From Underfoot to Overhead

AMERICAN SHEET AND TIN PLATE COMPANY

Frick Building — Pittsburgh Pa

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"The TERNE which TURNS the Elements"

FROM UNDERFOOT TO OVERHEAD

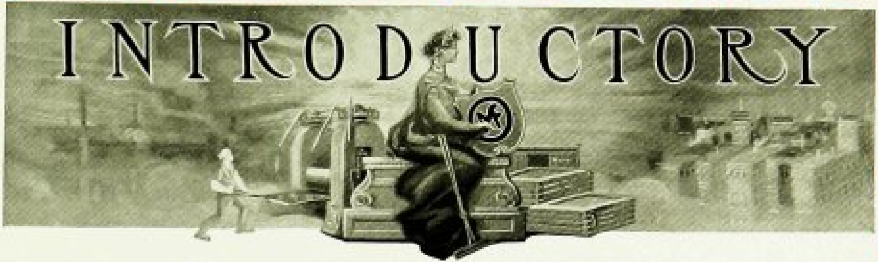
The experience of a piece of ore from it's home in MOTHER EARTH
to it's place on the HOME of MAN

American Sheet & Tin Plate Company

Frick Building PITTSBURGH PA


From Underfoot to Overhead

INTRODUCTORY



THE man who becomes a success, is the man who makes it his business to learn all he possibly can about the articles which he daily handles. He is not satisfied to know of them only while in his hands, but realizes that their past and future are even more important to him than their present condition.

Therefore, this booklet has been prepared with a desire to give the Architect, the Builder, the Roofer and the Property Owner an idea of the many processes through which a piece of ore must pass before it becomes the base of an MF Terne Plate.

Statistics have been carefully omitted from this book, because we wish you to consider its reading a pastime, not a study. However, the terms used, and the descriptions given, are accurate to the letter, and the photographs have been added that a clearer understanding of every process can be gained.

We believe both old and new customers will be interested in the progress of the piece of ore, while the tables and general information contained in this booklet, will be of great value to the man who estimates or does the work.

Our aim has been to show you that "The Terne which turns the elements" is all we claim it to be, and we hope the few who, as yet, have never given MF a chance to show its value will decide that it is well worthy of their best consideration.

AMERICAN SHEET & TIN PLATE COMPANY.

From Underfoot to Overhead

THE products of Iron ore, for ages, have played a most important part in the rise and progress of man. Indeed, iron and steel have become so much a part of our daily lives that we scarcely give its presence a passing thought.

But, for one moment, let us see what would happen if they were suddenly taken away. What would become of our telephones; our telegraphs; our railroads; our manufactures; our commerce; our very homes? The two first mentioned would be less affected than any of the others, but even they would fall into absolute ruin, while at one stroke the progress of 6000 years would be wiped away, and we would return to the huts, the habits, and to many of the customs long ago considered dead, and to-day called barbarous.

Therefore, it becomes almost essential that we learn more about the staff upon which we lean so forcibly, and a study of the many processes through which the ore must pass from the time it leaves the mine until it becomes of the greatest commercial value, will doubtless be most interesting.

Stripping the Mine

THE Mesaba district of Minnesota yearly produces more iron ore than any other in the world.

The deposits in this territory are called "free ore," and the depths at which they are found vary from a few to many feet.

The method adopted for reaching it is quite novel, for instead of driving a shaft and running levels, as is usually done in mining, the entire surface of the mine is opened.

This is called "stripping" the mine and the production of such a mine, when once opened, is practically unlimited.

To remove the surface soil, powerful steam shovels are used; these load the dirt trains, which in turn carry the soil to some "fill" or railroad improvement nearby.

WHERE surface mining is adopted the ore must be easy to remove. In the Mesaba district it can be readily taken up by steam shovels, and in appearance only differs from the surface soil in color, the ore being a dull reddish-brown.

After a part or all of the mine has been opened, tracks are laid in all directions upon the face of the deposit, and the ore cars are loaded by the same shovels which aided in the stripping of the mine.

A Steam Shovel in Operation

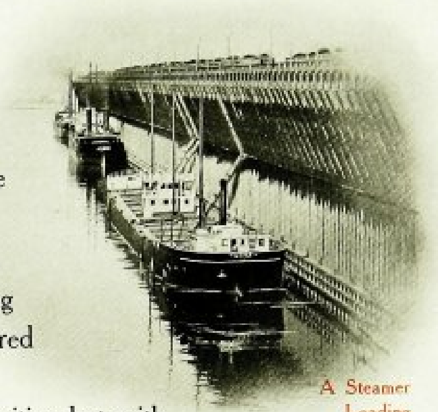
AS the cars are filled a shifting engine pulls them out of the mine and takes them to the yards where trains, bound for the ore docks at Two Harbors or West Duluth, are made up.

Numerous railroads in this section haul but little freight other than ore, and in fact, several of them are owned and controlled by the ore interests.

Most of the ore shipped from the Minnesota mines is sent to the Pittsburgh district; therefore, it will be readily seen that its transportation is a very large item.

Off to the Ore Dock

WHEN the dock is reached the ore cars are run out upon it; their hopper floors are dropped and the ore runs into immense bins. These bins have sloping sides and an outlet at the lowest point.



A Steamer Loading

To fill the vessels, each bin is fitted with a long chute, which, when not in use, is raised along the outside of the dock, but can be easily lowered into the hold of the vessel whenever desired.

The lake ore carriers have enormous capacities, but with these facilities for loading the largest can be filled to the hatches in four to eight hours.

ON the Great Lakes, a large fleet of ore boats are constantly plying between their western docks and the eastern unloading harbors along Lake Erie.

These vessels are of two classes—the Ore Steamer and the Whaleback.

Naturally the former is self propelled, and until recently, not only carried its own load, but towed the whaleback as well.

Of late, however, most of the latter class are fitted with engines and, when empty, navigate under their own steam, while some make the entire trip unassisted.

A Whaleback Returning in Ballast

AFTER a trip through Lake Superior, across the end of Lake Michigan, and through Lakes Huron and Erie, the laden ore boat, either Steam or Whaleback, is at last tied up at one of the many unloading docks in the vicinity of Cleveland.

Unloading a Steamer

Here powerful unloaders are set to work removing the ore. These are operated by steam or electricity, and their capacity is remarkable.

The record for unloading the largest ore carrier on the lakes in nine hours is held by one of the new style machines.

WHEN cars can be had the ore is emptied from the unloaders into them. Each car has a capacity of fifty tons, and as rapidly as possible, they are forwarded to their destination.

During the summer and fall months, however, the receipts of ore far exceed the car supply; therefore, it is necessary to store large quantities for transportation later.

At times there are millions of tons awaiting shipment from Conneaut and Ashtabula, and while there, they are deposited in immense piles.

Unloading a Whaleback

One of the many Steam Shovels

WHEN ore is to be piled awaiting shipment, large buckets are lowered into the boat. These are filled with the ore, then lifted out and carried away from the dock upon a bridge tramway.

Upon reaching the proper place, their contents are emptied on the pile and they return for more.

Possibly this ore may be untouched for several months but at last it is taken up in one of the many steam shovels made for the purpose and loaded upon the cars.

At the Ore Pile

THE trip from Lake Erie to a blast furnace near Pittsburgh usually consumes several days.

At the mill, the long trestle upon which the cars are shunted, resembles greatly the ore docks in Minnesota. The cars are unloaded in the same manner; the bins are almost identical, and the ore is removed therefrom through an opening at the lowest point.

When the ore is to be held to supply the future demands of the blast furnace, it is again deposited in a pile to await the coming of winter and the closing of navigation on the lakes.

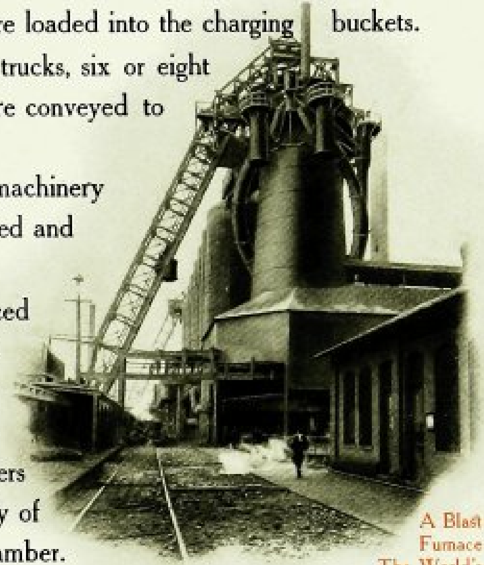
TO reach the blast furnace, the ore must be taken from the pile, placed in another set of hoppers, and from there loaded into the charging buckets.

These buckets stand upon separate trucks, six or eight in a train, and when all are filled they are conveyed to the incline.

Here each bucket is gripped by machinery and carried to the top where it is inverted and its contents charged into the furnace.

Coke and limestone are also placed therein; the former to hold the heat; the latter to act as a flux and purify the ore particles.

The furnace is fired by a train of heaters and blowers, which constantly drive a body of super-heated air and flame into the ore chamber.



A Blast Furnace The World's Record Holder at Duquesne Mill

Running a Blast

THOUGH charging the furnace continues without intermission twenty-four hours of every working day, the furnace is tapped at intervals of every four hours.

As the ore and other substances are reduced by the heat, they run into a large, brick-lined receptacle in the bottom of the furnace. The molten iron, being heavier, seeks the lowest level, while the cinder, or slag floats upon the surface.

It is, therefore, an easy matter to make an opening near the top of the reservoir, and run the waste off into ladles through it, while lower down another is opened which allows the refined ore to pass into the runway leading to one of the several empty ladles.

EACH blast from a furnace will fill from four to six ladles. These have a capacity of 18,000 pounds each, and, when the last one is filled, a shifting engine is brought up, coupled, and the train starts for the scales.

Weighing the Ladles

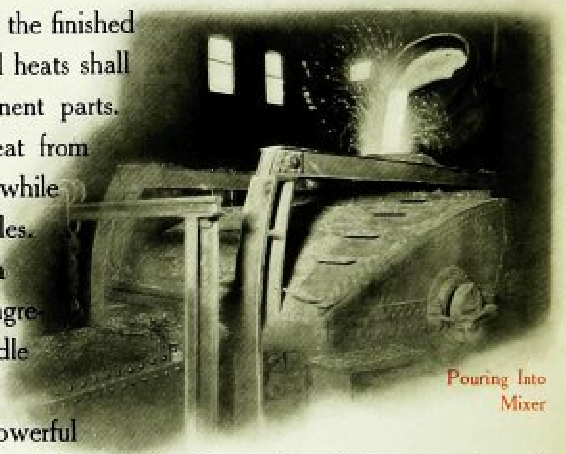
Here the ladles are weighed separately, then re-coupled, and the recently refined ore is started upon its way to become either Bessemer or Open Hearth Steel.

When the ladles are emptied, they are again taken to the scales and re-weighed, so that the contents of each can be separately figured.

TO insure the uniform quality of the finished product, it is essential that all heats shall have the same proportion of component parts.

A chemical analysis of each heat from the blast furnace is therefore made while the ladles are on their way to the scales.

If the assay shows a too high or too low percentage of the different ingredients, other metal is run into the ladle which will equalize the formula.



Pouring Into Mixer

The ladle is then lifted by a powerful crane and carried over to the mixer, where it is inverted and the metal gradually poured in.

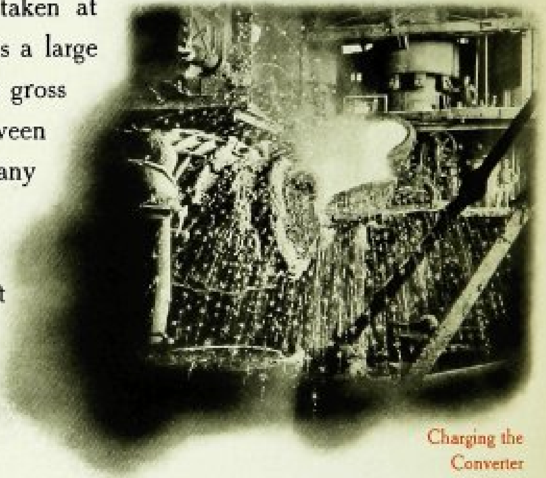
THE Mixer plays two important parts in the process of steel making. By keeping the metal constantly disturbed it insures a thorough mixing of the recently added metal to that coming direct from the furnace. Too, it is a storage room for the molten metal, where the intense heat is kept up and where the metal can be held until the converters are ready for it.


Pouring Out of Mixer

As it is hung upon an axis, the Mixer can be raised and lowered at will, making it possible to hold the mouth well in the air while the mixing process is under way, and to lower it, when the ladle, standing upon the floor below, is ready for filling.

FROM the Mixer the metal is taken at once to the Converter. This is a large barrel-shaped crucible of about fifteen gross tons capacity and so suspended between two uprights that it can be turned at any angle with ease.

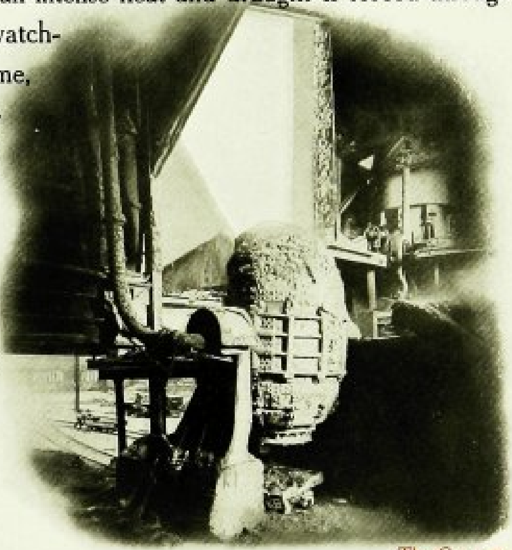
To be filled the top is lowered until the Converter lies in an almost horizontal position; a trough is then inserted, and the ladle containing the metal turned gradually until its contents has been poured in.



Charging the Converter

THE Converter is then turned up; an intense heat and draught is forced through the metal, and the operator, by watching the changes in the color of the flame, can accurately determine when a sufficient percentage of the sulphur and carbon gases have been blown off.

This process changes the iron into steel, and practically all the foreign particles which, until now, have resisted separation from the metal, are carried off.



The Converter
Blowing Off

Pouring the Heat

WHEN the converting of the iron into steel is completed, the Converter is "turned down" and its contents emptied into a ladle.

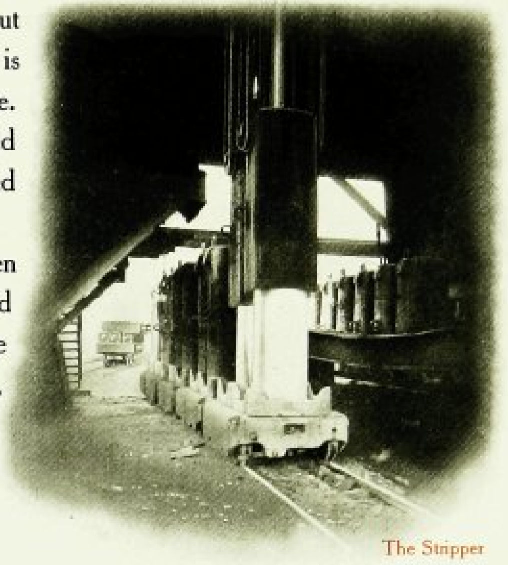
Unlike all others, this one is supplied with an outlet at the bottom to facilitate the operation of filling the ingot moulds.

When filled the ladle is swung over the waiting train of moulds by a powerful hoist or derrick; the plug which prevents the premature escape of the newly made steel from the ladle is loosened, and the metal rushes out to fill the mould immediately under it.

EACH mould has a capacity of about 6000 pounds, and as rapidly as it is filled, its place is taken by an empty one.

For the first time since the ore entered the Blast Furnace, the metal is now allowed to partially cool, and become rigidly set.

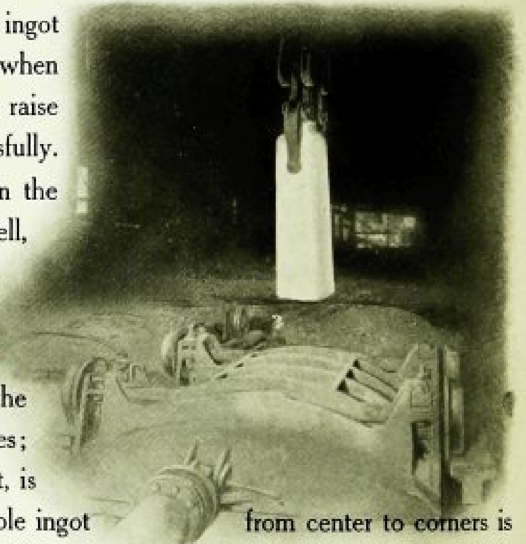
The train of filled moulds is then taken to the stripper where each mould is lifted off, and the ingots, still at almost a white heat and standing upon the mould bases, are taken to the soaking pit.



The Stripper

NATURALLY the outside of the ingot becomes considerably cooled when exposed to the air, and it is necessary to raise the heat before it can be rolled successfully.

To accomplish this it is placed in the soaking pit, a small-sized brick-lined cell, its only opening at the top, and with a capacity of six ingots standing side by side upon their ends.



The Soaking Pits

These pits are heated by gas, and the heat radiating from the ingots themselves; the latter, as it strikes the sides of the pit, is refracted and the temperature of the whole ingot from center to corners is equalized by what might be called a sweating process. When the ingot has regained its proper heat, it is lifted out by a large traveling crane.

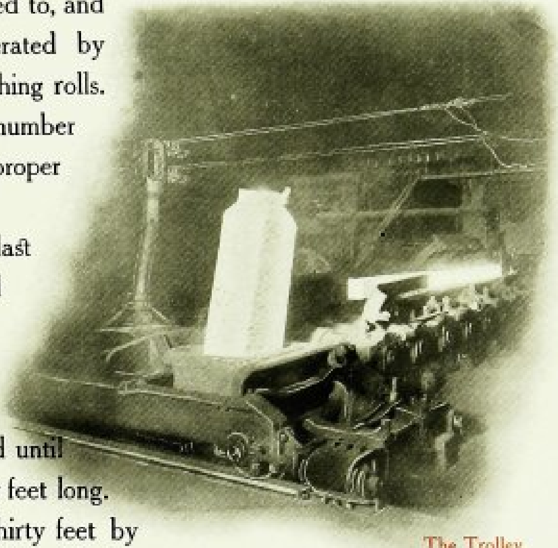
BY the crane, the ingot is conveyed to, and deposited upon a truck, operated by electricity, which carries it to the roughing rolls.

There it is given a sufficient number of passes through to roll it to the proper width and thickness.

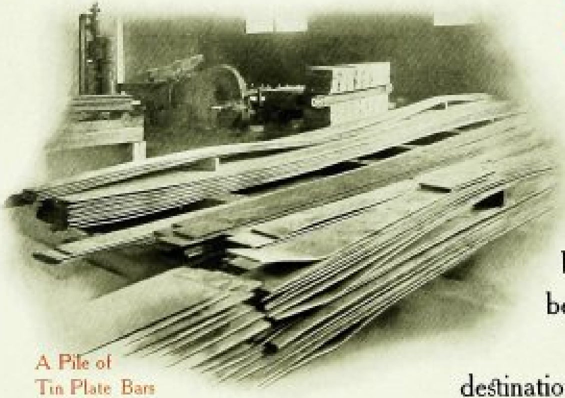
Upon going through for the last time, it is caught by the shears and cut into lengths suitable for rapid handling.

While still hot it is passed on to the bar mill and the bloom is rolled until it is about eight inches wide, and many feet long.

It is then cut into lengths of thirty feet by the hot saws and deposited upon the hot beds to cool.



The Trolley, and the Blooming Rolls



A Pile of
Tin Plate Bars

THE long bars are then cooled, bundled and placed upon open cars for shipment to the sheet rolling mills.

Black Plates for tinning are seldom rolled at the plant where the bars are made, the two industries being vastly different in every way.

When the cars have reached their destination, they are unloaded and the bars stacked in piles to await the time when they will be needed by the rollers.

TO make sheets all of an exact size and gauge, and to trim as little to waste as possible, it is necessary that each bar contains a certain amount of steel.

Therefore, the long bars are fed into shears made specially for the purpose which snip them off into accurate lengths.

This makes a bar 20"x8"x½", and when rolled will make four finished black plates, each 20"x28" in size.

Cutting Up the Bars

ON arrival at the sheet mill furnace, the bars are placed within it and brought to a cherry-red heat.

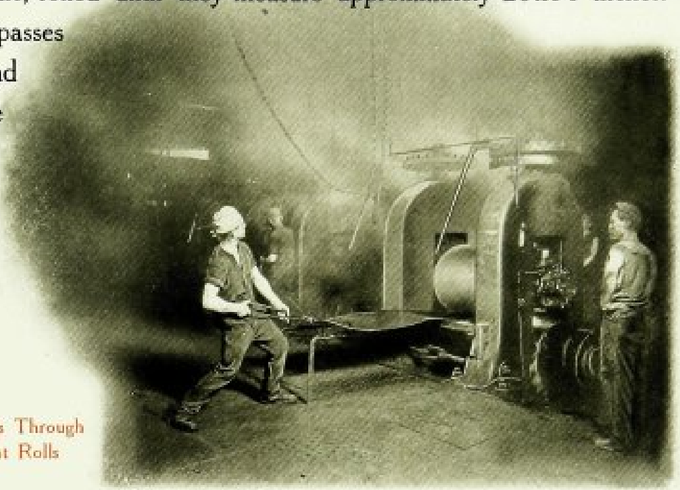
In pairs they are taken out and given three or four passes through the roughing rolls, each bar being fed through sidewise and rolled singly.

This rolling makes a heavy plate about twenty-six inches long by twenty and one-half inches wide.

Heating the Bars

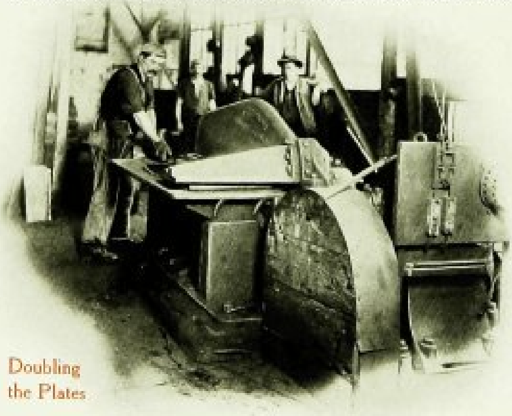
BY this time the plates have become considerably cooled and must be reheated before they can be again rolled. They are, therefore, placed one upon the other, reheated, and in pairs, rolled until they measure approximately 20x50 inches.

From two to three passes are required at the second rolling to bring them to the required length, and before being again heated they must be given to the doubler.



A Pass Through the Hot Rolls

WITH large tongs the doubler quickly grasps one end of the pair of plates as they are passed to him, and, by bending them in the middle, brings the two ends together. He then lifts them upon a table, shears their loose ends off square, and a powerful press flattens them at the fold, thus making four thicknesses or plates; one end of each free, the other still forming the bend.



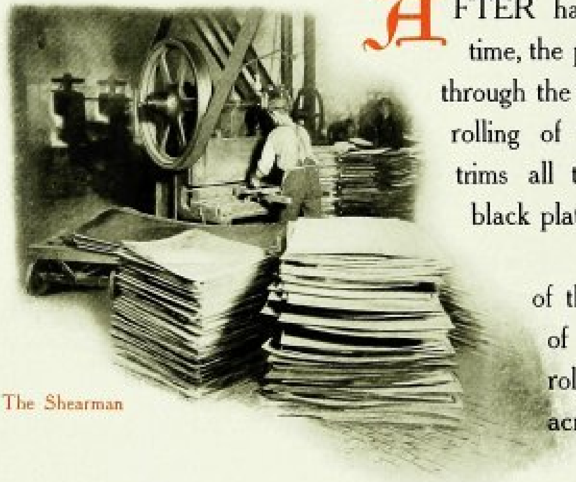
Doubling the Plates

The Reheated Plates
(Illustration shows doubled end)

IN this form they are for the third time heated and passed through the roughing rolls.

Again the plates are taken by the doubler, each sheet is opened back to the bend, and the plates once more doubled.

To prevent them from buckling and to insure a perfect finished plate the first bend is snipped off when the ends are squared, thereby giving each sheet in the pack one free end.



The Shearman

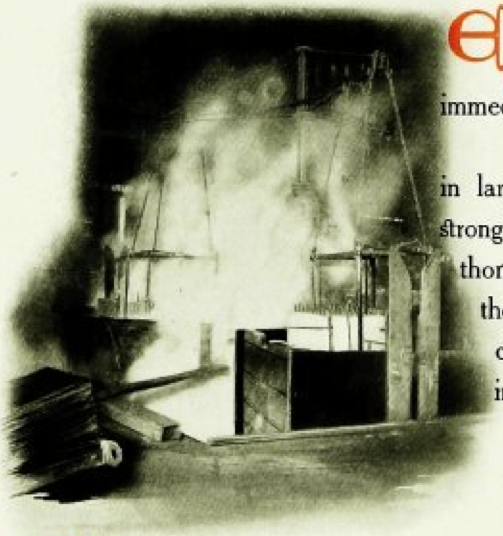
AFTER having been heated for the fourth time, the plates are given two or more passes through the finishing rolls. This completes the rolling of the plates. The shearman then trims all the edges, making eight separate black plates each 20x28 inches in size.

It will be noticed that the length of the bar, 20 inches, makes the width of the finished plate, and that the rolling, therefore, has been wholly across the original bar.

WITH the tremendous pressure brought upon the plates while undergoing the rolling process, it is small wonder that they are extremely hard to separate.

Every sheet must be grasped singly and pulled loose. This is usually done by women or boys, who become quite skilful by working at it constantly.

One of the Openers



The Black Pickler

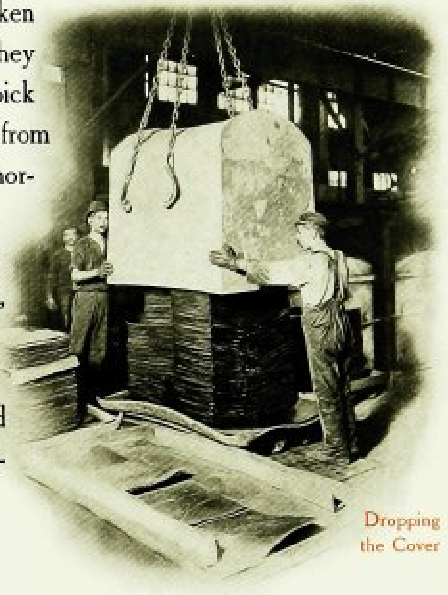
EACH plate is examined for flaws as it is opened, and all perfect ones are sent immediately to the Black Pickler.

Here, they are placed upon their ends in large trays, or cradles; immersed in a strong acid-and-hot-water solution which thoroughly removes from their surface all the scale and dirt, and then rinsed in clean water, thus preventing the adhering of any acid to the surface.

FROM the rinsing vat, the plates are taken to a table and allowed to drain. They are also carefully examined by assorters, who pick out and return to the acid vats all sheets from which the scale and rust has not been thoroughly removed.

As they come from the pickler, the plates are yet unfit for use as a roofing material, the continuous rolling having made the steel much too hard for such commercial work.

Therefore, to soften them, they are baked in the Annealing Furnace, this operation opening the pores and toughening the plate.

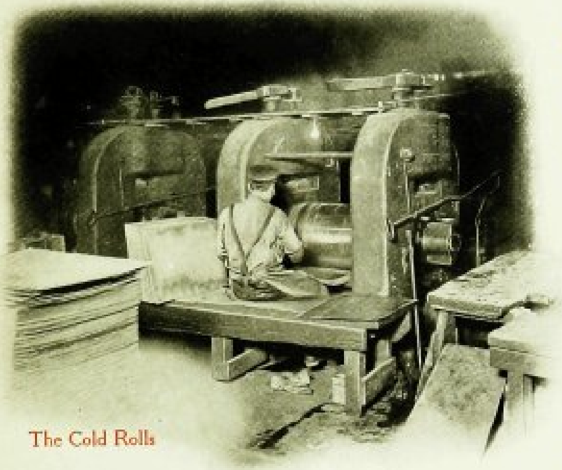


Dropping the Cover

Into the
Annealing Furnace

AS the air must be kept from the plates while undergoing this process, a large annealing box is brought up, the plates are stacked upon the stand, and when a sufficient number of them are placed thereon, a large cover is dropped over them and dry sand packed around the ledge where the cover rests upon the base.

The box is then lifted by a powerful crane and carried over to the Annealing Furnace, where it is inserted. The heat is then turned on and the plates thoroughly heated. This requires about twelve hours of intense heat, at the end of which time they are removed from the furnace and allowed to cool thoroughly before the cover is taken off.



The Cold Rolls

AFTER the annealing, several hours are required by the plates to cool properly. These are then carried to the cold rolls where they are passed through singly.

At this rolling they are not heated, the sole aim being to give them a surface to which the terne mixture will adhere closely.

Very great care must be exercised by the operator of these rolls. A plate fed in crooked, or two or more fed in at a time, will in many instances break the casting in which the rolls revolve, and cause great delay while repairs are being made.

THE plates are now sent to the re-squarer, who takes them one at a time and accurately trims and squares their four edges.

This is done to insure a perfectly straight edge and to make the working of the plates, when in the hands of the roofer, much easier.

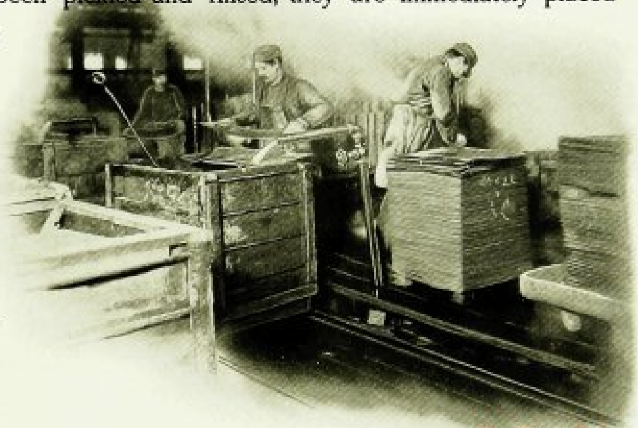
After being squared, they are restacked in the annealing box; again annealed and later given a bath in the white pickler.

Resquaring

THE acid solution in the second pickling is much weaker than in the first, the sole aim being to remove the small amount of blue oxide formed by the indrawing of air while the annealing box is cooling off.

After the plates have been pickled and rinsed, they are immediately placed in the water boshes and covered with clean water.

The water boshes are large wheeled tanks used to convey the finished black plates to the tinning house, and are always filled with water to prevent the rusting of the plates.



The Water Boshes

The Tinning Stack

UPON reaching the tinning house the plates are taken out of the water bosh, and immersed in a bath of melted palm-oil.

This cleans the plate thoroughly and insures a perfect amalgamation of the terne mixture when brought into contact with it.

The palm-oil and tinning pots stand side by side, and as the plate is taken from the former, it is pushed down into the molten tin and lead.

It remains here until it is thoroughly tinned or coated with metal; then is lifted out, and again dipped into another pot of tin of lower temperature than the previous one.

FROM the second bath in the Terne mixture the plates are lifted out and placed on the hob, from which they are picked up singly by the washman and placed in the grease pot. The thickness of the coating upon the finished Terne Plate is here determined by the length of time it remains therein.

If the coating is to be heavy, it is dropped in and immediately taken out; if light, it is allowed to remain in the pot a few moments.

The Branner at Work

This also equalizes the coating on all parts of the plate, and the rapidity with which the plates are cooled after coming out of the grease pot, regulates the size of the mottle. After being cooled on the rack, the plates are passed through the branner, which thoroughly cleans them by passing them through bran and dust.

AS the Terne Plates are finished they are stacked upon a truck and taken to the Assorting Room. Here a girl examines each plate carefully and throws aside all those having the slightest flaw.

One hundred and twelve plates, 14x20 inches, or fifty-six plates, 20x28 inches in size make a base box. Therefore, the sorters, as they work, count the perfect plates, and also weigh them to be sure that they come up to the required standard.

Assorting

THEY are then taken to the stamper, who embosses the brand in the upper right hand corner of each one.

This is done to prevent substitution and as a guarantee that each plate has had the best of attention throughout.

At the stamping machine they are packed in boxes; the lid is nailed on; and the boxes sent to the store room, later to be forwarded to some part of this country, or even to the old world.

The Stamp of Quality

FROM this point on, we are all well acquainted with the working and use of Terne Plates. As a fire, storm and wind protection they know no equal; and if care in selection and workmanship is exercised, no more satisfactory or longer-lived roofing material can be found.

A perfect Terne Plate is a perfect roof covering, but even the best must be properly joined, soldered, and painted if it is to accomplish the best results.

Therefore, on the following pages, we have endeavored to give such information as will be valuable to all users of Roofing Tin.

A Protector At Last

IN the foregoing we have given you a clear idea of the process by which MF Ternes are made.

This is the oldest of Old Style methods, and became world-famous because the Tin, made according to its formula, lasted longer and gave better protection than any of the others.

By the use of palm-oil, the coating is well amalgamated with the base plate; the terne mixture is evenly distributed upon all parts of the surface, and the plate can be bent to any angle without breaking the coating.

MF Ternes are noted for their easy working qualities and the complete satisfaction which they give. Therefore, when we sum up their many points of merit in the phrase "The Terne which turns the elements," we have combined all that can be asked of any roofing material.

MF Ternes will always be in favor with the man who wishes to do good, lasting work, and the fact that last year more boxes were sold than ever before, proves that their hundred-year popularity is still growing.

How to Construct a Tin Roof

ROOFS with less than one-third pitch are made with flat seams and should preferably be covered with MF or U. S. Eagle Roofing Tin, from sheets 14 x 20 inches dimension, rather than from sheets 20 x 28 inches, because the larger number of seams stiffen the surface and help to prevent buckles and rattling in stormy weather. For flat-seam roof one-inch barbed and tinned roofing nails should be used, not over six inches apart, well under the edge. They should be well covered up and the seams should be pounded down over the edge with wooden mallet. Nails must never be exposed. The seams should be made with great care; sufficient time must be taken to properly "sweat" the solder into the seams.

Steep tin roofs should be made with standing seams and from sheets 20 x 28 inches. The sheets are first double-seamed and soldered together into long strips that reach from eaves to ridge. The sloping seams are composed of two "upstands," interlocked and held in place by cleats. The standing seams are not soldered, but are simply locked together with the cleats folded in from 15" to 18" apart. Nails should be driven into the cleats only.

While it is always cheapest to use the best material, roofing plates with a lesser coating may be used for steep standing seam roofs. IC roofing plates, in which the iron body weighs about 50 lbs. per 100 square feet, are more suitable than IX plates ($62\frac{1}{2}$ lbs. per 100 square feet), because the seams in the lighter plates will not suffer as much from contraction and expansion as the thicker plates.

For spouts, valleys and gutters heavily coated IX plate should always be used.

The amount of terne coating on the lighter sheets should in all cases be fully as heavy as on the heavier plates.

In late years the anxiety of some manufacturers to satisfy the demand of the people for cheap goods has been the cause of many inferior grades being introduced. This latter class of material may suit for some purposes outside of roofing or for roofs on temporary buildings, but for roofs that are expected to last, the "double dipped" and "extra coated" plates should be used.

The use of acid in soldering seams in a tin roof is to be carefully avoided; acid coming in contact with the bare iron on the cut edges and corners where the sheets are folded and seamed together will cause rusting. No other soldering flux but good rosin should be used. Every roof should be carefully cleaned and all rosin spots and detrimental substances should be removed as the tinner's work is being finished. Lumps of rosin left on the roof will melt in the sun, stick to the roof, cause blisters and prevent paint from adhering.

For valleys, spouts and gutters of a tin roof no other metal than terne plates should be used, because the galvanic action produced by different metals coming in contact with each other will cause disintegration under atmospheric influences.

The sheathing boards underlying the roofing tin should be put close together. The wood should be well seasoned, dry and all knots should be culled out. It is also advisable to cover the boards with good building paper before the tin is laid on. The paper serves to protect the tin from injurious vapors, gases, or fumes that continually rise from the rooms below.

When no paper is used the tin must in all cases be painted on the under side with good reliable oil paint before it is laid and fastened on the roof. The outside should receive two coats of paint as soon as the roof is finished.

To make tin roofs last for generations they should be repainted every three to five years with good iron oxide and linseed oil paint. The frequency of the intervals will depend largely on the climatic conditions of the country.

Flat Seam Tin Roofing

Table showing quantity of 14" x 20" tin required to cover a given number of square feet with flat seam tin roofing. A sheet of 14" x 20" with ½" edges measures, when edged or folded, 13" x 19" or 247 square inches. In the following all fractional parts of a sheet are counted a full sheet.

No. of sq. ft.	Sheets required	No. of sq. ft.	Sheets required	No. of sq. ft.	Sheets required	No. of sq. ft.	Sheets required	No. of sq. ft.	Sheets required
100	59	280	164	460	269	640	374	820	479
110	65	290	170	470	275	650	379	830	484
120	70	300	175	480	280	660	385	840	490
130	76	310	181	490	286	670	391	850	496
140	82	320	187	500	292	680	397	860	502
150	88	330	193	510	298	690	403	870	508
160	94	340	199	520	304	700	409	880	514
170	100	350	205	530	309	710	414	890	519
180	105	360	210	540	315	720	420	900	525
190	111	370	216	550	321	730	426	910	531
200	117	380	222	560	327	740	432	920	537
210	123	390	228	570	333	750	438	930	543
220	129	400	234	580	339	760	444	940	549
230	135	410	240	590	344	770	449	950	554
240	140	420	245	600	350	780	455	960	560
250	146	430	251	610	356	790	461	970	566
260	152	440	257	620	362	800	467	980	572
270	158	450	263	630	368	810	473	990	578

1000 square feet, 583 sheets. A box of 112 sheets 14" x 20" will cover approximately 192 square feet.

Standing Seam Tin Roofing

Table showing quantity of 20" x 28" tin required to cover a given number of square feet with standing seam roofing. The standing seams and the locks on a steep roof require 2¾" off the width and ¾" off the length of the sheet; fractional parts are counted as a full sheet. A sheet will cover 475 square inches.

No. of sq. ft.	Sheets required	No. of sq. ft.	Sheets required	No. of sq. ft.	Sheets required	No. of sq. ft.	Sheets required	No. of sq. ft.	Sheets required	No. of sq. ft.	Sheets required
100	31	250	76	400	122	550	167	700	212	850	258
110	34	260	79	410	125	560	170	710	215	860	261
120	37	270	82	420	128	570	173	720	218	870	264
130	40	280	85	430	131	580	176	730	221	880	267
140	43	290	88	440	134	590	180	740	224	890	270
150	46	300	91	450	137	600	182	750	228	900	273
160	49	310	94	460	140	610	185	760	231	910	276
170	52	320	97	470	143	620	188	770	234	920	279
180	55	330	100	480	147	630	191	780	237	930	282
190	58	340	103	490	149	640	194	790	240	940	285
200	61	350	106	500	152	650	197	800	243	950	288
210	64	360	109	510	155	660	200	810	246	960	291
220	67	370	112	520	158	670	203	820	249	970	294
230	70	380	115	530	161	680	206	830	252	980	297
240	73	390	118	540	164	690	210	840	255	990	300

1000 square feet, 303 sheets. A full box, 112 sheets 20" x 28", will cover approximately 370 square feet.

The common sizes of tin plates are 10" x 14", and multiples of that measure. The sizes most generally used are 14" x 20" and 20" x 28".

Wind Pressures on Roofs

(Pounds per Square Foot)

Rise Inches per foot of Run	Angle with Horizontal	Pitch Proportion of Rise to Span	Wind Pressure Normal to Slope
4	18° 25'	1/6	16.8
6	26° 33'	1/4	23.7
8	33° 41'	1/3	29.1
12	45° 0'	1/2	36.1
16	53° 7'	2/3	38.7
18	56° 20'	3/4	39.3
24	63° 27'	1	40.0

IN addition to wind and snow loads upon roofs, the weight of the principals or roof trusses, including the other features of the construction, should be figured in the estimate. For light roofs having a span of not over 50 feet, and not required to support any ceiling, the weight of the steel construction may be taken at 5 pounds per square foot; for greater spans, 1 pound per square foot should be added for each 10 feet increase in the span.

Approximate Weight of Materials for Roofs

Material	Average Weight, Lb. per Sq. Ft.
Corrugated galvanized iron, No. 20, unboarded	2¼
Copper, 16 oz. standing seam	1¼
Felt and asphalt, without sheathing	2
Glass, ⅛ in. thick	1¾
Hemlock sheathing, 1 in. thick	2
Lead, about ⅛ in. thick	6 to 8
Lath and plaster ceiling (ordinary)	6 to 8
Mackite, 1 in. thick, with plaster	10
Neponset roofing, felt, 2 layers	½
Spruce sheathing, 1 in. thick	2½
Slate, 3/16 in. thick, 3 in. double lap	6¾
Slate, ⅛ in. thick, 3 in. double lap	4½
Shingles, 6" x 18", ⅓ to weather	2
Skylight of glass, 3/16 to ½ in., including frame	4 to 10
Slag roof, 4-ply	4
Terne plate, IC, without sheathing	½
Terne plate, IX, without sheathing	⅝
Tiles (plain) 10½" x 6¼" x ⅝ in.—5¼" to weather	18
Tiles (Spanish) 14½" x 10½"—7¼" to weather	8½
White pine sheathing, 1 in. thick	2½
Yellow pine sheathing, 1 in. thick	4

Snow and Wind Load

DATA in regard to snow and wind loads are necessary in connection with the design of roof trusses.

When the slope of a roof is over 12 inches rise per foot of horizontal run, a snow and accidental load of 8 pounds per square foot is ample. When the slope is under 12 inches rise per foot of run, a snow and accidental load of 12 pounds per square foot should be used. The snow load acts vertically, and therefore should be added to the dead load in designing roof trusses. The snow load may be neglected when a high wind pressure has been considered, as a great wind storm would very likely remove all the snow from the roof.

The wind is considered as blowing in a horizontal direction, but the resulting pressure upon the roof is always taken NORMAL, at right angles, to the slope. The wind pressure against a vertical plane depends on the velocity of the wind, and, as ascertained by the United States Signal Service at Mount Washington, N. H., is as follows:

Velocity (Mi. per Hr.)	Pressure (Lb. per Sq. Ft.)	
10	0.4	Fresh breeze
20	1.6	Stiff breeze
30	3.6	Strong wind
40	6.4	High wind
50	10.0	Storm
60	14.4	Violent storm
80	25.6	Hurricane
100	40.0	Violent Hurricane

THE wind pressure upon a cylindrical surface is one-half that upon a flat surface of the same height and width.

Since the wind is considered as traveling in a horizontal direction, it is evident that the more nearly vertical the slope of the roof the greater will be the pressure, and the more nearly horizontal the slope the less will be the pressure. The following table gives the pressure exerted upon roofs of different slopes by a wind pressure of 40 pounds per square foot on a vertical plane, which is equivalent in intensity to a violent hurricane.

Safe Bearing Loads

Brick and Stone Masonry	Lb. per Sq. In.	Foundation Soils	Tons per Sq. Ft.
Brickwork—Bricks, hard, laid in lime mortar .	100	Rock, hardest in native bed	100
Hard, laid in Portland cement mortar . . .	200	Equal to best ashlar masonry . . .	25–40
Hard, laid in Rosedale cement mortar . .	150	Equal to best brick	15–20
Masonry—Granite, capstone	700	Clay, dry in thick beds	4– 6
Squared stonework	350	Moderately dry, in thick beds . . .	2– 4
Sandstone, capstone	350	Soft	1– 2
Squared stonework	175	Gravel and coarse sand, well cemented .	8–10
Rubble stonework, laid in lime mortar . .	80	Sand, compact and well cemented . .	4– 6
Rubble stonework, laid in cement mortar .	150	Clean dry	2– 4
Limestone, capstone	500	Quicksand, alluvial soils, etc	1– 5
Squared stonework	250		
Rubble, laid in lime mortar	80		
Rubble, laid in cement mortar	150		
Concrete, 1 Portland, 2 sand, 5 broken stone .	150		

The Metric System

THE metric system is based on the meter, which, according to the United States Coast and Geodetic Survey Report of 1884, is equal to 39.370432 inches. The value commonly used is 39.37 inches, and is authorized by the United States government. The meter is defined as one-ten-millionth the distance from the pole to the equator, measured on a meridian passing near Paris.

There are three principal units—the meter, the liter (pronounced lee-ter), and the gram, the units of length, capacity and weight, respectively. Multiples of these units are obtained by prefixing to the names of the principal units the Greek words Deca (10), Hecto (100), and Kilo (1,000); the submultiples or divisions, are obtained by prefixing the Latin words deci (1/10), centi (1/100), and milli (1/1000). These prefixes form the key to the entire system. In the following tables the abbreviations of the principal units of these submultiples begin with a small letter, while those of the multiples begin with a capital letter; they should always be written as here printed.

Measures of Length

Name		Meters		U. S. In.		Feet
Millimeter (mm.)	=	.001	=	.039370	=	.003281
Centimeter (cm.)	=	.010	=	.393704	=	.032809
Decimeter (dm.)	=	.100	=	3.937043	=	.328087
Meter (m.)	=	1.000	=	39.370432	=	3.280869
Decameter (Dm.)	=	10.000	=		=	32.808690
Hectometer (Hm.)	=	100.000	=		=	328.086900
Kilometer (Km.)	=	1,000.000	=	.621 mi.	=	3,280.8690000
Myriameter (Mm.)	=	10,000.000	=	6.214 mi.	=	32,808.690000

The centimeter, meter and kilometer are the units in practical use, and may be said to occupy the same position in the metric system as do inches, yards and miles in the United States and English system of measurement.

Measures of Area

Name		Sq. Met.		Sq. In.		Sq. Ft.
Sq. millimeter ($mm.^2$)	=	.0000010	=	.001550		
Sq. centimeter ($cm.^2$)	=	.0001000	=	.155003	=	.00107641
Sq. decimeter ($dm.^2$)	=	.0100000	=	15.5003	=	.10764100
Sq. meter or centare ($m.^2$, or ca.)	=	1.0000000	=	1,550.03	=	10.76410000
Sq. decameter, or are ($Dm.^2$, or A)	=	100.00000000	=	155,003.	=	1,076.4101
Hectare	=	10,000.00000000	=		=	107,641.01
Sq. kilometer	=			.3861099 sq. mi.	=	10,764,101
Sq. myriameter	=			38.6109000 sq. mi.		

Measures of Volume

Name		Cu. Met.		Cu. In.		Cu. Ft.		Cu. Yd.
Cu. centimeter ($cm.^3$)	=	.000001	=	.061025				
Cu. decimeter ($dm.^3$)	=	.001000	=	61.0254				
Centistere	=	.010000	=	610.2540	=	.35316		
Desistere	=	.100000			=	3.53156		
Stere [=cu. m. ($m.^3$)]	=	1.000000			=	35.3156	=	1.308
Decastere	=	10.000000			=	353.156	=	13.080

A Few Other Products

Terne Plates

American, American Numethodd, U. S. Eagle N. M., Official Seal, Moonflower, U. S. Monongahela, Long Terne Sheets and Continuous Roofing made from any of the above products.

Galvanized Sheets

Apollo Best Bloom Galvanized Sheets, Charcoal Hammered Bloom Galvanized Iron Sheet.

Formed Roofing Materials

Corrugated Sheets, Crimped Sheets, V and 3V Crimped Roofing, Plain or Self-Capping Roll Roofing, Roll and Cap Roofing, Side and End Wall Flashings, Plain and Corrugated Ridge Capping.

Metal Siding

Beaded Ceiling or Siding, Weatherboard Siding, Plain and Rock Faced Brick Siding and Rock Face Stone Siding.

Metal Lath

Ætna Expanded Metal, Cambridge Rigid Reversible Metal Lath.

Black Sheets

Blue Annealed, American Bessemer, American Bessemer Refined, American Bessemer Special, American Open Hearth, American Open Hearth Refined, American Open Hearth Special, Hammered Polished Steel, Reworked Muck Bar Iron, American Armature, U. S. Electrical, American Blue, Leechburg Blue, Leechburg Blue Refined, W. Dewees Wood's Cleaned Refined Smooth Finish, W. Dewees Wood's Patent Planished Iron, Wood's Round Oak Stove Body, Wellsville Polished, Range Steel, Metallic Furniture, etc.

United States Standard Gauge and Weights

For all uncoated Sheets and Plates of Iron

Wire gauge	Approximate thickness in fractions of an inch	Approximate thickness in decimal parts of an inch	Weight per square foot in oz. avoirdupois	Weight per square foot in pounds avoirdupois	Wire gauge	Approximate thickness in fractions of an inch	Approximate thickness in decimal parts of an inch	Weight per square foot in oz. avoirdupois	Weight per square foot in pounds avoirdupois
0000000	1-2	.5	320	20.	18	1-20	.05	32	2.
000000	15-32	.46875	300	18.75	19	7-160	.01375	28	1.75
00000	7-16	.4375	280	17.50	20	3-80	.0375	24	1.50
0000	13-32	.40625	260	16.25	21	11-320	.034375	22	1.375
000	3-8	.375	240	15.	22	1-32	.03125	20	1.25
00	11-32	.34375	220	13.75	23	9-320	.028125	18	1.125
0	5-16	.3125	200	12.50	24	1-40	.025	16	1.
1	9-32	.28125	180	11.25	25	7-320	.021875	14	.875
2	17-64	.265625	170	10.625	26	3-160	.01875	12	.75
3	1-4	.25	160	10.	27	11-940	.0171875	11	.6875
4	15-64	.234375	150	9.375	28	1-64	.015625	10	.625
5	7-32	.21875	140	8.75	29	9-640	.0140625	9	.5625
6	13-64	.203125	130	8.125	30	1-80	.0125	8	.5
7	3-16	.1875	120	7.5	31	7-640	.0109375	7	.4375
8	11-64	.171875	110	6.875	32	13-1280	.01015625	6½	.40625
9	5-32	.15625	100	6.25	33	3-320	.009375	6	.375
10	9-64	.140625	90	5.625	34	11-1280	.00859375	5½	.34375
11	1-8	.125	80	5.	35	5-640	.0078125	5	.3125
12	7-64	.109375	70	4.375	36	9-1280	.00703125	4½	.28125
13	3-32	.09375	60	3.75	37	17-2560	.006640625	4¼	.265625
14	5-64	.078125	50	3.125	38	1-160	.00625	4	.25
15	9-128	.0703125	45	2.8125	39	3-512	.00589375	3¾	.234375
16	1-16	.0625	40	2.5	40	7-1280	.00546875	3½	.21875
17	9-160	.05625	36	2.25					

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