The Manufacture of Crucible Steel*

Its History and Technology

By George H. Neilson

The pioneers in crucible melting are said to have been the Chinese, who used the process many centuries ago. But the art in China never progressed beyond the initial stage. The real father of the crucible steel industry was Daniel Huntsman, of Sheffield, Eng., a clock-maker, who found it impossible to get uniform steel from which to make his springs, and he hit on the idea of fusing blister steel in a crucible. This was in the latter part of the eighteenth century, and the melting of crucible steel has changed but little since that time. The details have changed somewhat but the actual process is much the same.

The material to be melted is loaded in a crucible, covered with a cap to keep out the gases, and placed in a hot hole and left there until melted. The crucibles have changed, the holes also have been changed in shape and size, and the method of heating is not the same, but the process is practically unchanged. Clay crucibles were the first of which we have any definite knowledge. They held about 50 or 75 pounds and lasted but one heat, and very often cracked and went to pieces before the steel was melted. Clay crucibles of the present day are much more durable and are extensively used in Europe, but little in this country. They have one decided advantage over the plumbago, or graphite, crucibles inasmuch as they do not throw off any carbon during the melting process. The plumbago crucible, which is the most generally used in this country, consists of about equal parts of plumbago and clay. The greater part of the plumbago is imported from Ceylon. These crucibles are capable of withstanding a very severe heat, and can be used a number of times, depending greatly on the nature of the mix and also whether the crucibles are replaced in the furnace before they get cold. The usual practice is to get as many heats as possible from the crucible without letting it cool. As soon as the melted steel is poured out, it is re-charged by hand, or by means of a mechanical shaker, and the crucible returned to the melting hole.

Furnace. The modern crucible furnace is of the regenerative type and is heated by gas, generally producer gas, although where natural gas can be obtained it is often used. Natural gas is probably a more costly way to run a furnace, but it has many advantages over producer gas. It is easier to regulate, as the flow is constant, which is not the case with producer gas unless a large holder is used. It is free from the poisonous fumes of the producer gas and is much cleaner. I am not in a position to say whether or not it is harder on the crucibles and furnace than producer gas. The capacity of a furnace is spoken of in pots. That is a 24 pot, 36 pot or 60 pot furnace. That is the number of crucibles the furnace will accommodate at one time. The furnace holes, in which the crucibles are placed, hold 6 crucibles, so a 36-pot furnace is one of 6 holes. The gas enters the holes at the bottom on one side, mixing with the air immediately before entering the melting hole, and passes out at the opposite side and then through checker work to the stack. When the valve is reversed, the direction of the flow of the gas is reversed. This is done every 15 or 20 minutes, and, in this way, the checker work on both sides is kept hot. The gas should not be pulled through the melting hole too rapidly. If it is, it will cut the port holes and also cut the crucibles. The gas should fill the melting hole and show a small flame around the covers. This is a sure indication that the gas is getting around the crucible and not pulling across the bottom. The detail of the hole is shown in Fig. 1, and a modern 36-pot furnace in Fig. 2.

Charge or Mix. The basis of good crucible steel is iron, and, consequently, the better the iron the better will be the steel. Therefore, it is vitally necessary that iron low in phosphorus and sulphur be used. As the crucibles generally in use hold from 100 to 125 pounds, the mix or charge is weighed up in lots of that weight and placed in pans, called weigh pans, from which it is transferred to the crucibles. In order to get the exact analysis, the weighing must be carefully done, in many cases to the exact ounce. When the crucible is filled it is covered with a cap. This is done to exclude deleterious gases which otherwise would impregnate the steel. When the material to be melted is weighed up, the amount of carbon given off by the crucible must be taken into consideration. If this is not done, the carbon content of the ingots will run higher than expected. The new pots, as a rule, do not throw off as much carbon as they will the second time used, and after the third heat the amount thrown out will be immaterial.

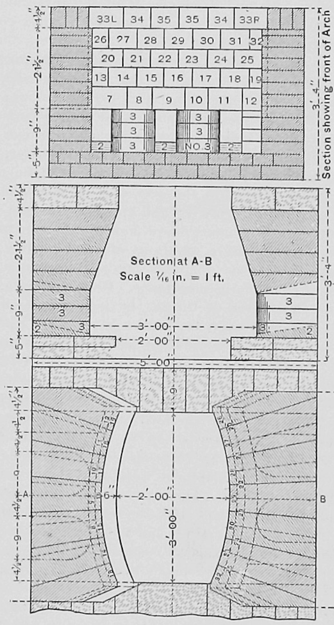

Fig. 1.—Detail of hole in a crucible furnace.

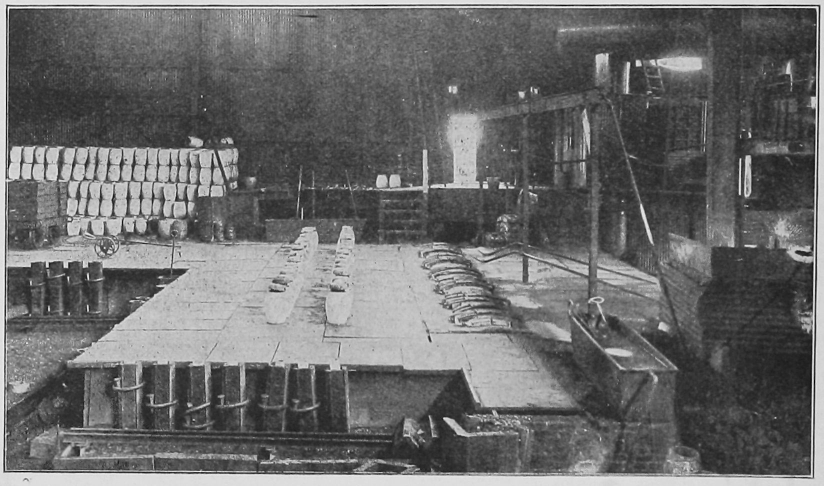

Fig. 2.—A 36-pot furnace.

Melting. The length of time necessary to reduce the mix to a molten state varies, depending on the makeup of the mix itself, and will take anywhere from 2 to 5 hours. When the steel becomes fluid, it is usually good practice to "kill it," or, in other words, drive out the gases which would otherwise result in blow holes in the ingot. This process of "killing" usually takes from 20 minutes to one hour or longer.

Molds. The molds in general use are known as split angle molds. They are made in two pieces, held together by rings and wedges—one ring at the top and one at the bottom. The three essential qualities are long life, smooth finish and tight joints. If the inside finish is not smooth, the ingot will have a rough surface which may result in defects in the finished bar. If the joints are not tight, the hot metal will work through and form a fin on the ingot. This fin will have to be removed, which means added cost. If it is not removed, it will work into the steel and cause complications. The smaller molds have the bottoms cast with the sides. The larger molds, 7-inch and over, have no bottoms as a rule, the molds being set up on removable bottoms. Before the molds are used, the general practice is to smoke them with rosin, or some other heavy, greasy, smoke-making material. This prevents the ingots from sticking, and also makes a smoother surface. The molds should also be warmed before using.

Teeming or Pouring. Teeming is a very important feature and is not merely dumping the hot steel from the crucible into the mold in a haphazard way. In the first place, the stream must be steady; if it is stopped and then started again there will be a weak spot in the ingot. The

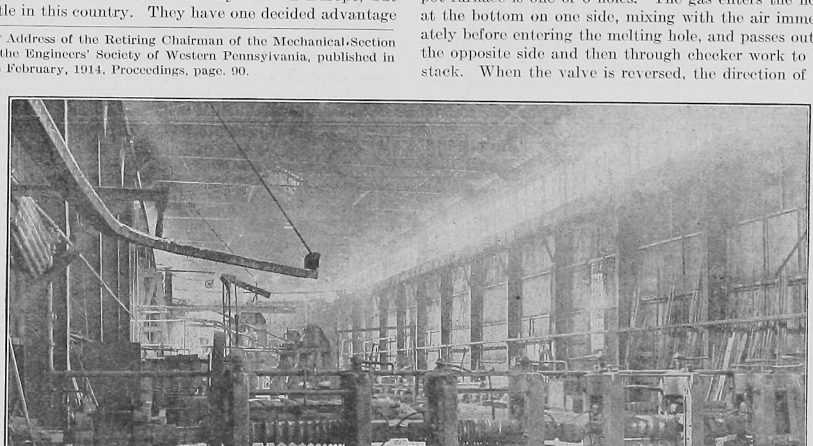

Fig. 3.—A 10-inch bar mill.

* Address of the Retiring Chairman of the Mechanical Section of the Engineers' Society of Western Pennsylvania, published in the February, 1914, Proceedings, page. 90.

chilling of the metal first poured, however slight, will result in a non-homogeneous mass and the ingot when hammered will break at the point where the stopping of the stream occurred. The stream should never be allowed to strike the sides of the mold; if it does it will cut the mold and the result will be rough ingots, and in a heat or two put the mold out of commission; also the stream should be started as gently as possible. If it is teemed in without care the metal will splash against the sides of the mold, and cause the lower part of the ingot to be rough. This teeming is not as easy as it looks and it takes considerable practice to make a man an expert. The weight lifted is quite considerable; the crucible and the tongs weigh about 60 pounds and the steel about 100 pounds, a total of 160 pounds. When you remember that this weight has to be lifted and held steady so that the steel will flow from the crucible evenly and at a uniform rate, the difficulty of doing the work properly can be appreciated. It is not altogether a question of strength, it is knack. Some of our strongest furnace men never learned to teem properly. They had the strength but could not master the art. When a ladle is used, of course, the difficulty of teeming is done away with as the steel can be dumped into the ladle as fast as possible and the teeming is then done from the ladle itself. Both methods have their advantages. It is necessary that the molds be set up straight, or, in other words, plumb; if they are not the melter is more than likely to teem against the side, and also a mold out of plumb is apt to have a bad effect on the steel as it chills. Before the steel is poured out of the crucible, the dirt, which has risen to the top, should be removed. This is easily and quickly done by means of a steel rod known as a flux stick. The flux will adhere to it and can be removed without trouble.

Pipe. The worst enemy of the crucible steel melter is piping. Piping is caused by the sides of the ingot cooling faster than the center. The molten steel which comes in contact with the sides of the mold cools much faster than the center of the ingot. This cooling effect of the mold is felt for as great a distance, approximately, as the mold is thick. In other words, a mold 2½ inches thick will have a chilling effect on the hot steel for that depth, and the result is that the steel thus affected will separate from the rest and the pipe will form. Of course, this result is greatest at the top of the ingot for the reason that the tendency of the pipe to form lower down is offset by the metal from the upper part of the ingot filling in the space. The pipe usually continues as shown in the left hand section of Fig. 4, but often, especially if the teeming has been done too rapidly, the pipe appears as shown in the right hand section of Fig. 4. This is the most dangerous form of pipe, as it is not easy to detect and remains when the visible pipe has been removed. There is no cure for pipe after it gets into an ingot, as it cannot be welded out or worked out and will result in the splitting of the steel when hardened. The most general mode of treating pipe is to use hot tops. A hot top is a brick made of fire clay with a hole through it, the size of brick and hole depending on the size of the ingot cast. The method of handling hot tops is as follows: When the mold has been almost filled, the hot top is placed on top of the hot steel in the mold and the hole filled with the melted steel. This plug, as we may call it, settles into the pipe as it develops, and also has a tendency to keep the top of the ingot hot, and thus lessen the pipe. When the entire mass has cooled, the hot top is broken off and the top of the ingot appears as shown in the right hand ingot of Fig. 5, the hot top, which has been broken off, lying on top of the ingot. The result of teeming without a hot top is shown in the left hand ingot of Fig. 5. The hot top, however, does not prevent the formation of small cavities below the main portion of the pipe as shown in Fig. 4. It should be remembered that the hot top brick must be heated to as high a temperature as it will stand before being placed in the ingot. If this is not done, the cold brick will chill the steel and destroy the usefulness of the hot top.

To Decrease Pipe. A number of patent molds have been tried but all have been of indifferent success, and the added cost has worked against them. There is no doubt that the present style of mold aids piping, and all of us who are makers of high carbon steel are living in hopes that some day someone will discover a mold that will eliminate it, at least to a great extent. Some of the present molds, those for instance which are tapered with the large end up or those that have hot material packed around the top are merely adaptions of the hot top idea.

Topping. When the ingots are cold, they are removed from the mold and topped, that is, the top is broken off so that a clean fracture is obtained. This is not a laborious job and two trained toppers can top a large number of ingots during a day's work. A trained eye can tell from the fracture the carbon content of the ingot within 0.05 per cent. This is not as difficult as it may seem, and anyone with practice can become very efficient. The manganese, phosphorus, sulphur and silicon cannot be determined this way. Neither can the carbon of high speed steel be determined from the fracture.

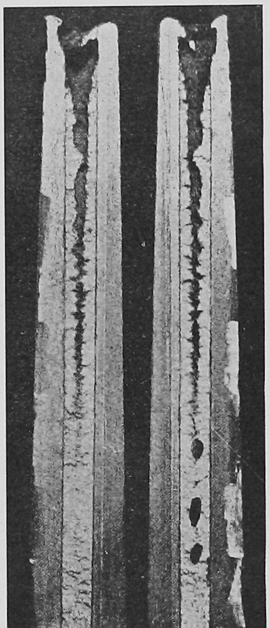

Fig. 4.—Cross-sections of ingots showing piping.

Working. The process of working the steel after it is made is of great importance and the old rule of thumb days are over. The heating of steel was guessed at and many a good piece of steel was ruined by a worker who inherited his trained eye from his grandfather. Luckily for the steel maker, the use of pyrometers is becoming more general every day and guessing at hardening temperatures is rarely done. No steel can be made fool proof, and no overheated steel can be made as good as it was before it was overheated. It can, if not too far gone, be restored partially, but that is all. High speed steel is as near fool proof as any, but even it can be harmed by too much fire. The result of overheating is interesting, and I have here some pieces of steel which show its effect. Later I will be glad to show them to anyone interested.

Rolling. Rolling, like hammering, must be carefully done, if good results are to be expected. The heating should be exact, not guessed at. If the heating is not made to conform to the carbon content of the steel, the results will not be satisfactory. Rolling crucible steel is not a tonnage proposition, it cannot be rushed out if good results are expected. It is unlike open hearth steel, where as a general thing "quantity" is the slogan. To illustrate the difference: In reducing a 3-inch square billet of open hearth to ½-inch round we would have, say 14 passes through a mill driven at high speed, and, at the finish, a bar of approximately 100 feet in length. With crucible steel, if a ½-inch round, we would have 21 passes through a mill driven much slower and a bar about 12 to 14 feet long, but the extra and slower work means a finished bar much closer to size, planished and free from scale. Fig. 3 shows a modern 10-inch bar mill for rolling high carbon crucible steel.

Hammers. Hammers are of two kinds, single leg and double leg. The single leg hammer has one advantage, the absence of one leg allowing the hammerman to work both across and lengthwise on his die, which is at times an advantage. This hammer, however, is more difficult to keep steady than the two leg hammer, as it has a tendency to spring with the blow of the ram and thus work loose on its foundation. The different size hammers and the size of the work usually done on them is as follows: A 500-pound hammer is capable of handling bars ¼-inch up to and including ¾-inch. Fig. 6 shows a 1,000-pound hammer which handles bars from ¾-inch to 1⅝-inch. A 2,000-pound hammer can work bars 1⅝-inch to 3-inch, and a three-ton hammer (see frontispiece), bars from 3 to 6-inch. Of course, smaller or larger sizes than those enumerated can be worked on the various hammers, but the general practice is within the limits given.

The 500-ton steam hydraulic press, shown in Fig. 7, will work high carbon ingots 16-inch square. The press has some advantages over a hammer. It is much easier on the workmen, as it is free from shock and jar, and for this same reason it does not cause deterioration of furnaces and foundations adjacent to it. It works the steel all the way through and gives it a density which a hammer does not. This is probably due to the fact that pressing the steel causes it to flow while the blow of the hammer

Fig. 5.—Ingots cast without and with hot tops.

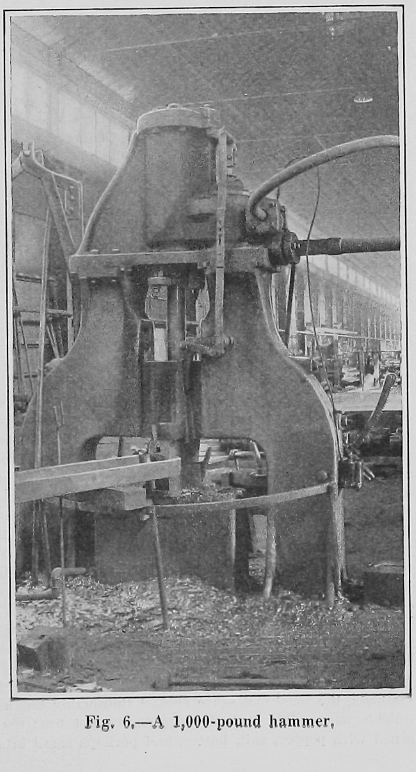

Fig. 6.—A 1,000-pound hammer.

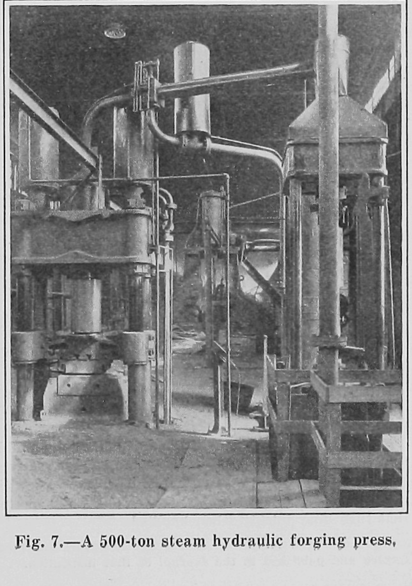

Fig. 7.—A 500-ton steam hydraulic forging press.

is merely local and is not sustained long enough to affect the steel to the center.

Hammering. Hammered steel, that is steel worked into shape under a hammer, must be very carefully handled if the best results are to be obtained. The bar to be hammered must not be overheated, if it is the coarse grain resulting will not respond to the refining influence of the hammer, but it must be soaked, or in other words heated through. The hammering must be done intelligently and the blows of the hammer regulated to correspond to the diminishing heat of the bar. It is also important that the work done should not be done under a hammer too heavy or too light for the work. A heavy hammer will rupture the steel and a hammer too light will necessitate too many blows and continued reheating. The weight of a hammer is, in shop parlance, governed by the weight of the ram, piston rod and piston head. For example, if the hammer is a 6-ton hammer then the rod, ram and head weigh 6 tons. The dies of the hammer are made of cast iron with a chilled surface, ground to a smooth finish. The proper grinding of dies is an art, for if the dies are improperly ground it is impossible to get good results, as the bar will be hard to hold and will jump at each blow of the hammer, the result being that the work will not be true to shape or size. Steel dies are sometimes used but they do not take the smooth surface and polish of the iron dies, and consequently will not planish the steel as well. The proper hammering of steel is the work of an expert. It cannot be learned in a day, and a man to be a good hammerman should have served an apprenticeship under a first-class worker. Although hammermen are paid by the ton the work is not rushed out, and quality not quantity should be the watchword. This does not mean that a man does not do a fair day's work. It is well known what a day's work is on any shape and size, but if the work is to be first-class as to finish and heat treatment, it cannot be rushed, but must be given its proper allowance of time.

Inspection. All crucible steel should be very thoroughly inspected for defects before shipping. It is much better for all concerned to keep your trouble at home, and if there is any doubt as to the soundness of a bar it should be scrapped. It will be cheaper in the end to do this than to take a chance. Inspectors should be given plenty of time and not hurried in their work. All bars should be topped and carefully examined for pipe. Usually pipe is easy to detect, but at times pipe shows in the form of a bright spot, no larger than a pin point, known as a "star." It does not indicate the size of the pipe further in the bar, and must be followed until no trace of pipe can be found. If the surfaces of the finished bars show seams they should be filed out if not too deep. If allowed to remain, they will cause trouble, especially in a cutting tool, as they will cause cracks when the steel is hardened. If the seams are too deep to file out easily, the bar should be scrapped.

Carbon and Alloy Steels. The usefulness of alloy steels was not generally known until a few years ago. Mr. Robert Mushet, who was the pioneer manufacturer of self-hardening or air-hardening steel, made his discovery in 1868. This steel differed from the ordinary or straight carbon steel in that it contained tungsten and that it would harden if heated and then allowed to cool in the air. This Mushet steel had the field to itself until Mr. F. W. Taylor and Mr. Maunsel White, of the Bethlehem Steel Company, discovered high speed steel. This discovery was the result of about 25 years of hard work. About 50,000 experiments were made and recorded at an approximate cost of $200,000. It was unfortunate that these gentlemen did not receive the reward their labors surely entitled them to. Their application for a patent was denied and there was a general rush of steel manufacturers into the high speed market, and to-day there are over 100 brands of high speed steel. The Taylor-White steel was a tungsten steel with the addition of vanadium. These "tungsten-vanadium" high speed steels had the market to themselves until Becker introduced cobalt steel. This steel is a tungsten-vanadium-cobalt steel, which has some valuable properties. Tungsten interested the scientific world some years before Mushet demonstrated its value. We find that in 1783 tungsten was found in the metallic state by D'Elbingar, who presented a memoir on the subject to the Academy of Science at Toulouse. The Duc de Luynes in 1844 published a memoir on the manufacture of cast and damasked steel wherein he pointed out that tungsten appeared in 8 of 9 analyses given of oriental damasked steel. At the Congress of Miners and Smelters, held in Vienna in 1858, many specimens of tungsten steels were shown. At that time, there were many advocates of the good results of tungsten and also many who could see in it no value.

Do not confuse tool steel with crucible steel. This is a very common error and one which should be avoided. Cast steel is also misleading inasmuch as it often deceives the user. Many of the cheaper grades of tools are made of open hearth steel, which is also a cast steel, so it is seen that tool steel and cast steel do not necessarily mean crucible steel. Another error which is frequently run into is the supposition that the grade of steel depends on its carbon content. This is a mistake and the ordinary grades, I mean by ordinary, straight carbon steel, or in other words non-alloy steel, can be furnished in any reasonable carbon. Another misapprehension under which many users of steel labor is that the grades of steel can be established by analysis. This is, of course, not the case. I have seen many analyses of open hearth steel which were better than the ordinary grades of crucible steel. If the chemical analysis of steel was all that was necessary to establish its worth, the open hearth would have put the crucible out of business long ago.

Edible Fungi*

By W. A. Murrill

The use of mushrooms in this country is as yet very limited, and every season an immense quantity of nutritious, digestible, and palatable food goes to waste in our fields and forests which would be utilized in China and many other parts of the Old World. The reason for this is ignorance and fear; lack of knowledge regarding the edible kinds, and a very definite impression that some of them, or most of them, are dangerous.

All knowledge regarding the edible and poisonous properties of mushrooms is based on experiments, either intentional or unintentional. The only safe rule is to confine oneself to known edible forms until others are proven harmless. If one is a beginner, he is like an explorer in a new country with an abundance of attractive fruit near at hand, which may be good or may be rank poison; he cannot tell without trying it, unless some native, who has learned from his own and others' experience, shares his knowledge with him.

The majority of fleshy fungi are edible. A certain number are bitter, or peppery, or slightly poisonous, or otherwise objectionable, but not deadly. Their digestibility often depends on the way they are prepared and cooked, and on the peculiarities of the individual who eats them. A few are deadly poisonous. Two species, *Venenarius phalloides* and *Venenarius muscarius*, are responsible for most of the deaths from mushroom eating the world over. If these two were thoroughly known and avoided in the vicinity of New York city, there would probably be no fatalities here from mushroom-eating for the next ten years.

My advice to beginners is to confine themselves at first to groups that contain no poisonous species so far as known, or to certain species that cannot be easily confused with harmful ones.

EDIBLE FUNGI FOR BEGINNERS.

Common mushroom, morel, chantarelle, beefsteak, and sulphur-colored polypore.

Shaggy-mane, common inkcap, and glistening inkcap.

All puffballs, provided they are white, tender, and homogeneous within.

All coral-fungi, if they are fresh, crisp, tender, and have no bad odor nor bad taste.

The oyster mushroom and its near relatives. These are large, with white gills and short stems, and grow on dead wood above ground.

After considerable study and experience, more difficult distinctions may be made and other groups taken up.

SOME CRITICAL EDIBLE SPECIES.

Polypores that are sufficiently tender, avoiding certain Boleti and *Fomes Laricis*.

Boleti that have been tested and found edible, avoiding *Suillellus luridus*, *Ceriomyces miniato-olivaceus*, and *Tylopilus felleus* in particular, or all species with red tube-mouths and bitter or peppery taste, and species that turn blue quickly when handled.

Species of *Russula* and *Lactaria* with pleasant odor and flavor, avoiding such species as *L. rufa*, *L. torminosa*, *R. foetens*, and *R. emetica*.

Several species of *Lepiota*, avoiding *L. Morgani*, with green spores, and species of *Venenarius*.

Marasmius oreades must not be confused with *M. urens*, nor with *Inocybe infida*.

Clitocybe, *Tricholoma*, and *Collybia* are usually edible; avoid *Clitocybe illudens*. *Vaginata* too closely resembles *Venenarius*.

Before attempting to use mushrooms at all for food, one should become acquainted with the chief poisonous species, if possible, by consulting any one of several books on mushrooms to be found in the public libraries. The deadly poisonous species are included in the genus *Venenarius*, formerly known as *Amanita*. *Venenarius cothurnatus* is much more common farther south, and *V. solitarius* can hardly be called deadly.

THE CHIEF POISONOUS SPECIES.

Venenarius phalloides, *V. muscarius*, *V. cothurnatus*, and *V. solitarius*.

Clitocybe illudens.

Inocybe infida.

Panus stypticus.

Chlorophyllum Molybdites (*Lepiota Morgani*).

Russula and *Lactaria*, about ten species.

Rosy-spored species, a few.

Several of the phalloids, probably.

Several species not yet tested, doubtless.

Note that no brown-spored, purplish-brown-spored, nor black-spored species are listed above, but not all have been tested.

Nearly two hundred water-color drawings of local edible and poisonous mushrooms have recently been installed in the public museum of the New York Botanical Garden. These are not accompanied by descriptions, nor are the edible species designated, but the student of fungi will have no difficulty in recognizing most of the common local species from these drawings alone.

PREPARING AND COOKING MUSHROOMS.

Reject old specimens or those infected with insects, cut off the stems except in rare cases where they are unusually tender, peel a few kinds that seem to require it, wash quickly in cold water, drain and keep in a cool place until ready to cook. As a rule, mushrooms cannot be kept very long in a fresh condition, and this is particularly true of certain very desirable species. When more are collected than can be used at once, it is best to boil them ten minutes, drain, keep in a cool place, and finish the cooking next day as desired. If allowed to stand in water, the flavor is impaired; also, peeling may remove some of the best flavored parts.

Detailed directions for cooking mushrooms are given in most of the books. The most practical and successful methods resolve themselves into broiling, baking, and stewing. In the first, which I prefer to all other methods, the mushrooms are cooked thoroughly but as quickly as possible on both sides over a hot fire; seasoned with pepper, salt, butter, and perhaps small bits of toasted bacon; and served hot on toast. To bake mushrooms, line the pan with toast, add the specimens, season, pour in half a cup of cream, cover closely, and bake rather slowly for fifteen minutes or more, according to quality. In stewing, the mushrooms are boiled in water until thoroughly cooked, then seasoned, thickened, and served on toast. This last method is often used for the tougher or poorer varieties.

* Abstract of a lecture delivered at the New York Botanical Garden and published in the *Journal* of that institution.

The Application of Jets for Mixing Purposes

By Oskar Nagel

Jet appliances consist principally of two or more nozzles of increasing diameter and so connected with each other that the jet of gas or liquid passes from a narrow to a wider nozzle, whereby a vacuum is created, and the material that is to be moved is transported by the jet, which acts as motor. Such apparatus is easily handled, has no moving parts, and requires little repair, so that its low efficiency as a motor is not a drawback when used only for intermittent work. The injector, however, occupies an exceptional position, since the heat energy of the steam is recovered by being returned to the boiler.

The low efficiency of jet apparatus as "transporters" is caused by the fact that about 75 per cent of the energy of the jet is consumed in the whirl, which is formed at the transit of the jet from one nozzle to the other. This whirl effects so intimate a mixture of the motor jet with the medium to be moved, that it is a matter of surprise that jet appliances have not been used as "mixers," rather than "transporters."

The chemical industry rather lacks mixing appliances for gases and liquids, and the jet apparatus is well worth consideration for certain operations. One of these is the chamber process of manufacturing sulphuric acid, which requires chambers of very large dimensions in order to mix the gases thoroughly during their passage. Were it possible to introduce the gases as a perfect mixture into the chamber, its dimensions could be much reduced.

While this apparatus has been recommended for moving the gases through the chamber system, its effect as a mixing machine has been entirely overlooked.

In order to use the jet blower as a mixer it must be connected with the system in a different way from what it would be if used for the transportation of gases. It is not enough to lead steam jets through the wall of the chamber, nor to install a steam jet blower without housing into the pipe coming from the Glover. With such an installation only a part of the gases would get incorporated into the whirl, and a partial mixture only would take place. In order to effect a perfect mixture, the whole of the gas must be forced through the nozzles. This is accomplished by tightly connecting the gas pipe of the system, preferably that part which leads from the Glover to the first chamber, with the inlet opening of the steam jet blower.

In order to prevent the gases from entering the chamber at too high a temperature, it is advisable to enlarge the lower part of the casing of the steam jet blower. In the space so gained a tubular cooler is provided (for either air or water), in order to cool the gases to 65 deg. Cent. The gases travel from the Glover through the jet blower to a small chamber, and from here through two reaction towers to the Gay Lussac.

In order to increase the mixing effect of the apparatus as much as possible and to reduce the "motor-effect" of the jet, it is best to have the gas delivered at the inlet opening of the apparatus at atmospheric pressure, so that the function of the jet blower is exclusively to mix the gases, the latter being delivered at the outlet of the apparatus at atmospheric pressure. By this mode of working the efficiency of the jet as a mixing machine reaches a maximum, at which 20 cubic meters of air is drawn through the nozzle by means of 1 kilogramme of steam of 2 atmospheres.

It is clear from these figures that in the chamber process less steam is needed for effecting the mixture of the gases than is required for the reaction leading to the formation of sulphuric acid. The plus of steam necessary for the formation of the acid can either also be sent through the jet apparatus (in which case the apparatus would need to be correspondingly larger), the energy of the plus steam being utilized for the increase of the draught in the chambers, or it may be injected directly into the chamber by means of spray nozzles.

Preliminary experiments show that for a plant in which 3,150 kilogrammes of sulphur are burnt per day, a chamber of a capacity of 850 cubic meters may be sufficient, if after the chamber two reaction towers are provided. The first tower should contain about 20 layers of 20 plates, the second about 30 layers of 12 plates each.

While we are able to utilize the steam jet as a mixer in the chamber process, we can with the same convenience apply the liquid jet in the contact process. In this case sulphuric acid is used as "motor" liquid, while trioxide is the material to be drawn into the whirl. By using a water jet condenser very satisfactory results are obtained in this process of absorption, and also in other processes of similar nature.

An effect in many respects similar to that of jet apparatus is obtained by spray nozzles, since the spray, in forming a hollow cone, creates a vacuum in the direction of its motion. On the other hand, the spray is also a mixing machine and adapted to effect absorption of large volumes of gases with small volumes of liquids. For this purpose the spray nozzle must be inclosed in a suitable cover in order to force every particle of the gas through the hollow cone of the sprayed liquid.—*Journal of the Society of Chemical Industry.*

A Congress of Scientific Kite-flying was held at Boulogne-sur-Mer, France, May 31st and June 1st, 1914, under the auspices of the Ligue Française du Cerf-Volant.

The Rockefeller Institute for Medical Research

A statement has been given out from the Rockefeller Institute for Medical Research to the effect that in order that further opportunities may be afforded for the more complete investigation of the nature and causes of human disease and methods of its prevention and treatment, Mr. John D. Rockefeller has just donated $2,550,000 to the Rockefeller Institute for Medical Research.

Of the sum just donated a part will be utilized to purchase additional land in New York city so that the institute will have acquired the entire tract where its buildings are now located, between Sixty-fourth and Sixty-seventh streets on Avenue A, extending through to East River—about four acres. The remainder will be used to erect and equip additional laboratories, buildings, and plant, and to insure the proper maintenance and conduct of the extended work.

This gift of $2,550,000 is in addition to a special fund of $1,000,000 which Mr. Rockefeller has provided in order that the institute may establish a Department of Animal Pathology. Dr. Theobald Smith, now professor of comparative pathology in Harvard Medical School, is to become director of the new department.

It will be the purpose of this branch of the institute's work to give special attention to the study of maladies such as hog cholera, foot and mouth disease, and diseases of poultry, which are of such immediate and practical concern to farmers, and the elimination of which is so important. This will be the first enterprise of this kind upon an adequate basis to be established in this country. The results of its work should eventually be of great value in improving the health of cattle and other farm animals.

Mr. Rockefeller's previous gifts to the institute had amounted to practically $9,000,000, exclusive of real estate in New York city, so that the endowment of the institute will now approximate $12,500,000.

The Rockefeller Institute will, with the new gift, now become the most amply endowed institution for medical research in the world. In 1902, when the institute was founded, there was not a single undertaking of the kind in this country. England had the Lister Institute, Germany the Institute for Infectious Diseases, France the Pasteur Institute and Russia the Royal Military Institute at St. Petersburg. Since 1902 a number of other research laboratories have been established in this country, including several in Chicago.

In addition to the laboratories there is connected with the institute a hospital with every improved facility for the treatment of patients afflicted with diseases at the time under special investigation. For the treatment and study of contagious diseases—a most important phase of the institute work—there is a separate building with isolated rooms.

The aims of the Rockefeller Institute and the lines along which its future work—upon an even more comprehensive basis—will be conducted, are indicated by some of its practical achievements already accomplished, such as the serum treatment of epidemic meningitis; the discovery of the cause and mode of infection of infantile paralysis, the surgery of blood vessels, through which blood transfusion has become a daily life-saving expedient; the safer method of administering anesthetics by intratracheal insufflation; the skin or luetic reaction and the cultivation of the parasite of rabies.

The scope of the work of the institute will be indicated by a list of the several special scientific departments which it maintains. It includes pathology, bacteriology, protozoology, biological chemistry, physiology and pharmacology, experimental biology, and animal pathology, besides the special hospital.—*Science.*

Iceplant as a Food

Mesembryanthemum crystallinum is the scientific name of the singular crystal-covered, white-flowered iceplant, so indispensable in a rockery. *Mesembryanthemum tricolor*, with rose-colored flowers, is the dewplant. *Mesembryanthemum variegatum* has variegated green and white foliage, with sometimes yellow and sometimes pink flowers.

All kinds are propagated by both seeds and cuttings.

In France the iceplant is cultivated for greens, and cooked like spinach. In England it is valued for garnishing, as we use parsley. The troublesome weed pusley is often used for greens in this country, and is a near relative of the iceplant.

In Africa *Mesembryanthemum edule*, the fig marigold, is highly prized by the Hottentots, who eat the figlike fruits. In Palestine the Arabs make a bread claimed to be more nutritious than wheat, from the seeds of *Mesembryanthemum forskahei*. This plant is of great value for forage, and the seed pods will not open with heat, so the seed gathering is extended through several months. The seed is soaked in water to open the pods, and when stirred, the pods float on top of the water and the seeds sink to the bottom. They are next dried in the sun and ground into flour and baked in cakes sweetened with a molasses made by boiling the seeds of *Juniperus Phoenicea* and straining the liquid.

The United States Department of Agriculture has secured a considerable quantity of the seed, which will surely be of great value as a forage plant, sheep and cattle eating it greedily, the succulent foliage answering for both food and drink. Many lives would have been saved if iceplant of different species had been found growing in our arid southwestern States; and stranded cattlemen and prospectors of the future will have reason to thank Uncle Sam for providing this manna on the desert.

The Safe Operation of Pleasure Cars*

Suggestions That No Automobile Owner Can Afford to Ignore

Less than a quarter of a century ago a person would have been considered visionary and unpractical, to say the least, if he had predicted that a self-propelled vehicle would soon be invented that would travel over the public highways at speeds as high as a mile a minute, and with power sufficient to enable it to climb the steepest hills with ease. To-day a performance of this kind is commonplace, and no special comment is excited by published accounts of automobile races in which speeds of 80, 90, or even 100 miles an hour are attained. When the automobile reached the stage of mechanical perfection that permitted it to travel twenty-five miles or so, without stopping for repairs, it was considered marvelously efficient; but at the present time delays on the road due to mechanical troubles are rare, and the tourist may often continue his journey day after day, without giving any special attention to his machine, beyond providing fuel and supplying the necessary oil and grease for lubrication.

The evolution of the automobile, from the slow, uncomfortable, cumbersome, and mechanically imperfect conveyance of the past, to the swift, dependable, luxurious car of to-day, has been attended by a correspondingly increasing amount of danger, not only to the operator of the car and his passengers, but also to the public at large. The number of accidental deaths in cities has largely increased since the advent of the automobile, and in country towns and on all public highways the danger of being struck by a swiftly moving car, in charge of an inexperienced or careless driver, is always present. Even the careful driver may not entirely escape accidents, because many injuries are direct consequences of carelessness or inattention on the part of pedestrians and drivers of other vehicles. Some of these accidents may be avoided by constant watchfulness on the part of the automobile operator, but in other cases no amount of care will enable him to escape them.

There is no doubt that the blame for many accidents is unjustly laid upon the shoulders of the automobilist, and it is equally true that the neglect of some simple precaution on his part has often led to serious injuries, or even to loss of life. The following suggestions are given in the hope that the risks to users of the public streets and highways may be lessened, and that the operation of automobiles may also be made safer for drivers and passengers.

One of the prime requisites in the safe operation of an automobile is a thorough and instinctive knowledge, on the part of the driver, of the uses of the various levers and pedals that control the movements of the car. The seasoned driver does not stop to think what motions must be made to bring the car to a sudden stop in case of an emergency. When an accident seems imminent he instinctively throws out the clutch and applies the brake, in a mere fraction of the time that would be required if he were obliged to think out each motion in advance. No person should attempt to operate a car in crowded traffic until he has acquired something of this manipulative instinct, and a beginner should not trust himself to drive a car under any circumstances, until he has received adequate instructions from a skilled and experienced operator.

Before leaving the garage the car should be looked over carefully to see that everything about it is in a safe condition. The steering gear and the brakes should receive particular attention in this respect, and loose nuts and other defective parts should be attended to in a thorough manner. The tires should also be examined for weak spots that may blow out while on the road, and tires showing such imperfections should be changed, if necessary, before starting out. Many accidents might be averted by paying proper attention to these points, and by making necessary repairs as soon as the defects are discovered, instead of waiting until a more convenient time.

Although many of the more recently built automobiles are equipped with self-starting devices, the great majority of automobile engines are probably started by means of a crank-handle. The arms, hands, and wrists of the operators are often broken, sprained, or badly bruised by "kick-backs" from these starting handles. Safety handles can be had, which practically eliminate these dangers; but for some reason or other they do not appear to be widely used. Before attempting to crank the engine, the spark should be retarded, to prevent too early ignition. The operator should grasp the crank with his *left* hand, placing his thumb along the length of the handle rather than around it, and *pull upward* on it. When starting a large engine with high compression, it is quite common for a driver to "rock" the handle, to obtain the advantage of the slight momentum given to the flywheel in this way, so that the engine may be more easily turned over the compression stroke; but this is a dangerous practice, and it should be avoided as far as possible. A striking example recently came to our notice, of the utter disregard for safety that is occasionally displayed by drivers

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