 370\cdot6 \div 1{,}000 = 5\cdot33664$ theoretical water-gauge, and by dividing the registered water-gauge by the theoretical we find the efficiency, thus:

$3\cdot2 \div 5\cdot33664 = \cdot599$ per cent.

Yours, etc.,
T. K.

Mt. Olive, Ill., June 20th.

A Word of Thanks.

Editor Colliery Engineer :

SIR:—I wish to thank "J. W.," of Trotter Mine, Pa., for correcting my mistake in answering question No. 2 asked by "Alberto." I simply neglected to deduct the 2,000 feet return, otherwise, the question was solved the same.

Yours, etc.,
T. K.

Mt. Olive, Ill., June 20th.

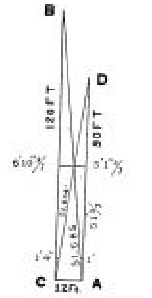
Mensuration.

Editor Colliery Engineer:

SIR:—Please insert the following answer to question (1), asked by "R. L.," of Gosford, Pa., in your May issue:

Two entries are driven parallel to each other as shown by the diagram. Now wishing to drive from A to B and from C to D what would be the distance from AC to where the lines would cross each other?

ANSWER.—From the sketch we see that gangway No. 1 is driven 120 feet and gangway No. 2 is driven 90 feet with 12 feet intervening. Now the angle ADC has a raise of 12′ in 90′, or a raise of 1′ 4″ in 10′, and the angle ABC has the same raise of 12′ in 120′, or a raise of 1′ in 10′. Therefore 1′ 4″ + 1′ = 2′ 4″, which is the distance between the two lines at 10′ distance. The foregoing



is necessary to find the length of the base of a triangle whose altitude is 12′ and having a raise of 2′ 4″ in 10′. Then, as we wish to find the distance from A and C to the point of intersection of the lines we solve thus:

$$12' \div 2' \, 4'' = 5\tfrac{1}{7}, \text{ or } 5'\,1\tfrac{5}{7} \text{ to center.}$$

$$1'\,4'' \times 5\tfrac{1}{7} = 6'\,10\tfrac{2}{7}''$$
$$1' \times 5\tfrac{1}{7} = 5\;1\tfrac{5}{7}''$$
$$\overline{\quad 12' \qquad 0'' \quad}$$

Then,

$10' \times 5\tfrac{1}{7} = 51\tfrac{3}{7}'$, and

$$\sqrt{51\tfrac{3}{7}^2 + 6'\,10\tfrac{2}{7}''^2} = 51.884'.$$

$$\sqrt{51\tfrac{3}{7}^2 + 5'\,1\tfrac{5}{7}''^2} = 51.685'.$$

Yours, etc.,
JAMES STIRLING.

Jeanesville, Pa., May 27th.

NEW MINING COMPANIES.

Names and Post-Office Addresses of the New Mining Companies Incorporated in the United States Since Our Last Issue.

The Gould Mining & Milling Co.,	Colo. Springs, Colo.
The Edwin Booth Gold Mining and Milling Co.,	Denver, Colo.
The Carmer Mining Co.,	Aspen, Colo.
The Victoria Mining and Milling Co.,	Denver, Colo.
The New York and Chance Mining Co.,	Denver, Colo.
The Amalgamating Chemical Electric Reduction and Manufacturing Co.,	Denver, Colo.
The Mettie D. Gold Mining Co.,	Cripple Creek, Colo.
The Motto Mining Co.,	Aspen, Colo.
The Carson Tunnel Co.,	Carson, Colo.
The Lincoln-Lucky & Lee Mining Co.,	Denver, Colo.
The Atlantic Mining and Milling Co.,	Fort Collins, Colo.
The Anaconda Gold Mining Co.,	Denver, Colo.
The White Star Mining Co.,	Denver, Colo.
The Atlantic Ward Gold Mining Co.,	Denver, Colo.
Southern Illinois Oil and Mining Co.,	Pulaski, Ill.
Lastle Mining and Manufacturing Co.,	Listie, Pa.
Phoenix Oil and Mining Co.,	Omaha, Neb.
Youghiogheny and Lehigh Coal Co.,	Superior, Wis.
The Soliwe Mining Co.,	Dayton, Ohio.
The Pittsburgh Land and Mining Co.,	Pittsburgh, Pa.
The New York Mining and Smelting Co.,	Pittsburgh, Kans.
Crystal Rock Salt Co.,	Chicago, Ill.
Tennessee Oil Co.,	Port Huron, Mich.
Phoenix Mill and Mining Co.,	Spokane, Wash.
The Washington and Nevada Mining Co.,	Vancouver, Wash.
The Jicarilla Iron Mining Co.,	East Las Vegas, N. M.
Troy Development Co.,	Spokane, Wash.
Rainy Mining Co.,	Seattle, Wash.
The Berniece Mining and Milling Co.,	Denver, Colo.
The Benita Mining Co.,	Cripple Creek, Colo.
The Napoleon Gold Mining Co.,	Colo. Springs, Colo.
The Elkton Mining and Milling Co.,	Colo. Springs, Colo.
The Mollie Eppert Mining and Milling Co.,	Colo. Springs, Colo.
The Union Gold Mining Co.,	Colo. Springs, Colo.
The Goodland Mining and Milling Co.,	Goodland, Kans.
The American Asphalt Co.,	Denver, Colo.
Black Hills Tin Metal and Developing Co.,	Chicago, Ill.
Providencia Gold Mining Co.,	Jersey City, N. J.
Dugger Co-operative Mining Co.,	Dugger, Ind.
The Federal Hill Gas Co.,	Noblesville, Ind.
The Helena Coke Co.,	Mt. Pleasant, Pa.
Levs Artesian Well Co.,	San Francisco, Cal.
Ruby Mining and Smelting Co.,	East St. Louis, Ill.
Good Hope Mining Co.,	Washington, D. C.
The Hub Mining and Milling Co.,	Cleveland, Ohio.
The Minnesota Consolidated Mining Co.,	Davenport, Ia.
Montana Precipitator Co.,	Helena, Mont.
The Enterprise Mining and Smelting Co.,	Livingston, Mont.
The F. F. V. Placer Mining Co.,	Cripple Creek, Colo.
The Cheyenne Mining Co.,	Cheyenne, Wyo.
Rock Oil and Gas Co.,	Mannington, W. Va.
Barbeuse Mining and Smelting Co.,	St. Louis, Mo.
The Smith Oil and Gas Co.,	Washington, Ind.
The Williams Process Iron Co.,	Newark, N. J.
The Yellow Jacket Mining and Milling Co.,	Pueblo, Colo.
The Glengarnock Onyx Co.,	E. St. Louis, Ill.
California Smelting and Manufacturing Co.,	San Francisco, Cal.
The Marigold Mining and Investment Co.,	Denver, Colo.
The Mountain Lion Mining and Milling Co.,	Saguache, Colo.
The Buffalo Creek Coal Mining Co.,	Denver, Colo.
The United Concentration Co.,	Cleveland, Ohio.
The Puget Sound Reduction Co.,	Cleveland, Ohio.
Duluth and Winnipeg Terminal Co.,	Baltimore, Md.
The Goodland Mining and Milling Co.,	Goodland, Kans.
Bella Mining Co.,	Boise City, Idaho.
The Deming Ore Co.,	Deming, N. Mex.
Schreiner Mining Co.,	Las Cruces, N. Mex.
The Queen Bess Gold Mining Co.,	Denver, Colo.
The Ben Hur Mining and Milling Co.,	Fremont, Colo.
The Romance Consolidated Gold and Silver Mining Co.,	Denver, Colo.
Industrial Mining and Milling Co.,	San Francisco, Cal.
The Home Block Coal Co.,	Youngstown, Ohio.
German Mining and Milling Co.,	Rochester, N. Y.
Guthrie Center Coal Co.,	Guthrie Center, Iowa.
The J. M. Cooper Mercantile and Mining Co.,	Galena, Kans.
The Comstock Mining Co.,	Stockton, Kans.
The Blake Pearsall Co.,	Seattle, Wash.
Pora Iron Co.,	Duluth, Minn.
Bell Boy Mining Co.,	Joplin, Mo.
The Howells Mining Co.,	Massillon, Ohio.
Jordan Mining and Milling Co.,	Long Creek, Oregon.
The Grant Mining and Milling Co.,	Colo. Springs, Colo.
The Giant Camera Gold Mining and Milling Co.,	Denver, Colo.
Wisconsin Ornamental Stone Co.,	Chicago, Ill.
The Golden Castle Mining Co.,	Spokane, Wash.
The Gold Deposit Mining Co.,	Denver, Colo.
Eureka Consolidated Mining and Construction Co.,	Scona, Idaho.
Oliver Aluminum Co.,	New York City.
The Spring Creek Gold Mining and Milling Co.,	Denver, Colo.
The California Gold Mining and Milling Co.,	Fremont, Colo.
The Grey Eagle and Pocahontas Consolidated Mining Co.,	Leadville, Colo.
The Argent Consolidated Mining and Milling Co.,	Grand Junction, Colo.
Kniffin Coal, Coke and Mining Co.,	Dallas, Texas.
The Sopris Mining and Milling Co.,	Colo. Springs, Colo.
The Nettie Mining Co.,	Tacoma, Wash.
Saint Mary's Copper Co.,	Hancock, Mich.
Blue Jay Gold Mining Co.,	San Fransisco, Cal.
Jay County Mining Co.,	Portland, Ind.
The Southern Indiana Mining Co.,	Washington, Ind.
Union Metal Reduction Co.,	Chicago, Ill.
The Idaho Gold Extraction Co.,	Boise City, Idaho.
Solace Mining Co.,	Hailey, Idaho.
The Montana Hydraulic Mining Co.,	Butte, Mont.
Legal Tender Silver Mining Co.,	Missoula, Mont.
Swank Creek Mining Co.,	Tacoma, Wash.
White Sands Soda and Gypsum Co.,	Las Cruces, N. M.
The Carlton Consolidated Mining Co.,	Denver, Colo.
The Colusa Quicksilver Mining Co.,	San Francisco, Cal.
The Broad Top and Cambria Coal Co.,	Harrisburg, Pa.
Pacific Coal Co.,	Pittsburgh, Pa.
The Mitchell Coal and Coke Coke Co.,	Tyrone, Pa.
Southern Salt Co.,	Mason, W. Va.
The Beacon Gold and Silver Mining Co.,	Florrissant, Colo.
The Brookvale Mining and Tramway Co.,	Colo. Springs, Colo.
Erie Mining Co.,	Auburn, Cal.
The Gold Bluff Mining Co.,	Jersey City, N. J.
Blue Ridge Slate and Tile Co.,	Jersey City, N. J.
The Kaolin Mining Co.,	Chicago, Ill.
The Sunny Belle Mining and Milling Co.,	Colo. Springs, Colo.
The Nellie Mining Co.,	Telluride, Colo.
The Coin Silver Mining Co.,	Creede, Colo.
The Enola Mining and Milling Co.,	Fremont, Colo.
The Idaho Aluminum Mining and Manufacturing Co.,	Rathdrum, Idaho.
The Roanoke Coal and Coke Co.,	Rolfe, W. Va.
Eagle Mining and Milling Co.,	Tacoma, Wash.
American Smelting and Refining Co.,	Topeka, Kansas.
Empire Coal and Mining Co.,	Chicago, Ill.
The Quartz Creek Mining and Milling Co.,	Pitkin, Colo.
The Marguerite Consolidated Mining Co.,	Denver, Colo.
The Mo. Pac. Mining Co.,	Denver, Colo.
The Cripple Creek Gold Extraction and Power Co.,	Denver, Colo.
The Alverta Gold Mining Co.,	Denver, Colo.
The Latonia Mining Co.,	Leadville, Colo.
The Golden Gate Mining and Milling Co.,	Fremont, Colo.
The Spring Creek Mining Co.,	Colo. Springs, Colo.
The Merino Mining Co.,	Chadwick, Mo.
The Electric Lead and Zinc Co.,	St. Louis, Mo.
Colorado and Illinois Milling and Mining Co.,	Chicago, Ill.
The Bismarck Mining and Milling Co.,	Portland, Oregon.
Jonesport Red Granite Co.,	Jonesport, Maine.
American Kaolin Co.,	Portland, Oregon.
Spokane Smelting Co.,	Cheyenne, Wyoming.
James Duryea Mining Co.,	Sacramento, Cal.
Sweet's Metal Cross Tie Co.,	Los Angeles, Cal.
The Lincoln Mining Co.,	Helena, Mont.
The Philippi Coal and Coke Co.,	Philippi, W. Va.
The Pool Coal and Coke Co.,	Pittsburgh, Pa.
Inter-State Chlorinating Co.,	Olean, N. Y.
The American Electric Rock Drill Co.,	Jersey City, N. J.
The Jefferson and Monroe Manufacturing and Mining Co.,	Upland, Ind.
The Chief Lode Mining Co.,	St. Paul, Minn.

Messrs. McClave and Brooks, manufacturers of the celebrated McClave Grate and Argand Blower have removed from No. 401 Lackawanna Ave. to more commodious quarters at Nos. 301 and 303 Seventh St., this city. In the future they will be in better shape to meet the rapidly increasing demand for their grate and blower. We advise all steam users who have not seen these arrangements in use to write to them for one of their illustrated catalogues. There are hundreds of these grates and blowers in use, all of which are earning the highest commendations from users. The New York Steam Co., which has the largest steam heating plant in America, experimented with various grates and blowers for several years, and now use none but those manufactured by Messrs. McClave & Brooks. Hon. Eckley B. Coxe, of Drifton, Pa., who has probably done more experimenting in mechanics connected with mining than any other man in the country, has also adopted the McClave Grates and Argand Blowers at the steam plants connected with all of Coxe Bros. & Co.'s collieries.

On a recent order for Selden Patent Packing received by the manufacturer, Mr. Randolph Brandt, of 38 Cortlandt St., New York, the following foot note appeared:

"We consider the 'Selden' Packing far superior to any other packing we have ever used. It has so proven to us for both water and steam." Signed

MARTIN CAHILL,
Manager Mutual Mining Co., of Cannelburg, Ind.
J. N. CASSIDY,
Engineer Mutual Mining Co.

These gentlemen have been using the Selden Packing on large plunger pumps for over a year.

Messrs. Thomas Carlin's Sons, of Allegheny, Pa., write us as follows: "At present we are having quite a run on plans for grinding fire and red brick clays, and our hoisting engine department is also fairly busy."

HEAT AND FLAME.

Delivered in the Guildhall, Derby, February 27, 1892.

BY GEO. FLETCHER, ESQ., F.G.S., A. INST. E.E.

Of the Derby Municipal Technical College.

Mr. Fletcher said: The subject to which I ask your attention this afternoon is one of great importance to those engaged in mining and engineering work. It includes a large number of questions of great practical value. In the first place, I shall attempt to make clear certain great principles which will enable you to connect together many of the facts which I shall this afternoon illustrate by experiment. In the younger days of science, when what passed for philosophy concerned itself with speculations rather than experiments, heat was regarded as a material substance, and while philosophers like Bacon, Boyle, and others, imagined that heat was a kind of motion among the particles of a heated body, it remained for such investigators as Rumford and Davy to show that heat was not a material substance, but might be created by friction. Time would fail me to do more than mention the labors of these men. It is now an accepted fact that heat is simply a state due to the molecular condition of the heated body. We must regard it as a form of energy. As such we can convert it into other forms of energy and convert these in their turn into heat. It is one of the familiar facts of every-day life that friction gives rise to heat. Everyone knows that the tendency of friction is to destroy motion. We endeavor in our machinery to reduce friction to a minimum. Why? Because we know it is wasteful of the energy of mechanical motion, and also because we have heat produced where the friction takes place, in some cases to such an extent as to cause trouble with the bearings of machinery, and the greater the amount of friction the greater the quantity of heat developed. We see then that while mechanical motion may be destroyed, the energy which that motion represents cannot be destroyed; it is only converted into some other forms. Let us consider in what different ways heat may be produced. We may produce it by the friction of substances, by the striking together of two bodies, or simply by compression. Here is a brass cylinder into which fits a piston, to one end of which is attached a small piece of German tinder. If I suddenly push the piston into the cylinder so as to compress the air, sufficient heat is generated to set fire to the tinder. (Experiment.) In all these cases you will see that the heat is generated at the expense of motion, at least of visible motion, for as I shall presently hope to make clear, the destruction of the visible motion is accompanied by the quickening of the motion of the molecules which constitute the heated body. Thanks to the labors of such investigators as Mayer and Joule, the precise numerical equivalence between heat energy and mechanical energy has been determined. The latter, by a series of the most careful experiments, showed that if the work done by a body one pound in weight in falling through a distance of 772 feet were wholly expended in producing heat, that heat would be sufficient to raise the one pound of water through 1 deg. F. Or, conversely, if the amount of heat liberated by one pound of water falling, say from 60 deg. F. to 59 deg. F., be wholly expended in lifting a weight of one pound, it will be sufficient to lift it through a distance of 772 feet. Thus *the mechanical equivalent of heat* is 772 foot-pounds. The practical and theoretical importance of this determination cannot be overestimated.

There are yet other ways in which heat may be produced, but in every case the heat is generated at the expense of some other form of energy. You are already familiar with the conversion of electrical energy into heat and light. We may also produce it from what may be termed the energy of chemical separation. In order to dissociate the elements of a chemical compound, we have to apply energy. Thus we may separate the elements of water—oxygen and hydrogen—by means of the electrical current. The separation of these two gases represents the energy expended in dissociating them, and we can, by mixing them together and applying a light, cause them to reunite, with the production of heat. In all cases of combustion, in the burning of a fire or a gas, we have the energy of chemical separation converted into the energy of light and heat. (Experiments.)

The physical effects of change of temperature on bodies is of immense practical importance. As a general rule, solids, liquids, and gases expand with an increase of temperature. Their constituent molecules are caused to move more rapidly, and a change of volume results. Here is a rod of iron, which, as you see, fits accurately in a gauge bar. On heating it, however, it becomes too large to go in the gauge, but on cooling again it resumes its original dimensions. The force of the expansion and contraction, due to heating and cooling, is considerable. The contraction of this bar of wrought iron in cooling is sufficient to break this small rod of cast-iron. (Experiment.) Liquids expand more than solids for an equal rise of temperature. You will perceive that only a slight amount of heat is necessary in order to expand the water contained in this flask, and when the water is heated over a flame, the rise of the liquid within the tube indicates the rapid expansion. It must not be forgotten that the flask itself is expanding, but the liquid is expanding at a far greater rate. Here is another flask containing air. Through the cork runs a tube open at both ends. When the flask is heated the air expands considerably, and you observe that when I hold it with the open end of the tube below the surface of water, a continuous stream of bubbles passes through the water. The contained air is not very hot, and when I withdraw the flame it begins to cool. This is accompanied by contraction, as is manifested by the fact that the water is now being forced up the tube. Now it has reached the top of the tube and is running into the flask, and you notice that as soon as this takes place the air within is rapidly cooled by the water, which is projected against the end of the flask with some violence, forming a beautiful miniature fountain. You will see by the quantity of water in the flask that the expansion must have been considerable. Air, and, indeed, all gases, expand 1-273d part of their volume for every degree centigrade. This is known as the co-efficient of expansion for gases. There is one important exception to the general law of the expansion of bodies by heat to which I must refer. I refer to water. If we take water at 32 deg. F. (freezing point) and heat it, contraction will take place until a temperature of 39 deg. is reached, above which the liquid expands. This temperature is known as that of the maximum density of water.

In the case of a solid, increased temperature leads to an increase in volume, which means that the molecules which constitute it are driven further apart. This may take place to such an extent that the force of cohesion, which becomes feebler and feebler as the molecules are pushed further apart, is at last insufficient to prevent the particles from moving freely one over the other; and we have the change from a solid to a liquid state. With a still further increase of temperature, the molecules are driven further apart, until at last they are entirely freed from the influence of cohesion, and the gaseous state is reached. As you are perfectly aware, the temperature at which different substances change their state differs considerably. Some substances are gaseous at very low temperatures, while others cannot be rendered gaseous by the most intense heat which we can artificially produce.

Accompanying these changes of state are thermal phenomena of great importance. This may be well illustrated in the case of water. If we take ice and apply heat, we find that it does not melt suddenly, but that in order to melt it we must supply a considerable amount of heat. This heat is absorbed without raising the temperature, and hence is called latent heat. It is really employed to bring about that separation of the molecules which I have previously referred to. As soon as the last particle of ice has disappeared, the temperature begins to rise, and continues to do so until the boiling point is reached, and then the temperature is once more constant until all the water is turned to steam, the heat being employed to overcome the molecular cohesion.

The manner in which the heat is transmitted from one place to another is a subject of considerable importance. It may either pass *through* matter—conduction, *with* matter—convection, or independently of matter as ordinarily understood—radiation. In this case the medium of transmission is the ether. Different substances differ from each other very markedly in their ability for conducting heat. You will see that the heat from this flame, when applied to the junction between a compound bar of copper and iron is transmitted more rapidly through the copper than through the iron. (Experiment.) Liquids and gases become heated by means of convection. Water, as you will see, is a very bad conductor of heat, for when I heat the water in the upper part of this tube to the boiling point, that in the lower portion remains quite cold. If, however, I heat the water at the bottom of the tube, the heated water rises and cold currents descend to take its place. Here the water is heated by convection. You have an excellent example of the manner in which heat is transmitted through space independently of matter—namely, by radiation—in this little instrument (exhibiting Crooke's radiometer, which he explained).

It has already been explained that heat is produced by combustion. Now the burning of gas or a candle, or the coal on the fire, are examples of combustion—of chemical combination. The constituents of these substances are uniting with the oxygen of the air; the products of burning are given off, and light and heat are evolved. In each case the flame is produced by the chemical union of gases, which, in the act of combining, develop so much heat that their products are rendered incandescent. It is seen that it is necessary to initiate this chemical action by applying a light in the first place, but that as soon as started the action continues, for in the act of union, great heat is evolved, and this is communicated to other neighboring parts of the burning substance. The temperature required to initiate the action is different in many cases. Thus, certain gases combine spontaneously with oxygen at ordinary temperatures, while others, such as coal gas, require a high temperature to start the action. Unless the gases be raised to the temperature necessary they will not combine, or if gases in the act of combination—a flame—be cooled below that temperature, the action will cease. Thus, if a coil of copper wire be placed around a candle flame, the copper conducts the heat away so rapidly that the temperature of the flame is reduced and goes out. This does not take place if the coil of wire is previously heated. This is a fact of immense practical value. Upon it depends the action of our safety-lamps. Sir Humphrey Davy found, in his early experiments on explosive mixtures of fire-damp and air, that a high temperature was necessary to bring about an explosion and that, therefore, it was not difficult to cool down the flame below the temperature essential in order that combination should take place. He found that metallic tubes, a fifth of an inch in diameter and 1½ inch long, stopped an explosion, and that the flame would not pass through wire gauze, owing to the cooling action it exerts upon the flame.

The heat liberated by the burning of a particular gas will, of course, depend upon the rate at which the action of combination takes place. If we increase the supply of air to a burning gas, we increase the rate, as in the case of a blowpipe flame. Here I have a blowpipe, in which, instead of air, I supply pure oxygen, and we get intense heat produced—so intense that, as you see, wrought iron is rapidly melted, and iron filings are instantly raised to a white heat and oxidized. Here the rate of combination is very rapid.

Where we have the two gases between which union takes place *mixed* with each other, the combination takes place with great rapidity, and an *explosion* results. It must not, however, be imagined that this is really instantaneous. A number of experiments have been made with a view to determine the rate at which flame travels through various explosive mixtures. In the case of a mixture of oxygen and hydrogen of maximum explosive power, it was found that flame travels at the rate of about 37 yards per second, and in many other mixtures at a much slower rate.

It will be interesting now to consider upon what the luminosity of flames depends. Here is a burner in which air is allowed to *mix* with coal gas before burning. It is known as a Bunsen burner, and you will observe that the flame produced is non-luminous. If I close the holes which are at the bottom of the tube, and so prevent the air mixing with the gas, the flame becomes luminous, as with the use of an ordinary burner. There is another important difference between the flames: that of the Bunsen burner is smokeless and will not blacken anything placed over or in it. The luminous flame is smoky, and covers with soot a glass rod or other body placed within it. Is there any relation between the two phenomena? Davy's idea was that the luminosity was due to soot in the flame; but it has been argued that there are certain luminous flames (such as the flame of phosphorous burning with oxygen) which cannot contain solid particles. Professor Frankland proposed a theory which explains the luminosity as due to the presence of dense gases. He had observed that a candle burning on Mont Blanc gave less light than under ordinary circumstances, although the rate of burning was unchanged. Experimenting in the laboratory, he found that the luminosity of any flame was diminished by a diminution of pressure, and *vice versa*, while a non-luminous hydrogen flame becomes as luminous as a coal-gas flame of the same size under a pressure of 20 atmospheres. He discovered that soot from a flame contained a quantity of hydrogen which could not be separated, and it was found that under pressure a hydrogen flame yields a spectrum in which the hydrogen lines widen out until the spectrum becomes continuous. He thought that the soot from a flame was purely a condensation product, and urged that, if a flame contained solid particles, it would not be transparent. The German chemist, Heumann, however, showed that soot was not a condensation product—that if you heat a porcelain rod and held it in the flame you will get as much soot deposited upon it as if it were cold, and also that you would get a larger amount deposited upon the under than upon the upper side. He further showed that a flame casts a shadow, due to the solid particles it contains, and that if you mix with luminous coal gas carbonic acid gas, or even hydrogen, its luminosity is diminished, or even destroyed. Indeed, if by any means you can prevent the carbon from being separated out as soot you reduce the luminosity. Now a certain temperature is necessary to separate the carbon from the carbon-holding molecules, and if you added an indifferent gas, such as nitrogen or carbonic acid gas, the carbon-holding molecules are separated one from the other; the carbon is not separated, and the flame is non-luminous. Gas used for illuminating purposes should, then, be as free as possible from these indifferent gases, which diminish the luminosity.

It is found that heat aids the separation of the carbon as soot. Here I have a Bunsen burner with a platinum tube. You notice that we now have an ordinary non-luminous Bunsen flame. I will now direct upon the platinum tube a blowpipe flame, and you notice that as it gets hot the flame becomes more and more luminous. I now extinguish the blowpipe flame and direct a current of cool air across the tube. The flame again becomes non-luminous. We see the advantage then of warming the gas before it is burnt, and the gas may be carried over its own flame, as is now commonly done in street lamps. You will further see that if I allow two ordinary gas flames to play one upon the other, we get a greatly increased luminosity without increased consumption. It is also advantageous to use burners with nozzles of low conducting power, such as steatite.

In conclusion, Mr. Fletcher dealt at some length with the influence of suspended combustible dust, such as coal-dust, in enhancing the effects of explosions in coal mines, illustrating his remarks with experiments.

TESTING FOR GAS IN COAL MINES.

A Lecture Delivered in the University College, Nottingham, (Eng.), February 6th 1892.

BY PROFESSOR CLOWES.

Professor Clowes said: The term "gas testing" should refer only to the best ways of detecting the presence of low percentages of fire-damp in air, and of measuring their amount. This involves the careful use of an appropriate safety-lamp or other apparatus. Any form of safety-lamp in unskilled hands will indicate proportions of fire-damp exceeding about 6 or 7 per cent. Such mixtures make the flame increase in size, and then flare and flicker, or they totally extinguish it if the proportion of gas is high. These signs of the presence of gas cannot be mistaken, and they are supplemented in some of the less perfect forms of lamp by the burning of the gas itself inside the lamp (experiments shown).

The Garforth detector, which serves to introduce the gas, taken from any suspected part, into the lamp, and make it light the flame, serves well to find gas, if it is not mixed with much air (gas was shown by this detector).

When the proportion of gas to be detected falls below 2 per cent., however, only the careful use of a suitable lamp or apparatus will serve to detect it and measure its amount.

It may be urged that very low percentages of gas need not be detected, as they give rise to no risk of explosion. This statement, however, certainly requires qualification in the light of what is now known with regard to the influence of the presence of fine coal-dust. Air containing less than 2 per cent. of gas becomes explosive if it is mingled with coal-dust, and accordingly, in dusty mines, percentages of gas less than those which can be found by an ordinary lamp must undoubtedly be looked for.

Then, again, in order to test the sufficiency of the ventilation, and more especially to ascertain that the air reaching the mine by the "downcast" is properly divided up into the "splits," so that each split gets its due share, it is absolutely necessary to ascertain periodically the percentage of gas in the "returns." The percentages of gas to be determined in the returns will usually be below the lowest quantity detectable by an ordinary safety-lamp.

If there should exist amongst managers any unwillingness to use the most perfect means of gas-testing, simply because they do not wish to know the worst concerning the state of the ventilation of their mines, either as regards its amount, or its proper distribution, this feeling must surely give way in the present age of scientific progress, and in view of the preventable danger which is incurred by such recklessness.

The only satisfactory and trustworthy methods of gas-testing at present known depend upon the fact that even the smallest percentages of gas in air, which cannot be kindled by a flame, will yet burn completely if they are kept in contact with a sufficiently hot surface (experiment shown). Thus, air containing a mere trace of gas shows a pale mantle of flame, or "flame-cap," around an ordinary flame which is burning in it (experiment shown). Also a wire maintained at a red heat by the passage of an electric current, when introduced into such air, becomes visibly brighter; this is due to the gas present in the air burning around the wire, and imparting the heat of its combustion to the wire. It is on these facts that the most important methods of gas-testing rest.

The most satisfactory gas-indicator as yet produced is that of Liveing. It consists of a small box, enclosing apparatus for producing an electric current. This current is passed through two spirals of fine platinum wire, and heats them to redness; both of them being maintained at the same heat. One of the spirals is enclosed in air free from gas, the other is exposed, with suitable precautions, to the air of the mine. If gas is present in the air of the mine, the spiral which is immersed in the mine-air glows more brightly than the other. This increase of brightness is proportioned to the amount of gas present; and by a simple arrangement for measuring the difference of the brilliancy of the spirals, the percentage of gas present in the air can be at once read off upon a scale. The delicacy of this instrument is shown by the fact that, with 2 per cent. of gas in the air, the spiral becomes no less than five times as bright as the other; and the difference of its brightness is easily perceptible when only 0·25 per cent. of gas is present (this apparatus was explained, and its uses illustrated by means of a large dissected model, by diagrams and projected photographs, and by the exhibition of the indicator itself). The only objections which seem to be raised to the use of this apparatus in the mine is that it is costly, that it necessitates the carrying of a special apparatus, and that some trouble has arisen from the spirals being rendered useless by fusion of the metal, caused by overheating them. If no simpler and less costly and troublesome apparatus is available, these objections surely are not of very great weight; they seem insufficient to account for the neglect with which this apparatus has been treated since its invention in 1880.

Another apparatus depending upon the use of an electrically-heated wire is that devised by Maurice, a man practically connected with coal mining. In this apparatus a sample of the air to be tested is enclosed, and a wire is kept glowing in it by means of electricity for a few minutes. Any gas present in the air is thus burnt. The percentage of gas in the air is then measured by the decrease of pressure which occurs, and which is measured upon a water-gauge. The gas in burning causes three times its own volume of air to disappear: hence arises the decrease of pressure, which will be proportioned to the amount of gas present. This apparatus is sound in principle. It seems doubtful whether it is as simple in practice as that of Liveing (Maurice's apparatus was explained by diagrams, by a working model, and the apparatus was shown).

In endeavoring to devise a satisfactory and delicate gas-indicator, attempts have been made to improve the method originally employed, that of detecting the gas by the "cap" appearing over the flame of the safety-lamp. The ordinary forms of safety lamp, even in the hand of those experienced in gas-testing, will not with certainty indicate less than 2 per cent. of gas. The delicacy of the "flame-cap" test has, however, recently been vastly increased. The examination of lamps specially designed for gas-testing has been undertaken in Prussia, and has resulted in the recommendation of an extremely sensitive lamp devised by Pieler. The examination of the sensitiveness of certain modified lamps for gas-testing has also more recently been reported upon by a Royal Commission on Accidents in Mines. The lecturer has devised a special apparatus for the purpose, and his experiments have thus far had the result of proving that the Hepplewhite-Gray lamp, as modified by James Ashworth, is capable of detecting and measuring extremely low percentages of gas.

The Pieler lamp burns methylated spirits; the flame is large and is shielded from the eye; the "cap" seen over this flame with very low percentages of gas is large and well-defined; there is no difficulty in detecting and measuring it. The cap is over an inch in height when only a quarter of 1 per cent. of gas is present (the Pieler lamp was shown in action). Objections have been taken to this lamp on the score of its being useless for lighting purposes, since its flame is pale; this necessitates the carrying of a safety-lamp with it. It is also said to be dangerous; in one sense at least there is danger incurred when the lamp is in careless hands, since the spirits, if spilt upon the flame, will blaze, and its vapor is explosive when mixed with air and fired (proved by experiments). These sources of danger, however, vanish with care (the Pieler lamp was shown burning in air containing gas).

The modified lamp introduced by Ashworth, when it is burning benzoline is open to the same objection when it is placed in careless hands. Benzoline is an inflammable spirit, and its vapor when mixed with air is explosive. But it presents no other danger, and it has the decided advantage of furnishing either a brilliant illuminating flame or a pale gas-testing flame as may be desired. The preparation of the part of the glass cylinder immediately behind the flame also adds immensely to the sensitiveness of the lamp for gas-testing. The "flame-cap" is so pale that in order to render a small cap visible, the lamp-flame must itself be almost non-luminous; and, further all reflections of the flame from the glass must be abolished. By a low-pitch screw, the wick of the lamp can be gradually drawn down until the flame is small and pale blue in color. This flame is then examined against a lamp-glass ground at the back, so as to give no reflections. A still better surface is obtained by smoking the back of lamp-glass inside with the flame of a wax taper. Ashworth's modified lamp used in this way readily detects half a per cent. of gas by a cap about 7 millimeters, or a quarter of an inch, in height: with one per cent. the cap is 10 millimeters, with 2 per cent. 14, with 3 per cent. 20, with 4 per cent. 25, and with 5 per cent. 30 millimeters in height. Here we have a lamp which is at once a good lighting and a good testing-lamp. Mr. Ashworth has arranged for burning safe oils, which are free from the dangers of benzoline, in his lamp. With these oils the lighting power of the lamp is admirable, but the lowered flame is not absolutely pale, and is not, therefore, as sensitive for gas testing as the benzoline flame (the lamp and its special glasses were shown, and the lamp was shown with full lighting power, and with a cap in gas).

It will be seen that much has been done towards producing a safety-lamp which is very sensitive for gas-testing, and is at the same time a good illuminator. But, probably, more may yet be done; and an arrangement for gas-testing may be applied to a safety-lamp which will free the lamp from the reputed danger of burning benzoline or inflammable spirit of any kind, and yet give good flame-caps.

What is to be desired is a flame which shall not only be pale, but hot, and also sufficiently large. The flame produced by drawing down the wick of a safety-lamp burning oil is not sufficiently pale; it is also so small that it lacks the heat necessary to produce a large and well-defined cap; while the very smallness of the flame makes it liable to go out, and to cause the gas-tester to lose his flame in a place where he cannot relight it.

As far as my experiments have gone at present, they indicate that the flame of burning hydrogen fulfills all the conditions required for very delicate gas testing. I shall probably have more to say about this in a future lecture.

The apparatus which I have constructed for testing the sensitiveness of lamps for gas testing consists of a large air-tight wooden box of about 100 litres capacity. It is mounted on legs of a convenient height. In the front is a window for examining the lamp in the interior; the lamp being introduced through an opening in the bottom of the chamber, which is closed by a small tray of water. The interior of the testing chamber is painted dead-black. And a large thin board, almost equal in size to the section of the chamber, is suspended from an axis in one of the upper corners, so that it can be swung up and down in the chamber to mix the gas and air. The gas is introduced in measured quantity from a gasholder into the top of the chamber, the air which it displaces being allowed to escape below. After the gas and air in the chamber have been mixed, the lamp is introduced, and the size and appearance of the flame-cap caused by the known percentage of gas is observed. The experiments are made in a dark room, and the eye should have been in darkness for some time before examining the flame. The gas used in the experiments was marsh-gas chemically prepared. The apparatus furnishes a ready means of testing the sensitiveness of safety-lamps as gas-indicators; and I am at present applying it to other matters of interest in connection with gas-testing (the testing-chamber was exhibited, and explained by diagrams and photographs; it was then charged, and a lamp was introduced).

WESTERN PENNSYLVANIA CENTRAL MINING INSTITUTE.

An Interesting and Well Attended Meeting Held at Pittsburgh.

The Western Pennsylvania Central Mining Institute met in the Court-House at Pittsburgh June 28th. In absence of the President, Inspector J. T. Evans was made President *pro tem.*

The first paper was read by Inspector William Duncan on "The Advantages of a Slope over a Shaft." Mr. Duncan took the ground that under certain circumstances the advantages in economy of construction and working were as 5 to 3 in favor of the slope.

This view was combated quite briskly by several, and ex-Inspector F. C. Keighley asked, and was granted leave to prepare a paper for the next meeting showing "The Advantages of a Shaft over a Slope."

The next question for debate was "Does The Present Bituminous Mine Law Need Revising?"

The general expression was that it did and that the law proposed at the last session of the Legislature was in general a very good one and with a few changes would be acceptable to both miners and operators. After a discussion of the weak points of the present law the Chair was authorized to appoint a committee consisting of the eight Inspectors, three operators and three miners, to serve without pay, who should consider the matter and report to the next meeting of the Institute what changes should be made in the law as proposed to the last Legislature.

The general feeling shown during the debate was that several points of the law were impossible of enforcement and impractical, and that if these could be modified there would be little opposition to it.

The next question was: "Should a Miner Have a Theoretical Knowledge of Mine Gases?"

There was considerable discussion on the question, but it was very one-sided, and the meeting decided the question unanimously in the affirmative.

The next question was: "What are the Relative Advantages and Disadvantages of the Exhaust over the Blowing Fan for Ventilating Purposes?"

Inspector Jenkins said he thought the blowing fans best as the exhaust fan rarifies or lightens the air and allows the gas to come forth in undue quantities upon small changes in the barometer, while a blowing fan compresses and to a large degree overcomes this tendency. Also if there is black-damp the extra pressure from the blowing fan serves to keep it back in the falls and unused places. Also, an exhaust fan on account of handling the expanded air will require more power than the blower, as the blower puts it into the mine under pressure and in smaller bulk and it expands in the mine. In case of falls stopping the current, the exhaust fan rarefies the air, and the mine is quickly filled with gas.

Mr. Stinner said: The exhaust fan will produce more air than the blower, for while the blower fan makes the air heavier it thereby increases the friction.

Mr. King said he knew of no particular advantage for either. Fans should be so put up that they can be used either as force or exhaust. In the Broad Top region it is necessary that they shall be able to work in either direction at different times of the year, as the great difference in elevation between the intake and outlet causes a powerful natural current which changes its direction with the changes of outside temperature.

Mr. Keighley favored the blowing fan, and gave some figures in regard to a change which he had made from exhaust to force fan. He said, however, that certain natural conditions had much to do with the apparently favorable results of the force fan, so that the test was hardly a fair one.

Mr. Evans said: The advantages of an exhaust fan are: *1st.* The fouled return air does not pass through the haulage road. *2d.* In case of an explosion the jar to the fan is less. *3d.* It has advantages in protecting the shaft timber. Its disadvantages are: *1st.* The air meeting loaded mine cars causing greater friction; *2d.* Winter causes ice in the shaft; *3d.* Pressure is less and more gases are liberated.

Mr. Hartley considered force fans dangerous in gaseous mines, as on account of compression the gases are held in the waste places and crevices, and a sudden diminution of the ventilating pressure will allow them to come out and expand, thus filling the mine quickly.

Mr. Blick preferred exhaust fans. It was better to take all the pressure possible off and let the gas come out and be carried away than to pin it up with a blowing fan and have it let loose by some unexpected accident.

The meeting was about equally divided on the merits of the two fans. The meeting then adjourned till the next morning.

When the meeting was called to order on the morning of the 29th the report of the committee on oil and gas wells was read. This committee was appointed at a former meeting of the Institute to consider how coal mines should be protected from oil and gas wells. The report was debated by the Institute article by article, and as finally adopted is as follows:

REPORT OF COMMITTEE ON GAS AND OIL WELLS.

Owing to the imminent danger and constant menace to the lives to the miners working in the Bituminous mines of this State, and the great liability of many of the valuable coal properties thereof being rendered useless from the blind policy that is being pursued by the oil operators in boring oil and gas wells through the workings of the said coal mines without proper regulation, and regardless of what might become of the lives of the workmen or property rights of others, therefore we, your committee appointed at the last meeting of this Institute, beg leave to make the following suggestions which we deem necessary to afford a reasonable degree of protection to all engaged in operating mines in the oil and gas regions of this state:

First. That we petition the Legislature at its next session to enact a law for the protection of workingmen employed in the Bituminous mines and to guard against the probable destruction of valuable mining properties from the escape of explosive gas and oil into the coal mines from bore-holes bored into the gas and oil bearing strata which underlie the coal measures in so many counties of the State.

Second. That an expert Mining Engineer be appointed to enforce the statue regulating the boring of oil and gas wells through the coal measures and the sealing of the same after abandonment.

Third. That all bore-holes which are to be bored for natural gas or oil shall be properly located by the State Mining Engineer on a county map immediately after boring operations begin, said maps to become the property of the State and a copy of all such to be kept at some of the State departments for public inspection and a copy also to be filed as a public document with the prothonotary of the county in which said wells or bore holes are situated.

Fourth. That before any individual, firm, or corporation owning or operating a gas or oil well shall abandon the same, he or they or their lawful agent shall notify the said State Mining Engineer of their intention of abandoning it, who shall immediately visit the said well and shall see that it is properly sealed from bottom to top by an approved cement.

Fifth. That after the sealing of the well has been approved by the said State Mining Engineer, he shall issue a certificate as evidence of the fact that said well has been hermetically sealed, after which the oil or gas company shall be released from further liability.

Sixth. That if any coal operator, firm, or corporation shall have opened a coal mine, thereby giving them the prior right of working their mineral property, no individual, firm, or corporation thereafter desiring to bore oil or gas wells shall be allowed to locate said wells at such places as to interfere in any way with the main passages or projected passages, main or cross-headings and air courses of the mine.

Seventh. That when any gas or oil well has been bored through solid coal, the coal company, provided the well is not abandoned and hermetically sealed, shall be required to leave a solid block of coal around the producing well, of such dimensions as the State Mining Engineer shall approve; but for each ton of coal left for such purposes the oil operator or company shall be required to pay to the owner or operator of said coal a reasonable compensation for the amount of coal left, provided said coal cannot be profitably recovered by the mining company after the well is abandoned.

Eighth. That when gas or oil wells are bored through an abandoned part of a producing coal mine, and the roof strata above the coal seam have not subsided, stone or brick walls shall be built by the parties boring such wells and said walls shall be of such size as the State Mining Engineer shall approve and should the roof strata have thoroughly subsided in said abandoned parts, the said oil operator shall be required to put in the well, for a depth of at least ten feet below the floor of the excavated coal seam, a strong outer metal casing, leaving between it and the main casing of the well, a space of at least one inch at all parts.

Ninth. That all pipe lines for conveying gas over coal properties which are being mined or over abandoned parts of any mine that is in operation, shall be layed on trestle work on the surface and the method of laying the pipe line shall be approved by the State Mining Engineer.

Tenth. That the State Mining Engineer shall be empowered to locate, at the expense of the State or county, all abandoned holes, such holes to be filled up as herein set forth.

Eleventh. That each deed of property shall describe the number of holes that are being or have been drilled on the estate that the deed represents.

Twelfth. That all individuals, companies, or corporations, before drilling a hole shall cause to be deposited in the hands of the State or County Treasurer a sum equivalent to the cost of locating and filling up such hole or holes.

Thirteenth. That all oil or gas companies shall be placed under bonds to faithfully carry out the provisions of the act.

The consideration of this question consumed all the morning and it was found necessary to omit part of the program for the afternoon.

At the afternoon session, the first paper was by W. S. Gresley, of Erie, Pa., entitled "The General System of Longwall." Mr. Gresley was not present, and the paper was read by Inspector Evans. At the close a vote of thanks was given Mr. Gresley for his paper. The next was a paper by Inspector Blick, entitled "The Longwall that would be Applicable to the Pittsburgh Seam." This was a very able paper and excited much interest and some criticism. Mr. Blick explained several points that were criticised. After this the meeting adjourned to meet again next December.

The Mineral Wealth of Newfoundland.

In a report to the Colonial Office on the condition of Newfoundland, it is stated that ores of antimony, zinc, molybdenite, manganese, chromite, nickel, hæmatite, rutile, gold, silver, etc., are all known to exist; while of the earthy minerals and non-metallic substances there are a great variety, and in many cases an abundance of material. During the year 1890 valuable seams of coal were discovered in the vicinity of St. George's Bay. Previous to this the St. George's Bay carboniferous area was generally thought to be destitute of workable coal seams, and as being occupied almost entirely by the lower measures, namely, the carboniferous limestone and millstone grit series. It is gratifying to be able to state that, upon reference of the fossil plants and samples obtained during the year to Sir William Dawson, Principal of M'Gill University in Montreal, one of the most eminent authorities upon fossil botany in North America, he has given it as his opinion that "the specimens sent indicate a development of the coal measures not unlike that of Eastern Cape Breton, with which the beds may be connected under the gulf;" and he adds that the government of this colony would do well "to inform the English Government of the value of the coals on the west coast and their prospective importance to Britain and Newfoundland as well as to the other colonies. You have," he adds, "the nearest coal to England on this side the Atlantic." The investigation in the section of country referred to has brought to light 27 ft. of coal, which is but 10 ft. less than that of the North Sydney Section. The analysis of this coal gives a percentage of carbon not inferior to that of Cape Breton coal.

Messrs. Abendroth & Root Manufacturing Company, 28 Cliff St., New York City, recently furnished two 266 H. P. Root water-tube safety steam boilers to the great Shattuck & Babcock Co. Mill, De Pere, Wis., one of the finest pipe-making establishments in the Fox River Valley paper district.

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THE SALARIES OF THE BITUMINOUS MINE INSPECTORS OF PENNSYLVANIA.

ONE of the peculiar differences existing between the Anthracite and Bituminous Mine Laws of Pennsylvania, and a very unjust one, is the inequality of the salaries of the Inspectors of Mines. The Inspectors of the Anthracite mines are each paid $3,000 per year, while the Bituminous Inspectors are paid but $2,000. That the salaries paid the Anthracite Inspectors are not too high, is proven by the fact that a number of them, in the past, have resigned to accept more remunerative and less laborious and less hazardous positions with large firms or corporations engaged in the coal business. They were offered these positions on account of superior mining ability, such as is absolutely necessary in a competent Inspector, and which also made them desirable to their new employers. If superior mining ability is worth more than $3,000 per year to private firms and corporations, it must certainly be worth $3,000 to the State.

The Bituminous Inspectors, to comply with the spirit and letter of the Bituminous Mine Law, must be men equal in ability to the Anthracite Inspectors. Their duties are equally as laborious and hazardous, but they only receive a salary of $2,000 per year each. This is unjust and tends to keep many men of superior ability from competing for the position, because they can do better with private corporations.

No class of men connected with the mining industry of Pennsylvania are exposed to as many dangers as the Inspectors, and nobody could cope with these dangers more fearlessly and with more disregard for self than they do. The ordinary superintendent or mine foreman must only meet the dangers incident to the mine or mines with which he is directly connected. The Inspector must be on hand and direct the work of rescue after every serious accident at any of the many mines in his district, and he is frequently called to assist in similar work in neighboring districts. He must lead the rescuing party into the very jaws of death, and on his judgment and coolness the lives of scores of men often depend. In the discharge of his duty, even when no accident has occurred, he must visit dangerous localities and direct how the dangers are to be removed. He must, besides his mining ability and good judgment, be sufficiently politic to secure the enforcement of the law without causing friction between employer and employe, and between the State as represented by himself and all parties coming under the provisions of the law. Taken all in all, he must be just such a man as is desired by every large mine owner as a manager, and should therefore receive from the State a salary large enough to make it an object for him to remain in the employ of the Commonwealth.

The Bituminous inspection districts, as a rule, cover much more territory than the Anthracite districts, and as railroad facilities are generally not quite as good, the Bituminous Inspector is compelled to spend more time away from his home than the Anthracite Inspector. To fill his office satisfactorily, he must be the peer of the Anthracite Inspector in knowledge, judgment, and courage. He is called on to perform exactly the same duties, and is exposed to exactly the same dangers. His services are in demand from Bituminous colliery owners who offer him less laborious and less hazardous positions with greater salary.

Recently the H. C. Frick Coke Company wanted a well-qualified superintendent for one of its extensive collieries and General Manager Lynch offered the position with a fair salary to Inspector Austin King, of the Eighth Bituminous District, and secured his services. Mr. King resigned an office with most onerous duties, to accept a more profitable position, with less work and fewer dangers, and the State lost the services of a most competent man. It is true, the State secured a good man in his place, but it has no guarantee that his successor will not follow Mr. King's example at the first opportunity, and he cannot be blamed if he does. Another similar instance occurred when Mr. F. C. Keighley resigned as Inspector of the Fifth Bituminous District. If the salaries paid Messrs. King and Keighley had been $3,000 per year instead of $2,000, they would probably not have resigned.

If the salaries of the Bituminous Inspectors are placed at $3,000 per year, the State will simply be doing justice to deserving and hard-worked officials. With such a salary attached to the office many men of superior ability, who will not now accept the position, will appear before the examining boards and naturally the efficiency of the inspection service will be increased.

Great Britain pays her Chief Inspectors £800 or $4,000 per year, and her first-class Assistant Inspectors £400 or $2,000 per year, and the inspection districts are not nearly as large as those of Pennsylvania. Besides the term of office is for life or good behavior. The result is that the inspection service of Great Britain has reached a high standard of efficiency. To attain such a result in Pennsylvania, the State must pay sufficient salary to not only obtain, but to retain first-class talent. An increase of the salaries of the Bituminous Inspectors to $3,000 per year will be a move in the right direction and it will be productive of good. All colliery officials and miners should employ every means in their power to influence the next Legislature to pass an amendment to the Mine Law of 1885, fixing the salaries of the Bituminous Inspectors at $3,000 per year instead of $2,000 as they now are.

FALLS OF ROOF AND SIDES.

OVER 40 per cent. of all the fatal accidents which occurred in the mines of Pennsylvania during the year 1890 were due to falls of roof and sides. This percentage is about the average of similar accidents in the other States in the Union and in Great Britain.

Two papers which have been recently read before the Manchester Geological Society (Eng.) afford a few statistics and practical suggestions on this subject.

In England during the past 40 years the deaths from all kinds of accidents have decreased from 1 in 219 to 1 in 530 persons employed. During the same period the deaths from falls of roof and sides have only decreased from 1 in 661 to 1 in 1,135 persons employed. In other words, the number of deaths from this kind of accident has only been reduced to $\frac{3}{5}$ of what they previously were, while deaths from *all* kinds of accidents have decreased to $\frac{2}{5}$, so that the fatalities from falls have not decreased in as great a ratio as the whole.

Mr. Henry Hall, English Government Inspector of Mines, states that during the 17 years ending 1889 the total deaths in England from falls of roof and sides was 7,790, or 45 per cent. of the total number of deaths from accidents.

In Northumberland the ratio of deaths from falls was less than in Lancashire. It was generally supposed that the good roof in the former district was the cause of its comparative freedom from such accidents. As the percentage in Northumberland is, however, gradually decreasing, while that in Lancashire remains steady, this reason does not seem to be good.

Mr. Hall says that Northumberland men work 1½ to 2 hours less per man per day than the Lancashire men and are therefore exposed a shorter time to danger. This may be a reason for the lower percentage but the real reason is that in Northumberland the timbering is done by skilled officials, and not left to the workmen. In Lancashire the timbering at the working face is done by the miners themselves.

In every branch of mining it is noticeable that where the work is done by the owners the security of life is greater, but where it is left to the men working on contract no appreciable advance has been made. As circumstances vary in every mine, Mr. Hall suggests that each manager should have a rule, and be compelled to enforce it, specifying how far the props should be placed apart suited to the special conditions of the mine. This distance would depend on the nature of the roof and floor and on other conditions, and while it is not feasible to alter the present custom of the miners setting their own timber, more official control might be secured in this way.

ELECTRICAL TERMS.

A GREAT number of mining students are desirous of obtaining some practical knowledge of electricity, but find at the outset difficulty in understanding the terms used. When an Englishman first comes to reside in America he is best able to appreciate the value of his purchase at the stores by converting the dollars and cents into pounds, shillings, and pence. It is just the same with the young electrical student. He knows by reading a text-book on electricity that the "volt" is the unit of electric pressure but he has no means of estimating what relation there is between volts or amperes, and pounds or gallons.

Practically there is no thorough definition of electricity. No one has as yet found out really what the subtle force is.

Probably the best way is to compare it with some force, with which we are familiar and the best for that purpose seems to be hydraulics, or water power.

In some large cities there are pipes laid underground called high pressure hydraulic mains. These mains pass water at a high pressure for the purpose of supplying water power for working hydraulic hoists, etc., in the city. The water is passed through these mains under pressure supplied by the engines at the main pumping station. In electrical practice the power is supplied by what is called the dynamo at the generating electric station. This power is passed through wires either under or above ground to the electric motor.

A tabulated statement will help to make the comparison clear.

WATER POWER.		ELECTRIC POWER.
Pumping Station	=	Generating Electric Station.
High Pressure Main Pipes	=	Conducting Wires.
Water Motor	=	Electric Motor.

There are other conditions in hydraulics which have their equivalents in electricity. For instance, the water in passing through the pipes underground meets with a certain amount of frictional resistance in rubbing against the sides of the pipes and the extent of the resistance is in proportion to the diameter and length of the pipes. A certain percentage of the total pressure or power exerted at the pumping station is thus absorbed and only the remainder is available at the water motor. In the same way a certain percentage of the total power exerted at the generating electric station is absorbed in passing through the conducting wires and this percentage depends in the length, size, and quality of the wire used.

The effective pressure of the electric motor is expressed as so many "volts" in the same way as the pressure of the water motor is expressed in "pounds per square inch." The quantity of electricity is measured in "amperes" as the quantity of water is measured in "gallons." The resistance of the wires is expressed in "ohms" as the frictional resistance of the pipes is expressed in "pounds" pressure required to overcome it.

The "volt" is the unit of electric pressure as the "pound" is the unit of water pressure. The voltage or number of volts is sometimes called the electro-motive force, or for ›hort the E. M. F.

The value of a "volt" is the amount of pressure required to cause a current of one "ampere" to flow through a wire with a resistance of one "ohm." It is the measure of the energy of any electric battery or cell. An ordinary Daniell's cell newly made up has an E. M. F. of 1·072 volts, a Leclanche cell as used for electric bells or household use has an E. M. F. of $1\frac{1}{2}$ volts and a bichromate cell, well known from its bottle shape, has an E. M. F. of nearly 2 volts.

The "ohm" is the unit of resistance and is that offered by a column of mercury one square millimeter or ·00155 inch in section, and 106 centimeters or 41·733 inches in length. A copper wire 1000 feet in length and $\frac{1}{100}$ of an inch in diameter will, if the metal is pure, offer a resistance of 1·0068 ohms at a temperature of 60° Fahr. A German silver wire only 36 inches long and $\frac{1}{250}$ of an inch in diameter will offer a resistance of 1·12 ohms.

The "ampere" is the unit of current and is the amount which a pressure of one volt can force through one ohm. The volt is represented by the letter E, the ohm by R, and the ampere by C, the number of amperes can be obtained by dividing the volts by the ohms, thus:

$$\frac{\text{Volts}}{\text{Ohms}} = \text{Amperes},$$

Or, using symbols:

$$\frac{E}{R} = C.$$

In mechanics, hydraulics, etc., we do not speak of pounds pressure but of horse-power, and we know that a horse-power is the power required to raise one pound 33,000 feet in one minute or 33,000 pounds one foot in one minute. A horse-power is therefore called the unit of power and in the same way the unit of power in electricity is called a "Watt." This horse-power is most usefully employed when the greatest percentage is used in doing work and is least usefully employed when a large percentage is needed to overcome friction before it gets to the point where the work is to be done. In the same way a "Watt" is doing its best work when it is giving the best results either in electric light or as mechanical power, and it is least effective when it is wasting its power in heating the wires, the dynamo, or the motor.

The horse-power is the pressure multiplied by the quantity, the Watt is the volts multiplied by the amperes, and as volts is equivalent to pressure and amperes to quantity then a Watt is equivalent in character to a horse-power. We say they are equivalent in character but they are not, however, equal in power as a Watt is only $\frac{1}{746}$ of a horse-power, to find out therefore what horse-power is being exerted by an electrical installation, we must multiply the volts by the amperes and divide by 746, thus:

$$\frac{E \times C}{746} \text{ or } \frac{\text{Watts}}{746} = \text{H. P.}$$

In the same way if we have a certain horse-power and want to know to how many Watts it is equivalent we use the following formula:

$$\text{H. P.} \times 746 = \text{Watts},$$

and

$$\frac{\text{Watts}}{\text{Amperes}} = \text{Volts},$$

or,

$$\frac{\text{Watts}}{\text{Volts}} = \text{Amperes}.$$

EDITORIAL NOTES.

A NEW explosive. Messrs. Von Dahmen & Co., of Castrop, Westphalia, Germany, have introduced a new explosive called Dahmenit. Experiments have been made with it at several coal mines and stone quarries throughout the Westphalian and Saarbrucken mining districts. The results have proved everywhere very satisfactory. It is claimed that Dahmenit is quite harmless, and can be handled with safety. It explodes only by the action of a powerful detonator. The flame of the explosion is not communicative, and there is no danger of the ignition of coal-dust or gases. This has been tested and satisfactorily reported upon by several German mining experts. As a proof that the compound is quite harmless, it may also be mentioned that the German State Railway authorities have given the company permission to dispatch it by rail, as ordinary goods, a privilege which no other explosive can boast of. Herr Hans Ritter von Dahmen is the inventor of this explosive, and patents have been taken out in all countries. A number of Westphalian mine-owners are interested in the undertaking.

THE great Przibram mine fire. A disastrous mine fire broke out on May 31st in the Maria shaft of the Birkenberg silver mine, near Przibram, which is the richest and most extensive in Austria-Hungary. There were 807 men in the mine at the time and only 475 escaped. The 332 who lost their lives leave 292 widows and 692 orphans below 14 years of age.

The Austrian Socialist Congress has passed a resolution declaring charges of culpable negligence against the management.

The cause of the outbreak is said to be the ignition by some lighted tapers of a small wooden altar erected by devout miners in honor of John Nepomak, the patron saint of Bohemia.

The mines which belong to the State yield an annual revenue of $300,000. The principal production is silver, but lead and ochre are also mined in smaller quantities.

This is probably the worst metalliferous mining accident on record.

THE following is a summary of the present condition of the Anthracite blast furnaces in the Schuylkill valley, including Swedeland, Port Kennedy, Norristown, Phœnixville, Pottstown, Bechtelsville, Birdsboro, Reading, Temple, Leesport, Potteville, Topton, Macungie, Robesonia, Sheridan, and Alburtis. At all of these places there is a total of 31 furnaces, and of these 17 are in operation, 13 out of blast and one is banked.

The 17 in active operation include four in Reading, two each at Swedeland, Pottstown, and Alburtis, and one each at Port Kennedy, Birdsboro, Pottsville, Topton, Macungie, Robesonia, and Sheridan. There are two idle each in Reading and Birdsboro, and the remainder are scattered along the main line of the Phila. and Reading Railroad and near-by points. Iron men say that this condition of affairs presents a very hopeful aspect, and that among the furnaces in operation are some of the largest in this valley. There are furnaces at Ringgold, Lyons, and Kutztown, which have been idle for many years, and may never be put again into operation, while several others have been dismantled during the past few years.

THE COAL TRADE

The Anthracite Trade.

The Anthracite coal trade continues quiet and there is not much new business being done, but large quantities of coal are being moved from the mines to various points of distribution. The stock of coal at Port Richmond is lower now than it has been at any time since the strike in the latter part of 1887 and early part of 1888. The sales-agents of the coal companies met in New York on the 29th ult, and advanced the price of coal to Eastern points as follows: Broken coal, 15 cents a ton; stove, 30 cents; egg, 35 cents; chestnut, 35 cents. A general increase of 25 cents per ton for coal for Western points was also decided upon.

The agents also fixed the production for July at 3,500,000 tons.

The Bituminous Trade.

The Bituminous trade is fairly good for this season of the year, though prices rule low. The New York Central contract for 1,500,000 tons has been awarded. It includes the supply of coal needed for the Rome, Watertown and Ogdensburg and West Shore roads. The contract has been divided between The Fairmount Coal and Coke Co., and The Bell, Lewis & Yates Mining Co., of Buffalo; Morgan, Moore and Baine, and Osborne, Sager & Co., of Cleveland, have secured the larger part of the contract, but how much each party interested received is kept quiet by those interested.

The Coke Trade.

There has been no improvement in the coke trade since our last report. The same dullness, prices, and conditions exist, and the iron trade remains the same, with the prospects of a general lockout strong. This of course has a very depressive effect on the coke trade.

PERSONALS

MR. JABEZ WOOLEY, one of the pioneer miners of the Schuylkill region, and now located at Evansville, Ind., spent a portion of the past month visiting old scenes and old friends in the Mahanoy valley. Mr. Wooley is full of interesting reminiscences of early mining in that valley. Before any railroads entered the valley, the Boston Run mine and the old Pott Run tunnel, down the valley, were opened under his direction. He also opened the Lee and Wren mines, now known as Elmwood Colliery, P. & R. C. & I. Co., and for some time operated the old Trenton colliery. He was surprised to learn that old Boston Run, the first house of which was occupied by himself, was no longer in existence as a village, the houses, on account of the caving in of the surface, having been removed to the other side of the valley. He was equally surprised to learn that the name of Pott Run mine has faded out of the memory of most people. He was also a pioneer in the Ashland district. He prospected there, and was the first to open up and develop the Mammoth vein with a water-level tunnel. This work was done before the Gordon Planes and old Mine Hill Road were constructed. Some twelve years ago, Mr. Wooley was prospecting in the then wilderness of West Virginia, far from any settlements or railroads, and he secured some coal interests there that, owing to the development and opening up of the country by opening railroad extensions, have become valuable. Before returning to his home he intends visiting his West Virginia properties and make arrangements to either develop them or sell them.

MR. JAMES F. BEATTIE has been appointed mining engineer for the Guyandot Coal Land Association, a corporation owning large tracts of coal and timber land on the line of the Norfolk & Western R. R., and whose headquarters are in Philadelphia. Mr. Beattie's headquarters are at Dunlow, Wayne County, West Virginia.

MR. HUGH ROSS, formerly inside foreman at the Mullin Mine of the McClure Coke Company, near Mt. Pleasant, Pa., is now filling the same position for the J. A. Strickler Coal and Coke Company at Southwest, Westmoreland County, Pa. The mine he is in charge of is a slope opening with a tipple fitted for raw coal. There are no coke ovens as yet erected, the raw coal being of excellent quality meets with ready sale.

MR. S. W. GILMAN, of Chicago, for the past three years president of the Brazil Block Coal Company, has resigned on account of ill health. Mr. Charles H. Niblock, for some years past engaged in mining in the State of Washington, and at present president of the Snoqualmie Coal and Coke Company and general manager of the Acme Coal Company, both of Tacoma, Wash., has been elected president in Mr. Gilman's stead.

MR. JOHN MCGONIGAL, inside foreman for R. B. Wigton & Sons at Troy mine, has been appointed assistant to Mr. Charles E. Sharpless, engineer and superintendent for the same firm. Mr. McGonigal's title will be assistant superintendent.

JONATHAN WEIR fire-boss at the Lehigh & Wilkes Barre Coal Company's South Wilkes-Barre shaft, has been appointed inside foreman for the West End Coal Company at Mocanaqua, Pa., vice John Protheroe, deceased.

MR. GEORGE MAUE has disposed of his Hazleton *Sentinel* to a stock company, with Mr. C. F. Paul as business manager. John McCarthy, for some time past associated with Mr. Maue in the editorial work, becomes the editor, and Mr. Maue takes charge of the job printing department. The new management has secured the Associated Press service and will undoubtedly publish an interesting and readable journal. It has one great advantage over most of its contemporaries in have as editor a young man with a remarkably vivid imagination, who, in case the Associated Press service becomes impaired, can improvise one.

THE death of Mr. Harry M. Luther, assistant engineer in charge of the Mahanoy District, P. & R. C. & I. Co., has caused a redistricting of the company's collieries in the Mahanoy and Shenandoah valleys. Mr. Luther's old district has been divided. One half of it has been added to the Shenandoah district, under charge of Mr. John H. Pollard, assistant engineer, and the other half has been added to the Ashland district, under charge of Assistant Engineer F. P. Weiser. The force of transitmen and chainmen formerly under charge of Mr. Luther, have also been assigned to work in the offices of Messrs. Pollard and Weiser.

WILLIAM SCAIFE, of Coal City, Illinois, has been appointed inside foreman for the Pacific Star Coal Company, at Mystic, Iowa.

MR. WM. GRAEBER, Coal Inspector for the Philadelphia & Reading Coal & Iron Company, died at his home in Shenandoah, Pa., on the evening of the 5th ult. Mr. Graeber was well-known in mining circles in the Schuylkill region, and was for some years superintendent of the Philadelphia & Reading Coal & Iron Company's North Franklin collieries at Treverton, Pa. He resigned this position on account of failing health, and was given the position he held at the time of his death, because its duties were not confining and not beyond his failing strength. He was a man of most kindly disposition, and his jovial voice, always marked with a strong German dialect, was an index of his sunny and kindly disposition.

MR. E. G. TUTTLE, of Hondo, Coahuila, Mexico, general superintendent of the Coahuila Coal Company, was a visitor to the Anthracite regions during the past month. The object of his business was to purchase a lot of mining machinery, consisting of hoisting engines, screens, etc. After inspecting the machinery in use at several of the larger collieries in the Wyoming valley, he placed his order with the Vulcan Iron Works, of Wilkes-Barre, Pa., and started for home via New York City.

ANTHRACITE COAL STATISTICS.

Statement of shipments of Anthracite coal for month of May, 1892, compared with the corresponding period last year. Compiled from the returns furnished by the Mine Operators.

	May, 1892.	May, 1891.	Difference.		For Year 1892.	For Year 1891.	Difference.	
From Wyoming Region,	2,040,436·02	1,807,931·04	Inc.	232,504·18	8,506,273·03	7,480,189·11	Inc.	1,026,083·12
From Lehigh Region,	518,243·03	557,314·05	Dec.	39,071·02	2,269,870·11	2,319,621·10	Dec.	49,750·19
From Schuylkill Region,	972,442·10	974,289·08	Dec.	1,846·18	4,799,171·00	4,385,040·07	Inc.	414,130·13
Total	3,531,121·15	3,339,534·17	Inc.	191,586·18	15,575,314·14	14,184,851·08	Inc.	1,390,463·06

The stock of coal on hand at tide-water shipping points, May 31, 1892, was 684,662 tons; on April 30, 1892, 714,842 tons, decrease 30,180 tons.

EXPLOSIONS IN COAL MINES.

BY J. B. ATKINSON.

[From the Transactions of The Mining Institute of Scotland.]

No industry has been subject to disasters involving so large a loss of life as coal mining, and these disasters have been principally due to explosions.

The magnitude of colliery explosions has strongly directed public attention to the dangers of mining, and has led to the passing of Mines' Regulation Acts, each more stringent in its provisions than its predecessor.

It is now held by many persons that the extension of nearly all the larger explosions has been caused by coal-dust, and even that some explosions have been wholly due to the combustion of that agent.

The words "coal-dust" do not occur in any Mines' Regulation Act except that of 1887. It is evident, therefore, that an important factor in colliery explosions has been overlooked, and it is probable that many explosions have occurred simply from a want of knowledge in which all connected with mining have shared.

The influence of fire-damp in explosions has been two-fold, it is itself the cause of explosions, and it has diverted attention from another factor—coal-dust.

We may even go further, and say that one of the precautions, large currents of air, adopted to lessen the danger of fire-damp, has directly assisted in increasing the danger of coal-dust by rendering the mines dryer, and promoting the formation of the most dangerous class of dust deposits, those due to the fine upper or wind-borne dust and common on many main intake and haulage roads.

If these considerations be true it is clear that our knowledge of the causes of colliery explosions, and of means for their prevention, will require to be recast, and in this paper attention will be especially directed of coal dust as the cause of explosions that is least understood.

Explosion may be defined as the sudden large increase in volume of matter.

In practice accidental explosions are of the following kinds:

(*a*) The expansion of gunpowder and allied explosives on combustion.

(*b*) The expansion of dynamite and allied explosives on disassociation.

(*c*) The expansion of mixtures of inflammable gases or vapors with air on combustion.

(*d*) The expansion of mixtures of inflammable dusts with air on combustion.

(*e*) The expansion of gases or vapors under pressure on the rupture of retaining walls.

a,b,c, and *d* may be called chemical explosions, and are accompanied by flame; *e* may be called a mechanical explosion, and is not accompanied by flame.

Explosions under the above heads occur in mines. This paper will, however, be confined to the consideration of the explosion of mixtures of fire-damp and air, and of mixtures of coal-dust and air, and also of gunpowder and other explosives, so far as they initiate the two former classes of explosions.

A true explosive is a body containing within itself the power of explosion. Thus gunpowder on the application of heat, or nitro-glycerine compounds on detonation or shock, explode without the assistance of any other body. These are true explosives. Fire-damp and coal-dust are not explosives. Mixtures of fire-damp and air or of coal-dust and air are explosive, but the oxygen of the air is as essential to the explosion as the fire-damp or coal dust. It is scientifically incorrect to speak of the explosion of fire-damp or coal-dust. Gunpowder is an example of a solid explosive, nitro glycerine of a liquid explosive, and there are explosive gases, but they are never met with out of the laboratory. Thus one of the oxides of chlorine (hypochlorous acid) is an explosive gas. When slightly heated it decomposes with explosion.

Fire-damp is usually a mixture of marsh gas, with nitrogen, oxygen, and carbonic acid gases. The marsh gas, or light carbureted hydrogen, is the combustible constituent. Fire-damp is pent up in the strata at high pressures, and issues into the workings of a mine, usually as a steady flow, but sometimes as a sudden outburst. In elevated unventilated parts of mines it collects, and often issues from such places in large volume on a fall of the barometer.

When flame is applied to fire-damp issuing as a jet into the atmosphere, it burns at the point of issue like ordinary lighting gas. There is combustion but no explosion. If mixed with air in certain proportion, flame passes rapidly through the mixture, and explosion results, the explosion being wholly due to the expansion of the resultant gases, caused by the heat of combustion. There is no absolute increase in volume of the mass, such as takes place when gunpowder is fired when the resultant products, apart from the expansion due to the heat of combustion, occupy many times the volume of the original gunpowder.

The temperature of ignition of an inflammable mixture of fire-damp and air, the speed of the passage of flame, the temperature of combustion, the increase in volume of the resultant gases if free to expand, the increase of pressure if confined, and the composition of the resultant gases, are all points for consideration to which it is not proposed to direct attention. Recent researches, however, have shown that, as regards the speed of flame, the pressure developed, and the composition of the resultant gases of an explosion of fire-damp and air, the older text-books are not altogether correct.

Coal-dust is more or less prevalent in all dry coal mines. When the heat of a mine raises the temperature of the air entering the mine its capacity for absorbing moisture, or its drying power, is increased; and if the quantity of moisture in the strata mined, and that due to the respiration of men and horses, and to the combustion of lights is not sufficient to saturate the air, the mine becomes dry. The temperature of the strata increases with the depth, while the quantity of moisture usually decreases. Deep mines, are, therefore, dryer than shallow mines.

Some coal seams produce more dust than others—the more friable the coal the more dust. Coal seams are traversed by joints or cleavage planes running at right angles to the plane of stratification, and by partings parallel to the stratification. The latter planes of division are very generally coated with a dull, black, friable substance, known as mother of coal, dant, or mineral charcoal, which probably is largely present in fine coal-dust.

The hewing, filling, and leading of the coal are the principal causes of coal-dust deposits in mines. Two other causes (1) the falling of coal from the sides of the passages, and its subsequent trituration by the feet of men and horses, and (2) the carrying down of coal-dust from the screens on the surface by the air current descending the downcast shaft.

If a pound of ordinary coal is placed upon a fire it burns and is eventually consumed; first the combustible gases that are driven off combine with the oxygen of the air, producing flame and heat; next the solid carbon is consumed until nothing but ash remains. It can be shown by calculation that if the combustion of the pound of coal took place suddenly the heat given off would so expand the resultant gases that explosion would result, exactly as in the case of the combustion of fire-damp. If the pound of coal was in the form of fine dust and suspended in air, under some conditions such rapid combustion will take place, and this is a coal-dust explosion.

The explosions of fire-damp and air of coal-dust and air are therefore in some respects similar phenomena; in each case the explosion depends on the heat of the combustion expanding the resultant gases, and each explosion is accompanied by flame and a vitiation of the atmosphere.

A mixture of fire-damp and air readily takes place—the motion of the air in a mine, the mobility of the fire-damp, and the property of diffusion which gases possess, even when stationary, all favor the mixture. The fire-damp is readily ignited, and does not require to be broken up before combustion takes place.

With coal-dust and air the conditions are different, and opposed both to the ready formation of an explosive mixture and its subsequent ignition.

Coal-dust is a solid body: it is not present in the air of a mine under ordinary conditions in any considerable quantity, but requires to be raised from the floor or dislodged from the sides and roof before a cloud is formed; it requires to be broken up, or the gases it contains driven off, before combustion takes place. The combined effect of these conditions makes it difficult to initiate an explosion of coal-dust and air. The fact that it requires special conditions to obtain an inflammation of a cloud of coal-dust in an air free from fire-damp does not, however, prove that the extension of an explosion in such a mixture is equally difficult to obtain, because the conditions are then different. After an explosion is started in a mine the coal-dust is no longer quiescent, but is blown into the air by the explosion, and forms a dense cloud; behind the cloud is heat, flame, and pressure.

The behavior of coal on an ordinary fire resembles somewhat that of coal-dust in an explosion. The first step to start a coal fire is to ignite paper. The paper ignites wood, which in turn ignites the coal; once a coal fire is thoroughly kindled it is self supporting, but the coal cannot in the first instance be readily ignited without the assistance of heat from other material.

The heat and consequent force developed by the inflammation of a mixture of fire-damp and air in such proportion as to secure complete combustion is greater than the heat and force developed by a similar mixture of coal-dust and air.

Mixtures of fire-damp and air are, however, only capable of transmitting flame within certain limits. There must be from 5 to 20% by volume of fire-damp in the mixture. The case, with respect to coal-dust and air does not appear to be parallel. 1 lb of coal dust and 160 cubic feet of air are required for complete combustion. Assuming an air way to be 8 ft. by 5 ft. sectional area, and taking coal-dust to weigh 26 lbs. per cubic foot, then for each 160 cubic feet of air in such a road to be supplied with 1 lb. of coal-dust, the surfaces of the road would require to be coated with a film of dust [illegible] inch thick. Such a quantity is far below what in practice is present on ordinary dusty roads, along many of which it has been observed that an explosion has passed with great force. These roads would, at the time of the explosion, have suspended in the air a quantity of dust in excess of 1 lb. to 160 cubic feet of air, and in no case where the dust was pure has the writer seen any evidence that the passage of an explosion has been checked by an excess of dust. It seems that in a coal-dust explosion a minimum quanity of dust must be present, which is probably much greater than the quantity named as being required for perfect combustion, but practically no maximum. If this be true, it has an important bearing on the question. The minimum quantity of coal dust occurs constantly over long lengths of roads in mines, and consequently the conditions are present for the propagation of a coal-dust explosion. That is to say, many roads in mines, in their normal condition, contain the necessary agents for an explosion of coal-dust and air; while a similar state of things, due to the presence of fire-damp and air, is an abnormal condition.

With regard to the force developed by an explosion of coal dust and air, as compared with the force developed by the explosion of fire-damp and air, the following is worth consideration:

In an explosion confined to coal-dust and air, traversing a road in a mine containing a large excess of fine coal-dust, there will probably be only coal gas distilled from the dust consumed; the combustion of coal gas results in more heat than the combustion of an equal volume of fire-damp, the coal gas containing free hydrogen; if this excess of heat is equal to the heat absorbed in distilling the coal gas from the dust, then the heat available to expand the resultant gases will be as great in the one case as in the other. Experience in actual explosions shows that, where there is a large excess of fine coal-dust, the force developed is greatest.

In an explosion of either fire-damp and air or coal-dust and air, a limiting factor is the quantity of air the road contains; fire-damp, if present in volume so as to form the most explosive mixture, occupies one-tenth of the air space; coal-dust may be present in excess, and yet practically leave the road full of air.

Sir F. A. Abel, when experimenting on coal-dusts, observed that one of the samples of dust, consisting largely of stone dust, had the property of determining the ignition of a mixture of fire-damp and air not inflammable *per se*. This led him to experiment under similar conditions with non-inflammable dust, such as calcined magnesia, and he obtained similar results—that is to say, a mixture of fire-damp and air not inflammable *per se*, became so on the addition of a non-inflammable dust. This shows that coal-dust may act in two ways in explosions: 1st, it may supply combustible matter; and 2d, it may cause mixtures of fire-damp and air not inflammable *per se*, to become capable of transmitting flame.

Having satisfied ourselves that fire-damp and coal-dust are the only bodies that, in conjunction with air, cause explosions in mines, we can investigate the subject (1) by the study of actual explosions, and (2) by experiment.

Explosions may be studied by observation made in the mine after their occurrence, or by the perusal of published accounts.

The writer has visited the scene of a large number of explosions in mines, most of which were caused by the ignition of small quantities of fire-damp, and were not generally followed by any death, or caused much damage to the mine. Some of these ignitions resulted in one or two deaths—the persons injured usually living for a few days after the accident. In a few cases of undoubted fire damp explosions, lives were lost in the mine, but this was exceptional.

The most considerable explosion of fire-damp which the writer has personally investigated occurred at Whitehaven Colliery on the 25th April, 1885.*

In a few cases of minor explosions, investigated by the writer, coal-dust has had some influence more as extending the flame of a gunpowder shot.

The writer has had opportunity of becoming acquainted with the circumstances attending the large explosions described in Table I., soon after their occurrence, and he at the same time made more or less complete examinations of the mines; he believes that in these explosions coal-dust played a leading part.

TABLE 1.

No.	Colliery.	Date.	Lives Lost.	Flame causing explosion.	Agent first inflamed.	Agent causing extension of explosion.	Point of origin of explosion.
1	Seaham.	25th October, 1871	26	Gunpowder shot.	Coal-dust.	Coal-dust.	Intake air-way.
2	"	8th September, 1880	164	" "	" "	" "	" "
3	Trimdon Grange.	16th February, 1882	74	Open light.	Fire-damp.	" "	Engine landing next drowned workings.
4	Tudhoe.	18th April, 1882	37	Gunpowder shot.	Coal dust.	" "	Intake air-way.
5	West Stanley.	19th April, 1882	13	" "	Coal-dust and [illegible] of fire-damp.	" "	Working face.
6	Usworth.	2 March, 1885	42	" "	Coal-dust.	" "	Intake air-way.
7	Altofts.	2 October, 1886	22	" "	" "	" "	" "
8	Elemore.	2 December, 1886	28	" "	" "	" "	" "
9	Walker.	24th October, 1887	8	" "	Coal-dust and [illegible] of fire-damp.	" "	Working face.
10	St. Helens.	19th April, 1888	30	Fire in the mine.	Fire-damp.	Fire-damp, coal gas and coal-dust.	" "

The explosions in the table are, it must be noted, not selected, but comprise all the large explosions the writer has personally investigated.

The reasons that lead to the conclusion that coal-dust was the principal factor in these explosions will be stated shortly.

First, there are reasons of a negative character depending on the apparent impossibility of ascribing the explosions to the combustion of fire-damp, the only body other than coal-dust likely to cause them.

In Nos. 1, 2, 4, and 7, the explosions were entirely confined to the intake air-ways; in Nos. 3, 6, and 8, the principal effects of the explosions were observed on the intake air-ways, although some of the working faces were traversed, and the return air-ways affected to a very limited extent. In No. 5 the intake air-ways, the working faces, and the return air-ways were all traversed. In No. 9, a small explosion, the working face and return air way of one district were affected. In No. 10 the working face of one district and intake air-

*This explosion, as well as Nos. 2, 3, 4, 5, and 6, in table I., are described in detail in a book entitled "Explosions in Coal Mines," prepared by Mr. W. N. Atkinson and the writer.

way were traversed, but owing to operations that were being carried out to isolate a fire at the working face, the direction of the air current had been changed shortly before the explosion, and a part of the intake air-way was return air-way at the time.

On the whole the explosions had traversed longer distances of intake air ways than other parts of the mines, in some cases being entirely confined to such roads. That is to say the roads least likely to contain fire-damp were most affected.

Experience in mines would justify the expectation that an immensely greater proportion of explosions of fire-damp would extend along the return air-ways than along the intake air-ways, whereas the reverse was the case in these explosions.

In the North of England, where this feature had long ago been observed, it has been customary to say with what has been termed "the unlearned wisdom of experience" that explosions of fire-damp always faced the fresh air, or that the gas sought the purest air.

In some of these explosions it was observed that the blast, on arriving at points on the intake air-ways where the air current split, had afterwards traversed one of the splits only. If the air current, before dividing, and in one of the splits, was in an explosive condition through the presence of fire-damp, how did the other split escape being in a similar state? In one case it was observed that the split which escaped was a continuation of the straight line which was the course of the explosion up to that point, the split traversed by the explosion deflecting to one side.

In Nos. 1, 2, 3, 4, 5, 6, 7, 8, and 9, so far as a judgment could be formed, no person in the mine was in a state of alarm at the moment of the explosion.

In No. 10 the mine was on fire, and all the ordinary workmen had left the pit. The persons who were in the mine at the time of the explosion, engaged in isolating the fire, were, however, under no apprehension of a large explosion taking place likely to injure them; they were 600 yards from the fire.

It does not seem possible in the first nine cases, that fire-damp could have entered the air currents in such volume as to have made the explosions possible without the officials or workmen observing it.

In Nos. 1, 2, 4, 5, 6, 7, 8, and 9, a shot was fired, and was the point of origin of the explosions; had fire-damp been present in the air current in sufficient quantities to make the explosions possible through its agency alone, it is highly improbable that any shot would have been fired.

In the collieries where the ten explosions given in the table occurred, safety-lamps only were used at the working face, and in some of them also on the intake air-ways, therefore we must go to other explosions for a condition which supplies a negative reason why fire-damp is not the principal factor in some large explosions.

In many mines worked entirely, or nearly so, with naked lights, a great explosion has swept over the whole pit. Scotland affords an example of this in the explosion at Blantyre in the splint coal. It does not seem possible that any great area of a seam in which naked lights are scattered here and there could be so charged with fire-damp as to render an extensive explosion possible. A sudden fouling of the air current from any cause would lead to an explosion at the first open light encountered, and so would limit its extent. Yet at Blantyre, Clifton Hall in Lancashire, Llanerch in Monmouthshire, and in many other cases, the mines were working with open lights, and all at once an explosion traversed the whole seam, causing in the cases just mentioned the death of 207, 178, and 176 persons respectively.

On exploring the mines after the occurrence of the explosions given in the table, there was no evidence of any outburst of gas or failure of the ventilation to account for the presence of fire-damp in sufficient quantity to cause the explosions. In No. 9 a single issue of fire-damp could have explained the explosion. In the other cases the course taken by the blast could not be explained by supposing that fire-damp had entered the air current at any particular point; on such an assumption roads that should have been traversed were missed out, and roads were traversed that should have escaped. By no reasoning could the explosions be ascribed with any degree of probability to fire damp only.

The positive reasons that support the view that coal-dust was the principal factor in these explosions are as follows:

The intake air-ways were in all the cases, except No. 9, also used as haulage roads. In Nos. 1, 2, 3, 4, 6, 7, 8, and 10 mechanical haulage was in use on these roads, the main and tail-rope system in all except No. 7, where the endless chain was in use. In No. 5 horses were employed. These roads were dry, they were traversed by large currents of air, and coal-dust was blown off the trains of laden hutches passing, often at high speeds, in the opposite direction to the air current. The result was that fine coal-dust accumulated on the roof and sides, as well as coarser dust on the floor. Near the downcast shafts coal-dust, carried down with the air from the screens, assisted materially in forming these deposits. The writer has not seen a road in a colliery in Scotland containing so much of the upper or wind-borne dust as occurs on similar roads in the dry mines of the north of England. These dust-laden, intake air roads were the roads principally affected by the explosions, and, as already stated, in Nos. 1, 2, 4, and 7 the explosions were entirely confined to them. In Nos. 1, 2, 4, 6, 7, and 8 the explosions originated on them.

The inner portions of the haulage roads, where the laden hutches, drawn by horses and ponies moved at slower speeds against feebler currents of air, contained little of the upper dust, and often the coal-dust on the floor was much mixed with stone-dust. The explosions were often checked on reaching such points.

In some cases, however, where these roads and the working face contained a considerable quantity of coal-dust they were traversed by the explosions.

The explosions were in many cases stopped by damp ground. This was specially noticeable with regard to the explosions which extended to the downcast shafts, which was the case in Nos. 2, 3, 4, 5, 6, 7, 8, and 10. When the downcast shafts were wet the explosion were arrested, and did not cross them. In No. 2 the shaft was dry, and the explosion crossed it. In No. 3 the downcast shaft was very dry, and the explosion entered it and extended upwards to the surface, and downwards to four levels below. A dampness in the floor, it was observed, was not sufficient to arrest an explosion if upper dust existed.

In Nos. 3, 5, and 9 short lengths of the return air ways were affected principally next the working face where coal-dust was present in quantity greater than is usual in such roads. The return air-ways on the whole could be said to be free from coal-dust, and were not so dry as the intake air-ways. At Altofts the return air-ways were used as traveling roads for the colliers, and were full of stone-dust ground up from the floor of the seam.

If the explosions were caused by the combustion of coal-dust, the absence of alarm on the part of the workmen can readily be understood. The mines were in their normal state up to the moment of the explosion, and there was no new condition present calculated to cause alarm.

Naked lights could be in use all over a dusty mine and be a source of no immediate danger, although the necessary elements for propagating an explosion in the shape of coal-dust resting on the floor, roof, and sides, and pure air were everywhere present.

The fact that some of the explosions were originated by the firing of a shot, is strong evidence that the air current was not in an explosive condition from the presence of fire-damp alone where the shots were fired, and affords some presumption that coal dust, either alone or in conjunction with such a proportion of fire-damp as not to be considered dangerous by the person igniting the shot, was the agent first inflamed, as the danger of coal-dust is not understood.

The personal experience of the writer points strongly to the preponderating influence of coal-dust in large colliery explosions. How far this may be true for other large explosions, it is in many cases now almost impossible to say. Until a few years ago coal dust was not recognized as a factor in these disasters and in published accounts of earlier explosions, it is only mentioned incidentally. The explosions were always referred to fire-damp, and theories to account for its presence in sufficient quantity by a sudden outburst, the leaving open of ventilating doors, or some other cause, were put forward with more or less confidence.

There are, however, so many points of resemblance between the explosions briefly described and most other large explosions that the writer does not hesitate to express the opinion that in almost all widespread explosions the influence of coal-dust has been predominant.

It is not, however, probable that so large a proportion of other large explosions have been caused by coal-dust in air practically free from fire-damp, being the agent first inflamed, as in the cases tabulated. Fire-damp ignited by the flame of a naked light or safety-lamp or a mixture of coal-dust and air containing a small percentage of fire-damp ignited by the flame of a shot, have probably been the origin of most large explosions.

The experimental investigation of the influence of coal-dust in colliery explosions has been undertaken by individuals, Committees, and Government Commissioners, both at home and abroad.

Mr. H. Hall, H. M. Inspector of Mines for the West Lancashire District, and Mr. Clark, mining engineer, described in a paper read before the North of England Institute of Mining Engineers, in June, 1876, some experiments they made with coal dust in a mine from the surface. The mine was 45 yards long, and 30 feet sectional area. They scattered coal-dust on the floor and fired a cannon at the face to represent a blown-out shot. The most decisive result obtained by them may be given in their own words:

"Coal-dust having been scattered on deals the whole length of the slant (the thill being very wet), fired 2¼ lbs. powder; in this case flame issued strongly at the mouth of the slant, having traveled 45 yards. The blast was very fierce, and would certainly have proved fatal to any one struck by it in its course."

In 1890 Mr. Hall experimented by firing a small cannon at the bottom of shafts after coal-dust had been emptied into them, and caused explosions extending to the surface or in one instance 180 yards.

These are the only experiments on a large scale in Great Britain.

Mr. Wm. Galloway, who was probably the first to recognize the great influence of coal-dust in large explosions, has conducted and published the results of many experiments on a small scale in which he demonstrated the inflammability of coal-dust. The Chesterfield and Derbyshire Institute of Engineers conducted experiments on a small scale, but obtained no very definite result, and appear to have been led by the negative results obtained to underestimate the importance of the question.

Sir F. A. Abel carried out experiments with coal-dust on a small scale, at the request of the Home Secretary, in connection with the enquiry into the Seaham Colliery explosion (No. 2 in list). He obtained no decisive result as regards the inflammability of coal-dust and air alone, but he discovered, as already mentioned, the effect of dust, as dust and apart from its inflammability in promoting the inflammation of mixtures of fire-damp and air.

He also conducted some experiments in larger galleries with coal-dust and blown-out shots, which showed that coal-dust "will feed the flame projected by a blown-out shot so as to carry it on to a comparatively considerable distance."

The most important experimental work in connection with this question is that of the Prussian Fire-Damp Commission, a translation of whose report will be found in Vol. 34, of the Transactions of the North of England Institute of Mining and Mechanical Engineers.

The experiments were made in an elliptical gallery, 167.3 ft. long, and having a sectional area of 17⅙ sq. ft. A side gallery 32.8 ft. long was added to the main gallery at a later period. Shots were fired at one end of the gallery from cannons to represent blown-out shots. The Commission sum up the result of their labors at considerable length. They state:

(1.) "The *presence of coal-dust* in more or less abundance in the immediate vicinity of the working face, *gives rise to more or less considerable elongation of the flame* projected by a blown-out shot, *whether small quantities of fire-damp be present in the surrounding air or not.*

(2.) *a.* "*In the complete absence of fire-damp, the elongation or propagation of flame is generally of limited extent*, however far the deposits of dust may extend in the mine ways.

b. "*There are, however, certain descriptions of coal-dust which*, if ignited by a blown out shot, will not only *continue to carry on the flame, even to distances extending considerably beyond the confines of the dust deposits*, but will also *give rise to explosive phenomena or results, in the complete absence of any trace of fire-damp*, which, in character and effects are similar to those produced with some other dusts in air containing 7 per cent. of fire-damp.

(3.) *a.* "All *the phenomena produced by the burning of, and propagation of flame by coal-dust are intensified by the presence in the air of small proportions of fire damp.*

b. "*Certain dusts* which, under favorable conditions, appear to have the power of propagating flame to an indefinite extent in a dust-laden area, the air being free from fire damp, *will, if only sparsely suspended in air containing fire-damp in some proportion below 3 per cent., render such a gas-mixture susceptible of explosion by a blown out shot.*

(4.) "Special experiments, in which the branch gallery, described as opening into the main gallery near its extremity, was charged with a fire-damp mixture (retained by brattice cloth), demonstrated that *a coal-dust ignition or explosion, developed in the complete absence of fire-damp, can communicate ignition to an explosive gas-mixture existing at a very considerable distance from the point of first ignition.*"

The Royal Commission on Explosions from Coal-Dust in Mines now sitting will probably experiment on a large scale. From the volume of evidence issued by the Commission, it appears probable that an artificial gallery, 200 yards in length, will be erected. This length will not be sufficient to test all the questions that arise. The writer's suggestion to the Commission was that some experiments should be made in a gallery not less than half a mile long.

From actual observation in mines, it appears that a coal-dust explosion proceeds from 50 to 100 yards from the point of origin before developing its maximum force. It is doubtful if this can be illustrated in a gallery 200 yards long. The arresting of a coal-dust explosion, traveling with maximum force and velocity, by a space free from dust could not be tested in such a gallery.

REMEDIAL MEASURES.

The first step in this direction is to obtain a proper conception of the causes of explosions in mines. The danger arising from fire-damp is well known, and also the precautions necessary to prevent its accumulation and ignition, such as sufficient ventilation and the absence of naked flame. The danger of coal-dust is not so generally understood or admitted, but it is hoped that this will be secured by the labors of the Royal Commission now sitting.

The danger arising from coal-dust in mines may be met (1) by precautions to prevent its ignition, and (2) by the adoption of means to prevent its accumulation or to render it innocuous.

The formation of a cloud of coal-dust in mines and its subsequent ignition is practically caused by the disturbance and flame attending the explosion of shots or of mixtures of fire-damp and air; both of these will, it is believed, under some conditions raise and inflame a cloud of coal-dust in air, and initiate a coal-dust explosion which becomes self supporting.

Most shots are fired at the working face, and in mines deep enough to be dry and dusty some fire-damp is nearly always present in the air in such situations, and fire-damp may be liberated by the shot: the coal-dust, however, is confined to the floor, and is not so fine as the wind-borne dust on main haulage roads. At the working face a blown-out shot fired near the floor, or pointing to the floor, is most dangerous, and the dust must be present in considerable quantity before a coal-dust explosion is possible, and then the effect of the probable volume of fire-damp present in the air is to be considered.

On main haulage roads where, after their completion, it must be noted comparatively few shots are fired, and where fire-damp is practically absent, coal-dust of the finest character is often found on the roof and sides, as well as coarser deposits on the floor, and strong currents of air are usually present to sustain any cloud formed.

The effect of a shot in disturbing dust on such roads is twofold. The powder gases rushing from the shot agitate the air in its vicinity, and shock or tremor is communicated to the solid sides of the passage. At the working face, the first cause only operates. Any tremor given to the floor on which the dust there rests would have no effect in raising a cloud; but where dust is on the roof and sides as well as on the floor both causes assist in forming a cloud.

The combined effect of these conditions appear to make it much more dangerous to fire a shot on an old haulage road, where there is much dust, than at the working face. Nos. 1, 2, 4, 6, 7, and 8 explosions were, it is believed, caused by shots, which were not blown out fired in stone on old intake and haulage roads, where the air was practically free from fire-damp.

Nos. 5 and 9 explosions were caused by shots fired in stone at the working face. In these cases there was an unusual quantity of coarse dust on the floor near the shots, and there would probably be from 1 to 2 % of fire-damp in the air. In No. 5 the position of the shot hole could not be determined; in No. 9 the shot was partially blown out, and pointed to the floor.

The raising of a cloud of coal-dust by shots may be prevented by removing or damping the dust in their immediate neighborhood, as is required by the present Mines Act, without resorting to any general system of removal or damping.

The use of a flaming explosive in conjunction with some material to kill the flame, or the use of a flameless explosive (if such exist) are remedies adopted.

The danger arising directly from explosions of fire-damp and air is a sufficient reason for adopting every reasonable precaution to prevent their occurrence. In dusty mines, where such explosions may be indefinitely extended by coal-dust, even greater precautions are necessary.

No. 3 explosion was probably originated by a local explosion of fire-damp at an open light; No. 10 was caused by fire-damp ignited by the flame of a fire. The fire-damp had collected in passages near the working face from which the air current had been cut off by the erection of a stopping in the intake in order to isolate the fire, the initial explosion so caused being extended to the downcast shaft by coal dust.

Means to prevent the formation of dust deposits, or life occasioned thereby, as registered in the reports of the Inspectors of Mines, from the year 1851 to 1891, both inclusive. There are 2104 separate explosions, causing the loss of 9172 lives, the average death rate per explosion being 4.36.

It has occurred to the writer that some argument in support of or against the coal-dust theory may be founded on these figures.

It will be observed that the number of explosions causing the loss of one life is 1430, of two lives 303, and so on to the final explosion causing the loss of 334 lives. The number of lives lost by an explosion is, roughly speaking, in proportion to the area of the field of the explosion.

Three assumptions may be made with respect to these figures:

1st.—That the explosions are all due to fire-damp.

2d.—That the explosions are all due to coal-dust.

3d.—That the explosions are due to both agents.

The first assumption, that the explosions are all due to fire damp, has been held until recently, and is still held by some persons, modified by the admission that coal-dust has aggravated or intensified some explosions. On this assumption there appears to be some difficulty in explaining the figures. Why should there be such an extremely rapid decrease up to a certain point of the number of the explosions as their fatality increases? If fire-damp is the cause of the large number of small explosions causing 1, 2, and 3 deaths and also of the monster explosions might not a considerable greater number of intermediate explosions have been anticipated? A reason that might be suggested is that the use of safety-lamps renders a large explosion possible in some mines by enabling a great length of air current to become explosive before it is ignited, while the use of naked lights in other mines causes the large number of small explosions. The explosions causing the loss

LIST OF EXPLOSIONS CAUSING LOSS OF LIFE RESULTING FROM THE IGNITION OF FIRE-DAMP AND COAL-DUST IN THE COLLIERIES AND MINES IN THE UNITED KINGDOM UNDER THE VARIOUS COAL AND IRONSTONE MINES REGULATION ACTS.

Year.	Number of Explosions, arranged according to Loss of Life.											Total No. of Explosions.	Total Lives Lost.
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11 or more Lives—Each Explosion given separately.		
1851	70	12	5	5	—	1	1	—	2	—	13, 35, 52, 61,	100	321
1852	79	10	—	3	1	2	—	—	—	1	12, 22, 38, 65,	91	284
1853	51	12	2	1	2	1	—	—	—	1	11, 20, 58,	73	202
1854	62	9	4	3	—	2	1	—	—	—	89,	82	232
1855	65	17	5	3	1	—	1	—	—	—		92	138
1856	54	8	3	1	1	—	—	—	—	—	11, 11, 12, 114,	71	236
1857	43	13	5	5	1	—	—	1	2	—	13, 40, 189,	73	377
1858	44	10	8	3	—	1	—	—	—	—	12, 19, 25, 53,	70	215
1859	53	10	3	2	1	—	—	—	—	—		69	95
1860	47	8	7	—	—	—	—	—	—	—	12, 13, 13, 22, 76, 142	68	362
1861	45	12	—	1	—	—	1	—	1	1	13, 13,	63	125
1862	49	5	1	1	—	1	—	—	—	—	16, 47, 59,	60	194
1863	42	11	1	2	—	1	—	—	—	—	13, 15, 26, 39,	61	174
1864	48	13	4	1	1	—	1	—	—	—		68	102
1865	44	7	8	3	1	—	—	1	—	—	26, 34,	66	167
1866	47	14	1	3	—	—	—	1	—	—	12, 24, 27, 30, 38, 91, 331,	73	654
1867	41	9	7	—	—	—	1	—	—	—	12, 34, 178,	61	291
1868	36	5	1	1	—	—	—	1	—	1	26, 62,	47	150
1869	32	5	2	2	1	1	1	—	—	—	11, 27, 37, 53, 59,	49	261
1870	38	13	3	1	1	1	—	—	2	—	19, 19, 20, 30,	63	194
1871	29	9	—	3	1	1	—	1	1	—	19, 24, 26, 38, 70,	59	266
1872	52	4	2	1	—	1	—	1	—	—	13, 27, 34,	64	156
1873	28	8	—	2	1	2	2	—	—	—	18,	44	101
1874	33	6	—	2	1	—	—	—	—	—	13, 17, 23, 54,	46	167
1875	28	6	2	2	1	—	1	—	—	—	16, 23, 43, 143,	40	287
1876	26	10	3	1	2	1	—	—	—	—	23,	44	98
1877	35	3	1	1	—	—	—	1	—	1	18, 18, 26, 207	46	345
1878	17	5	3	—	—	1	1	—	—	—	17, 23, 42, 189, 268,	32	589
1879	21	5	2	—	2	2	1	1	—	—	21, 28, 63,	37	186
1880	14	4	—	2	—	2	—	—	1	—	62, 101, 120, 164,	27	498
1881	24	4	—	1	—	—	—	1	—	—	23, 48,	32	117
1882	19	4	1	4	1	—	1	—	—	—	18, 22, 37, 43, 74,	35	259
1883	15	4	1	1	1	2	—	—	—	—	20, 68,	26	135
1884	21	4	2	—	—	—	1	—	—	—	14, 14,	30	70
1885	17	5	—	—	—	—	—	1	1	—	42, 81, 178,	25	341
1886	12	2	1	1	—	—	—	1	—	1	22, 28, 38,	21	129
1887	13	3	5	—	—	—	—	1	—	—	20, 73,	24	154
1888	11	1	1	—	1	—	—	—	—	—	30,	15	51
1889	8	4	2	1	—	1	—	—	—	—	20, 23, 64,	19	139
1890	16	2	—	—	1	—	—	—	—	—	87, 176,	22	290
1891	12	8	1	—	—	—	—	—	—	2		23	51
Totals.	1430	303	97	63	23	24	14	12	10	8		2104	9172

11 (5)	20 (4)	30 (2)	42 (1)	59 (2)	74 (1)	142 (1)
12 (6)	21 (1)	32 (1)	43 (2)	61 (1)	76 (1)	143 (1)
13 (8)	22 (3)	34 (2)	45 (1)	62 (2)	81 (1)	164 (1)
14 (3)	23 (3)	35 (1)	47 (1)	63 (1)	87 (1)	176 (1)
15 (2)	24 (1)	36 (2)	48 (1)	64 (1)	89 (1)	178 (2)
16 (2)	25 (2)	37 (2)	52 (1)	65 (1)	91 (1)	189 (2)
17 (2)	26 (3)	38 (3)	53 (2)	68 (1)	101 (1)	207 (1)
18 (3)	27 (3)	39 (2)	54 (1)	70 (1)	114 (1)	268 (1)
19 (4)	28 (2)	40 (1)	58 (1)	73 (1)	120 (1)	334 (1)

to render them innocuous, will be briefly glanced at.

Main roads are watered on the floor, and in some cases mechanical sprayers are used, so as to damp the roof and sides as well. Water pipes are laid along the main roads, the water issuing under pressure as a fine jet at intervals. Compressed air is used in connection with the water so as to secure a fine spray, and both damp the roads and saturate the air current with moisture.

In some cases the water pipes are simply provided with cocks at intervals, to which a hose pipe is attached when watering is necessary.

At some collieries the laden hutches are watered at the engine landings. More attention is paid to the construction of the hutches, so as to prevent coal and coal-dust being shaken out of them.

By the use of steam the temperature of the air descending the downcast shaft has been raised to the temperature of the mine and at the same time saturated with moisture; the air current passing round the mine then ceases to have any drying power.

Hygroscopic or water-absorbing salts have been sprinkled on the roads to secure dampness.

Coal-dust from the screens on the surface should be prevented as far as possible from descending the downcast shaft with the air current.

The above table shows the number of fatal explosions due to fire-damp and coal-dust, and loss of of one life are undoubtedly nearly all due to fire-damp; this the writer can state from investigation of a large number of them. Had mines been free from coal-dust, probably the number of big explosions would have been less. As the rate of fatality increases, so it is believed does the influence of coal-dust.

The second assumption is clearly untenable. Many explosions occur in mines free from coal-dust such as damp coal mines, oil shale, ironstone, and occasionally in lead mines; it may be noticed, however, that in such mines large explosions do not occur. If coal mines had been free from fire-damp, the dust remaining the same, probably the number of small explosions would have been less.

On the third assumption the figures may be explained bearing in mind the following facts: Fire-damp is readily ignited and as many mines yielding it in small quantity are worked with naked lights, local explosions due to it are not unfrequent. On the other hand the danger of fire damp is well known, and if present in large quantity suitable precautions are taken. Coal dust is not readily ignited, and in the past no precautions have been thought necessary with regard to it, but if it is once inflamed it is likely to cause a large explosion, because it is present in dry mines continuously over wide areas, and in many large explosions the loss of life has been practically that of all the miners underground.

Book Review.

REPORT OF THE DEPARTMENT OF MINES, NOVA SCOTIA, FOR THE YEAR 1891.—This report which is issued six months ahead of our Pennsylvania reports for the same year gives full particulars of the production and sales of all the various minerals and metals. It also gives an account of the technical schools of instruction now in existence in the Province.

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION FOR THE YEARS 1889 AND 1890.—These two volumes which have just reached us contain complete reports of the operations, expenditures, and condition of the Institution. They also contain a number of papers on Mathematics, History, Travel, and Scientific Research, and are generously illustrated throughout.

NINTH ANNUAL REPORT OF THE BUREAU OF LABOR AND INDUSTRIAL STATISTICS OF THE STATE OF MICHIGAN, FEB. 1, 1892. — We are indebted to Mr. Henry A. Robinson, Commissioner, for a copy of the above report. It is full of interesting statistics as to wages, hours of labor, yearly expenditures and savings, etc., etc. The volume contains several illustrations of the principal industries of the State.

Additional Fast Express to the Southwest via Pennsylvania Railroad.

In order to better accommodate the increasing traffic to the Southwest, the Pennsylvania Railroad Company have placed in service a new fast train to Cincinnati and St. Louis. This train is known as the Southwestern Express, and leaves New York at 8.30 P. M. daily; Newark, to take on passengers for the West, 8.50, Trenton at 10.03, Philadelphia at 11.10 P. M., Washington 9.40, Baltimore 10.40 P. M., Harrisburg 2.05 A. M., Altoona, 5.40, Johnstown 6.53, arriving at Pittsburgh 9.15 A. M., Cincinnati 6.15 P. M., and St. Louis 7.00 A. M. the second morning after leaving New York. It is completely equipped with Pullman sleeping cars to Pittsburgh, St. Louis, and Memphis, via Cincinnati, and coaches to Pittsburgh. A dining car is attached at Altoona, from which all necessary meals are served. The Southwestern Express is the fastest and best equipped train to the Southwestern territory, and is a great convenience to travelers to the Mississippi River and beyond.

The Western Pennsylvania Mining Institute.

The Fifth Anniversary of the Western Penna. Mining Institute will be celebrated by a meeting in Monongahela City, Pa., on the 9th inst., commencing at 9 A.M. The following interesting and instructive papers will be read and discussed:

1. Health, Light, and How to Lessen the Force of an Explosion in Coal Mines. By John Foley, Courtney, Pa.
2. Mining: Its Past and Present and What it Might Be. By R. C. Campbell, California, Pa.

The above two papers will occupy the morning session. The programme for the afternoon session is as follows:

1. The Present Ventilation of Coal Mines on the Monongahela River, Compared With the Past. By O. Crede.
2. Analysis of Fire-Damp Taken From Fayette City Mine.
3. A Tramp Through the Minute Book. By Wm. Seddon, Secretary of the Institute.

On a recent visit to Western Pennsylvania we were being shown through the pump-room of a large furnace plant by the General Manager. Among the various pumps at work were several of the famous "Yough" pumps manufactured by Boyts, Porter & Co., of Connellsville, Pa. Laying his hand on one of them, the Manager said, 'Here is a first class all-around pump. It works equally well with clean or gritty water, and I have seen good sized pieces of coal pass through one at our coal mines, without doing any damage to the pump. For general mine work it beats anything I have yet tried for efficiency and durability. It is especially constructed for rough usage, and Captain Boyts made no mistake when he placed it on the market as an ideal mine pump."

The receipt of Messrs. Boyts, Porter & Co.'s new illustrated catalogue reminded us of this remark. We advise our readers to send for a copy of this catalogue and learn more of the merits of the "Yough" pump than we have space to give here. Besides being a fine piece of typographical work it contains a considerable data and a number of valuable tables concerning the flow of water through pipes, pumping, and general hydraulics.

The largest single order ever received for Reducing Valves was placed on June 21st, by the Consolidated Car-Heating Co., with the Mason Regulator Co., of Boston, Mass. It was for 500 locomotive reducing valves. There is an old adage that "the proof of the pudding is in the eating." It can in this case be paraphrased to "the proof of superiority is evidenced by the demand." The Mason Regulator Co.'s Reducing Valves are most successful and the Consolidated Car-Heating Co. naturally wanted them.

Mr. Geo. D. Whitcomb, proprieter of the well-known and most successful Harrison Mining Machine, has removed his general offices from 175 Dearborn St., Chicago, to No. 1224 Manhattan Building, 307 to 321 Dearborn St., same city, where he will be pleased to receive calls from all coal men interested in machine mining.

EASY LESSONS FOR BEGINNERS

IN THE STUDY OF THE

ART OF MINING

AND THE

SCIENCES RELATED TO IT.

This department is intended for miners and others, who in their youth have not been able to attend school and who are now desirous to inform themselves in the theory of mining and to learn how to answer the questions in ventilation, mine surveying, and mechanics which are asked at the examinations for mine manager's and mine foreman's certificates, and which it is important for them to understand as foremen and officers of mines. All the questions asked at the different examinations for mine manager's and mine foreman's certificates and for mine inspectors in this country are printed and answered in this department. The principles involved are explained in detail so as to be easily understood and the calculations are worked out at length for the benefit of those who are not familiar with figures.

GEOLOGY

In Its Relation to Coal, Iron, Oil, Gas, and Ores.

100. What is the difference between a spouting well and a dry well?

When boring for any of the three substances one may finally drill down into a stratum that contains them. If they are under pressure they will spout up to the surface, otherwise not. For example, the well W, Fig. 14, is drawing water from the stratum B; if the accumulation is deep and extends up above the level of W, as at C, for instance, then the well will spout. But if the surface is more like that at D and W is higher, the water will only rise to some point like F. Now the first example is one of a spouting well, the second, of one that is a pumping well, it requires power to raise the water. A dry well would be one that either did not reach B or else went through A and let the water out.

101. Is that the same with petroleum and gas?

Somewhat, though it is not like water in that there is *no perennial supply*. The rain is continually feeding the stratum B with water, but there is nothing to keep up the supply of oil or gas. The accumulations of ages may be exhausted in a few months. The spouting oil wells are the lucky strikes into the reservoirs of nature that have been long collecting.

102. How is it accumulated underground?

In Figs. 15 and 16 you will see what I want now to explain. Rocks are quite porous, and some have caves caused by the action of underground currents of water. Sandstone is very porous, and so is shale, therefore oil and gas can circulate freely in them. Besides this limestone has caves in it something like Fig. 15. Water is very solvent as you have already seen in the description of iron ore formation. If it flows long, it eats away the cave like at M and as it trickles from the roof of the cave it forms icicles of lime called stalactites. The Mammoth Cave, of Kentucky, and Ouray Caverns are good examples. Some caverns may not have stalactites. In the rocks are such caverns which somehow accumulated the oil and gas like in Fig. 16. Oil is lighter than water and so will float on top of it. So also gas will gather above the oil as in the figure. Now one man may sink a well at B and get gas only; another hole drilled at A will get oil and later gas; the hole sunk in C will strike salt water. As these have accumulated from the decomposition of coal or organic matter with great heat, the gas is under heavy pressure, just like steam in a boiler. It forces itself out through B, or else A or C, driving out the other materials first. It may be a long time before the oil is all forced out at A but in time the gas will escape. This has been the history of several neighbors in the oil country.

Fig. 15.

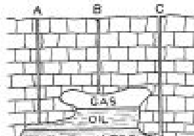


Fig. 16

103. Where should one bore for gas or oil?

If one can strike the rocks of the oil-bearing series, one should try to reach a spot on the top of the folds of the strata. Experience does not prove this to be always true, but it naturally tends to accumulate in the gently crumpled strata.

104. Why does the explosion of a cartridge at the bottom of a dry hole bring oil or gas?

In the oil country, you expect to find oil in certain rocks. If, however, you fail to get a pumping or a spouting well you simply have not bored into one of the caves or reservoirs. But you may be near one. So by putting 50 or 100 pounds of nitro-glycerine in the bottom of a hole and dropping a drill rod on it you may, possibly, break into a neighboring reservoir and so get oil, but it is not certain. This method is never advisable in shelly ground unless the hole is lined with tubing, for the blast will cause a caving that will be forever troublesome and has often resulted in the abandonment of the hole.

105. Are there any surface indications?

Yes, what is called oil show is one. On the surface of pools or springs a scum floats and gives good sign; while again there are what be called burning springs—rising gases which may be set fire to.

106. Where does the petroleum come from?

Russia and America are the chief oil-producing countries of the world. But other countries have large supplies. Geologically speaking it occurs with natural gas.

107. How much oil is produced in America?

Last year it was 1,160,000,000 gallons. And since 1870 it has been steadily growing from 1000 wells giving 201,471,000 gallons until there has now been produced altogether 18,400,000,000 gallons. Russia, during 1886 alone turned out 260,000,000 gallons; Scotland has slates that are mined and hoisted to the surface where the oil is sweated out of them. The Kimmeridge clay of England, is able to furnish a one-half barrel of oil from every cubic yard.

108. Is the supply without limit?

Geologists estimate an area of over 200,000 square miles as having more or less oil. The amount can not be estimated but is still very large, and the number of spouting wells, while uncertain, has not been decreasing. The Census reports show that the United States produced \$223,066,388 worth of petroleum during the past ten years and \$76,863,674 worth of natural gas. Some of this came from Colorado and California but far the largest amount is produced in States bordering on the Ohio River. The natural gas supply will be much more quickly exhausted than the oil and that of Ohio and Indiana will not last as long as the Pennsylvania gas fields. The average pressure of the gas in the wells owned by the City of Toledo, Ohio, is now only about 115 pounds to the square inch. In 1889, it was 250 pounds, and in 1890 it fell to 175 pounds. Many of the gas wells originally had a pressure of 400 pounds.

109. Why is the origin of oil associated with coal?

Do you remember how in Q. 8 we showed the coal to be a marsh product? You are aware of the miasma and gas that comes from a marsh—we call it marsh gas. Now, coal, when burned in the stove, or a coke oven or in a gas works, or in the analysis (See April number) gives off some gaseous material, coal gas; some volatile liquid, as naptha; some liquid as coal oil; some tar and a little pitch. We find in nature a similar series—gas called natural gas, or fire-damp if it occurs in a mine; that which comes out at springs or from bore-holes some light oils as rock-naptha; liquid petroleum; tarry substances like bitumen; and some solid material like asphalt. From these similarities we believe that petroleum had an organic origin. (See page 145, February, 1892, number of The Colliery Engineer.)

110 Has natural gas the same composition as marsh gas?

Natural gas is composed of	Marsh gas	95·50 %
	Hydrogen	2·00
	Oxygen	1·50
	Carbonic acid	1·00

Marsh gas is a compound of 1 part of carbon with 3 parts of Hydrogen. Fire-damp is nearly pure marsh gas. (See Q. 65 of Ventilation of Mines, and also p. 66, October, 1891, number of The Colliery Engineer.) You see the gases are about the same in composition, but fire-damp stayed in the seams and pores of the coal while natural gas succeeded in escaping. In the Anthracite region the rocks were nearly all broken up, thus giving escape to most of the gas which remained in the Bituminous districts.

111. Is natural gas as dangerous as fire-damp?

Exactly as bad. The blowers, as you call them, that let in fire-damp at the faces of the coal is practically natural gas. That is why there is so much complaint about the leaky main pipes that carry natural gas. At the points of leakage the gas works into the ground and affects the air of shallow mines near by.

[TO BE CONTINUED.]

POWER IN MINING.

The Elementary Principles of Mechanics—Steam—Boilers—Engines—The Machinery Employed in Mines.

75. Does the power of water depend upon the height of the fall and the weight of water?

Yes, Niagara falls is 160 feet high and over twenty million cubic feet of water tumbles over it every minute. Each cubic foot weighs 62·5 pounds. So the work that might be obtained from the Niagara would be over $160 \times 20{,}000{,}000 \times 62{\cdot}5 = 200{,}000{,}000{,}000$ foot lbs. per minute or over 6,000,000 horse-power

76. Can all the work be utilized?

Not all of it. The moment that a piece of machinery is introduced, some work is lost in friction. No water wheel can give more than 85% of the work it receives—and that is only obtained from the best wheel. Common overshot wheels will give 60%, while undershot water wheels give only about 40%.

77. What is this called?

The ratio between the work a machine actually does and what it should do is called the efficiency, or modulus. The better the machine, the higher is its efficiency. For example, the efficiences of the wheels quoted in Q. 76 are 0·85, 0·60 and 0·40 respectively. The modulus of a steam engine is about 0·80; of a very good one, 0·90, and an ordinary one, 0·70.

78. What becomes of the remainder of the power?

It is lost in friction and imperfect machinery. The steam that enters an engine cylinder loses some of its power by condensing or leakage and some power by not escaping freely from the cylinder. Then the friction due to tight packing and the wearing of rubbing parts consumes some power. These causes take from 10 to 30% of the steam power, leaving 90 to 70% with which the engine may perform work. (See p. 153, February, 1892, number of The Colliery Engineer).

79. What causes the loss of so much power in a water wheel as you say in Q. 76?

The losses of power in a water wheel are due to friction on the bearing; the loss from the water which splashes out of the buckets and also that due to the fact that the wheel will not turn as fast as the water naturally would fall.

80. What is the principle of the water wheel?

The overshot receives water in the buckets and in its fall the wheel is turned. The weight of the water in the buckets falling a distance equal to the height of the wheel gives the work of the water. As said, however, the wheel can not turn as rapidly as the free falling water would. So the efficiency of the wheel is not over 60%.

81. If a water wheel is 50 feet diameter, and a flume delivers 6 cubic feet per second to it. What power does the wheel give?

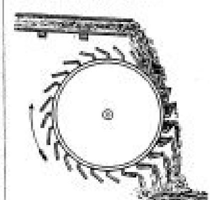


Fig. 15, overshot wheel.

Six cubic feet weigh 375 lbs. and each minute the wheel receives 22,500 lbs. of water, which fall 50 feet. This would give 1,125,000 ft. lbs; but the efficiency of the wheel is 60%, which gives 675,000 ft. lbs., or 20·4 horse-power.

82 If an undershot wheel is 20 feet high and receives 760 cubic feet of water per minute. What would be its power?

The height of an undershot wheel is of no consequence except for the disposition of the buckets on it But we must know the fall of the water or its velocity. If the velocity of the water is 60 feet per second, the practical fall of the water is 56·3 feet, as we shall learn later.

So, $760 \times 62{\cdot}5 \times 56{\cdot}3 \times 0{\cdot}40 = 1{,}069{,}700$ ft. lbs.

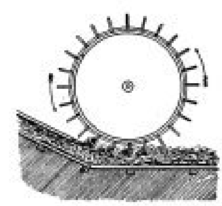


Fig. 16, undershot wheel.

83. How is it with a turbine wheel?

The principle is much the same. A timbered shaft or penstock, is built so that its top is on the level with the ditch or creek supplying the water and its bottom encloses a wheel, as in Fig. 17. The water column presses upon the wheel; its weight and velocity of discharge determine the work of the turbine.

84. A turbine 20 inches in diameter under 10 feet of water gives what power?

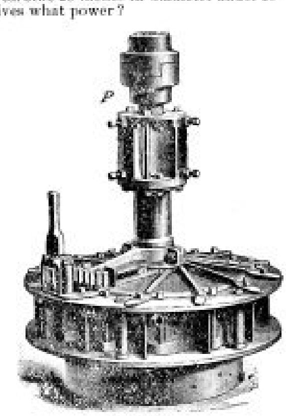


Fig. 17.

If the wheel can turn so fast as to consume 476 cubic feet of water (which weigh 29,750 pounds) per minute and these falling 10 feet give 297,500 ft. lbs., and if the wheel has an efficiency of 87%, then the wheel gives nearly 8 horse power. $476 \times 62\frac{1}{2} \times 10 \times 0{\cdot}70 \div 33{,}000 = 6{\cdot}3$ horse power.

85. Then you simply multiply the weight of the water consumed by the height through which the water falls?

Yes. Each cubic foot of water weighs 62·5 pounds and multiplying the number of cubic feet by 62·5 gives the weight of water. If you have gallons instead of cubic feet, multiply by 8·35 instead of 62·5, for each gallon weighs 8·35 pounds. Then the height of the penstock, in which the water is held above the wheel (as in Q. 83, the height of the overshot wheel) is multiplied by the weight of the water to get the theoretical work; or, to get the amount actually performed, multiply by 70%, or thereabouts.

86. Why do you multiply by the height of the water?

We call that height the "head" and when the water falls through a certain height, no matter if it takes a year to do it, or if the fall is affected in a minute, the work it is capable of doing, is the same that would be required to lift it the given height. The "head" is always the equivalent height of water to that which produces the work. And whether the water is all vertically above the turbine or not, the difference in level between the surface of the water and the point of discharge measures the "head." (See Fig. 18 where T is the turbine, and O T the theoretical head.) Though there may be more water in the pipe N T than in O T, there

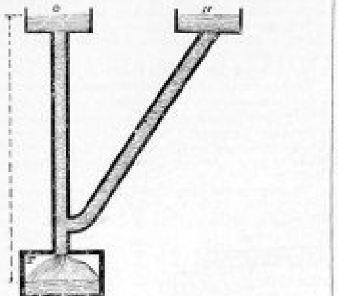


FIG. 18.

will be no more water discharged from one than from the other at T, so that the work is the same in either case Perhaps the student may not appreciate the statement that the inclination has nothing to do with the volume of water discharged (excluding the effect of friction) but let him try the case of a pipe almost horizontal. He would find how slowly the water would flow out of it, whereas, if the pipe were held more nearly vertical the amount would be very great, as the water would pour out very fast; while if the pipes were of different lengths and so placed that their ends were on the same level, the same amount of water would be collected from the pipes—indeed, owing to friction, the longer pipe would discharge less water than the short pipe.

87. What effect has friction upon the flow of water through the pipe?

It reduces the head so that the effective amount of water flowing is less than there would be if there were no friction.

Will you explain?

88. I can not now, but will later show how both the diameter and the length of the pipe affect the flow of the water. An air current flowing through the galleries of a mine behaves in very much the same manner and both these will be discussed together.

[TO BE CONTINUED.]

VENTILATION IN MINES.

Including a Description of the Gases Met With in Mines and the Atmospherical Conditions Necessary to be Known to Understand the Laws of Ventilation.

75. Then you think that the only security is in having a good air current?

Yes, that is all.

76. How will an air current act?

Just as you can mix vinegar and water and whisky together by shaking, so you can sweep a current of air and it will mix the carbonic acid and fire-damp together and carry them out of the mine.

77. How can you reach all the places where these gases are?

By a proper splitting of the air. I would drive it through every place. I would send plenty of air along the gob and goaf and would carry it straight along every face of coal that is exposed; each gang of men or each entry should have its own air, directly from the intake and after having passed along every nook, I would send it out to the return air-way or upcast, where it would meet the returns from all the other entries or panels.

78. How much air is required?

The amount should be enough to dilute the various mine gases to such a degree as not to be dangerous. The laws require from 100 to 200 cubic feet per man per minute. But the allowance should be made not only for the number of miners but also for the extent of the mine. A mine with a large goaf and a long working face should have more air than a small mine which has less chance of being filled with gases. So 200 cubic feet per hour is added for every acre of goaf.

79. What means are there for distributing the air to the working faces?

In some specially difficult mines to ventilate the faces receive air, through a pipe of iron or of wood and from a blowing fan that takes its supply from the main gangway. Other faces are ventilated by a brattice so placed in an entry as to give an ingoing and outgoing current and which is always carried along as fast as the work advances. Check curtains are the quickest means for turning the air to working places.

80. What precautions should we take in using brattice?

The brattice is only good if it is air tight and well nailed, to cut the gangway into two separate air-ways. A working face can only be well aired by continuing the curtains along behind you as fast as you advance. The rooms must have air carried up, into and through them to be safe. That is one reason why Longwall may be better ventilated than bord and pillar.

81. What is the test for bad air?

A test for bad air is not easy to give. Generally speaking bad air is that which has much carbonic acid (see Q. 60) or fire-damp or is hot. If a room receives an amount of fresh air equal to 100 cubic feet per minute per man working therein, it has pretty good ventilation.

82. How can we know whether there is that much entering a room?

Go to a place in the entry feeding the rooms or to a through. Measure off 100 feet or so of its length and also measure its size. If you fire off a little gunpowder at one end and see how long it takes for the smoke to travel the distance you measured off. Then the quantity of air moving in cubic feet per minute is found by dividing the distance measured by the number of seconds it takes to travel that distance, then multiply this result by the area of the road and by 60.

83. Is there not some other method?

Yes. Instead of watching how long it takes smoke to travel, you could hold up an anemometer at arm's length from you and that will tell you how fast the air is moving. Let the wheels turn for exactly one minute. Then multiply the reading by the area of the airway. See Fig. 4.

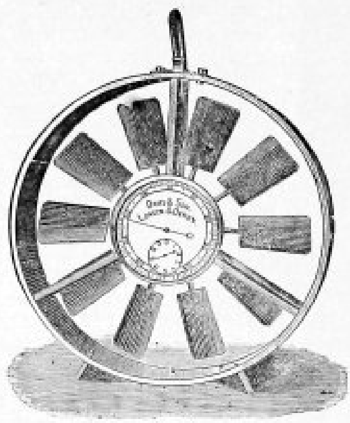


FIG. 4.

84. What is the anemometer?

See p. 163, February number of THE COLLIERY ENGINEER. The anemometer is like a weather vane and when held up in the air-current will revolve nearly as fast as the air-current. Its pointers show how fast it does turn.

85. Could I not measure the air current by the candle?

Yes. Hold the candle out from you, its flame will be bent by the wind, but if you walk as fast as the wind the flame will remain upright. So the speed with which you must travel to keep the flame erect gives you the speed of air-current.

86. Does the ventilation improve as the velocity is greater?

Not necessarily If a large air-way has air moving rapidly through it there may be a very large amount of air and plenty. But the velocity of the air-current may be great while the air-passage is very small. Then the amount of air may be too small for good ventilation.

87. But is not the air better as the current is faster?

To a certain extent, yes. But the air must not be too strong in the entries. It is chilling and uncomfortable It is unsafe in fiery mines and it increases the friction. too fast to be economical.

88. What should be the speed of the air-current?

It may be anything up to, say, 600 feet in the airways while the velocity is often as much as 1000 ft. per minute in the shaft, slopes, or entries connecting mine with surface. Greater than 600 feet per minute would drive the flame against the gauze of the lamp (see p. 285, July, 1891, number of THE COLLIERY ENGINEER), and induce explosion.

89. How does the friction affect the velocity?

You will remember how in Q. 37 we spoke of the drag of the mine as influencing the height of the water-gauge? The greater the friction of the air in passing through a mine, the higher will the water-gauge stand and the greater must be the value for the pressure p (Q. 34) which is necessary to force the air through the mine. As p increases, so must the power u, required of the fan or the furnace in the proportion $u = p\,q$.

See also THE COLLIERY ENGINEER for discussion of this formula under "Power in Mines."

Now the friction increases with the square of the velocity while the power necessary to drive a given volume of air q is proportional to the cube of the velocity. From this, it will been seen that it is cheaper to have the velocity as low as possible provided you get the requisite amount of air.

90. But in reducing the velocity the amount of air is reduced, is it not?

That is so when a certain air-way is considered. But as a given mine requires a stated amount of air, it becomes necessary to so enlarge the air passages that the air will flow readily at a safe velocity.

91. What fixes the amount of air to be delivered to a mine?

The ordinary legal requirement of 100 cubic feet of air every minute for every man employed underground.

92. Does a man breathe as much air as that?

Oh, no. The average miner inhales into his lungs 1,500 cubic inches of air every minute, and he expels from them 52·5 cubic inches of carbonic acid, or about 3½ % of the amount inhaled every minute. This must be diluted with pure air and washed away at once, because it has a poisonous effect upon those breathing it. (See Q. 95).

Then, again, a mine employs one mule for every 10 miners and air must be furnished for the animal which should have 4,000 cubic feet every hour. The explosion of gunpowder produces gases which must be cleared away. And, finally, as the fresh coal face is continually throwing off gas from its pores, an extra allowance of air must be made in proportion to the area of the working and worked-out faces. For each square foot of face, exposed, one-third of a cubic foot per hour is added. Counting up all these allowances it will be found that for each man employed, there will be required at least 100 cubic feet of air per minute. Some States insist upon 300 cubic feet a minute per man.

93. What is the theory of the ventilating current?

To create a current of air large enough in volume to dilute the vairous gases produced in the mine to a very harmless proportion; and sufficiently rapid to remove the gases at once.

94. Is that the only means of giving pure air?

Yes and it is the only preventative of accident by explosion of fire-damp.

[TO BE CONTINUED].

ANALYSES OF COAL, ORES, ETC.

Instructions in Sampling and in Making Analyses to Ascertain the Quality and Value of Coal, Ores, &c., &c.

Assay for Lead is performed in a crucible. When the sample is received it is pulverized and thoroughly mixed. From various parts of the heap ten grammes (one gramme = 15·432 grains) are taken. Pour into a crucible and add material which will help to fuse the ore and reduce the lead. [The simplest flux is a mixture of 1 part of flour and 10 of bicarbonate of soda. This should be made in quantity and kept in stock, as "black flux substitute."] With the ore thoroughly mix 25 grammes of the "b. f. s." Now insert 3 nails, points down, and cover all with salt. Place this in the muffle by means of the scorifier tongs. Then as many more crucibles, usually not more than 9, never more than 12, are charged as there are ores to be assayed, *but never until the muffle has become white hot*. It usually takes about one and a half hours to get up heat enough for fusion. A zinc plate or a fire-clay stopper is put at the mouth of the muffle and the furnace is kept up at high heat for one-half or three-fourths hour, until the bubbling has ceased, and all is quiet in the crucibles.

The mould, Fig. 14, is now placed on the shelf at D and the crucibles removed from the furnace by the right hand, while with the left the cupel tongs are employed to gently pull out the nails. The crucible is then tapped a little and its contents poured out into the mould. The crucibles in turn are taken out, their nails removed, tapped, and poured.

In a short while the contents of the mould will be found to have cooled sufficiently for handling. They will be found to consist of a lead metallic button in the bottom, covered by a slag composed of all the other material in the ore. This button is handled with a pair of pincers, while it is pounded by a hammer into a small cube. The clean button is then weighed and represents the amount of lead in ten grammes of the ore. By simple proportion the percentage is found. If the button weighs 4·1 grammes, then the ore contains 41 per cent. of lead, because

$$10 : 4{\cdot}1 :: 100\,\% : x$$

The precautions are:

Keep up a very hot fire.

Never use moist or wet substances in the furnace.

Be expeditious in removing the crucible as soon as the boiling ceases.

Use the scorifier tongs for the crucibles, and the cupel tongs *only* for nails and for cupels.

Be careful that none of the broken slag enters a fresh wound or cut in the hand.

Unless very great accuracy is desired, one crucible charge is sufficient, otherwise duplicates are put through. To avoid errors in the tests the assayer is advised to systematize his work by numbering each test 1, 2, 3, etc.

In the note-book the tests are described opposite their respective numbers. The weighing of the tests follows the same numerical order. They must be placed in the muffle in the same way, observing always the order shown in Fig. 15. This plan saves confusion and prevents mistakes. When the crucibles are emptied into the mould, the order is again observed, No. 9 being first emptied, but into its corresponding cup with 6 poured in front of it and 8 emptied into the cavity alongside.

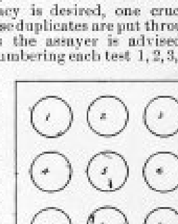


FIG. 15.

Assaying for Silver and Gold. The process described above is the industrial method of recovering lead from its ores on a large scale and includes the mode of saving the silver and the gold, but for many reasons the assayer has not carried out the latter part of the smelters' method in his more delicate, yet not more efficient process. The lead button which is weighed contains most of the precious metals, but not all, so another method called the Scorification or roasting process is employed. Before describing the method it is necessary now to explain a few details of measurements.

A ton of silver or gold contains 29,166⅔ Troy ounces, and all ores are valued by the number of ounces of gold or silver contained in a ton of ore. An ore of eighty ounces silver per ton is very rich. One of 200 ounces is exceptional. It becomes necessary therefore to have some simple weight by which to compare the assay results with the actual weights. Now, an ore of eighty ounces per ton avoirdupois is one which has eighty ounces of silver out of 29,166⅔ ounces of ore; so an ore of 200 ounces has 200 parts out of 29,166⅔ parts of ore.

Suppose we take 29,166⅔ milligrammes (29·166⅔ grammes) of the ore, then it should have 80, or 200, milligrammes of silver in it, according to which ore we are assaying. Then if we make a brass mass, weighing 29·166⅔ grammes we might call it an *assay ton*, [A. T.], letting each milligramme of it represent an ounce of the actual ton of ore, and we might weigh up an A. T. of the ore and find how many milligrammes of silver the fire assay will produce out of it. Then there are as many ounces of silver in the actual ton of ore as there were milligrammes of silver button reduced from an assay ton of the sample.

In general the assay of gold and silver ores are embodied in the following steps:

1—Preparation of the sample.

2—Reduction of the ore and the collection of the precious metals in the lead button.

3—The cupellation of the lead.

4—Weighing the metallic globules after 3.

5—Separation of the silver and gold.

6—Weighing the gold.

The first has already been explained.

The second, in crucibles, has been indicated, but instead of relying solely upon the lead in the ore for the collection of the precious metals, lead is added in conjunction with other chemicals.

The amount of the ore taken depends upon the probable richness of the ore. For gold ores from 1 to 4 A. T. are taken. For silver ores, from ½ to 1 A. T. Whatever the amount, it is placed in the crucible with sufficient litharge to furnish a lead button weighing about 20 grammes. An ore containing much lead may require little litharge for producing a button of the most convenient size. An ore without lead should have litharge charged with it, perhaps as much as 50 grammes. The object of seeking to obtain a final button weighing about 20 grammes is to facilitate cupellation, as will be seen later.

To reduce the ore and melt lead out of the litharge, which is only an oxide, 1 gramme of argol or ¼ gramme of charcoal must be added to the charge for ½ assay ton of the average ore requiring 50 grammes of litharge. Again, to obtain a clean fusion of the earthy matter of the ore, another agent must be introduced. If the earthy matter is silicious, add some borax (fused and pulverized); if it is basic and contains much zinc or spar, instead of quartz, add silica, finely ground. With care and a little observation on the part of the assayer, the required amounts of the various ingredients may soon become known.

To recapitulate, the assayer will weigh out from ½ to 4 A. T. of ore and add about 50 grammes of litharge, a gramme of argol, or ¼ gramme of charcoal, and silica or borax; after mixing thoroughly on a clean sheet of paper, it is poured into a crucible, covered with a layer of salt, and inserted into the muffle. When ebullition has ceased, the contents are poured into its proper cavity of the mould and allowed to cool, after which the lead button is cleaned and hammered into a cube, as before explained, and returned to its proper place in the mould for cupellation. Should the button happen to be of an excessive size, say over ½ inch on the side, there has been too much reduction. The assayer may repeat the test, using less litharge, or less of the reducer, or adding some niter for oxydizing the ore, otherwise, he may place the lead button in a scorifier with a little borax and conduct the operation as will be explained below.

The process of scorification is the more common one for silver and gold ores because it is simpler. The majority of the ores of silver require roasting or oxidation of the sulphur. To accomplish this in a crucible requires niter which has the unhappy faculty of boiling over, destroying not only the analysis, but also injuring the floor of the muffle. The broad exposure of surface of the scorifier permits of oxidation without any such risk, and hence is invariably employed.

The ordinary-sized scorifier will receive a charge of $\frac{1}{10}$ A. T. of ore which having been carefully weighed is mixed with about a thimble full of pure granulated lead. The whole charge is then covered with another thimble full of granulated lead and topped with three or four lumps of *fused* borax about the size of a pea. If great accuracy is required or a large quantity of ore desired for assay, two, or even three scorifiers are used, each charged as above. As mentioned above, should the ore contain much spar, some powdered silica is added. If zinc blende or grey copper be present in the ore, the charge of granulated lead should be increased.

Having prepared as many tests as are to be "put through" in the given "run," the scorifiers are placed in order as previously observed. The muffle should be white hot, in which state it may receive nine charges without seriously reducing the temperature. The muffle is then closed by means of the stopper, S, while the fire is being stirred up. In five or ten minutes it is removed to allow a free, liberal access of air. The contents of the scorifiers, which should now be in fusion, the ore floating on the bath of molten lead. Fumes will be seen to arise, and as long as they continue, the oxidation should be permitted, but the draught should not be excessive. This may be judged by the slow movement of the fumes. When the ore disappears, the fire should be raised somewhat and white lead fumes will begin to escape, a ring of slag will form and gradually encroach upon the lead bath, the exposure of which grows rapidly smaller. If the slag does not appear to be very fluid, a little borax or silica is added by means of the small shovel. If borax has been previously charged, perhaps silica may assist the fusion of the pasty mass, otherwise add a little more borax. In about thirty minutes the lead will have oxidized sufficiently to be completely covered by the enlarging ring of slag, when the operation is complete. As soon as all of the scorifiers are thus "closed," the doors are closed a moment to ensure a perfectly fluid slag. The contents are then poured out in proper places in the mould, Fig. 14, and allowed to cool. In time, the lead buttons are freed from their adhering slag, hammered into a cube and replaced for cupellation. Should any of the lead buttons appear to be covered too quickly, a little granulated lead wrapped in paper is dropped into it by means of the cupel tongs.

The lead button resulting from any of the processes mentioned should be malleable. A little granular button indicates the presence of sulphur, arsenic or antimony. A button larger than twenty grammes must be re-scorified with borax; brittle buttons, also, should be re-treated with lead before attempting to cupel them; those containing copper cannot be cupelled and must needs be again scorified.

[TO BE CONTINUED].

SURFACE APPLIANCES.

The Preparation of Coal and Ores for Market

83. Are they of same make?

The machines are not identical with those used for coal because they are intended only for small quantities

First, there comes the separators based upon the second principle mentioned in Q. 21, called hydraulic separators. These are to separate the particles into two classes; First, those which have a given resistance to falling in a body of quiet water, or which fall with equal facility in still water; and second, those which have a greater resistance than the first class. These are fed directly from the fine crushers.

Second, the numerous forms of tables upon which the fine mineral is treated in a thin current of water.

Fig. 8 is the view of a concentrating mill, at which C is the crusher, R the rolls, E the elevator, S, S², etc., the screens feeding to the jigs J¹, J², etc. The tailings from the jigs after crushing go to H¹, H², H³, etc. which in turn feed to certain machines at B¹, B², B³, etc.

84. Describe the separators.

These may be of two classes, according as to whether they are intended for the second or third method Q. 21. Those operating upon the third method are very simple.

Imagine a long trough inclined at a convenient angle. At the head a stream of water and fine ore is received and washes down the plane with a velocity sufficient to carry everything before it. At about 6 feet down the plane, the trough suddenly widens out to twice the width of the first 6 feet. The stream being spread over a greater surface has its carrying capacity reduced. Six feet further on there is another sudden widening of the trough that still further reduces the ability of the water to wash away its suspended contents. If this constituted the entire machine, nothing would be accomplished. But at the end of each 6 feet length there is a pointed V box having its mouth open and the apex at the bottom closed by a valve.

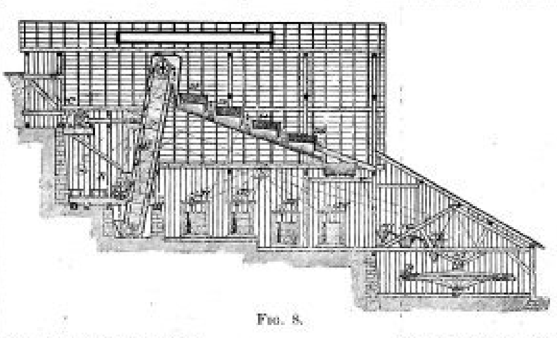


FIG. 8.

The first box is at the point where the second part of the trough suddenly widens. Therefore it is at the point where the carrying capacity of the current is diminished and hence where some of the sandy mineral will be released. So in this first V box is received the material which the current is the least capable of moving—the heaviest mineral is therefore the first collected.

Meanwhile the current of water at a lower velocity continues until it encounters another V box, larger than the first, at another point of change. Here again the stream parts with the next heavier material. After which the finest slime is deposited in the third V box in similar manner.

In each box, the contents differ in weight and size, while the material that fails to settle in the third box is allowed to escape into the creek. Each box is being filled automatically, and no labor or attention is required beyond occasionally watching its progress. Each box is emptied into its bin whence the contents are delivered to the proper machines for concentration. For although the contents are classified according to their weight (that is the particles of heavy and light mineral are of such sizes as to weigh the same) we have merely an agglomeration of small heavy and large light particles.

85. Are not the products of these several classifiers at once salable?

No. Each V box has collected quite a range of particles, as mentioned, extending from the comparatively coarse quartz to the very fine galena, and unless they be further separated we have not accomplished a concentration. Hence the classifier is merely a preparatory stage in the treatment of fine mineral.

86. How large is the material you are now referring to?

What I have called "coarse" is perhaps of the size of a small mustard seed or a grain of sand. The fine particles are those which are about $\frac{1}{150}$ of an inch in size and are called "slimes." The contents of the last V box are even finer than the material mentioned. Some of it will remain in still water, without settling, for several minutes; it is so very light.

87. If each box produces such a variety of unsized material, why could not their contents be delivered to screens and thus be separated in sizes?

That plan might be adopted, for by screening the material from each box separately, that which goes through the finest mesh screen is the heaviest, and is therefore the mineral; that through the next finest screen is still quite rich in heavy mineral; while that which fails to go through the coarsest screen is composed of large particles of quartz and spar. This method, however, is too expensive for practical work on a large scale. So the V box savings are treated on other machines.

88. Are there any means of producing at once a salable concentrate out of the fine material?

We have several forms of machines and more every day being patented. You will readily appreciate the necessity for some efficient machines, when you recall that at least 40 % of the valuable mineral of the ore is present in the tailings of the jigs. In many mills even more than this amount is lost, especially if there is any free silver minerals. For though they are much heavier than water and should sink, they are so flaky in character as to be borne away on the current. It is to save this material that the majority of machines are constructed.

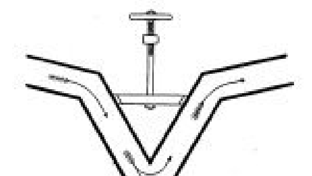


FIG. 9.

89. What variety of machine will with one operation collect the concentrates in salable value?

Conical separators receiving the pulverized tailings will separate the mineral quite effectively. A pair of cones are supported on stands in such manner that the distance between them may be regulated. A hopper or sluice empties the wet slimes and sands into the trough thence into the space between the 2 cones, as shown by the arrow. When they have arrived at the lowest point the coarsest grains separate and sink through the aperture at the bottom whence they are conveyed to the table or finishing concentrator. The finer sands which do not sink when they reach the bottom are carried up with the current as shown (very little of the mineral will fall out of its ascending current). This finer material is delivered to another larger conical separator when the current is not swift. Here the lighter and smaller mineral settles and from it escapes again the lightest of the slimes which are carried to the largest conical separator for final deposition. Each separator produces a very good concentrate which is at once salable, but if it is desired to further improve upon it, the savings are delivered to other machines. The speed of the flowing current is easily regulated, and this form of box gives very great satisfaction. The only way of treating the concentrates of these separators is on tables, to be explained, where a *thin layer* of very diluted slimes effect the washings.

90. What are the forms of slime dressing machines?

They are, in the main, but three varieties.

A bumping table, called, sometimes, Rittinger table.

A revolving inclined table, called, sometimes, buddle.

A moving inclined belt like the Frue Vanner.

91. Do these give salable concentrates?

Yes, each one of these receive the accumulations from one of the V pointed boxes and separates the mineral from the gangue or waste. Sometimes the waste from one of these machines is delivered to one of the other variety of machines.

92. Is there any difference in their behavior with slimes?

Yes, for example, as experience has taught that round sandy particles are better treated on the bumping or revolving tables, while flaky mineral is best saved by the inclined belts, it is evident that such a mixture of material as the V boxes deliver will contain some flaky mineral that the Frue Vanner will save, and some sandy particles that will roll off from it. If these tailings should be delivered to a buddle or a Rittinger, the round mineral can thereon be recovered. If, however, a certain ore for which you are designing a mill should produce only flaky or only sandy slimes, then one should choose, in accordance with the above mentioned principles, a Frue Vanner or a Rittinger.

[TO BE CONTINUED.]

METHODS IN MINING.

Shaft Sinking—Tunneling—Systems of Working Coal and Metals—Timbering in Mines.

86. Why are return air-ways driven along with each coal gallery?

The return air-way is always carried parallel to and near the haulageway (which is the intake) for a long distance ahead of the mining work to keep in advance of the winning. As the two are connected every few hundred feet, the gallery can be safely driven. Besides it is never safe to try to get along without a return airway. Coal operators would like to, if they could, because this narrow work is expensive but they cannot

FIG. 19.

for two reasons, as will be explained in questions on Ventilation there must be two air-ways if a mine is to be ventilated (and I may say here that metal mines require ventilation just as much as do coal mines) one for incoming air and one for outgoing air. Now one might divide the gallery into two parts by running a partition down its full length and from floor to roof, but that is dangerous. If the partition, leaks or if an explosion breaks it down there is no ventilation at all and the miners must suffer proportionately. Again it is a much more difficult arrangement to connect the working faces with the two parts of the same gallery so that the fresh air can be taken from one while the other receives the bad air. Finally the law, recognizing these risks and difficulties, has passed such regulations as will prevent such parsimonious efforts that invite disaster.

While the gallery is driving a temporary partition is carried by the miner along with the face. Posts reaching from floor to roof have nailed to them heavy tarred canvas cloth (Fig. 19) so that, until the gallery has advanced far enough for another *break* being made *through* the coal to the return air-way, the air current can travel as shown by the arrow. The return air-ways are always driven up hill from the gangway (that is to the rise). In thick coal seams the air way may even be in an upper bench or on top of the haulage-way.

[TO BE CONTINUED.]

A Simple and Practical Sight Feed Lubricator.

Below is shown Lunkenheimer's "Senior" Sight Feed Lubricator, which is acknowledged by all users to be a very satisfactory and perfect working cup. It is guaranteed by the makers to give entire satisfaction.

THE "SENIOR."

Description: B, oil reservoir; C, upper valve; E, filling plug; F, drain valve; H, union to connect condenser pipe and valve; K, discharge valve; L, valve for regulating flow of oil; N, indicator glass; P, sight-feed glass valve to drain or blow out sight-feed glass P.

Among its many and superior advantages are these: First, it is simple in construction. Second, it has no condensing bulb to freeze and burst. Third, the plugs S facilitate the replacing and cleansing of glasses. Fourth, it has a vent to blow out the sight-feed glass P. Fifth, the shanks on the one third and one-half pint sizes are threaded for $\frac{1}{4}''$ pipe instead of $\frac{1}{2}''$, consequently they are easily attached to small steam pipes. Sixth, every cup is tested and warranted.

These advantages combined with neat design and superior workmanship and finish make the "Senior" the most modern and efficient sight-feed lubricator in the market. It is made in eight sizes from one-half pint to one-gallon inclusive, and can be supplied by any dealer in brass goods. Complete directions are sent with every cup.

The "Senior" is manufactured only by The Lunkenheimer Brass Mfg. Co., of Cincinnati, Ohio, U. S. A., who manufacture a complete line of Superior Steam Specialties, Regrinding valves, Sight-Feed Lubricators, Glass Oil Cups, Grease Cups, etc. It will pay every steam user to send for their new 1892 catalogue.

The United States Mineral Wool Co., of No. 2 Cortlandt St., New York City, have lately added to their line of specialties an improved Sectional Mineral Wool Covering. Having added to their factory improved machinery, they can guarantee satisfaction in the execution of orders for their products.

THE ANTHRACITE COAL SUPPLY AND THE READING LEASES.

Abridged From an Article by A. A. McLeod, Esq., in the July "Forum"

There could—and let me say this at the outset—be no graver misuse of terms than to call the Reading leases an "Anthracite trust." This is the creation of a phrase to attract toward the Reading Railway the unfriendly criticisms which trade combinations called "trusts" have awakened in certain circles. Nothing has been created by these leases. Under the Reading charter, the railway has simply continued its policy of extension and enlargement, which it has systematically pursued in recent years, not only without adverse criticism, but with the hearty and sincere commendation of the public and the press; and I think it cannot be successfully denied that the many additions and extensions acquired by the Reading company under the auspices of the present management prior to those now under consideration, whenever sufficient time has elapsed to warrant a just conclusion concerning them, have resulted in every instance quite as much to the benefit of the communities affected by them as to the advantage of the company. The "Reading leases" mean simply that corporations, each with elements of strength and usefulness to the public which the others did not possess, come into close relations, the one taking what the others gave and each giving what it could with advantage bestow. The result has been a gain all around, not only to those concerned in the Reading management, but to the public, in whose service alone a profit can be found. The Reading has only followed the policy of other corporations, a policy made necessary by the stupendous growth of the country, and distinctly authorized and encouraged by the statutes of every State in the Union, though long neglected by this company from causes which seemed to be beyond the control of its management.

To criticise the Reading system as a commercial monopoly seeking artificial and oppressive gains at the expense of a single article of commerce is either the misrepresentation of ignorance or the libel of a wanton spirit. The Reading has followed the example of others who have developed the agencies of civilization. By precisely such combinations America grows in greatness. We had this example in the consolidation of the New York Central and the Pennsylvania systems. What, in a word, the Reading leases mean is that comparatively small and dependent lines are gathered into one and made strong, useful, and independent.

The Reading system proposes to itself a twofold duty. It will bring the products of its territory—coal among the rest—home to the consumer upon surer and better terms, and to the manifold industries along its various lines the raw material and supplies which enter into their products. It will assure to the thousands of investers in the Reading securities their undoubted right to some return for the money invested. In this will be found a complete explanation of the motives of the management in negotiating the leases. It is a mistake to suppose that there is or has been recently any material or substantial competition between the transportation lines as to the carriage of Anthracite coal; the carrying of the coal from the various mines and from the various regions is mainly determined by the ownership or control of the lands or by the necessities imposed by geographical location. Corporations have been formed acquiring the coal lands. These corporations, acting under existing laws, obtained their properties and hold them by the tenure of law. They are as much the possession of their owners as Government bonds or the homestead deed. The corporations as coal-mine owners are in close relations with the Reading and other companies. As a consequence, the competition about which so much is written is between individuals and corporations producing and selling coal, and not between the transportation companies carrying the coal to the market. This condition is in no wise altered by the Reading leases. The same mines are tributary to the same railroads as before; each line serves the same markets, and neither line gains nor loses a ton of Anthracite traffic as a consequence of our transportation arrangements.

In considering the Anthracite coal question we must remember that the supply is exhaustable. We are taking from a fixed quantity, the accretion of ages, which, when used, can never be recreated by any agency known to man.

If squandered as other resources quite as valuable have been, we come to the real oppression of prices, for the cost would advance as the supply grew less, until coal became an article of luxury. Economy in production must be observed by improved methods; and in the unification and strengthening of industrial processes we have a more prudent, practical, and economical system of mining, enhancing the security of the investors in coal properties, promoting the comfort and assuring the more regular employment of the laborer, and all ultimately inuring to the benefit of the consumer of coal, if not in the lowering of prices when they are already too low, considering the cost of production, at least in the way of continuing the supply at moderate prices.

The allegation that the prices of coal have been advanced to extortionate rates under the recent arrangements is the burden of many articles of the press. I read of "the untold millions" which are to be taken out of the meagre earnings of the poor as a consequence of the alliances and the proposed economies in the coal business. There can be no better reply than to study prices during the past four years. Here are the commercial circulars giving prices in May, 1892, at the tidewater points of Weehawken, Hoboken, and Perth Amboy. Grate coal is quoted at \$3.75 a ton. This is 30 cents higher than in 1888, 25 cents higher than in 1890 and 1891, and the same as it was in 1889. These figures show how little in four years prices have varied from the average. In egg coal the circulars quote the May rate as \$3.90. This was the quotation in 1889 while in 1888 it was \$4.00, showing a fall in four years of 10 cents a ton. Stove coal quoted at \$4.15 was the same price in 1889 and \$4.25 in 1888; in that also a decline from 1888 of 10 cents a ton. Chestnut coal is quoted at \$3.90, as against \$4 in 1889 and \$4.25 in 1888, a decline of 35 cents a ton. Compare the May quotations of grate, egg, stove, and chestnut coal in 1892 with the May quotations of 1888, and we see that in grate alone has been an advance. There has been a fall of 10 cents a ton in egg and stove and of 35 cents a ton in chestnut.

These latest reports are cited to show that there has been no advance over that which ruled five years ago. As a matter of fact, they show that coal in its various forms has kept an even pace, in some years a trifle more and in others a trifle less, the average about the same, subject to fluctuations of trade and those mutations in the supply and demand from which no business, commercial, financial, or railway, is free. While it is true that the Anthracite coal traffic is an element of great importance, it must be remembered that it is only an incident in the problems of the Reading road. The company has other interests than Anthracite coal. If its policy contemplates a permanent system, the becoming a part of the structure of our national welfare, it must accept the fact that Anthracite coal is a temporary and diminishing value, that it will last our time and, perhaps two or three generations more, but that other agencies must be cultivated for the fulfillment of its work. A large proportion of its tonnage is Anthracite coal and will be for a long time. It is by no means the major part, and the proportion in the general volume of its business will lessen from year to year. The Reading Railway will carry coal as it carries wheat and sugar and oil, but it is not upon the coal traffic that the future of the system depends.

There are many discussions as to the mistakes made in the capitalization of the various companies in the Reading system, the wisdom of purchases of what might be called dormant properties in past years and the financial burdens involved in the necessity of holding them for development. These discussions do not apply to the present Reading management. It is in the presence of conditions which it did not create and which it is striving to strengthen and amend by every agency known to a prudent business direction of affairs. The Reading management is charged so to govern its properties that obligations shall be met and the rights of investors assured. This, as experience shows, cannot be done by abandoning one interest to suit the whim of another. It can only be continued with due regard to the rights of all. In the management of the coal supply it is done first by terminating the squandering methods under which such a large percentage of mining has been sheer waste. It will be done by the prevention of spasmodic production and the ignoring of the laws of supply and demand, which in coal, as in everything else, is sure to bring improvidence. This will prevent the inadequacy of prices, and, while maintaining the investors' rights, assure steady and well paid work.

Over-production has ever been the bane of all industry. The recurring periods of ruin and depression which have swept over the country have been invariably accompanied by the continued production of some important article of commerce beyond the requirements of the market, whether of cotton and corn, the products of the soil, or of the iron and copper and silver from our mines. The same inexorable law applies to Anthracite coal. Nature has imposed peculiar and unusual limitations upon the production and consumption of Anthracite. These limitations govern and control both supply and demand, and must be recognized, either willingly or unwillingly, by all concerned. For a brief season in each year the requirements of the markets of the country absorb for consumption upwards of four millions of tons per month for a few months, or at the aggregate rate of about fifty millions of tons per annum; whereas the aggregate consumption scarcely exceeds the rate of forty millions of tons per year. To supply the extraordinary demands of the fall season the great producing companies have developed a capacity for production equal to the supply required at times of the greatest activity; but it is obvious that if the production should be continued, regardless of the demand, at the rate of the full capacity of all the mines, it would not be long before all the evils of disastrous over-production which I have pointed out would be upon us.

The enormous development of the mining capacity of the Anthracite regions and the millions of capital invested in the mines to enable them to produce coal at the highest rate required by the market forbid that they should lie idle for a moment at any time when the product can be sold at a moderate profit. The interest account accumulates too rapidly upon these enormous investments to allow the producers to wait, even if they were so inclined, for an unnatural market stimulated by a short supply. There always has been and must continue to be a supply of mined coal in excess of the immediate demand, except perhaps occasionally for very short periods of particular sizes. I have not alluded to the competition of Bituminous coal, which is present everywhere, but, if there were no other reasons, its presence in every market operates as a prohibition upon any unreasonable advance in the price of Anthracite coal, even if the power and disposition to make such an advance existed, which is impossible under any condition of things.

Upon one other point I think a word may be profitably added. In the development and augmentation of local industries along its lines lies the path of prosperity for the future railway system. The concentration of the industries of the country in and about the large centers of population has been largely brought about by the establishment of inadequate rates for transportation at competitive points and the maintenance of proportionately high rates at local interior points which became necessary to preserve a sufficient average revenue to support the transportation system of the country. The time has now arrived when the material reduction of what are called through competitive rates has reached its limit, and the competition of the future will be, not the competition of the railroads among themselves for the same traffic, but the competition of the communities along the several lines of railroad with other communities along other lines for the markets of the country; and that community which, not served by lines of railroad reaching all parts of the country, at rates commensurate with those enjoyed by other communities on other lines, must fall behind in the race for progress, and the railroad which serves it must follow in their wake. Perceiving its duty to the communities upon whose prosperity its own depends, the management of the Reading Railway has sought to equip it with all the means for entering upon the broader field of competition which the future is sure to open; and in doing so it has not overlooked the necessity of acquiring access to all the sources of supply which enter into the industries along its lines and to the markets to which their products must be carried.

Finally, to rescue the Reading management from complications which we have accepted but not created; to give the Reading system its standing among the natural necessary transportation systems of the Middle States; to make the road an element of strength to every national and local interest, industrial as well as financial, is the underlying thought of those who consummated the Reading leases. Experience thus far confirms the wisdom and equity of that transaction; and when it is understood in all its relations and ramifications and seen likewise in the light of experience, there is no apprehension as to the reasonable and discerning judgment of the country.

A Month's Record.

Business generally is considered quiet and many complaints are made by machinery men. However, as a notable exception to this, we find that the Lidgerwood Manufacturing Co., of New York, makers of Hoisting Engines and Cableways, have broken all previous sales records during the month of May, just passed, having shipped 127 engines and 45 boilers; an average of five engines per day. This speaks volumes for the character of the hoisting machinery as manufactured by this well known company.

MECHANICAL NOTES

Tool Sharpening by Acids.

It has long been known that instruments and tools, such as knives, shears, scythes, and files which have become blunt by use may again have a keen edge imparted to them by means of acids, as well as by the common methods of sharpening and whetting. But so far the less usual process does not appear to have met with the favor which its merits deserve. All dilute mineral acids are adapted for tool sharpening: for example, 10 parts of sulphuric acid hydrate to 100 parts of water. The desired end is more quickly attained if a portion of the sulphuric acid be replaced by nitric acid. A suitable mixture is: 1 litre of water, 50 grammes of Chili saltpetre, and 60 cubic centimetres of concentrated sulphuric acid. This compound dissolves 1½ grammes of metal within ten minutes from an iron surface of one square centimetre; dissolution is slower where sulphuric acid alone is used. Steel is acted upon in the same manner as iron, with the exception that the process is not so rapid because of the polished surface becoming covered with a thin deposit of separated carbon. It has been sought to strengthen the action of the acids, or, in other words, to shorten their period of action, by attracting the electric resistance of the iron with gas-retort coal or with other metals; but up to the present no substantial advantage has accrued from this method. In order to secure as uniform an acid action as possible, preliminary cleaning of the metallic surfaces, preferably with a soda solution, is recommended.—*The Age of Steel.*

Use Good Graphite.

A correspondent in the *American Machinist* says: If engineers, machinists, and millwrights in general, and pipe-fitters in particular, knew of the good qualities of graphite, I dare say there would be ten times the demand for it. Its lubricating qualities are questioned only by the impractical and it is this quality alone that sounds its key note, so to speak. Let me describe a few of what I consider its most important uses. As above stated its primary object is lubrication and it is to this fact we must credit good pipe joints and cool bearings. In making pipe cement (or as I would term it, pipe smear), it is not necessary to use the best oil or grease, as it is the graphite and not the body in which it is suspended, that makes the mixture valuable and the joint perfect. I use the drippings from line shaft bearings, caught in the ordinary way and mix it with the best Ticonderoga flake graphite so that it can be applied with an ordinary sash tool.

During the past three years I have used about fifteen or twenty pounds of dry Ticonderoga flake graphite for pipe joints, cylinder heads, piston rod packing, etc.

Bolts, smeared with graphite mixed as above, I have unscrewed after having been in the dampest places for upward of two years, or more, proving the antirusting qualities of graphite. To cool hot bearings put in on as thick as it will mix with oil.

Almost any oil or grease will answer, but don't use poor graphite.

Magnetic Iron Rust.

The London *Journal* notes that at the recent meeting at Hobart, Tasmania, of the Australasian Association for the Advancement of Science, Professor Liversidge, F. R. S., of the University of Sidney, read a suggestive paper on the rusting of iron. The author remarked that in books upon chemistry it is usually stated that iron rust is composed of the hydrated sesquioxide of iron; but on examining a very large number of specimens of rust from many different places, and from iron articles of various kinds, and formed under very varied conditions, Professor Liversidge has found that in almost every instance the rust contained more or less magnetic oxide. Indeed, in some cases the rust, although presenting the usual rust-brown color and appearance, was, when powdered, practically altogether attracted by the magnet. The specimens of rust which first drew the author's attention to this subject were large rust scales obtained from some old tramway metals, which he was led to collect and examine on account of their resemblance to the crust so often present upon metallic meteorites. On crushing these scales in a porcelain mortar, and testing the dust with a magnet, it was found to be wholly susceptible to magnetism, owing to the small quantity of magnetic oxide present being mechanically inclosed in the rust particles. The production of this magnetic oxide does not seem to have been due to the presence of mill scale, because, when bright iron wire, plates, rods, nails, etc., were artificially rusted in many ways with free access of oxygen, in almost every instance a large amount of magnetic oxide was formed. These observations have some practical bearing upon the problem of the preservation of wrought iron structures from rust

Training the Eye.

A good mechanic must have a good eye, must be able to detect inaccuracies and imperfections at a glance. This is one of the important characteristics to be acquired, and must be a part of the education which makes a good mechanic. The following from one of our exchanges is so pertinent to the subject that it is worthy of a repetition, and is recommended, especially to the young mechanic, who should make it useful to himself and a part of his study:

A good authority said some time ago: "Every man who is engaged in any kind of mechanical labor should cultivate studious and observant habits. There is scarcely any description of knowledge but which he will at some time have use for, especially if he ever hopes to rise above the position of ordinary mechanical labor. No man can ever hope to attain distinction as a mechanic unless he educates his mind as well as his hands."

One of the most important requirements of a mechanic is that he should be able to readily and lucidly convey ideas to another. There are many men who, while otherwise competent to direct others, have failed from lack of this faculty, or have refused good positions because they knew their weakness in this respect. Perhaps as many foremen fail from this cause as from any other. Undoubtedly, this faculty is one to be acquired; it is not one, if there are such, that is born with a man. Every man who works at a mechanical business should labor in the direction of acquiring the habit of concisely expressing his ideas, making this a part of his mechanical education. Talking of such subjects will help a man; writing of them is excellent practice.

A good mechanical eye is also an almost essential requisite in a good mechanic. No one can ever attain distinction as a mechanic unless he is able to detect ordinary imperfections at sight, so that he can see if things are out of plumb, out of level, out of square, and out of proper shape, and unless he can also detect disproportioned or ill-shaped patterns. This is a great mechanical attainment, and one which can be readily attained by an ordinary person. Of course there are defective eyes as there are other defective organs; the speech, for instance, is sometimes defective, but the eye is susceptible of the same training as any other organ. The muscles, the voice, the sense of hearing, all require training. Consider how the artist must train the organ of sight in order to detect the slightest imperfection in shade, color, proportion, shape, expression, etc. Not one blacksmith in five ever attains the art of hammering square, yet it is very essential in his occupation. It is simply because he allows himself to get into careless habits; a little training and care is all that is necessary for success.

But in these cases the fact is that the eye is not half as much at fault as the heedless mind. Some carpenters acquire the careless habit of trying the tri-square every time they plane off a shaving, in place of giving their minds right to their business and properly training their eyes, and unless they cultivate this power of the eye they will always be at journey work.

Look at the well-trained blacksmith; he goes across the shop, picks up the horse's foot, takes a squint, returns to his anvil, forges the shoe, and it exactly fits the foot. Contrast him with the bungler who looks at the shoe, then fits the foot to it, often to the ruin of a fine horse. Now, the fault lies in ever allowing himself to put a shoe on that is not in proper shape for the foot; he should determine to make the shoe fit the foot in place of the foot fitting the shoe, and he should follow it up until the object is accomplished.

A very good way to discipline the mechanical eye is to first measure an inch with the eye, then prove it with the rule, then measure a half-inch, then an eighth, and so on, and you will soon be able to discover at a glance the difference between a twelfth and a sixteenth of an inch; then go to 3 in., 6, 12, and so on. Some call this guessing; there is no guesswork about it. It is measuring with the eye and mind. Acquire the habit of criticising for imperfections every piece of work that you see; do everything as nearly as you can without measuring (or spoiling it), or as nearly as you can trust the eye at the present training. If you cannot see things mechanically, do not blame the eye for it; it is no more to blame than the mouth is because we cannot read, or the finger because we cannot write. A person may write a very good hand with his eyes closed, the mind, of course, directing the fingers The eye is necessary, however, to detect imperfections. Every occupation in life requires a mechanically-trained eye, and we should realize more than we do the great importance of properly training that organ.—*Metal and Iron Journal.*

HOW TO LIVE

Exercise Better Than Medicine.

Much of the food actually digested and assimilated is not used to the fullest extent for want of sufficient oxidation to make it yield the greatest amount of vitalizing power to the tissues of the body. Such partially unoxidized products have an irritating effect on the organs and tissues, and predisposes them to disease if they do not directly affect them with it.

Exercise has a stimulating effect on all parts of the body by inducing further oxidation in all the tissues and organs. This increased oxidation is attended by a greater demand on the part of the system for oxygen—as indicated by the greater number, force, and frequency of the respirations.

During exercise the heart beats faster, and forces more blood through the lungs to all parts of the body, bearing in its little blood cells the precious life-giving factor, oxygen. These little cells—one constituent of which, hæmoglobin, has the wonderful facility of quickly loading and unloading itself with oxygen—thus act as direct aids to the process of oxidation in the tissues and organs.

It is the combining of oxygen with unoxidized products in the blood that gives to each individual cell its possibility of sustaining life. Any process which increases the oxygen supplied to all parts of the body tends to strengthen the life in each individual cell, and to give it more power to resist disease.

Exercise of all factors does this most effectively; and besides actually producing in each individual cell a greater vitality, it gives a favorable opportunity for the waste products of the tissues to be thrown off rapidly. By thus causing a further oxidizing of certain matters in the blood, it conduces in a double sense to life and health.

Habitual out-door exercise, with suitable protection from extremes of weather, is the most effective means of prolonging life to old age.—*Youth's Companion.*

The Aroma of Coffee.

The aroma of coffee develops especially during the process of roasting; its fatty oil oxidizes, is burned, and is changed into essential oil, or caffeine, a species of ether that can be isolated by distillation, and which we can sometimes see with the naked eye on the surface of the ordinary infusion. But coffee, like many other natural products, such as wine, tobacco, and cacao, requires a certain length of time after being gathered before it reaches its full maturity. Experience has shown that the development of its aromatic principle is acquired by keeping it in a green state from one crop to another. But it well known that for about the last half century the caffeine seems to be lacking in the infusion of coffee, which has no longer the exquisite qualities due to its aroma.

If now, on the one hand, we consider that the production of coffee is necessarily limited by the conditions of climate requisite for its growth, and that, on the other hand, the planter, in order to supply the demand which is constantly on the increase, is now obliged to deliver the crop as soon as it is gathered, we can do nothing but infer that the cause of the degeneration of coffee lies in the fact that it is supplied to trade too soon, while it has not yet developed its constituent principles, and particularly its caffeine.

The inference from this is evident. If we wish that our coffee should regain the quality through which formerly it was considered such an exquisite beverage, we shall have to go back to the traditional process of only supplying it to trade when the caffeine has acquired its full development, which can only be given to it by time, and by being kept in a green condition from one crop to the next.

We must not, however, expect that dealers are going to follow this rule, but, at any rate, consumers can do it for themselves, by only roasting and using coffee which they have kept in a green condition for at least a year.

Bicycle Riding.

Among the main reasons which bicycle riders give for their choice of locomotion are the following:

Bicycling, is a popular, clean, healthful sport, and a wheel is good company.

The wheel is a time-saving machine, and in this busy age time is money.

Exercise on the wheel is better than walking, because the weight of the body is principally supported by the saddle. Strength is economized, and the exertion of force distributed more generally throughout the muscles of the legs, arms, and body, and equal results in progress reached by far less exertion, or proportionately greater results by the same exertion. In other words, the wheelman rides ten miles in an hour with less fatigue than he would walk four in the same time, because in walking almost all the muscular exertion is thrown on the legs.

Few people breathe properly. They use only the upper portion of the lungs, and leave a large residuum of impure air. Bicycle riding causes thorough respiration, and tones up the general circulation. It is particularly beneficial to men and women of sedentary habits, and gives them such exhilarating pleasure that they do not feel the labor involved.—*New York Ledger.*

Nutritive Value of Various Foods.

In the committee which organized the Workingman's Congress d'Hygiene that has just been held in Paris, was conceived the idea of having the seances of this congress preceded by a series of preparatory lectures destined to enlighten the members on the present condition of science as regards the hygiene of food, dwellings, and workshops.

One evening, M. Dujardin-Beaumetz, of the Academie de Medecine, treated the general question of food, one of the most important in the entire branch of hygiene, and at the same time one of the most difficult to solve. There is no one who is not concerned in this subject, which forms one of the leading preoccupations of all rulers and economists.

The taking of food is done with a view to restoring the losses undergone by an organism in the course of the continual destruction of the constituent elements of our tissues and to keep up to the heat of our bodies. My readers are undoubtedly aware of the fact that our frame is constantly consuming a portion of itself, that each day it loses a certain quantity of nitrogen, carbon, water, and salts. It is, of course, necessary that the food we take should be sufficient in quantity and quality to make good these losses, otherwise we must of necessity grow weak, dwindle away, and die.

COMPOSITION OF FOOD.

This amount of nitrogen and carbon has been accurately estimated: in twenty-four hours a man consumes 20 grammes of nitrogen, 310 grammes of carbon, and gives off by the breath and by the different secreting organs two or three litres of water and about 30 grammes of salts. Our food, therefore, must be of such a nature as to allow the organism to repair its losses, a food-stuff being a substance of many different origins, which when introduced into the living body may be used for nutrition.

The inorganic kingdom supplies us, either directly or through the intermediary of the animals and plants with which we nourish ourselves, with water, chloride of sodium, which is found in the blood and muscles, salts of lime and particularly the phosphate and carbonate which constitute more than half of the framework of the body, and salts of sodium, potassium, magnesium, and iron, which are useful in different degrees for tissue formation.

The vegetable kingdom gives to man substances composed of oxygen, carbon, and hydrogen, ternary substances, which are starch, sugar, and fat, and, in addition, compound materials made up of the three foregoing elements, to which a fourth—nitrogen—is added, such as gluten, which we find in many seeds, but particularly in cereals and the soft portion of plants.

The food which we derive from the animal kingdom consists of a variety of forms of albuminoid or nitrogenous substances, such as albumen, fibrine, caseine, as well as non-nitrogenous substances, such as fat and sugar of milk.

A complete form of food, such as milk or eggs, contains all the elements necessary for our body.

RELATIVE VALUE.

Ternary forms of food, such as fat, which keep up the combustion that takes place in the depth of our tissues, sometimes go by the name of respiratory forms of food; whereas the nitrogenous or quarternary substances are often called plastic food elements, as they are specially destined to replace lost tissue. The importance of the latter is shown by the fact that the nitrogenous substances predominate in the blood and muscles.

Our food contains greater or less quantities of oxygen, hydrogen, carbon, and nitrogen, and those substances which contain them all in the exact proportion necessary for the restoration of organic tissues are, as I have already said, complete forms of food. At the head of this class we must place milk and eggs, and meat is the most nutritive element after them; it contains the most nitrogenous substance, and its composition is about the same, no matter from what species it is taken. Fish is very similar to many forms of meats, and its nutritive value is very nearly identical. Just as is the case with meat, fish with fatty flesh is the most nourishing variety.

Dried vegetables, such as peas and beans, contain more nitrogenous matter than cereals, and even than the flesh of animals; but as regards their nutritive value, it should not be thought that it is a matter of indifference to use either one or two forms of food which contain about the same amount of nitrogen and carbon. Thus, although 100 grammes of beans contain more nitrogen and carbon than a similar amount of meat, still they could not replace 100 grammes of this substance. That they are chemically equivalent is not sufficient, as the one is not so easily assimilated as the other.

CEREALS AND VEGETABLES.

The cereals supply us with flour, which is used every day in making bread. This form of food has a high nutritive value. The finer kinds of bread contain more nitrogen, but less saline matter, which is found in larger quantities in common bread, of which the flour has been less carefully bolted.

Certain vegetables, such as peas, beans, and lentils, contain a very high proportion of nitrogen and starch, and are so nourishing on this account that they have been called the poor man's meat. Potatoes, rich in starch, but lacking in nitrogen, are not so nutritive, but go very well combined with meat. Cheese, which is very rich in nitrogen has a highly alimentary value.

I shall not carry this study of detail any further, but there is one point to which I should like to draw attention—namely, the necessity of seeking the elements of nutrition in both of the kingdoms, both animal and vegetable, man being an omnivorous creature. To obtain 310 grammes of carbon it would be necessary to absorb 1,183 grammes of meat, which, in addition to the cost, would require the organism to do such an amount of work that it might suffer in consequence. In the same way a purely vegetable diet would require us to absorb such an enormous weight of food that our digestive tube would not be able to stand it, as the intestines of men have neither the form nor dimensions of those of animals.

ALIMENTARY RATIONS.

The exact knowledge of the losses incurred by an organism lead us to an estimate of the amount of alimentary substances necessary for the support of each individual. It is necessary to replace regularly the daily loss, but, in addition to this, when a person works—that is, to say, produces heat and movements, and, in consequence, consumes his tissues—it is necessary, in order that the equilibrium indispensable to health and even to existence may be upheld, that the organism should receive an amount of alimentary substances proportional to the expenditure due to the labor. In other words, we have to distinguish between the amount sufficient for every day needs and the amount required by a working organism.

The alimentary regimen must be modified in its quantity according to whether a person works a little or a great deal, and in its quality according to climates. The inhabitant of warm climates eats little meat, but relies chiefly on vegetables and sweet and slightly acid fruit; he should be very careful about the effect of alcoholic drinks. On the other hand, the inhabitant of cold climates prefers nitrogenous food and fats. The tonic action of the cold gives greater activity in the digestive functions, and enables the organism to accumulate the materials necessary for the production of heat, which places the body in the position to resist the action of any low degree of temperature.—*New York Herald.*

USEFUL INFORMATION

Disciplining the Mind.

If for a moment we could lay aside the thought of the established routine which we have become accustomed to calling education we should, I think, easily see that facts about things which we do not come in contact with are not helpful; while they usurp the place of those things which are needed for every-day life. Do you say they discipline the mind and strengthen the memory? This is the reason given for many of the arbitrary rules and studies in the schools, but this is assuming that what is uninteresting and dry is better for development and as a preparation for life than are those things which are gratifying and agreeable. The body can only be fully nourished by eating such food as is pleasant to the taste. The nerves of sensation must be pleasantly excited to secure perfect digestion and assimilation, and it is a serious mistake in our ideas of education that we fail to recognize this beautiful law in intellectual processes.

There is a deal of nonsense about discipline of the mind, of the will, and of the body. Life is, or ought to be, for all normal human beings a continual discipline of brain, body, and will, and the means for this discipline are furnished in the needs and processes of life. Our failures come from not recognizing these processes, or from being out of place. In either case we are out of harmony with the "inflowing universe," and so fail to get our discipline in God's own way. Then we formulate our arbitrary methods to supply the place of the natural order, very much in the same way as artificial limbs, teeth, and other organs are supplied by science when the natural ones have failed us from carelessness, accident, or disease.

This false and exaggerated idea of our responsibility in furnishing discipline first grew out of the belief that the human being is all wrong till we set him right, and though total depravity is practically a thing of the past, yet the opposite theory—that the child is right till we lead him wrong by our false estimates of values— has failed to find its way very generally into old avenues of thought. Still less have we learned to follow and obey nature, and thereby transform our educational system from arbitrary and unattractive methods to those which meet glad acceptance—glad, because the brain in its natural condition enjoys its supply of knowledge as the body enjoys its food. The flowers bloom and fruits ripen when we make the conditions right for them, and then let them alone to revel in the operations of unerring and beneficent law.—*From Harper's Bazar.*

Mob Law is Lawlessness.

There are many excuses for lynching, but no justification. The crime of the victim may be horrible in the extreme, the process of the law's administration may be exasperatingly tedious, but wherever law exists, by law should all abide.

The men who usurp its sacred functions by taking punishment into their own hands are doing the same thing in a lesser degree for which they inflict the awful penalty of death. The negro who was recently burned at the stake in this country broke a sacred law, but so did the men who burned him. For all good laws are sacred, and, to be kept so, must be executed by their proper authorities.

Another point deserves mention:

Every lynching makes more murderers. This is an absolute fact of observation, however accounted for, and it has always been so.

In past ages men were crucified, boiled in oil, and consigned by the theology in which they all devoutly believed to eternal torment in a literal hell.

But none of these things prevented them from committing the most horrible crimes. Only as far back as the eighteenth century men were hung by the hundred every year in England for trifling offenses; and despite the gallows, black deeds were never more rampant. Jack Shepard and Dick Turpin were the admired captains of a great multitude, who murdered with a red hand and died glorying in their shame.

The truth is, *no punishment, in and of itself, can make a lawbreaker a good citizen.* And least of all can that punishment do so which is itself a breaking of law.

Nor can its terrors withhold scamps from lawlessness nearly so much as some people imagine.

The brave man and the good citizen respect the majesty of government. The coward and the ignorant, brutalized criminal, lack that education of the mind which induces such respect, and so they exalt the criminal spirit. "*Outwit* the law, and it can not reach me," says the lynched one. "*Leave alone* the law; it is not speedy enough for our hatred," says the lyncher. And between the two, law is left—entirely out of the tragedy, which then goes on to repeat itself in increasing ratio. Educate men to abide by law, and control their passions, and both lynched and lyncher will soon be a thing of the past.—*New York Ledger.*

The Care of One's Clothes.

One's apparel will last much longer, and also much replenishing be saved, if everything is well taken care of. Nothing pays better than this watchfulness, which only takes a little extra time and patience. Always, if possible, look over every article of wearing apparel each time it is taken off. Shake dresses, brush them thoroughly and carefully; hang them away in the closet, and be sure that the loops are placed in the right places; a dress should never be hung up without loops. Many prefer to fold handsome dresses, wrap them in an old sheet and lay them in a drawer. I hang all of mine up in closets, always keeping a sheet pinned across evening or light dresses. Never throw dresses over a chair, or hang other articles over them in the closet, as it makes them badly wrinkled and injures them badly. Cloaks and wraps, after being well brushed, should be hung up by a loop at the back of the neck, or they may be carefully laid in a drawer. Fold shawls in their original creases, and either lay them in a drawer or on the shelf, but never hang them up. Hats and bonnets should also have as good care putting them in boxes; or if laid on the shelf they should be wrapped in a piece of white cloth to keep them from the dust. When taking bonnets off, straighten and smooth the ribbons and flowers before laying away. One large drawer in the dresser should be kept and especially dedicated to one's ribbons, laces, handkerchiefs, gloves, etc., also having separate boxes in the drawer for articles of a kind—laces by themselves, ribbons, etc. Always, when taking off gloves, pull them out lengthwise, smooth them and lay carefully in a box set apart for them; never roll them up together and toss them aside like a bit of rubbish; and, if possible, do not fold them over in the center. Laces should be well looked after, and kept fresh, neat, and smoothly folded. Do not allow any of these smaller articles of the toilet to be thrown altogether in a drawer in a mass of confusion; it will take the freshness and neatness from them.

Shoes should never be thrown about, left to lie on the floor under the bed, to collect the dust, which surely injures them; smooth them out, brush them, and if no buttons are off, no rips found, place them in the shoe bag or box. Never allow a button to stay off a shoe, as it shows great negligence, besides hurting the appearance of the shoe.

Always have a brush broom, a bonnet brush, a sponge and pieces of soft flannel, bottles containing ammonia, benzine and alcohol, and some cleansing fluid, to aid in removing spots of dust and dirt, stains, etc., from the clothing. Keep every article carefully mended, as by that means it can be made to last much longer. Verily, a stitch in time does save more than nine. And by all means never wear a stocking with even a very small hole in it, but change it as quickly as possible and darn it very neatly; so with all articles of wearing apparel.—*Good Housekeeping.*

Scientific Advancement

Photographing in Colors.

A little more than a year ago we reported, in some detail, the experiments in photography of colors that had been made by Mr. Lippmann, in Paris, and their results. The process employed by him, it will be remembered, consisted in placing a reflecting surface behind the sensitized plate, so that the rays of light, after penetrating the film, would be turned back through it again. Thus Mr. Lippmann succeeded in producing several negatives in which the colors of a stained glass window were pretty faithfully introduced. The chief difficulty with which he had to contend was the character of the sensitive film, which was too course in quality and too slow in action. His operations since that time have been largely directed toward an improvement of the film, and the success attained by him is now made known in the last number of the "Comptes Rendus."

By the use of albumen-bromide of silver films, made orthochromatic with azalin and cyanin, Mr. Lippman has obtained very brilliant photographs of the solar spectrum. All the colors, secondary as well as primary, even including the red, appear in all their natural vividness, and that without the use of any color-screen. The exposures of these plates varied from five to thirty seconds. On the same theory he also proceeded to photograph various objects of blended and complex colors, such as a stained glass window, some draperies, a plate of oranges surmounted by a red poppy, and a many-hued parrot. The draperies and the parrot required exposures of the plate of from five to ten minutes, in sunlight, and the window and the oranges of several hours in a comparatively dim light; but the results obtained were altogether satisfactory. On other negatives he accurately fixed the blue of the sky, the green of foliage, and the pale grey of a stone wall.

Mr. Lippmann is confident, therefore, that this interesting problem is practically solved. It remains only to intensify the orthochromatic quality of the film, and to increase its sensitiveness to light. How much the sensitiveness must be increased may be judged by any one who is accustomed to practical photography. A plate that receives a vivid impression on exposure to white light for a fraction of a second may be exposed for some time to a red light without being affected in the least. But in color photography it must respond instantaneously to the red rays, and the yellow, as well as to the white and the blue. In handling such plates, the "dark room" will have to be really dark, and not, as at present, illuminated by the radiation of a ruby lantern.

It seems to us entirely within the bounds of reason to expect that perfect and practicable orthochromatic photography will presently be attained; perhaps on the lines indicated by Mr. Lippmann, perhaps by some other method. Such an achievement requires no greater advance upon the photography of to-day than the instantaneous dry-plate system of to-day marks upon the slow wet-plates of a few years ago.—*New York Tribune.*

Notes of Recent Inventions.

The man who observed that he would not go abroad until he could cross the ocean in a car may not have to wait so very long after all for the realization of his hopes. There comes from Sweden news of the construction at Christianstad of what is called a locomotive steamboat. It was built for use on a chain of small lakes in Sweden which are separated by waterfalls, and to get around these the steamboat has been fitted with wheels like those of a locomotive, and on leaving the water runs smoothly along on the land on trucks built for its accommodation. A canoe built on this same principle for use in the Adirondack lakes would be delightful. It could be paddled on the water and propelled after the fashion of the bicycle on the land, so saving the tourist a great deal of time and many wearisome "carries."

An ingenious resident of Bridgeport has worked out an invention which should become a great boon to unfortunates afflicted with deafness. It is briefly a device which makes the deaf hear. It is the same to the ears as glasses are to the eyes, and consists of a soft rubber disk and spring, so shaped that when inserted in the ear it will focus the waves of sound on the natural drum of the ear with such intensity, that the afflicted person receives impressions from the outside that nature had seemingly desired to withhold.

A patent bowling machine has just been tested in England for the use of cricketers in practice. It is found to be more unerring in its aim than most mortal bowlers, and takes the middle stump of expert batsmen as easily as though the batsman used a feather instead of his bat. The machine is sighted just as a gun is sighted, and the revolving iron hand from which the ball is thrown can bowl overhand or under-hand, according to the desires of the manipulator. It is not entirely beyond the possibilities that a mechanical batsman will soon be devised, so that in the next century boys and girls, and we ourselves, who will probably be the grandfathers of those boys and girls, may expect to be invited to witness a cricket game played entirely by automatons.

Some remarkably clever person in St. Petersburg has arranged and placed on exhibition a clock with a phonograph attachment that will repeat at an hour set, according to the possessor's desire, any orders or announcements as may be committed to it. This the New York *Tribune* rightly calls a great boon to the tired house mother, and adds that in the nursery the solemn time piece could be made to say, "Children, it is time to get up; dress quickly, and do not dawdle." In the kitchen, at an early hour, it would be ready with," Breakfast at eight sharp, Mary; don't forget"; and in the breakfast-room," You must start in ten minutes, or you will lose your train." The dial of this clock of the future is, we are told, a human face, from whose uncanny mouth comes the announcement of the hours as well as any directions that may be left with it.—*From Harper's Young People.*

Tobacco and Depopulation.

Thoughtful Frenchmen are coming to regard with some uneasiness the signs of stagnation, if not of actual decrease, in the population of their country. Under the heading of "*Le Tabac et la Depopulation de la France,*" M. Decroix, who is the founder of a society intended to check the abuse of tobacco, maintains that among the causes of such stagnation a prominent place must be assigned to the influence of tobacco. The arguments by which he seeks to fortify this opinion are ingenious, and he supports them by information contributed by various medical men, and by the vital statistics afforded by different departments of the country. Among the former there seems to be a consensus of opinion that tobacco consumed in excess exhibits in various degrees a constant weakening influence; and experiments by Dr. Depierras are quoted in order to show that the same rule holds good among the lower animals. In this case, the offspring of cocks and male rabbits exposed to the fumes of tobacco are said to have proved feebler and shorter-lived than those born under natural conditions. After comparing ten departments in which a greater, with ten others in which a less, amount of tobacco is consumed, M. Decroix, by summing up their collected disparities, has no difficulty in showing that in the former there is a marked excess of deaths, still-births, of divorces, and falling-off in the size of families. When, however, we compare the departments with each other separately, we frequently miss that evident connection between cause and effect which the author would wish us to expect, and it is clear that we must, in many cases, allow for the action of other influences in producing the result for which it is blamed. Under the circumstances all persons cannot agree with all the propositions advanced by M. Decroix. At the same time, it cannot be denied that the continued use of "the weed" is to be numbered among the forces opposed to a continuance of healthy life.—*New York Ledger.*

Artificial Production of Rain.

At the close of a paper read before the Electrical Section of the Franklin Institute, Professor Edwin Houston said that the following general conclusions might, in view of the present state of meteorological science, be properly drawn concerning the artificial production of rain: 1. That rain can never be made to fall at will by mid-air explosions on any part of the earth's surface, irrespective of the climatic conditions there existing. 2. That during certain meteorological conditions mid-air explosions may result in rainfall over extended areas. 3. That the liberation of energy necessary for such rainfalls is due not to mid air explosions, but to the energy stored up in the moist air from which the rain is derived. 4. That the meteorological conditions which must exist for the successful action of mid-air explosions would probably, in most, though not in all cases, themselves result in a natural production of rain. 5. That a comparatively high difference of electric potential between different parts of the air, or between the air and the earth, is possibly favorable when taken in connection with other meteorological conditions for artificial rain-making. 6. That an undirected mid-air explosion is not as likely to produce rain as an explosion in which the main tendency of the energy liberated is to cause a general up-rush of the air.

HOT-BLAST STOVE.

No. 469,830. George W. McClure and Carl Amsler, Pittsburgh, Pa. *Patented March 1st, 1892.* Fig. 1 shows in vertical central section the upper part, or dome, and the lower part of our improved hot-blast stove. The part of this figure at the lower right-hand corner is in section on the line *x x* of Fig. 2. Fig. 2 is a horizontal sectional view in four different section planes—viz., on the planes shown by the lines A A, B B, C C, and D D, respectively.

The stove as shown is divided into a number of concentric flues, of which 3 is the central flue of the stove, the base of which serves as the combustion-chamber, while the upper part terminates below the stove-crown 4 and communicates with an annular flue 5, formed by an outer cylindrical wall 6, which extends from the crown to the stove's base.

7 is an outer flue constituted by the annular space intervening between the walls 6 and 2. The flue 5 is divided into a number of parts by radial partition-walls 8, which serve to increase the heating-surface of the stove, and the flue 7 is also divided by an annular wall 9 and cross-partitions 10. The flues 5 and 7 are connected by ports 11 at the lower part of the stove. These ports 11 enter the middle of the flues, and in addition thereto there are other connecting-ports 11[1] at the sides of the ports 11, which insure even flow of the gas to all parts of the flue and prevent unequal distribution of the gas. All the radial walls in the outer flue 7 terminate above the level of the ports, so as to afford an open continuous flue chamber at the base of said flue.

12 is a gas-inlet port opening into the base of the flue 3.

13 is a gas-burner pipe adapted to discharge gas thereinto, and 14 is an air-inlet port through which air is admitted to support combustion of the gas.

15 is the hot blast main provided with a suitable valve 16 and leading from the base of the flue 3. This main is also provided with an air-port 17 for the inlet of air to assist in combustion of the gas.

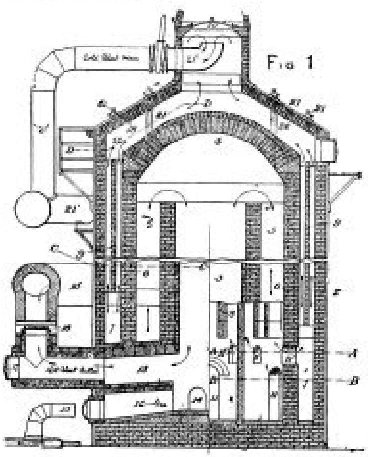


Fig 1

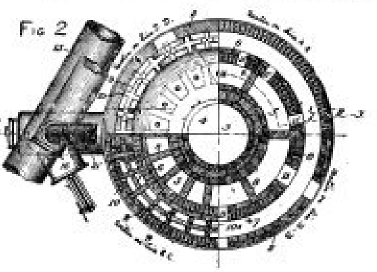


Fig 2

18 is a dome or arch which surmounts the outer wall 2 and is separate from the crown of the stove, so as to afford an intermediate flue or passage 22, connecting all the divisions of the outer flue 7 with a central stack-flue 19 for the exit of the products of combustion.

20 is a valve for closing the stack-flue, and 21[1] is the cold-blast-inlet pipe, which discharges into the stack-flue below said valve and is itself provided with a suitable controlling-valve by which the admission of air may be regulated.

21 21 are holes through which may be drawn chains attached to suitable brushes or scrapers in the flues.

The operation of the stove is as follows: To heat the flues the stack-flue valve 20 is opened, the valve of the hot-blast main is closed, and combustible gas is introduced into the gas-inlet 12. The gas, uniting with air admitted through the air-inlets, burns in the flue 3, ascends through this flue to the crown of the stove, then descends through the several divisions of the annular flue 5, and at the base thereof passes through the ports 11 and 11[1] into the outer flue 7, and ascends through the divisions of this flue, and finally passes through the flue 22 to the stack. When the flues have been heated in this manner to a sufficiently high degree, as in ordinary hot-blast stove practice, the gas and air inlets into the base of the flue 3 are closed, the stack-valve 20 is also closed, and the valves of the cold-blast pipe and hot-blast main are opened. The air then enters through the cold-blast main, descends through the flue 22, and passes in succession and in reverse direction to the movement of the burning gases (employed in heating) through all the flues, and passes off through the hot-blast valve 16 to the main 15.

GAS APPARATUS.

No. 472,077. Henry C. Rew, Chicago, Ill. *Patented April 5, 1892.* The coking chambers A are inclined so that the coal will feed downward toward the fire pot D by gravity. The chambers are made in pairs A and A[1]. Fig. 2 is a cross section, at right angles to Fig. 1 showing also two regenerators E, E[1]. Additional grates G G, are provided in the inclined floor of the coking-chambers to assist the coking of slow burning coal.

The operation of the apparatus is as follows: The fuel-chambers A, A[1], A[2], A[3], G, G, are first filled with coke or hard coal through the tight feeding apparatus H H, and the openings at the top are then tightly closed. The fuel is ignited in the base of chambers A A[1] and in the receptacles G G in the coking chambers. Air is supplied from a fan-blower through pipes and air-ports D, *d d*, to raise the fuel to incandescence. At the same time the exhauster is put in operation. The outlet-pipes being open, the primary products of combustion pass through flues L L[1] into the regenerators E E[1]. Heated air to burn the gases is supplied through pipes F, and the final burned products of combustion pass down through the regenerators E E[1] through outlet pipes and exhauster, and are discharged into the open air. This operation raises to incandescence the fuel in the steam-decomposing chambers A A[1] and in the combustion chambers G G located in the bases of the coking chambers. The heat generated by burning the primary products of combustion is stored in the regenerators. When the apparatus is properly heated, as seen through properly provided sight-holes, the air supply pipes are closed and steam is simultaneously admitted to the base of one of the regenerators, by opening the valve in pipe J, which is connected with outlet-pipe O. The valve *o* in outlet-pipe O is then closed, which directs the steam upward through regenerator E and through the flue L highly superheated, into and down through the incandescent fuel in chamber A, in which it is partially decomposed. The resulting water gas and undecomposed steam then pass through the flue C into and up through the incandescent fuel in chamber A[1] and the resulting water gas (the steam being thus completely decomposed) passes into the heated regenerator E[1]. At the same time the valve in pipe A[4] connecting the tops of the coking-chambers A[2] A[3] is wholly or partially opened to permit the passage of the coal-gas generated in the coking-chamber A[2] through said pipe into chamber A[3] and thence through space A[5] into the regenerator E[1] without passing through the incandescent fuel. A mixture of water-gas and volatile hydro-carbons distilled from soft coal are thus mingled and passed into the regenerator E[1], which are converted into a fixed illuminating gas, consisting of carbonic oxide and light carbureted hydrogen by passing down through the heated refractory material. The gas is drawn from the base of the chamber E through pipe O through the condenser, washer, and exhauster. The valve controlling the outlet-pipe for the final burned products is then closed and the valve to the gas-holder is simultaneously opened by a lever connected with both valves, thus directing the combustible gas into its proper holder. When the heat in the apparatus has been reduced by the super-heating and decomposition of the steam and by the fixing of the gases, the steam is shut off and the air is again admitted to the combustion and coking chambers for heating up and the valve in outlet-pipe O is opened. It is thus seen that the operations of heating up and of making gas are alternate, the exhauster being kept steadily in operation.

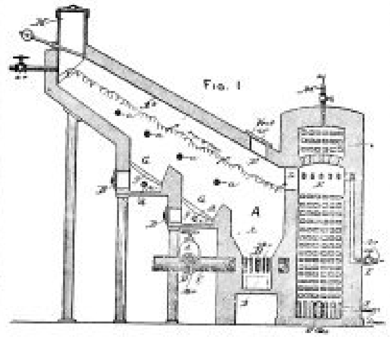


Fig. 1

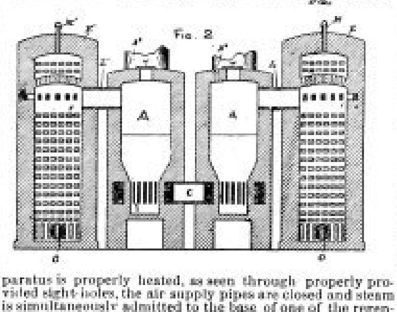


Fig. 2

ROTARY PUMP.

No. 471,280. Benjamin F. Taber, Buffalo, N. Y. *Patented March 22, 1892.* Fig. 1 is a vertical section parallel with the driving shaft, and Fig. 2 is a cross-section on the line *z z* of Fig. 1.

A represents the casing of the pump, having the usual suction chamber B and discharge chamber C.

D is the rotating cylinder or carrier, arranged eccentrically in the casing, and *e* is the abutment, against which the adjacent side of the cylinder runs.

F are the movable pistons, attached to the cylinder and arranged in pockets or recesses G, formed in the cylinder. These pistons each consist of a curved longitudinal plate *f*, pivoted at its inner edge to the front wall of its pocket and provided at its outer free edge with an outwardly extending bucket or receptacle f^2. These buckets are arranged on the front or advancing side of the pistons, and each bucket is composed of a longitudinal bottom plate f^2, arranged at an an angle to the piston plate *f* and curved concentric with the pivot of the piston, and plates f^3, and a longitudinal front plate f^4. The pistons with their buckets are free to recede inwardly into their pockets in passing the abutment *e* and to move outwardly, so that the outer edges of their buckets run in contact with the inner surface of the case. The pockets G are made of the proper form to receive the bucket pistons. The latter are provided at their inner edges with cylindrical knuckles f^5, which are seated in correspondingly shaped sockets *g*, formed in the front ends of the pockets. The interlocking hooks of the knuckles and sockets are so arranged relatively to each other that the knuckles will be confined in the sockets in all positions of the pistons, so that the pistons must be attached to the cylinder before inserting the latter in the casing by swinging the pistons outwardly beyond their normal position.

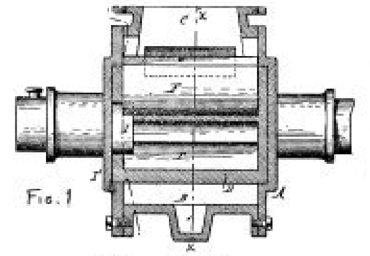


Fig. 1

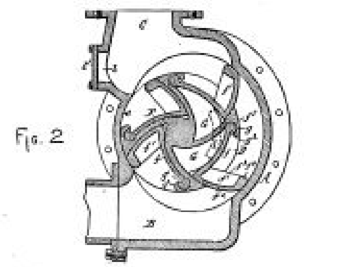


Fig. 2

I represents a stationary cam or projection arranged on one of the heads I[1] of the pump casing on the side of the cylinder opposite the abutment *e*, and whereby the swinging pistons are positively moved outwardly against the inner wall of the case after passing the abutment and in descending on the opposite side of the cylinder. The arms or solid portions *k* of the cylinder, which separate the pockets G, are provided with notches or recesses k^1, arranged in the path of the cam I, whereby the cylinder clears the cam. The shaft of the cylinder extends through the heads of the casing and is provided with the usual pulley for driving the cylinder. The pistons upon reaching the upper side of the cylinder and clearing the cam I drop into their pockets by gravity, and they are retained therein by the abutment *e* until they have passed below the latter. They then gradually move outwardly by gravity and in ascending on the opposite side of the cylinder ride over the cam I, whereby they are positively moved outwardly until the outer edges of their buckets bear against the inner surface of the pump casing. In passing from the suction chamber to the discharge chamber the pistons elevate the liquid and expel the same through the discharge chamber in the usual manner. Foreign substances, such as sand, stones, nails, etc., which are too heavy to be carried out by the current of liquid, lodge in the cupshaped part of the buckets, and remain there until removed by hand. A hand hole *l* is provided for that purpose. Thus they are prevented from jamming in the working parts of the pump and damaging the machine. The pump is designed for pumping thick and dirty liquids or sludge.

PROSPECTING DRILL.

No. 473,549. William Gehring, San Diego, California. *Patented April 26, 1892.* This is a small portable machine intended for miscellaneous work such as prospecting, drilling, chiseling, or pulverizing test samples. The bit T is attached to the end of the piston rod P, by a suitable socket (not shown) and different tools are used for various purposes. A square-ended tool is used for crushing or pulverizing ores. The piston Q has its edges beveled as shown, and operates two small tappet valves *c*, located in the upper side of the cylinder, which open the ends of the steam chest 2 and 3, Fig. 2, to the exhaust alternately, through the ports *j* and N, shown clearly in Fig. 3. This figure is a top view of the joint or face between the steam chest and the main cylinder A. The valve piston a^1 moves a small D valve *f*, across the ports *d*, d^1 and *z*, of which *z* is the exhaust port. Steam or compressed air enters at C and is controlled by a throttle valve D. The back head of a cylinder is provided with an adjustable leg G, by which the machine may be inclined as desired. The cylinder has also a boss K and socket L, by which it may be attached to a socket or post.

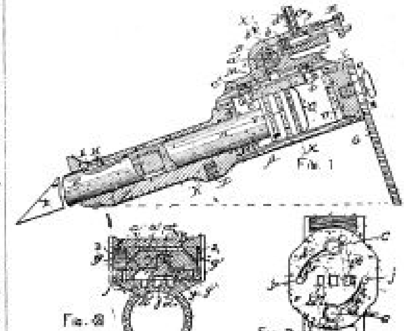


Fig. 1

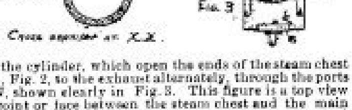
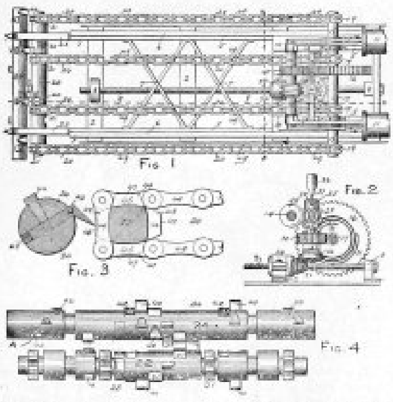


Fig. 2 Cross section on X X. Fig. 3

MINING MACHINE.

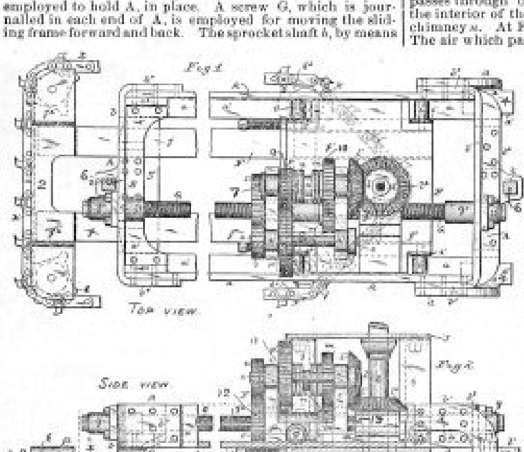
No. 473,604. Archibald Bailey, Philipsburgh, Pa. *Patented April 26, 1892.* This machine employs a rotary cutter bar 24 which is driven by a peculiar driving shaft 22 located close behind it. Fig. 1 is a top view of the machine; Fig. 2 is a partial elevation showing the feed works; Fig. 3 shows how the cutters pass by the driving chains, and Fig 4 shows the construction of the cutter shaft and driving shaft. The driving shaft 22 is driven by four chains 20, from the rear chain shaft 17. The sprocket wheels employed are shown in detail in Fig. 3. Power is supplied by the engines 11 which drive the crank shaft 14 and gears 15 and 16. The feed works are driven by a pair of bevel gears 32, 33, and a vertical shaft 25. The engine shaft carries a worm 29 which turns the worm wheel 28, and the gear-wheel 16 is provided with a spiral thread 31 on its side, which turns the worm wheel 30 in the opposite direction from 28. By means of



the clutch 35 either 28 or 30 may be coupled to the shaft 25, and so rotate the nut 34 in either direction. The screw 9 is stationary, and is fastened to the main frame. The engines and all the moving parts are attached to the sliding frame 5, 5, 7, and 23. The bars 5 slide in between the flanges of channel bars 6, which constitute the side bars of the main frame. The principal novelty is in the means used to drive the cutter bar. The cutters 42 are arranged in spiral order, as shown in Fig. 4. Behind each cutter is a single cog or gear tooth, and a corresponding set of cogs are formed on the driving shaft 22. Almost any number of teeth may be employed, thus making the motion very smooth. Clogging the teeth by dirt is impossible. As shown at A in Figs. 3 and 4, cutters may operate directly in front of the chains without touching them. The driving shaft is spotted or flattened off opposite each cutter to allow the cutter to project as much as possible from its shaft.

MINING MACHINE.

No. 472,363. Adam Kiel and Anton R. Westerdahl, Pittsburgh, Pa. *Patented April 5, 1892.* In its general features this machine resembles the one illustrated in the June number of The Colliery Engineer by the same inventors. The cutters are attached to a chain K which runs around the front cross-bar 2, around the guide pulley 3 and sprocket-wheel H. The sprocket-wheel is keyed on the lower end of a vertical shaft *h*, which is driven by a motor attached to the plate J. The chain is thus carried very close to the floor—as low in fact as may be desired. The main frame A stands above the sliding frame F, and rests on three feet—two, 4, 4, being at the rear, and one 5, at the front end. The bearing of 5, is as wide as the spread of the cutter chain will permit. The sides of frame A are made of angle bars, and the carriage which supports the motor and gearing is provided with rollers *i* which bear of the flanges of the side bars of A. Two jacks (shown in section at 6) are employed to hold A, in place. A screw G, which is journalled in each end of A, is employed for moving the sliding frame forward and back. The sprocket shaft *h*, by means



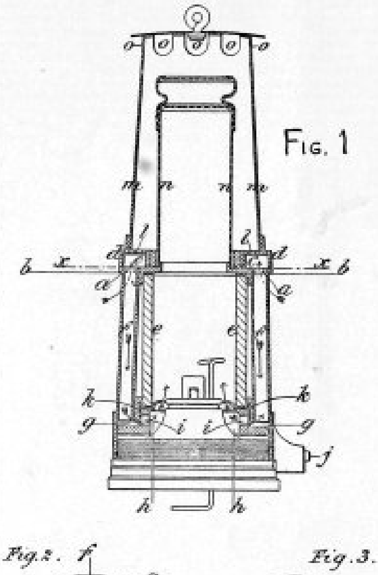
of bevel gears, drives a shaft 7, which carries a clutch *s*, and two loose pinions 9 and 10. Wheel 10 gears directly with a pinion 11, mounted on the screw G, and which has a feather engaging the slot in the screw. Wheel 9 meshes with an intermediate on the shaft 8 and drives a wheel 12 which also serves to drive the screw G in the opposite direction from 11, and at much lower speed. The slow speed is used for cutting and the fast speed for backing out.

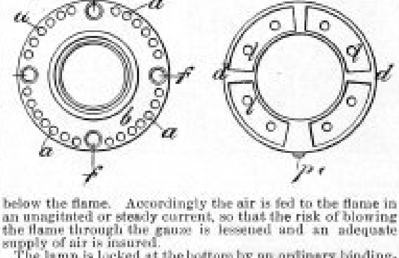
Either one is brought into use by coupling the clutch *s*, with pinion 9 or 10. The nut for the screw is formed in the boss 13, which also provides a bearing for the sprocket shaft.

SAFETY-LAMP.

No. 472,098. Lewis Noah Williams, Aberdare, England. *Patented April 5, 1892.* This invention consists of an improved method of supplying air to a miner's safety-lamp. In the accompanying drawings, Fig. 1 represents a part vertical section of a miner's safety-lamp constructed in accordance with this invention.

The air whereby the flame is fed with oxygen enters the lamp by orifices *a*, provided in the top ring *b* as seen more particularly at Fig. 2, which represents a plan of the top ring on and above the line *x x*, Fig. 1. The orifices *a* communicate with the annular space *c* in the ring *d* surmounting the glass *e*. Thence by the hollow pillars *f* the air is conducted to the space *g*, provided around the ring *h*, on which the glass *e* rests. From the space *g* the air is admitted by the orifices *i*, guarded by the band of gauze *k*, to the burner at a level





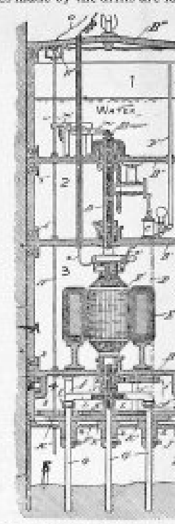
below the flame. Accordingly the air is fed to the flame in an unagitated or steady current, so that the risk of blowing the flame through the gauze is lessened and an adequate supply of air is insured.

The lamp is locked at the bottom by an ordinary binding-screw *j*, by which the outer shell is clamped to the oil-chamber.

Surplus air entering the annular space *c* in the ring *d* passes through orifices *l* into the space existing between the interior of the shield or bonnet *m* and the usual gauze chimney *n*. At Fig. 3 is shown a view of the ring *d* inverted. The air which passes by the orifices *l* into the space between the shield and the gauze chimney *n* escapes with the products of combustion through the apertures *o* at the top of the lamp.

SHAFT SINKING APPARATUS.

No. 473,570. Fulton Gardner, Chicago, Ill. *Patented April 26, 1892.* This apparatus is designed to cut a circular shaft of any desired diameter, having its walls smooth and straight. The drawing is a vertical section through the apparatus, in place in a shaft. The mechanism is encased in a circular shell A, which is divided into five sections. Section 1 is a water tank, section 2 contains a pump which takes up the water from the bottom of the hole, by a pipe P, and delivers it to the tank 1. Section 3 contains an electric motor which is employed to turn the pump in section 2, and to operate the drills. Sections 4 contains the gearing by which the motion is taken from the motor shaft D, and transmitted to the rotary drills G, and to the large circular cutter I. The head B is firmly attached to the lowest head F by several posts *f*. It is also made with a large groove 6 around its rim. The cutter shell I is attached to a ring 7, which runs between the heads F and B, and has internal gear teeth 8 around its interior; by which it is driven by one of the gang of gears K. The ring is also supported by rollers in the groove 6. The cutter I leaves the rock inside it standing as a core, and the drills G bore holes by which the core may be readily broken up by blasting. Water is supplied to the drills by a pipe running down through the shaft D and coupling by a swivel joint with the distributing pipe L. Each drill is hollow. The water is controlled by a valve M at the top of the shaft D. A "feeler" rod N extends into section 5, and when it touches the bottom of the hole it shuts the valve M, and touches an electric button N^1 on the top head, which rings a bell at the top of the shaft, and notifies the operator to hoist out the apparatus. The apparatus is lifted by a rope and ordinary derrick, and when it is removed from the shaft, the holes made by the drills are loaded and fired. The

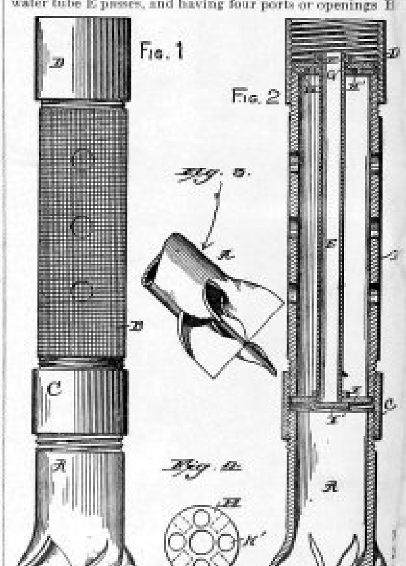


effect of the shots does not extend beyond the cut made by the cutter I, consequently the sides are left smooth, and the shaft is easily kept straight.

HYDRAULIC WELL DRILL.

No. 470,593. Charles H. Oxley, Norfolk, Nebraska. *Patented March 8, 1892.* This drill is intended for boring wells for water in earth, etc. The drill tube is provided with a hollow auger point A, constructed of the form shown, so that the water can pass through it, its upper tubular end being formed with a screw thread, while the lower end of this hollow cutting-point is enlarged and divided by equally distant slits, the sections thus formed being twisted so that their straight free lower ends meet in radial lines extending at right angles to each other, as clearly shown in the drawings. To the upper end of this auger is connected by a coupling C the screen tube B of the usual construction and the upper end of this screen is connected by a coupling D with the lower end of the well-tube when the well-point is to be used.

E indicates a water tube, on the lower end of which is secured a circular valve-plate I, the central opening of which is closed under upward pressure by a downwardly opening valve I^1. The valve plate I is of such size that it will fit against the lower end of the screen tube B, and upon the upper end of this tube fits a valve-plate H, having a central aperture through which the upper end of the water tube E passes, and having four ports or openings H^1



formed in it as shown. Upon the upper side of the valve plate H rests a leather valve G, and the water-tube and valves are all held firmly in position by a binding nut F. The valve-plates H and I are preferably formed of brass, so as to be non-corrosive.

In operation the motor liquid or water used in sinking the drill, is forced from the surface by a force-pump through the well-tube, when its downward pressure closes the valve G and forces it to descend through the central water-tube E, when it will open the valve I^1 at the lower end thereof and be forced out through the hollow auger point A, thus removing all dirt from the auger and passing up to the surface around the outside of the well-tube. When the desired water is reached by the boring-auger the force-pump is stopped and the pressure of the water from below will close the valve I^1, thereby preventing sand, &c., from passing up through the central tube E, the water entering the well passing up through the screen tube B, opening the valve G at the upper end thereof and rising up through the well tube, as will be clearly understood.

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