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IN a recent number of *Stahl and Eisen* (October, 1889), Professor A. LEDEBUR devotes considerable space to a rather supercilious review of Mr. JAMES RILEY'S paper on nickel-steel alloys, to which we referred editorially in our issue of October 26th. In this review Professor LEDEBUR seems to miss entirely the object of Mr. RILEY'S paper, which was merely to give the technical results of his tests of such alloys. The commercial aspect of the question was one that he expressed no opinion upon, barely referring to the engineering possibilities opened up by the use of the alloys, if feasible. The professor, however, predicts that the discovery of the alloys of nickel and iron and steel belongs to that class of inventions which crop up at greater or less interval, finally to be buried in oblivion because of their impracticability. This, of course, means that Mr. RILEY fails to show that nickel-steel can be made sufficiently cheap to become of commercial value (which was not the aim of his paper), as every one must admit that the technical advantages of the alloy are conclusively demonstrated.

A curiously practical commentary on this criticism is afforded by the report in some of the English trade papers that already there is a market demand among the steel-makers for several thousand tons of ferro-nickel with which to make these alloys, so that what we scarcely anticipated would occur until the price of nickel or nickel ores would admit of a cheaper ferro-nickel being made is already a fact, as there are evidently uses for the alloy that can afford to pay the present price.

It is interesting to note in connection with the possibility of cheaper nickel, to which, we believe, the Sudbury deposits will contribute, that a fresh discovery of nickel ore has been made in the Ural Mountains, in the neighborhood of Ekaterinburg. The ore is said to be free from cobalt, arsenic, and sulphur, and it is stated that there is no difficulty in producing from it a nickel 97 per cent. pure. The quantity is represented as large, one vein being calculated to supply 8,000,000 pounds of metallic nickel. The nickel occurs in the form of nickelous oxide, and is associated with magnesium silicate.

FRANKLIN B. GOWEN.

Mr. FRANKLIN B. GOWEN, whose tragic death occurred on the 14th inst., at Washington, was undoubtedly one of the most admirable men this country has produced. To brilliant ability, eloquence, undaunted courage, and an incorruptible honesty which placed him, even with his bitterest antagonists, above the faintest suspicion of doing a dishonorable thing, Mr. GOWEN united a winning personality that firmly attached to him all who had the honor and pleasure of his acquaintance.

His devotion to duty was not lessened when it called for the risk of his life and fortune, and the administration of the immense interests of the Reading Railroad and Coal and Iron companies was never influenced by his personal advantages, but was always and solely in that of his stockholders. A man of firm convictions and of utter and unconcealed abhorrence of dishonesty in every form, he naturally made many enemies as well as friends, but even his enmities were to his honor.

Mr. GOWEN was a firm and very enthusiastic believer in the immense value of our anthracite coal deposits, and he secured for the Reading Coal and Iron Company the most valuable mineral estate in the world. It is true much of it was purchased with bonds, and this involved an interest account so heavy as to have crippled his companies; but the policy of controlling this magnificent source of future profits, both for the coal company and for the railroad was, when exercised in moderation, a far-sighted and wise one. Mr. GOWEN'S sanguine temperament may have led him to a larger investment in undeveloped lands than was prudent, but there is no question of the immense value of the estate, (which covers fully one-half of all the anthracite coal in Pennsylvania), that he purchased for his company, or the moderate cost of the same.

In the council chamber he was an acute and profound legal adviser; at the bar a pleader of unsurpassed logical force and magnetic influence. Handsome, witty and eloquent, he was master alike of the rapier and the battle-axe. After the glamour of his speech had passed away, there remained the convincing strength of his statement.

These qualities, together with his fearless determination, found, perhaps, their highest exhibition in the victory which he won, at the end of more than three years of patient preparation, over the secret society of murderers which had so long maintained a reign of terror in the anthracite regions. If Mr. GOWEN had never achieved anything else, this one performance would have entitled him to the gratitude of mankind.

No language can fully portray the loss to family and friends of such a companion. We here can only echo the universal sentiment that in the unutterably sad death of Mr. GOWEN the world has lost one of the noblest of mankind, the most admirable and lovable of men.

THE ELECTRIC WIRES.

After the long interval caused by legal complications the work of removing the overhead electric light wires in New York City has been resumed. Immediately on the overruling of the restraining injunction last week, the Board of Public Works took up the task of demolition—this time with a vengeance.

There is no question that the wires should go underground, and as speedily as practicable. But it is curious to note the sudden zeal displayed by the authorities under the pressure of newspaper demands. The recent fatalities from the wires having stirred up the papers, the latter have in turn stirred up the courts and the officials, and a spasmodic activity is the result.

It will strike most people that the whole affair has been mismanaged from the start. The companies, in their own interest, should have provided the subways; when the city undertook the job, the work should have been more rapid, extensive and continuous; the occupancy of the subways should have gone on *pari passu* with their construction; the city officials, having been stopped in their aggressive measures by injunction, should have taken steps to have the matter settled as speedily as possible; meanwhile the companies, instead of wasting effort in resisting an inevitable conclusion (for the storm was surely coming), might have protected themselves more practically by removing the dangerous wire with a view to saving the rest. Finally, this sudden crusade of destruction is likely to be in part injudicious, doing damage as well as good. And work which might have been done in good weather on the subways is now being forced in winter—now in mud, and likely soon to be stopped by frost.

All the trouble was foreseen and everything should, and might, have been settled about five years ago. But it seems that it requires some such tragic occurrences as have lately happened to startle people to earnest action.

However desirable the underground system may be, there is no doubt as to the irrationality of the popular clamor. Simply putting the lines underground does not eliminate the danger. Not only do the wires have to come out of their conduits to the lamps, but several new possibilities of danger exist in the subways themselves.

Will the arc light and the power wires have to go? By no means. It is possible now to obtain insulation which will resist moisture and certain kinds of chemical reagents, as is shown every day in the long submarine cables. Some lucky inventor, or more probably some systematic experimenter, will soon come forward with a reasonably cheap and durable insulating covering which shall be reliable. We have already described the London system; what is needed for general application is something equally good but cheaper.

Electricity of high tension in large currents is bound to be used in the future. There will always be *some* accidents, as in the use of all high powers and machinery. Yet no one thinks of discarding steam for that reason; the result is, improvement of the boilers and connections. Such will be the history of electricity. The aim will be to reduce the risks to the minimum, for absolute impunity is not to be hoped for.

JET PROPULSION FOR STEAMSHIPS AGAIN.

A new steam vessel, called the "Evolution," was launched in Brooklyn on the 11th inst., the motive power of which is to be a jet of water discharged under pressure from her stern. The New York *Tribune* of the 12th gives a lengthy description of the boat, but in it we are not informed of its dimensions, except that it is said to be of less than 100 tons burden.

The power equipment is to consist of a coil boiler built under the patents of E. E. Roberts, with 5,000 feet of heating surface and 180 feet of grate surface. It is expected to develop over 1,600 horse power. The engine is a duplex compound Worthington pump of three-foot stroke, the diameters of the cylinders being 25 and 43·3 inches, and of the pump plunger $9\frac{1}{4}$ inches. At its full capacity the engine is expected to deliver through a nozzle $\frac{13}{16}$ inch in diameter, 1,000 gallons of water a minute under a pressure of 2,560 pounds per square inch and with a velocity astern of 609 feet per second.

The difference between this vessel and all previous water-jet propulsion steamers, which have for the most part proved failures, is its use of the propelling water at an exceedingly high pressure and velocity. It is claimed by the inventor, Dr. Walter Marsh Jackson, in a patent dated June 26, 1888, that "the herein described apparatus for propelling or manœuvering a vessel, which consists in developing a pressure exceeding the boiler pressure, by means located between the boiler and the water-exit, subjecting water received into the vessel to such increased pressure and then discharging it in the form of one or more jets against the water of flotation.

The article in the *Tribune* refreshes our memory with the following brief review of previous failures in jet propulsion:

The British Admirality, in 1866, authorized the construction of the "Waterwitch," an iron-clad gunboat of 1,100 tons, designed by Ruthven. She was tried in 1867, and attained a speed of nine knots, developing 838 horse power, and throwing 314 tons of water a minute by means of a turbine wheel out of two nozzles having a combined area of six square feet placed at the water line at each side of the vessel. The efficiency of this apparatus was found to be about 18 per cent., and after being taken out to sea and nearly foundering in a stiff wind, the Admiralty laid the "Waterwitch" up in an ordinary at Portsmouth.

Not content with this experiment, which was completed at a cost of $400,000, in 1884 another turbine was put in a torpedo boat of about fifteen tons by Thornycroft, at the expense of the government. This vessel developed 167 horse power and discharged sixty tons of water a minute through two nozzles, each nearly a foot in diameter. Her speed was twelve knots, as against seventeen knots with a vessel of the same size and displacement having a screw propellor and equal power. The efficiency of the Thornycroft turbine, usually called "The Squirt," was only 25 per cent.—and the noise of the water going out of the nozzles was likened to the popping of soda-water bottles, and could be heard, as Admiral Selwyn said, "half a mile away."

In the face of such a record of disaster the inventor and his friends who have furnished the money to build the new vessel have shown wonderful courage, not only in building the vessel, but in making it a "thing of beauty" as well.

Her cabin is furnished in hard wood, principally mahogany. Altogether, she is a fine example of wooden shipbuilding, in which art the Yankee nation always excelled the world. She is one of the most expensive vessels of her size afloat, as money seems to have been held secondary to making a ship worth showing anywhere.

It is stated that

The association controlling this and other patents of the inventor in all maritime countries, number over one hundred persons. Who they are does not yet appear. It is said, however, that almost every large shipping house in South and Water streets is interested in the project, and they hope by the triumph of the hydraulic principle to bring about a revival of American commerce in American-built vessels.

It is too bad to have to throw a jet of cold water on this new hydraulic vessel, but we think the courage of the large shipping houses in investing in it is more commendable than their judgment. We shall be surprised if the "Evolution" does not prove to be more inefficient than either the "Waterwitch" or the "Squirt." It is quite possible that a high speed may be attained by the "Evolution," since it has 1,600 horse power of boilers in a boat of less than 100 tons burden, but it would be impossible to carry out this ratio of horse power to capacity in a large vessel.

SECRETARY WINDOM'S SILVER SCHEME.

The silver proposition of Secretary Windom is attracting, as it deserves, a great deal of attention. It is generally understood to be a compromise measure, intended, not as an ideal settlement of the much-vexed bimetallic question, but as the lesser of two or more evils. The choice, it is assumed, is between free coinage of silver and the increase of coinage of standard silver dollars on the one hand, and the present proposition on the other. It is claimed that free coinage has a majority of eleven in the Senate, and every one knows the advocates of this policy are noisy. We do not, however, believe when the subject has been discussed in the House, or even in the Senate, that any such majority, or any majority at all, would be found to record their votes for free coinage.

The Director of the Mint, who has devoted much attention to the subject, and who is especially familiar with the foreign statistics of gold and silver, sees none of the dangers that many others believe lie in the proposed silver scheme, and is confident that it is not only a safe, but a good measure. Every one will admit that Mr. Leech's opinion on this matter should carry great weight, and no doubt it will be potent in influencing Senators to unite on this measure, in place of dividing on the free coinage scheme.

The chief objections we see to the scheme, and which we have already pointed out, are:

1st. That the government has no right to use the people's money to create a corner in any metal, or, in other words, to buy what is not needed—in this case for coinage purposes.

2d. The mere fact that the government announces itself ready to buy all the silver that may be offered at the average price in the chief open markets will, of course, inevitably lead to a prompt advance in the price of silver to $1.29 per fine ounce.

Let us assume the act passed to carry this proposition into effect. There are very few who believe that silver can be permanently maintained at this figure, or, in other words, that this country will continue permanently to tax its citizens in order to keep up the great corner; on the contrary, nearly every one believes that should an unexpectedly large amount of foreign silver be dumped on us, Congress would become alarmed at the amount of money required to keep it up and at the disappearance of our gold, and would repeal the act. Every one who has silver to sell; every nation that wishes to change its embarrassing silver into gold; every speculator who wants to make the handsome turn of buying silver for the rise, from, say, 95 cents up to $1.29 per ounce, would avail himself of the market we offer, and would thus precipitate the catastrophe; for each would say: Where will the price of silver go to if the United States Congress—that most mutable of all forms of concentrated wisdom—should stop the buying? Will the price then go down to 75 cents or 50 cents an ounce?

A study of the statistics of the several metals will satisfy every one that the tendency of their commercial values is always downward, corresponding with their cost of production, and if silver is to be considered as a commodity merely, and this is what the proposed plan ostensibly makes it in placing its value at its price in the open market, then, since the cost of production of silver is steadily and somewhat rapidly declining, the commercial value of the metal will also decline unless held up artificially.

We are aware that the belief is held that there are no known stocks of silver outside of what is held as coin or as security for currency by the different countries, and what is hoarded by the people of India, China, etc., and that it is consequently claimed that no foreign silver except the possible small surplus of current production over consumption (outside of this country) could be offered to us. We do not accept this view of the case. There is scarcely any silver or bimetallic country that in recent years has not mooted the question of changing to a single gold standard, though the change was deemed impracticable on account of the loss involved in selling the silver in the open market.

Every country would prefer to hold gold as the security for its paper money, and since no one expects silver ever to rise above the limit imposed by the corner, every country would undoubtedly be quite willing to give us *all* its silver for gold at $1.29 per ounce and issue paper based on gold, in addition to subsidiary coinage, in place of the silver so disposed of, so that instead of getting only the $50,000,000 to $70,000,000 of silver which these sanguine believers in the silver cult think would come to us, the Latin Union, India, Mexico, South America, or even China and Japan might think this an admirable opportunity to convert at least a portion of their silver into gold at the very top of the market and lessen the risk on their holdings of the metal.

The mere apprehension or belief that this country would in a short time repeal the act calling for these purchases would, of course, precipitate this deluge of silver, and in a very brief time we might indeed be called on to stop buying, or we would see our gold carried away and our currency reduced to the silver basis. The rapidity with which such a change can be brought about was well shown by our correspondent, who last week described the reign of the "silver nuisance" in Canada.

NEW PUBLICATIONS.

Inventor's Manual: How to Work a Patent to Make it Pay. Anonymous. Published by J. W. Davison & Co., New York, 1889. Cloth, 12mo., 98 pp. Price $1.

The anonymous author, who describes himself as "an experienced and successful inventor," has struck off from the beaten track of the publications issued by patent attorneys with the design of securing business. He tells us something about inventing, much about getting a patent; but the most useful part of the book is that in which he offers suggestions as to what to do with a patented invention after having made one. This is the sticking point with most inventors, and any common sense advice is decidedly in order. How to properly exhibit inventions, bring them before the public, effect sales, or manage a business founded on a patent—these are the questions which puzzle the patentee. Encouragement to rush into application for patents is superabundant; how to make them pay is something the agents have little to say about.

Whoever this author may be, he takes a rational view of the business and does not gush, though he does hold up the oft-quoted glittering prizes gained by the patentees of the lead-pencil rubber, riveted clothing, metal shoe plate and tip, shoe-lace hook, roller skate, emery cloth, gimlet screw, needle threader, pencil sharpener, ball with rubber string, "pigs in clover," and so forth, to say nothing of the big things like the sewing machine, Bessemer process, vulcanizing rubber, etc. He does not exactly throw cold water on aspiring genius, but is less enthusiastic and more practical than most writers on the subject. We might add to the hints given in the "Manual" that it would be well for the majority of inventors to "sleep on" their inventions before applying for a patent; in fact, allow time for a good many sleeps. Perhaps they would take less sanguine views of the utility of their inventions if they waited longer. As it is, there are no end of blanks in the great patent lottery, mainly due to ill-considered applications.

The topics discussed under the disposal of patents are joint ownership, advertising, territorial grants, selling agents, State laws as to the sale of patents, promoters, formation of companies, assignments, exhibiting, royalties, licenses, etc. A number of blank legal forms are given.

The general style of the book is somewhat rambling, apparently the result of hasty preparation. A good deal of reprint is also run in to make "copy," and probably that was the idea in appending the census population statistics, which are tacked on with naive irrelevancy. But it is a very good little book notwithstanding.

A PRACTICAL TREATISE ON THE MANUFACTURE OF BRICKS, TILES, TERRA COTTA, ETC. By Charles Thomas Davis. Second Edition. Published by Henry Carey Baird & Co., Philadelphia, 1889. Cloth, 8vo, xxxi. + 501 pp., including table of contents and index; 217 engravings. Price $5.

Mr. Davis, who is the editor of the Chicago *Brickmaker*, and who has for some time been a recognized authority in the industries of which he treats in the present book, has succeeded in compiling an excellent treatise which will be of value to manufacturers, architects, and contractors. This second revised edition is a timely issue, in view of the rapid strides recently made, particularly in brickmaking machinery and in the production of ornamental architectural material.

This progress has indeed been remarkable, and has perhaps nowhere been so noteworthy as along the line of seaboard cities of the Atlantic States, though throughout the country there has been a great advance in the art of manufacture and an enormous increase in the use of building material made from clays. The author will probably agree with us in ascribing this marked change very largely to the prevailing popularity of brick construction, which, beginning a few years back as a mere "fashion," inaugurated by enterprising architects as a reaction against the formerly prevailing type of dwellings built of common brick, but faced with a veneering of sandstone, a form that had become painfully monotonous in some localities, has taken a firm hold upon the popular taste. The growing scarcity of timber and lumber and consequent higher prices for this material, and the more general apprehension of danger from fire, have caused brick to supplant frame dwellings very largely. On the other hand, the relative cheapness of bricks over stone and iron is important. While the greatly increased demand for the finer grades of brick greatly stimulated the producers in increasing their output and improving its quality, the sharp competition which has arisen has relatively cheapened the material, so that strong, uniform and pleasing bricks are now on the market at less than the price of the best pressed front brick of former times, and grades are now procurable which were not made, because not called for, until quite recently. The effect has been reciprocal on both supply and demand, with mutual benefit.

While the finer grades of brick were becoming a fashionable material for the fronts of dwellings, it was only natural that more attention should be given to the common red and salmon kinds, which make up the mass of the structures, and these kinds are not only more extensively used but are also improving in quality. From dwellings, the preference for brick has gradually spread to the construction of the large office buildings which are so prominent a feature in American cities, and in a less degree to public buildings, thus encroaching somewhat on the domain of iron and stone (at least relatively); while, with the rapid increase of wealth and the concomitant desire for better, handsomer and more substantial work, all three materials—brick, stone and iron—are steadily gaining on lumber.

Excellent brick clays are common in the United States, and clays suitable for making terra cotta and fine tiles abound in many localities. The supply is practically inexhaustible, and even where the crude material is not close at hand, modern means of transportation admit of a wide distribution from the manufacturing points. The present vastness of the brick trade may be partially seen from the following figures of consumption, quoted by Mr. Davis for the year 1888.

	Bricks Used.
New York City	1,000,000,000
Chicago	440,000,000
Philadelphia	300,000,000
Boston	150,000,000
St. Louis	200,000,000
Cincinnati	100,000,000
Washington	125,000,000
Cleveland	84,000,000
Pittsburg	80,000,000
Omaha	80,000,000
New Orleans	36,000,000
Indianapolis	35,000,000

The total number of bricks used in these twelve cities in 1888 was 2,730,000,000, and these figures are, of course, far from being complete.

The author is an enthusiast on the subject, as, perhaps, it would be well for more writers to be, and enters into his descriptions and comparisons with a heartiness which invests what would otherwise be pretty dry reading with a degree of interest which renders his book acceptable to those who are not personally concerned in the industry. This is particularly the case in the historical portions, which form a large part of the work. Mr. Davis has journeyed extensively through Egypt, Assyria and Chaldea, and his impressions of the handiwork of the ancients are very striking. His conclusion is that it is only lately that the art which had remained almost stationary for more than forty centuries is about to "emerge from a crude manufacture only imperfectly understood and take its place among the higher arts." Sometimes perhaps this enthusiasm leads him to let the eagle scream a little. Having visited and studied the modern brick factories of England, Holland, Belgium, France and Germany, Mr. Davis says that "in all the countries, ancient and modern * * * there is none in which the business of brick making is carried on so extensively, and on the whole so satisfactorily and profitably as it is in the United States." Elsewhere he frequently makes comparisons as to machinery, material and product, which are by no means favorable to foreign countries.

In machinery there has been great progress during the last thirty years. In fact, the day for hand-made bricks is practically past. It seems wonderful now that the world worried along for such a protracted period with the slow and uneconomical methods. The machinery illustrated in Mr. Davis' book is, however, only a small part of that actually in use; and sometimes the descriptions read a little like free advertisements. Yet the machines selected for illustration are typical ones, in every-day use, and give a fair idea of prevailing practice.

We often hear of sulphuric acid and paper as quantitative indices of the stage of progress of a race or nation; but our author, in his predilection for his special subject, puts forth very strongly the claims of brick as a measure of advancement, and says: "A complete history of brick making would be analogous to that of civilization, with its advances and declines." There is evidently something in this view of the matter.

Architectural terra cotta and tiles naturally come in for a large share of attention. In this country we have begun late, but are now producing creditable designs and excellent qualities. This Mr. Davis well brings out. Perhaps in no department of clay manufactures has the advance been so marked during the last few years, and the present artistic development of these branches is very commendable, though there is a wide field yet open in this direction. The endurance and strength of such material is shown by the tests quoted, and the proper architectural handling is well stated.

"Bricks, Tiles and Terra Cotta" is very systematically arranged, and its utility as a reference book is much increased by the very full table of contents and index.

CORRESPONDENCE.

We invite correspondence upon matters of interest to the industries of mining and metallurgy. Communications should invariably be accompanied with the name and address of the writer. Initials only will be published when so requested.

All letters should be addressed to the MANAGING EDITOR.

We do not hold ourselves responsible for the opinions expressed by correspondents

Libraries, etc., for Workingmen.

EDITOR ENGINEERING AND MINING JOURNAL:

SIR: In response to "Manufacturer's" letter in your issue of November 9th, I beg to send you the following information relating to the Carnegie library. We have nothing but a library and reading room, both free, and the managers have arranged for a lecture course for the workmen on technical scientific subjects. It was the intention to add amusement rooms, but nothing has been done in this direction yet. The library and reading room are both well patronized, giving out about six hundred volumes per week. Started last March. Yours, etc.,

BRADDOCK, Pa., Dec. 6, 1889. JAMES GAYLEY.

Cœur d'Alene and Smelters' Charges.

EDITOR ENGINEERING AND MINING JOURNAL:

SIR: I wrote my former letter of November 27th before seeing Dr. Raymond's letter on the subject, simply with the knowledge that the correctness of my statements had been called in question. With your permission, I will now reply more specifically to Dr. Raymond's remarks. In the first place, Dr. Raymond says that the Cœur d'Alene miners "will wake up to find that they have allowed to slip by them a more favorable situation for their own interests than is likely to occur again." Now, while holding off from Montana, the ore is going to Omaha, Kansas City and Denver at rates more favorable to their interests than offered by the Helena Company. Further, as to the freight rates, I will give them exactly as follows: From Wardner Junction to Cœur d'Alene City the rate is $5.50 per ton, and 10 cents extra per ton for the two transfers—this is a distance of about 80 miles, say 85; from Cœur d'Alene City to Helena, or Garrison, the charge is $8 per ton—a distance to Helena of 381 miles. The total charge is $13.60 per ton to Helena or Garrison from Wardner Junction, 466 miles, or ·029 cents per mile per ton. Now, if ore is destined to any point not on the Northern Pacific Railroad, and it is necessary it should go over any of the other railroads of Montana, it has to change from Northern Pacific cars at Garrison. There is no such rate of $6 per ton on crude ore from Wardner Junction to Helena. This is a rate that would be satisfactory to the miners, as they have no rates that are satisfactory between those points.

The freezing of the Cœur d'Alene Lake interferes very little with the transportation in the winter.

Dr. Raymond further says: "Attempts are constantly made to persuade the railroad authorities to protect by lower rates the establishments using their lines; but no concessions have been obtained without the knowledge, or used against the interest, of the Cœur d'Alene miners. On the contrary, every reduction (for there have never been any advances) in freight is immediately credited to the miners."

This is very pleasant news to the miners—to know how kindly they are thought of by the Montana smelters. I think they would like some substantial proof on this matter. Any proof that may be set forth will be opposed by the following facts: Prior to December, 1887, and up to about May 1st, 1888, the freight charges from Wardner Junction to Helena were as follows: Wardner Junction to Cœur d'Alene City, $5.50; Cœur d'Alene City to Helena, $5; and from Cœur d'Alene City to Portland, Ore., $10.40; total charge from Wardner Junction to Helena, $10.50, and from Wardner Junction to Portland, $15.90. It is practically the same distance from Wardner Junction to Helena as from Wardner Junction to Portland. The transfer charges were extra on above rates, I believe. About April, 1888, the Portland Board of Trade began to agitate the question of freights, desiring to divert that business to Portland and San Francisco, and endeavored to have the rates from Cœur d'Alene City to Portland reduced by the Northern Pacific Railroad, though in the haul to Portland the Northern Pacific at that time hauled about half way, and the Oregon Railroad & Navigation Company the other half. The Northern Pacific immediately advanced its rate of $5 to $8 per ton from Cœur d'Alene City to Helena, but did nothing in regard to the rate to Portland. At the time of the rise some of the mining companies had contracts based on the $5 rate, and, hence, were not affected for some time afterward.

I am not, probably, just as well prepared to enter into a discussion of the profits and losses of the smelting business, and smelting generally, as Dr. Raymond. But one thing I do think, $21 per ton is an excessive charge for smelting a 50 per cent. lead ore (galena). (The Sierra Nevada ore is mostly carbonate.) Dr. Raymond says that after paying the freight the smelter has $21 left per ton to cover all risks, cost of roasting, smelting, transportation and sale of refined lead and silver, and profits. I would agree with him in this if he had said leaving him (the smelter) $21 per ton of ore to bear his share of all risks, etc. For it must be borne in mind that the approximate half ton of bullion resulting from this one ton of lead ore carries concentrates in it—the majority of the values of two or three tons of other ore, not so rich in lead, but smelted with it to make it profitable. And for those two or three tons the smelter is receiving more per ton than for the lead ore, if they charge for treatment in accordance to the nature of the ore. Now in producing a ton of bullion it will require two tons of lead ore and at least two tons of dry ore to make a bullion of a profitable grade, and to smelt profitably. Here are four tons at $21, assuming that the rate is the same in all cases, giving $84 to cover the cost of smelting four tons of ore, roasting and treating of residuary products, and transportation, refining and sale, and profits, etc., on one ton of bullion. My rough figuring, I think, is a little clearer than Dr. Raymond's, which is a little obscure. He says, "The allowance of 10 per cent. loss in lead and five per cent. loss in silver is not too much for ores which require roasting." This I don't dispute, for this is where the profits of the smelter come in other than from treatment; but large quantities of those ores are carbonates, not the majority by any means; and I don't think it is practical to roast a galena ore carrying 50 per cent. lead. In the last portion of Dr. Raymond's letter, he substantiated my assertion, that the freight and smelting charges are about $38 on a 60 per cent. lead ore of this grade. Fifty-five to 60 per cent. is quite common at certain mines, from which I obtained the information.

The Oregon Railway & Navigation Company, *i. e.* Union Pacific, will soon have their line completed into the Cœur d'Alene mines, and then it is a settled fact, I believe, that the rates will be about $6 per ton on raw ore and $8 on concentrated to Portland, by which time the Portland Smelting and Refining Company will be in running order. I am not connected with any smelter or smelting company, or mining company. I am entirely disinterested, except for the general welfare of the miner, and wish to see justice done on all sides.

Portland, Or., Dec. 7. Wm. Huntley Hampton.

The Duty on Argentiferous Copper Ore.

Editor Engineering and Mining Journal:

Sir: The Secretary of the Treasury, in his circular of October 18th, decided that argentiferous lead ore shall be considered silver ore and be exempt from duty, but that the copper contained in argentiferous copper ore shall be dutiable. This prohibits the importation of thousands of tons of ore that could be profitably treated by our smelters; instead, they will be shipped to England and Germany, and form an addition to the industrial power and wealth of those countries.

The discrimination appears to be unfair, especially as no question of economy is involved. The welfare of our copper mines is not affected any more by the importation of argentiferous copper ore than that of the lead mines by the importation of argentiferous lead ore. Besides, the metallurgical status of copper and of lead is about the same; that is, the silver in "dry silver ore" can be extracted as well by means of the copper in argentiferous copper ores as through the agency of the lead in argentiferons lead ores.

The worst feature of the discrimination, however, is the fact that it cannot even be upheld from any standpoint of law, for it can clearly be pointed out that it results from the misinterpretation of an act of Congress.

The Secretary says: "It must be assumed that the rulings and practice of the department were known to Congress when it passed the tariff act of 1883. It must be held that the designation of lead ore and silver ore in the tariff, in the absence of legislative definition, was that of existing decisions; that Congress intended the classification should turn on the question of value and not of quantity."

Now let us look into the definition of the department prior to the passing of the tariff act referred to. It ruled in a decision dated January 14th, 1880, "with regard to the classification of certain ore imported at Eagle Pass," that "the value of the silver contained in the ore being largely in excess of the value of the iron, the department is of opinion that the ore is entitled to entry free of duty as silver ore."

In the opinion of the Secretary, therefore, when Congress passed the tariff act in 1883, it was governed in its idea in regard to silver ore by the definition contained in the ruling just quoted. He concedes that if Congress had the intention to class argentiferous iron ore as silver ore, it would also have classed argentiferous lead ore as silver ore, and the same logic which induces him to make this concession must also compel him to assume that Congress likewise intended to class argentiferous copper ore as silver ore.

Now, under the special provisions of the free list for ores of gold and silver, Congress exempted silver ore from duty, not partly, but in its entirety. If, therefore, Congress intended to consider certain ores as silver ore, it most assuredly also desired that their status in regard to the tariff should be the same, and that such ores should also be exempt from duty, not partly, but in their entirety.

Besides, a silver ore, in the specific sense of the term, carries neither lead nor copper; hence, if Congress intended to regard certain argentiferous lead and copper ores as silver ore, it certainly desired to regard their lead and copper contents as not existing.

In the tariff act of 1883 (*vide* acts of the Forty-seventh Congress, sess. ii., ch. 121, sec. 2,502, schedule C, par. 186), it is stated "that there shall be levied, collected and paid upon copper, imported in the form of ores, 2½ cents on each pound of fine copper contained therein."

On the basis of the Secretary's own assumption no other logical conclusion can be arrived at but that the term "copper, imported in the form of ores" does not apply to such copper as was intended to be looked upon as not existing.

The Secretary quotes two decisions made by the department after the passing of the tariff act. In January, 1886, it was held that "when silver in any ore predominates in value it is considered to be silver ore, and, as such, is exempt from duty under the special provisions of the free list for ores of gold and silver." In May, 1886, it was stated that "ores composed of silver and lead, and iron or silver, and lead or silver, and other base metals of which silver is the component material of chief value, would, under the ruling of January 25th, 1886, be exempt from duty under the provisions of the free list for ores of gold and silver."

No matter what the various official interpretations may have been, the unbiased mind can only infer that these rulings class argentiferous copper ore as silver ore, and that, in consequence, in conformity with the expressed sentiments of the Secretary, the former should be entitled to the same exemption as the latter.

Nevertheless, the Secretary concludes that copper in argentiferous copper ore is dutiable. He says, in paragraph 186, "copper is made dutiable whenever found in ore;" and in paragraph 191, "nickel is also made dutiable whenever found in ore or in other crude form. In those cases it is clearly the metal obtained in the ore which is made subject to duty, and had the same form of expression been used in reference to lead that metal would have been dutiable at the rate prescribed whenever found in ore. According to well settled rules of statutory construction, this difference in the form of expression must be deemed to indicate a different legislative intent, and to limit the authority of the department to impose duty in such cases to the ore itself under existing rules of classification."

The Secretary herewith admits himself to be of the opinion that it was the intention of Congress in 1883 to levy a duty of two and a half cents on each pound of fine copper contained even in such ore as it intended to exempt from duty in its entirety, and whose copper contents it regarded as not existing. Of course, there is no sense in this, but it is a logical deduction that the conclusion of the Secretary leads to. So far as we can see he has not adduced the least proof in behalf of the legality of a discrimination between argentiferous lead ores and argentiferous copper ores; moreover, there is no conceivable reason why Congress should have intended to make it. Its inconsistency is neither more nor less than that of a law providing that John Smith shall be taxed $1,000 on entering the holy state of matrimony, but imposing no restriction whatever on his brother James.

Once on a time John Smith would, perhaps, regard such a law as striking him with undue severity. There is certainly no doubt that the Secretary will concede this, and he may rest assured that the smelters of argentiferous copper ore also feel his unwarranted discrimination rather keenly. B.

Belleville, Ill., Dec. 12.

WURTZILITE.

Written for the Engineering and Mining Journal by W. P. Blake, M. E.

During a recent visit to Salt Lake City my attention was directed to a newly discovered and peculiar bitumen from the Uintah Mountains, in Wasatch County, Utah, between Salt Lake and the valley of Green River. This locality is not far from the source of Uintahite, or "Gilsonite," now an article of commerce and industrial importance.

The new substance differs essentially from any hitherto described. It is a firm, black solid, a little heavier than water, and breaks with a brilliant conchoidal fracture, and has a general resemblance to jet or some of the cannel coals. It is sectile, cutting like horn or whalebone. The shavings and thin flakes, or fragments, have a degree of elasticity. These characters led, at first, in Salt Lake to the supposition and the report that the substance was allied to caoutchouc, or vulcanized rubber. But it was soon found to be without the essential qualities of rubber, not having tensile elasticity, and being very difficult of solution. It was then for a time referred to the species elaterite, the only elastic bitumen described in Dana's Mineralogy. But a comparison of the substance with the description of the assemblage of dissimilar substances classed under the name elaterite shows that it differs from each of them, and that it has much better defined characteristics, which permit a specific description and entitle it to a distinctive name.

Wurtzilite occurs in large, homogeneous masses, free from mechanical admixture and without any evidence of formation in layers, or of fusion. It is amorphous, and when cold, or at ordinary temperatures, it is brittle and breaks with a large conchoidal fracture, giving very brilliant, glossy surfaces with a vitreous lustre like uintahite, and resembling in appearance the splendent conchoidal surfaces of newly-broken obsidian. It has, however, a degree of toughness which increases with an elevation of temperature, and it requires a quick, sharp blow to detach a flake and secure a good fracture.

Elasticity is observable in thin flakes, but this elasticity may be compared to that of glass or mica rather than to the yielding tensile elasticity of "rubber." If the flake is bent too far, or suddenly, it snaps like glass. The substance is also flexible, and when slowly pressed and warmed a flake may be bent nearly double.

Color.—The extremely thin edges of the flakes obtained by fracture are garnet red by transmitted light, often brilliantly so. It would thus appear to be transparent in very thin plates, and to be deep red in color. The color of the mass by reflected light is a jet black.

Hardness.—The hardness is such that it is not impressed by the nail at ordinary temperatures. It scratches gypsum, and does not scratch rock salt. It is thus between two and three in the scale of Mohs.

Specific Gravity, at 60 degrees F., 1,030.

Infusibility.—Does not fuse in boiling water, but becomes softer and tougher, and is more plastic, but is not viscid or sticky, and fragments do not cohere.

Fusibility.—It melts in the flame of a candle, takes fire, and burns with a bright, luminous flame, with a slight crepitation and little smoke, giving off a strong bituminous odor. Fused in a glass tube it gives off a dense cloud of white and yellow smoke and distils over a thick, brown, tarry oil with a strong odor, and leaves a small residue of fixed carbon. Fragments warmed in the hand emit a strong odor like that of some of the crude petroleums, which is rather offensive.

Electrical Characters.—It is a good electric. Negative electricity is easily developed by friction. It will be found useful as an insulating material and for other purposes in the arts.

Insolubility.—It is not easily dissolved. It resists the usual solvents of bitumen, but experiments are in progress which will probably lead to a process by which it can be successfully worked in combination with other substances.

This material and the Uintahite, or Gilsonite, were first brought to notice by Mr. Gilson, of Salt Lake, to whom I am indebted for samples for investigation and description. A correspondent of the *Oil, Paint and Drug Reporter*, Mr. Wm. L. Lay, of Utah, has noticed the discovery of the bitumen, and, pointing out the differences between it and elaterite and its non-resemblance to rubber, expressed the opinion that it is an important new mineral, in which he is correct. It certainly requires a distinctive name, and in now proposing for it the name *Wurtzilite* I desire to compliment my friend, Dr. Henry Wurtz, of New York, who in 1865 described the mineral to which he gave the name grahamite, and has contributed largely to our exact knowledge of the hydro-carbon compounds, and who, I hope, may be induced to give this novel bitumen the chemical investigation it requires.

MILL ROCK, New Haven, Dec. 4, 1889.

FRANKLIN B. GOWEN.

Franklin B. Gowen was the son of James Gowen, who came to this country in 1811. He was born at Mt. Airy, in the State of Pennsylvania, on February 9th, 1836. His education was commenced at the Catholic School, at Emmettsburg, Md., and was completed at the Moravian College, at Lititz, Lancaster County, Pa.

He became a clerk in a store at Lancaster at the age of 19, and two years later accepted the superintendency of a furnace at Shamokin, Pa. Here he became acquainted with the vast resources of the anthracite coal fields and their relations to the Reading Railroad. He engaged in the mining business as a member of the firm of Turner & Gowen in 1857, but failed in the financial crash of that year. Mr. Gowen has since canceled all the obligations of the firm left unsettled by the failure of his first business venture. At the request of his father he took up the study of law, entering the law office of Benjamin Cummings, at Pottsville, and was admitted to the bar of Schuylkill County, May 31st, 1860. About a year later he was elected District Attorney of Schuylkill County, resigning at the end of two years to accept a position as counsel to the Reading Railroad Company. He was then only 27 years of age, and stood at the head of the Schuylkill County bar. It is said that he was offered at that time a salary of $50,000 a year to become counsel for a leading railroad outside the State, but this he refused to accept.

In 1869 Mr. Gowen was elected President of the Philadelphia & Reading Railroad, in which capacity he acted until 1881. We shall not go into the history of the railroad and its growth into a large corporation under Mr. Gowen's management, as these are details well known to most of our readers. During the period from 1882 to 1886 he again served the same company in the same capacity, and every one is ready to credit him for the foresight exhibited perhaps with too great audacity.

FRANKLIN B. GOWEN.

By permission of F. Gutekunst, Philadelphia.

While president of the Reading Railroad he made his famous record in the campaign against the "Mollie Maguires." With a sagacity equal to his courage, he exposed his life freely and without apprehension, convinced that the boldest policy was also the safest. It was easy *afterward* for others to see and to say the same thing; and we do not assert that no one would have done the same at the time, if called upon.

For more than three years the famous detective, James McParland (now superintendent of the Pinkerton agency at Denver, Col.), sent to Mr. Gowen his daily reports of the doings of the "Mollie Maguires," of which he was a member. Not even Mr. Gowan's private secretary opened these letters. During all this period McParland succeeded in preventing every murder (with a single exception) planned by the lodge with which he was connected. That he did this without attracting the least suspicion to himself was perhaps the most wonderful part of his extraordinary performance. He could not have done it but for the constant and vigilant co-operation of Mr. Gowen, whose measures were so promptly and skillfully taken that the assassins were always led to ascribe their failures to accident.

When the day for open action arrived, the detective, who had never assumed any obligation to become a witness, was convinced by Mr. Gowen that his testimony would be necessary to secure the ends of justice. From personal acquaintance with James McParland, we know that, like the man with whom he was confidentially associated in this enterprise, he felt no fear for himself. Conspirators of a certain class are usually cowards; and he knew his men. This knowledge was fully and dramatically vindicated on the memorable day when, in a court house crowded with the friends and accomplices of the accused, Franklin B. Gowen, in full evening dress, cool and *debonair* as usual, conducted the first case of the series, and James McParland appeared on the witness stand. The revelation that the secretary of the lodge was a detective officer struck instant dismay to the criminals; but the question of the hour was, Would this end in panic and *sauve qui pent*, or would desperate men seek to remove by assassination, as they had done more than once before, the dangerous witness and the one man who, through that witness, had become the sole repository of their dark secrets?

This question was soon answered. The lawyers for the defense asked, in cross-examination concerning a meeting at which it had been testified that the accused had taken part in arranging for a murder:

"Were there other persons present than those you have named? If so, who were they?"

Mr. Gowen instantly objected, and directed the witness not to answer the question. Being asked by the court to state his reasons for this objection, he rose, turned deliberately, surveyed the crowded galleries, and then said:

"We object, because the answer to this and similar questions might defeat the ends of justice. There are others besides these prisoners—*some of whom are now present in this room*—who ought to be, but are not yet, in the hands of the officers of the law. We object to giving them the notice which may enable them to escape!"

As we have heard Mr. Gowen say, in referring to this as the most critical period of the whole enterprise, the effect was tremendous. No one dared to accuse himself by flying from the court-house. The throng remained in a sort of paralysis of panic. But at the next session there was not a Mollie Maguire in the audience. From that time on there was no danger. Even Jack Kehoe, the wealthy ringleader, who had deemed himself too strong to be attacked, was arrested, tried, condemned and sentenced, and before his execution begged for an interview with Mr. Gowen, offering to give valuable testimony as to other persons, on condition that his own life might be spared. Mr. Gowen declined to see him, and sent him word that there was evidence enough without his help.

It is strange but undeniable that, after all this, there was apparently no animosity or desire for revenge as regarded either Mr. Gowen or Mr. McParland, among the friends or the fugitive accomplices of the criminals. Both the actors in this great vindication of justice went their way thereafter, fearless and safe.

THE MACARTHUR-FORREST PROCESS FOR THE TREATMENT OF REFRACTORY GOLD ORES.

Written for the Engineering and Mining Journal, by Mr. William Jones.

This process depends upon the great chemical affinity of cyanogen for gold and silver, and the ease with which these metals form soluble double cyanides with the alkali metals. Of the common metals gold has the greatest affinity for cyanogen, and their relative affinities are as follows: First, gold; second, silver; third, copper; fourth, zinc; lead, iron, arsenic, antimony, etc., very small.

I do not propose to discuss in this paper the chemical forms in which gold exists in these so-called gold ores; suffice it to say that so great is the affinity of gold for cyanogen that I have yet failed to meet with any ore which did not on shaking up with even dilute solutions of cyanides, yield up its contents of gold almost entirely to the cyanide solution, and become dissolved as the double cyanide of gold and the alkali used.

The cyanides of the alkali and earthy metals are, practically speaking, the only soluble cyanides, the cheapest and most common being the cyanides of potassium and sodium.

The relative solvent action of these various cyanides on gold and silver compounds, and on the gold and silver compounds existing in ores, has been most carefully and thoroughly investigated by Mr. J. S. Macarthur and Drs. Forrest, who have had a staff of research chemists at work on the subject for nearly three years. It has been found that the cyanides of potassium and sodium are as active in their solvent action as any of the other soluble cyanides.

When ores containing gold, silver, copper, zinc, etc., are treated with solutions of cyanide of potassium or sodium they are dissolved more or less, forming soluble double cyanides. The solvent action on the base metals can be reduced to a minimum by reducing the strength of the solutions, the readily soluble gold and silver being easily dissolved out with only traces of copper, zinc, etc. The action of these weak cyanide solutions on the metals iron, lead, arsenic, antimony, etc., is practically nil, and the solvent action on copper or zinc much depends upon the state of chemical combination in which they exist.

Thus the hydrated oxides and carbonates of copper are more soluble than the sulphides, and the oxide of zinc more soluble than the sulphide of zinc; again the white sulphide of iron is more soluble than the yellow sulphide.

The best strengths of solutions to use in "leaching" out the gold from these so-called refractory ores depends entirely upon the nature of the ore, and it is impossible to set any hard and fast line. The strength of solutions generally used vary from one-eighth to one per cent. of cyanide of potassium.* The correct strength to use in treating any class or lot of ore may be readily determined by treating a weighed quantity of the ore with varying strengths of cyanide solutions for various periods of time in the laboratory, and analyzing the ore after treatment with the cyanide liquor, and the liquor itself as to the amount of gold which they contain and the unconsumed cyanide in the liquor, these results being compared with the original contents of gold and silver in the ores, and the original strength in cyanogen of the solution used. (A neat and rapid method of determining the gold in the cyanide liquors is to draw off a known value and evaporate it to dryness over a beaker of water in a capsule shaped out of a piece of silver-free lead foil. The lead foil capsule is then wrapped up in a ball and cupelled in the usual way. The liquor should be as free as possible from base metals. When these are present the liquor may be boiled to dryness with litharge and the solid residue fused in the usual way for its contents of gold and silver.)

The approximate strength of the solution to use is thus determined, the point aimed at being to reduce the quantity of cyanide actually consumed to a minimum with, at the same time, the highest possible percentage of extraction of the gold and silver.

The process on a large scale is carried out as follows:

The ores (without any previous roasting of sulphur should be present), ground to 40 mesh, are placed in pans or wooden vats provided with a stirrer, and to every one ton of the ore there is added about 100 gallons of water containing one-quarter, one-half or three-quarters of one per cent. of cyanide of potassium or sodium, or other percentage which experiment in the laboratory shows to be the best approximate strength to use. The whole is then stirred for four to eight hours, the length of time depending upon the nature of the ore. Some ores give better results by grinding in the pan, others require merely agitation with the liquor.

The liquor is run off, carrying with it on an average 85 per cent. of the gold contents of the ore and 80 per cent. of the silver. It is filtered, and the gold and silver in it are precipttated by passing slowly through zinc turnings, when complete precipitation of the gold and silver takes place. They attach themselves as a loose powder to the zinc, and are easily removed by shaking or stirring, the gold and silver precipitate or sludge falling to the bottom of the vessel, and is removed, dried and melted in the usual way.

The filtration of the liquor is accelerated by using a vacuum, and there is no practical difficulty about this part of the process, except in the case of ores containing a large percentage of clayey matters. Concentrates work admirably, settling and filtering with the greatest facility.

The action of the cyanide of potassium or sodium upon the metallic zinc is very trifling, exact experiments, with accurately weighed quantities of zinc subjected to the action of hundreds of gallons of liquor, having proved this, and the complete precipitation of the gold, etc., having also been carefully investigated. The precipitation by zinc is superior to electrical and other methods, and hence is adopted on the large scale.

The amount of free cyanide existing in the liquors after passing through the zinc is then determined by means of a standard solution of nitrate of silver, and the liquor is again made up to its original strength and again used.

The actual consumption of cyanide on the large scale per ton of ore necessarily varies, running from 1½ pounds to 8 pounds per ton. I am, however, of opinion it will average about 5 pounds of cyanide of potash or soda per ton. At the same time I have witnessed ores successfully treated with a consumption of only 1¾ pounds of cyanide per ton, notably a very refractory South African pyrites containing over 3 ounces of gold per ton, the gold extraction being over 90 per cent.

In order to successfully carry out the extraction of the gold from these so-called refractory ores a number of points have to be observed. If the ores contain a noted acidity, due to the presence of basic sulphates of iron etc., (especially marked in the case of disintegrated and weathered sulphides of the metals), it should be neutralized with the equivalent quantity of caustic lime, in the form of milk of lime. The exact amount of acidity can be really determined by shaking up a weighed sample of the ore with water and adding standard normal or tenth normal caustic soda solution till the point of alkalinity is attained, as determined by litmus or other indicator. The amount of lime required is then easily calculated. Some ores show as much as four per cent. of acidity in terms of soda, and such ores on treatment with cyanide solutions without previous treatment with lime, show *no* extraction of their gold contents, whereas when previously treated with lime, the greater part of the gold was easily extracted. Nearly all sulphides show more or less acidity, but when it is under one-tenth of one per cent. it may for practical purposes be neglected.

The cyanide solution used should be as free from caustic alkali ($NaHO$) (or KHO) as possible, as it is apt to form a sulphide of sodium or potassium with the sulphur of the ores, and thus prevent gold and silver going into solution. This difficulty, when it does occur, is got over by adding chloride of calcium.

The cyanide solutions are best preserved from too great exposure to the air, as a part of the cyanide is apt to be converted by oxidation into the cyanate, an extremely stable compound.

This process is admirably suited for treating iron pyrites containing gold, as no roasting is required, and to ores containing fine or "float," which yield up their gold so easily that they can be treated by merely percolating the cyanide liquor through them. Complex ores containing antimony, arsenic, etc., also yield up their gold contents with great facility. I have had a large number of American and Mexican ores tested by this process and the average extraction of the gold was 90 per cent. and 85 per cent. of the silver, the percentage of silver extracted being generally less than the gold. Works on this process are now running in New Zealand and Australia, and a plant is about to be erected at the Cape. The process owes much of its success to the skill and untiring efforts of Mr. J. S. Macarthur and Drs. Forrest, and is now the property of a strong company who have secured patents in all countries of the world.

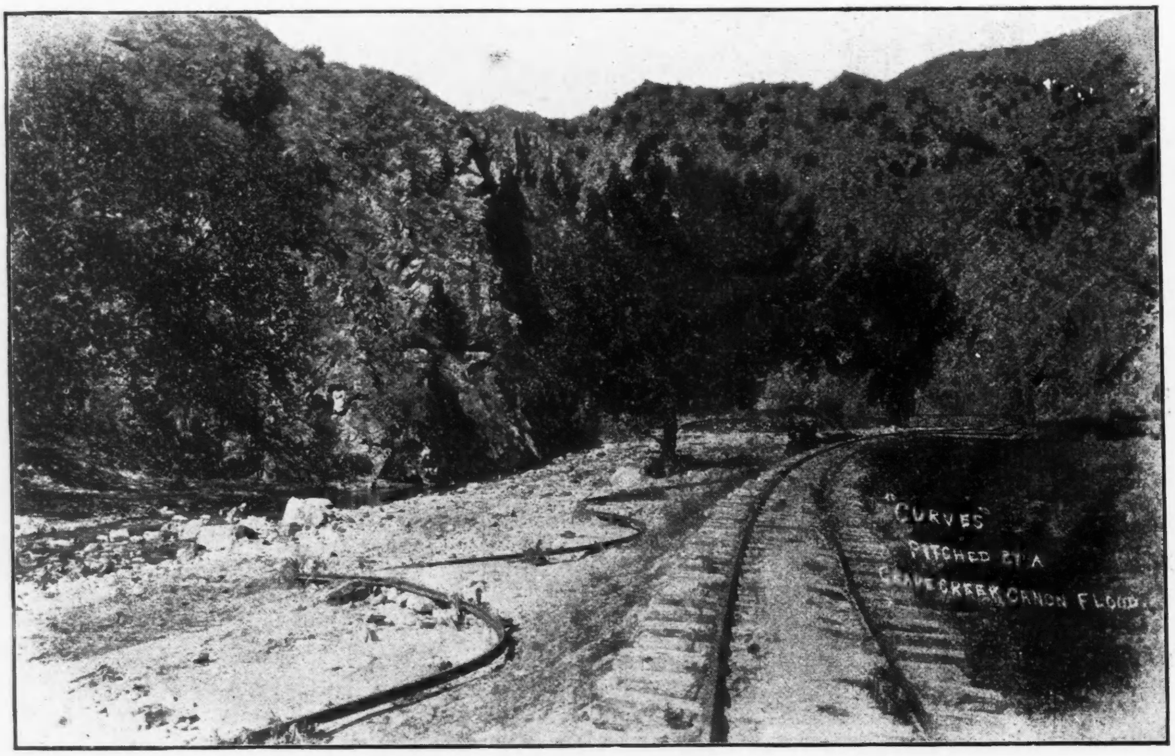
The cyanide used on the commercial scale is cyanide, or mixture of cyanides of potash and soda, made by fusing the yellow ferro-cyanide of potassium with a pure soda ash and carbon in an iron pot, at a dull red heat, till the ferro-cyanide is decomposed, as ascertained by testing a small sample with an iron salt. The liquid mass is then ladled or run into iron molds to cool, and the cooled mass forms a black brick containing 75 per cent. of cyanide of potassium and sodium. These bricks are made of a weight of about 16 pounds each. They are packed in long zinc cases, soldered up and shipped in wooden boxes to the mines or works.

The actual cost of manufacturing such a cyanide is not greater than 35 cents per pound. The above method is the old and well-known reaction.

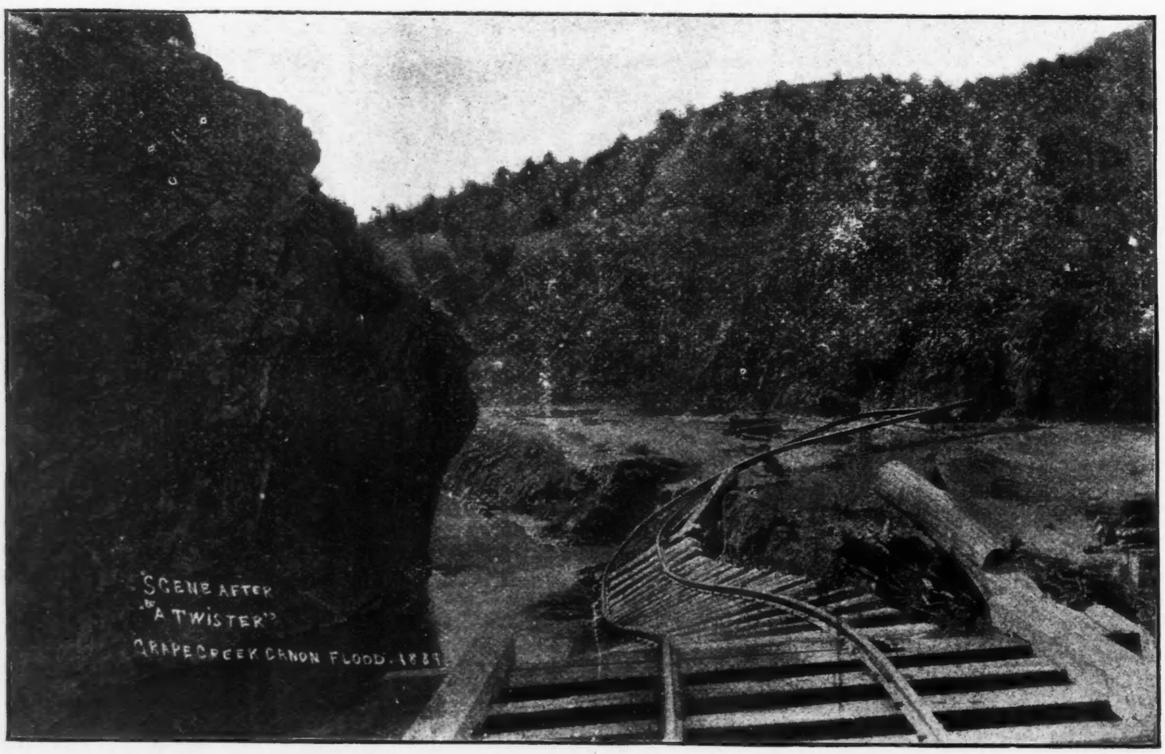
Experiments are now in progress for utilizing the reaction (proposed as early as 1845), of passing nitrogen or furnace gases (free from oxygen) over highly heated alkali and carbon, barium being preferred. From my own experience of this process, on a large scale, I hope to see the cost of the cyanide reduced to at least 20 cents per pound at an early date. I look for an early introduction of this process, on a large scale, into the United States.

* The above strength is on the basis of the cyanogen (CN) found in the sample calculated to KCN. Frequently some of the cyanogen (CN) may exist as $NaCN$.

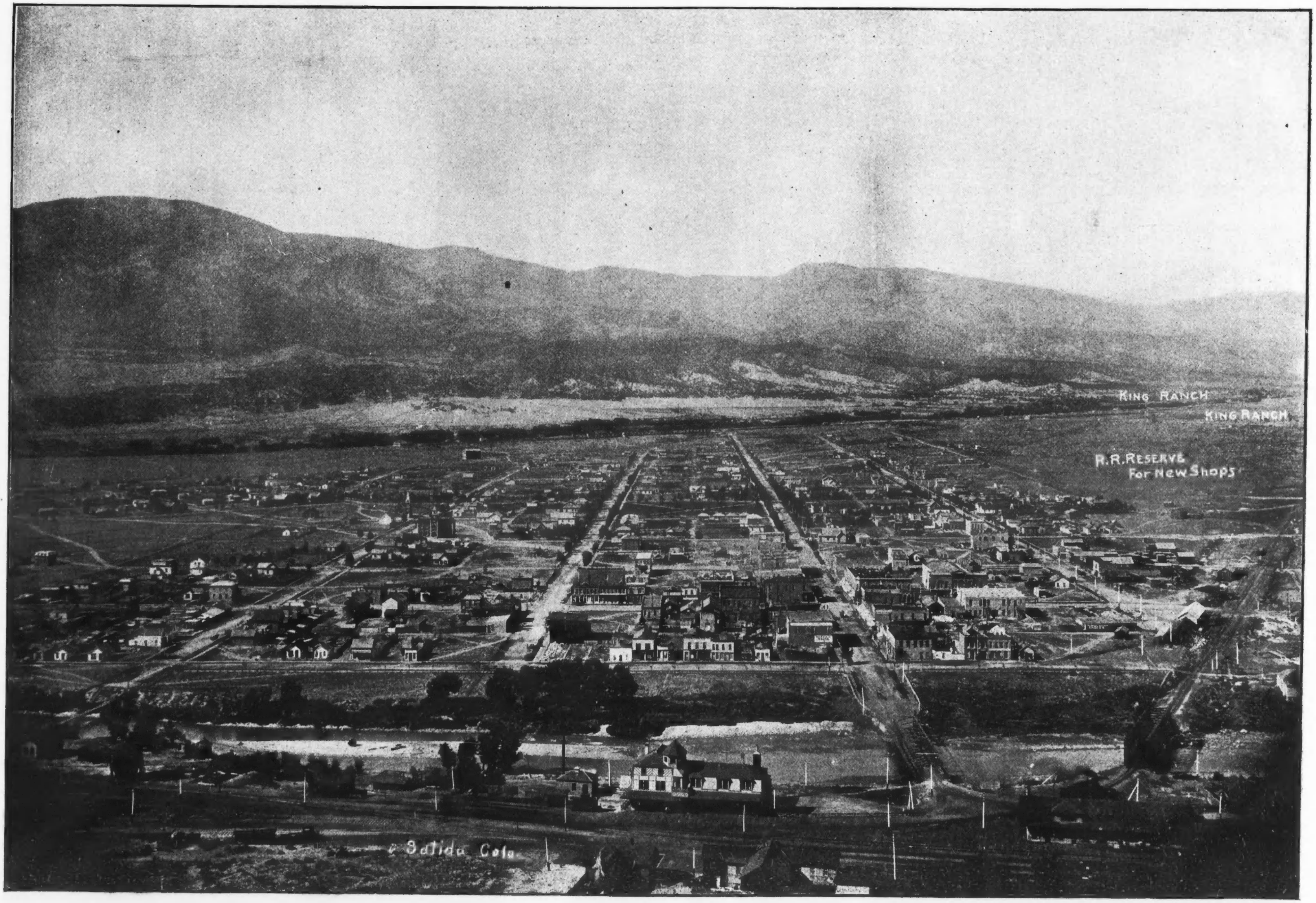
The Pulsion Mechanical Telephone.—Some interesting experiments were made with the Pulsion telephone near London, England, recently. This telephone, being independent of electric or magnetic agency, is simple in character. The invention consists of two instruments connected by an ordinary non-insulated double steel wire, the two parts being slightly intertwisted. The instrument consists of a dish in combination with a series of small spiral springs, inclosed in a case of some few inches in diameter. By this means a considerable volume of vibratory power is created. The distance to which the experiments were confined was about three and a half miles, namely, from the Finchley road station of the Midland Railway to within a few hundred yards of the statian at Hendon. The experiments were many and varied, and the strains of a musical box, conversation and whistling were heard with perfect clearness, and, without going near the instrument itself, were easily distinguished by means of hats being placed in contact with the wire. A special merit claimed for the pulsion telephone is that it conveys the actual sound of the voice and its inflections more truly than any other. At an early date the public will have an opportunity of judging of the value of the latest addition to telephone inventions.



CURVES PITCHED BY A GRAPE CREEK CANON FLOOD.



SCENE AFTER "A TWISTER," GRAPE CREEK CANON FLOOD, 1889.



SALIDA, COLORADO.

SALIDA, COLORADO.

At the end of the Grand Canon and almost at the foot of the famous Marshall Pass lies Salida, one of the many progressive and beautifully situated cities of Colorado, which we illustrate from a photograph in the supplement accompanying this number.

Salida was incorporated in 1880, and has a population of 4,500 people. Most of the buildings are of brick, very neat and substantial, lighted by electricity, and water is supplied from water works of a first-class character.

During the greater portion of the year the streets, of ample width, are kept constantly clean by the waters of the South Arkansas River, which flow in channels on each side, carrying all refuse into the swift current of the Arkansas, on the northern border of the city. All the streets are lined with trees, adding much to the beauty of the town. Clear spring water is in abundance.

Flowing directly in front of you as you step from the train is the noble Arkansas River, with a fall of 100 feet within the city limits, and consequently abundant power for manufacturing purposes.

On the other side of the city is the south fork of the Arkansas River. This extremely clear stream furnishes the city with pure cold water. A large reservoir a mile and a half above town is the base of supply for a complete system of water mains.

Salida soon became one of the most important points on the line of the Denver and Rio Grande Railroad and the most prominent town in the great Arkansas Valley. Since that time, with scarcely an interruption, the place has enjoyed prosperity, and success has crowned every enterprise.

Especial mention should be made of the progress in building during the year 1888. One hundred and twenty-three new buildings were completed and are now occupied, the greater portion of them being substantial brick and stone structures, the total amount invested in improvements alone reaching the respectable sum of $250,000. A comfortable hotel and good passenger depot add to the convenience of visitors.

A notable fact in regard to the buildings mentioned is that fully 90 per cent. of them were dwellings built and occupied by the owners, showing that Salida has a class of residents who desire to be permanently identified with the interests of the city. Among the buildings erected during the past season was a beautiful and commodious opera house, with a seating capacity of 1,000. This opera house is admitted to be second to none in the State, excepting the Tabor Grand at Denver.

MINERAL RESOURCES.

A great variety of minerals are found in large quantities in the territory tributary to Salida. Several of the Chaffee County mines are prominent among the richest and most productive mines in the entire State. There are shipped every day from this immediate vicinity 15 carloads of iron ore, 12 carloads of silver ore, three carloads of copper ore and 15 carloads of lime rock. Salida's carbonate belt embraces a strip of territory commencing about six miles southeast of the town, running in a northeasterly direction twelve to sixteen miles, and is from six to ten miles wide. The development so far made sustains the assertion that the field is full of paying mineral; and no one can make a fair examination of the ground, but will believe that this will yet prove to be one of the great silver, copper and iron producing points in Colorado. Even away from railroad the country is accessible. As is frequently the case, good roads and trails reach the heart of the region and make railroad shipments easy. Taking into consideration, however, the size of the belt and the number of good prospects, there has yet been comparatively little development work done. This is owing to the lack of capital among the present prospectors and owners, and opens up a good field for safe investments. Fifty carloads of bituminous and anthracite coal are shipped through here daily from neighboring mines. Copper ores are also found. The charcoal kilns, within a few miles, ship an average of twenty carloads per day to Salida.

Salida is not a strictly mining town, but the large and varied mineral production of the tributary districts are by no means an unimportant factor in her resources. The branch lines from this point tap the great Monarch district, which has already shipped over $10,000,000 worth of ore, the Calumet iron mine, the Sedalia copper mine, the famous Bonanza district, the newly-opened Alder Camp, and the Hot Springs iron mine, besides a large number of smaller camps and shipping claims. These various mines employ large forces of men who receive their supplies from Salida. The necessary elements for smelting are all at hand, and there is but little doubt that Salida is destined to become, sooner or later, a smelting point.

RAILROAD INTERESTS.

Salida was first started as a railroad town, and as a railroad center it is rapidly growing in importance. The Denver & Rio Grande makes Salida the terminus of six divisions—including the three main divisions of their great system. On the Gunnison branch alone 190 men are employed, all of whom make their homes in Salida. A great majority of the men on the other divisions live here. The Rio Grande company has extensive machine shops and offices in Salida, employing 150 men. Thus it is shown that fully 400 railroad employés make their headquarters here. The wages of these employés aggregate $40,000 per month, or nearly half a million dollars a year.

When the Rio Grande standard gauge short line is completed Salida will be the most important point between Salt Lake City and Denver. It will then be the headquarters for the narrow gauge system, and all freight to and from stations on the narrow gauge divisions will be transferred at this point. A location has already been selected for additional shops and yards in this city.

The railway hospital—a large and handsome brick building—is also located in Salida, and is the only one on the line of the Denver & Rio Grande Railway.

Twenty passenger trains a day leave and arrive at this station, affording facilities equaled by few cities in the West. The Denver & Rio Grande Railroad has already commenced the work of changing its main line to Salt Lake City from narrow to broad gauge, and Salida will then have a broad gauge outlet to the East.

The various attractions of this "baby" railroad of the Rockies, we do not intend to describe; they must be seen and felt before they are fully known. Only a few years ago the writer attended an "excursion" from Denver, of some twenty-six miles, that was heralded as a wonder of the times. To climb the mountains, then, was believed to be impossible. The result has been one of the grandest achievements of the age, and the opening up and developing of more mining camps than all other systems combined. It is marvelous when one adds up the amount of wealth that has been produced along the lines of the Denver & Rio Grande Railroad. Leadville, Aspen, Monarch, San Juan, Boulder, Tomitschi, Bonanza, and as many more. We illustrate one of the disadvantages the railroad sometimes labors under in developing some hitherto supposed inaccessible camp or section. The cuts represent a portion of the Silver Cliff branch that has been badly treated by a cloudburst and washout. They show the immense power that water has, when confined in one of those narrow canons, and to an engineering or mining man speak volumes for the indomitable pluck and energy of the people who overcome such obstacles, and at such a great expense accomplished so much good for the State and

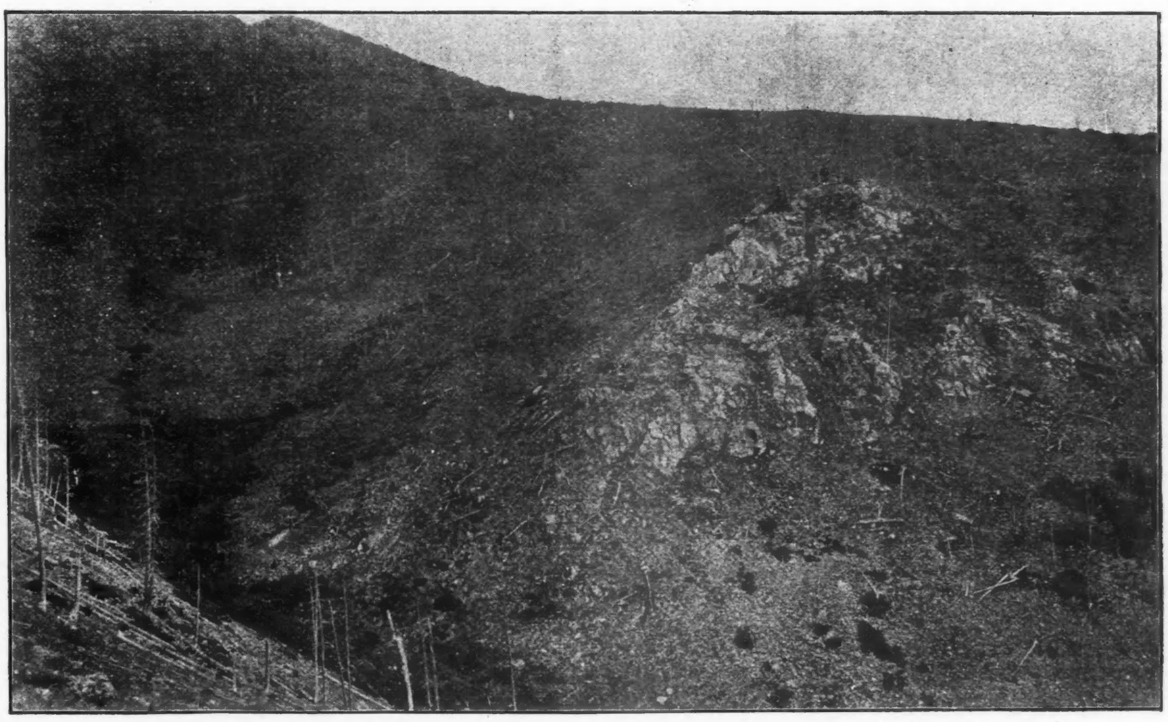


PLATE I.—CINNABAR CROPPING NEAR SILVER CLIFF.

people. Plate No. 1 represents a "cropping" of Cinnabar bearing rock lately found near the Silver Cliff branch of the Denver & Rio Grande Railroad. Preparations are being made to fully develope this apparently valuable deposit, and when work has progressed we shall give further particulars concerning it.

THE ELECTROLYSIS OF SALT.

Walther Hempel, in a recent number of the *Berichte d. deutsch. Chem. Gesellschaft*, gives a very suggestive laboratory method for obtaining crystallized carbonate of soda and chlorine gas directly from salt by electrolysis. The process is somewhat similar to one which was patented in Germany by Marx in the beginning of the year, but dispenses with the liquid diaphragms which the patentee proposed for separating the products of electrolysis. In Fig. 1 we show a section of the apparatus which the author employs, and in Fig. 2 one of the electrodes. The difficulty of finding a suitable porous diaphragm for dividing the electrolytic cell has been overcome by substituting asbestos paper for porcelain or earthenware plates, which were found to be quickly stopped by the carbonate of soda which separates from the liquid. The cathode consists of an iron plate bored with several holes sufficiently large to allow of the ready passage of gases through the plate, while the anode is similarly constructed out of a thin sheet of gas carbon. The two plates are separated by means of a sheet of asbestos paper, and are connected by wires to an ordinary Bunsen battery or small dynamo. The electrolytic cell is made on these plates by means of two porcelain rings *A A*, and thick glass plates *B B*. The apparatus is easily connected together, so as to be gas and water tight, by means of india rubber.

In the glass plate which forms the wall of the anode chamber of the cell is fitted a glass funnel-shaped tube, *C*, in which the charge of sodium chloride used in the electrolysis is introduced, and from the same chamber, through a tube, *D*, cemented to the upper part of the porcelain ring, the chlorine gas is evolved. On the cathode side of the apparatus, the porcelain ring is bored so as to admit of the tube *E*, by which carbonic acid gas is introduced into the liquid, and to allow of the removals of the crystals of carbonate of soda formed from time to time. The salt is in-

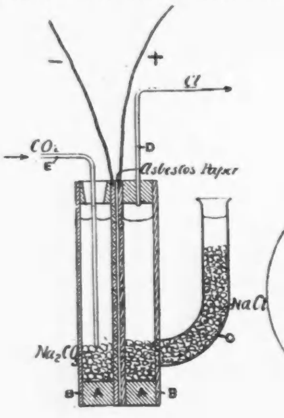


Fig. 1.

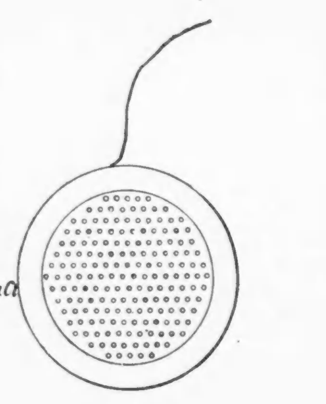


Fig. 2.

troduced into the cell in small lumps, so that the apparatus can be arranged to work continuously. Both the carbonate of soda and the chlorine gas are chemically pure. By heating the cell to the temperature of boiling water, the electrolysis proceeds at a better rate, and it will be easily seen that the apparatus can be constructed of more durable materials for use on a larger scale. The author suggests that the cathode half of the cell should be constructed entirely of iron, and other improvements will doubtless render the electrolysis of salt by this method possible on a manufacturing basis. In its present form, 3·2 volts are required to effect the decomposition of the salt, and 2·5 volts to overcome the polarization produced by the carbon plate immersed in the salt solution saturated with chlorine and the iron plate surrounded by a solution of salt saturated with soda. The total electromotive force required is therefore 5·7 volts, and when both plates are constructed of carbon the polarization was found by the author to be nearly as great. With a current of 1·73 ampères, furnished by an ordinary Bunsen battery, 0·93 gram of chlorine per hour was evolved. With a horse power equal to 680 volt-ampères, 64·5 grams of chlorine and 259·8 grams of crystallized sodium carbonate, $NA_2CO_3 10H_2O$ per horse power per hour can be obtained.—*Industries.*

PROPOSED NOMENCLATURE AND NOTATION IN PRACTICAL THERMICS.*

Written for the Engineering and Mining Journal by Dr. Henry Wurtz.

(*Concluded from page* 524.)

There are a number of other thermic constants which have received less investigation than the above, but have great prospective importance. Among these may be mentioned:

Diathermancy.
Radiating and absorbing power.
Reflective power for radiant heat.
Refractive power (of diathermanous bodies).
Vapor tensions, of solid and liquid forms.
Incipient dissociation temperatures.

As to these, it does not appear advisable to suggest any abbreviated terms at the present time.

*It is but just to Dr. Wurtz, the author of this essay on abbreviating and symbols for the literature of heat, to state that it has been in our hands, and crowded out of our columns for some four months' time. Within this time we have received accounts of recent discussions in Paris in which the use of *therm* in the same sense as by Dr. W. was urged. This is not, therefore, a case of an appropriation of an idea from others, as might be imagined in the absence of the present note.—Editors Engineering and Mining Journal.

The terms above proposed will not be found difficult to fix in the memory by most students. Each of them may be recalled by a closely related English word; thus:

No. 3, Flam, by Flame; No. 4, Ignis, by Ignite; No. 5, Tard, by Tardy, Retard; No. 6, Vert, by Convert; No. 7, Tend, by Extend; No. 8, Pand, by Expand; No. 9, Therm, by Thermometer; No. 10, Cal, by Calorimeter; No. 11, Pyr, by Pyrometer; No. 12, Fund, by Foundry; No. 13, Ferv, by Effervesce, Fervent; No. 14, Duc, by Conduct, Conduction; No. 15, Temp, by Temperature and Temporal.

Of the above fifteen terms, the first two are general and familiar; Nos. 3, 4, 5, 6 and 15 are simply constants, while the other eight are units or multiples thereof.

Two purposes may now be simultaneously served by presentation of a list that I have drawn up, of certain tabulations, scales or series appertaining to the above-named units and constants, which scales will have to be filled up, with reference to all known materials of definite natures, before thermics can approach to the condition of an exact science. One of these purposes is to show forth the meager and even skeleton-like character of our present precise thermic knowledge; the other to set forth as examples, a few of the ways in which the above new abbreviated terms may be conveniently employed and applied.

These said series or scales are as follows:

1. *A Scale of Flams*, most of which remain yet to be determined by experiment.
2. *A Scale of Ignes*, also mostly undetermined.
3. *A Scale of Tards*, for which few data exist.
4. *Scales of Verts*, of a multitude of different species, of which almost as little is known as in case of the tards. It is easy to foresee that series of *verts* will be very numerous.

Two Scales of Tends, namely:

5. A scale of tends of materials in solid forms; solid tends.
6. A scale of tends of materials in liquid forms; liquid tends.

Three Scales of Pands, namely:

7. A scale of solid pands.
8. A scale of liquid pands.
9. A scale of vapor pands.

Six Scales of Pyrs.—The pyrs may be either those of unit weights of material, which I prefer to call baropyrs (βάρος, weight, and pyr), or of unit volumes, stereopyrs (στερεός, cubic or volumic, and pyr); and each of these may pertain also to solid, liquid, and vaporous states of the material, when it is known in the three states. Thus we may have six scales:

10. A scale of solid baropyrs.
11. A scale of liquid baropyrs.
12. A scale of vapor baropyrs.
13. A scale of solid stereopyrs.
14. A scale of liquid stereopyrs.
15. A scale of vapor stereopyrs.

Of these the baropyrs only are in use by chemists, to whom, with few if any exceptions, stereopyrs will be altogether novel, not being alluded to in chemical text-books, so far as the writer is aware. There are, however, three other scales, based on equivalent weights of the materials, which are in common use by chemists. These may be called in the nomenclature here advanced equipyrs, comprising solid equipyrs, liquid equipyrs and vapor (or gas) equipyrs; In much chemical literature (in Watt's Dictionary, for example), the figures given for pyrs are equipyrs. They are really only baropyrs with a different standard or modulus—instead of one pound of water, one equivalent, or 18 pounds, being the modulus in these series; so that the equipyr is nothing more than the corresponding baropyr multiplied by 18. As to the mode of derivation of the stereopyrs, this is by multiplication of the corresponding baropyrs by the specific gravity of the material, solid, liquid, vaporous or gaseous, as it may be, at normal temperature and pressure, when it is existent at such.

In the case of vapors existent only at higher temperatures, such uniform temperature and pressure as found suitable and feasible must be adopted. Series or scales of stereopyrs, as will readily be seen, must differ altogether, as regards the relations and ratios between the individual members, from the common baropyrs, and should, whenever they shall have been thoroughly studied, lead to important scientific conclusions. Moreover, in a *practical* sense, they should be at least as important as the baropyrs. This is illustrated by the consideration that the relative fuel values of *bushels* of different fuel materials is practically more generally useful to know than those of *hundred weights* of the same.

It appears that, theoretically, the liquid baropyr should be derivable from the solid baropyr by adding thereto the fund of the solid material plus its fund-therm, the latter being taken as the difference between its fusing-point and 60 degrees F., as previously explained; while the vapor baropyr is derived from the solid baropyr by adding the same again, together with the ferv and the difference between the fund-therm and the ferv-therm. Unfortunately, there are as yet few, if any, cases of combustible materials of which the funds or fervs are known, and few of which even the fund-therms or ferv-therms can be stated with accuracy.

Two Scales of Funds; namely:

16. One scale of barofunds.
17. One scale of stereofunds.

Four Scales of Fervs; namely:

18. One scale of solid barofervs.
19. One scale of liquid barofervs.
20. One scale of solid stereofervs.
21. One scale of liquid stereofervs.

The derivation of the stereofervs from the barofervs is similar to that of the stereopyrs from the baropyrs, by multiplying into the specific gravity.

An example of these fours scales of fervs, in the case of ice and water, may be here given for illustration. In this case, as ice is non-existent at the normal temperature, we are obliged, for uniformity, to reduce all our figures to 32 degrees F. For convenience, the above order of statement is somewhat changed.

	Fahr.
The baroferv of liquid water from 32 degrees...........	= 1,147 degrees.
The baroferv of solid ice from 32 degrees	= 1,289 "
The stereoferv of liquid water from 32 degrees...........	= 1,147 "
The stereoferv of solid ice from 32 degrees...........	= 1,211 "

These figures are arrived at as follows: Regnault's expression for the latent heat of steam from water at 212 degrees, that is, for the water baroferv, at 212 degrees, is 1,091.7 — .695 (212 degrees — 32 degrees), which reduces to 967 degrees, to which addition of 212 — 32 (= 180 degrees) gives us 1,147 degrees, the first figure. The second is obtained by adding to this the fund of ice: 1,147 degrees + 142 degrees = 1,289 degrees. The two stereofervs are obtained, as has been explained, by multiplying the barofervs by the specific gravities of the materials; that of water, being unity, gives a stereoferv identical with the baroferv, while the specific gravity of ice = .918, multiplied into 1,289, gives us 1,211 degrees.

As the pyr, fund, and ferv are founded on the cal, being only multiples thereof, it may be well, before leaving them, to suggest further that the cal itself admits of two species, the ordinary cal (which is the barocal) and a *stereocal*, the latter based on the unit volume of water.

22. *One scale of ducs.*

Six scales of temps; namely :

23. One scale of solid barotemps.
24. One scale of liquid barotemps.
25. One scale of vapor barotemps.
26. One scale of solid stereotemps.
27. One scale of liquid stereotemps.
28. One scale of vapor stereotemps.

Equitemps are what are known as equivalent or atomic heats.

As remarked with reference to the stereopyrs Nos. 13, 14 and 15, the stereofervs Nos. 20 and 21 and the solid and liquid stereotemps Nos. 26 and 27 are all series which will be novel to chemists. Gas stereotemps, which come under No. 28, have, however, been considerably studied, so that some skeleton scales may probably be constructed. The materials for one of the missing scales or series here first pointed out happens to be quite large. This applies to the solid stereotemps No. 26, the study of which has already yielded to the present writer very interesting results, which he hopes to make the subject of a future special communication. The same remark made regarding the greater practical importance of the unknown stereopyrs over the known baropyrs applies even more strongly to the unknown solid stereotemps as compared with the very extensively investigated solid barotemps, and the reason is equally obvious when once the case is brought under consideration.

We have indicated above 28 distinct scales or series of figures which await completion and study in thermic science. But this is not all, as there are numerous other constants pertaining to this science which must hereafter furnish similar scales, some of which have already been mentioned.

I will conclude with the presentation of a table of the new terms which have been proposed in this paper, arranged alphabetically for convenience of reference, with definitions appended :

UNITS, TERMS AND SYMBOLS PROPOSED FOR PRACTICAL HEAT-SCIENCE.

Arranged Alphabetically.

	Terms.	Symbols.	
1	Cal. (calor.)	c.	Calorific Unit: Temperature that raises the unit-weight or unit volume of water one thermometric unit.
2	Duc. (ductus.)	d.	Rate of conduction of temperature; or time of penetration of one thermometric unit through the unit of thickness or linear extension.
3	Ferv. (fervere, to boil.)	fv.	Heat of vaporization: Total cals thereof for the unit weight or unit volume. { From the solid form, sfv. From the liquid form, lfv.
4	Fire.		General term for combustions generating temperatures above incandescence, and self-sustained.
5	Flam. (flamma.)	fm.	Maximum temperature of gaseous products of combustion with air (ascertainable as yet only by experimental determination).
6	Fund. (fundere, to pour out.)	fd.	Heat of fusion: Total cals thereof for the unit weight or unit volume.
7	Heat.	h.	General term for all manifestations and modifications.
8	Ignis. plur. Ignes.	i.	Temperature, in dry air, of ignition or kindling to fire or rapid combustion, in case of bodies generatting temperatures above incandescence.
9	Pand. (pandere, to spread.)	pd.	Fraction, proportion, or coefficient of cubic expansion, for the thermometric unit.
10	Pyr. (πῦρ, fire.)	p.	Total cals generated by the combustion of the unit weight or unit volume.
11	Tard. (tardus, slow.)	ta.	Minimum temperature to start slow combustion generating temperatures below incandescence.
12	Temp. (tempus, time.)	tp.	"Specific Heat": Temperature attained in the unit of time; or time required to attain a given temperature.
13	Tend. (tendere, to stretch.)	td.	Fraction, proportion, or coefficient of linear extension or expansion, for the thermometric unit.
14	Therm. (θέρμη, heat.)	t.	Thermometric temperature unit.
15	Vert. (vertere, to transform.)	v.	Minimum temperature to produce internal chemical transformation, within brief periods.

BOOKS RECEIVED.

In sending books for notice, will publishers, for their own sake and for that of book buyers, give the retail price? These notices do not supersede review in another page of the Journal.]

Arkansas Annual Report, Geological Survey, Vol. II. The Nezoic Geology of Southwestern Arkansas, by Robert T. Hill, Assistant Appendices. The Northern Limits of the Mesozoic Rocks in Arkansas, by O. P. Hay, Assistant Geologist. On the Manufacture of Portland Cement, by John C. Branner, State Geologist. Published by the State. 1888. Pages, 319. Illustrated.

High Tension Electric Lighting Currents.—The London correspondent of the *Electrical Review* says with reference to the Ferranti high tension currents for lighting the English metropolis : The first engine and dynamo at Deptford, of 1,250 horse power, has now, however, been running at intervals for the last two or three weeks, and has supplied light to Charing Cross and, on occasions, to some of the Grosvenor Gallery circuits. On November 18th the dynamo was run at 5,000 volts, the current converted to 2,400 at Charing Cross, then sent to the Grosvenor, connected with three of the Grosvenor circuits and converted again to 100 volts at the customers' houses. At a first trial for an hour 23 ampères were transmitted, but in a second trial an hour afterward 43 ampères were transmitted, corresponding at 72 ten candle-power lamps to ampère, at 2,400 volts to about 3,000 ten candle-power lamps. There was no trouble with the insulation, which has been tried to an equivalent of 40,000 volts with an induction machine before running. I learn that Fowler Waring cables have been substituted for the Ferranti conductors between Deptford and London.

Quarrying in India.—There is in India a cast of people known as wudders, who may be described in general terms as the navvies of India. They are of two classes—those who work in stone and those skilled in the manipulation of earth. The stone wudder is a hardy, sinewy fellow, whose stock-in-trade consists of a house which, when on his travels, he transports on the back of his donkey, or else on the head of his wife (no remarkable instance of tyranny, since it consists of nothing but a mat and a few bamboo stays); then he has a heavy crowbar, a few iron wedges, some earthen pots, a dog, and a small stock of rice. Arrived at his quarry, his first care is to lay in a stock of firewood, which he cuts in the jungle, and removes by means of peculiar bandy or cart with low wheels of solid timber, drawn by a pair of buffaloes—an important part of his equipment which I omitted to include before in the list. The wood is piled in small quantities on the surface of the rock, and ignited usually during the night, their favorite time for work. After the fire has been steadily kept up for some hours, the upper layer of the rock expands sufficiently to produce a separation from the substratum. The separation is accompanied by a dull bursting sound, and the extent of the severance is ascertained by a series of taps with the crowbar, the response of which is conclusive to a practiced ear. The next operation is to break up this loosened bed of rock into fragments of a size convenient for handling, and this is effected by means of a round boulder of greenstone, as large as can be lifted to his head with the assistance of another man. This he dashes down with all his might on the rock, and sometimes succeeds in making a fracture with a single throw; but it often requires to be repeated many times; and it is wonderful, considering the clumsiness of the method, with what success he turns out handsome square blocks of stone, of dimensions well suited for building. This, however, is more to be attributed to the natural tendency of the stone to square fracture, than to the skill of the wudder.

PATENTS GRANTED BY THE UNITED STATES PATENT-OFFICE.

The following is a list of the patents relating to mining, metallurgy, and kindred subjects, issued by the United States Patent-Office.

ISSUED DECEMBER 17TH, 1889.

417,236. Apparatus for use in Leveling. Auguste E. D. F. De Villepigue, Paris, France.
417,239. Dumping-Car. Edward E. Dwight, Toledo, O.
417,245. Instrument for Recording Differences of Pressure. Clemens Herschel, Holyoke, Mass.
417,246. Car-Brake. Henry S. Hopper, Detroit, Mich.
417,283. Rail-Supporting Bar for Street Railways. John D. Reed, Boston, Mass.
417,287. Process of Making Bleaching Powder. Ernest Solvay, Brussels, Belgium, Assignor to the Solvay Process Company, Syracuse, N. Y.
417,288. Process of Building Tunnels or Shafts. Chas. Sooysmith, and Edward L. Abbot, New York, N. Y.
417,291. Car-Coupling. Robert H. Stapp, Woodward, Cherokee Cutlet, Ind. Ter.
417,302. Hydrocarbon Burner. John Wilson, New York, and Allan Mason, Brooklyn, Assignors to Herbert H. Sanderson, trustee, New York, N. Y.
417,314. Apparatus for Separating Lead and Base Bullion from Slag, Mattes and Speiss. Walter B. Devereux, Glenwood Springs, Colo.
417,315. Apparatus for Separating Lead and Base Bullion from Slag. Walter B. Devereux, Glenwood Springs, Colo.
417,323. Tube Expander. William D. John, Scranton, Pa.
417,338. Method of Operating Electric Railways. Elias E. Ries, Baltimore, Md., Assignor by direct and mesne assignments to Ries & Henderson, same place.
417,339. Irrigating Apparatus. Joseph Rist and Andrew F. Clubine, Kansas City, Mo.
417,340. Journal-Bearing. William S. Scales, Everett, Assignor of two-thirds to George G. Frost, trustee, Newton and Joseph H. Clark, East Weymouth, Mass.
417,342. Process of Burning Hydrocarbons. Jacob Schinneler, Pittsburg, Pa.
417,347. Car-Coupling. James Timms, Columbus, O.
417,352. Well-Boring Machine. Grove S. Bartholomew, Garvanza, Cal.
417,362. Artificial Fuel. John Morris, London, England
417,387. Motor for Pump. Horace F. Hodges, Boston, Mass.
417,394. Car-Brake. Edgar Peckham, New York, Assignor to the Peckham Car Wheel Company, Syracuse, N. Y.
417,409. Roller-Mill Adjustment. Perley T. Couch, Philadelphia, Pa., Assignor of one-half to Thompson & Campbell, same place.
417,426. Railway-Rail Tie. Richard Jones, Houston, Tex.
417,429. Manufacture of Explosives. Wilbraham E. Liardet, Cambria, New South Wales.
417,434. White Lead. Julius F. F. F. Lowe, Frankfort-on-the-Main, Germany.
417,448. Air on Steam Brake. Friedrich Schemann, Philadelphia, Pa., Assignor of one-half to Samuel M. Hyneman, same place.
417,457. Hydrocarbon-Burner. William Wilson, Chicago, Ill.
417,476. Dry Ore Concentrator. Miles B. Dodge, San Francisco, Cal.
417,482. Air-Compressor. Samuel Guthrie, San Francisco, Cal.
417,484. Rolling-Mill. Patrick F. Hanley, Homestead, Pa.
417,485. Composition for Welding Steel. Anthony J. Hindmeyer, Philadelphia, Pa.
417,493. Pneumatic Engine. Henry W. Metzing, New York, N. Y.
417,499. Railway Rail Brace. Lewis McElroy, De Kalb, Assignor of one-half to Edward P. Edwards, Sterling, Ill.
417,508. Sectional Boiler. Joseph H. Ricker, Lock Haven, Pa.
417,515. Governor for Steam Engines. James A. Seymour, Auburn, N. Y.
417,553. Machine for Bending Pipe. Herbert E. Fowler, New Haven, Conn., Assignor to the United States Pipe Bending and Coiling Company, Chicago, Ill.
417,577. Explosive Compound. John F. A. Mumm, Dayton, Ky.
417,622. Apparatus for reducing Metal to Powder. Richard Yeilding, Detroit, Mich.
417,634. Process of Manufacturing Cement. George Duryee, Orange, N. J.
417,646. Boiler-Tube Cleaner. Sylvanus Kelly, Fremont, O.
417,654. System of Electrical Distribution of Currents. Charles J. Van Depoele, Lynn, Mass.
417,688. Conduit for Electrical Conductors. James Tatham, Philadelphia, Pa., Assignor of one-half to Henry B. Tatham, same place.
417,691. Process of Reducing Unsmelted Ore. Jacob T. Wainwright, Pittsburg, Pa.

PERSONALS.

We desire the present address of Mr. Enoch Kenyon, mining engineer, who was at Yuscaran, Honduras, in 1886 and 1887. We shall feel obliged to any of our readers who will send us this information.

Mr. W. F. Gresley, mining engineer, has gone to Spring Valley, Ill., for the purpose of inspecting the large coal mines of the Hon. Wm. L. Scott, with a view of introducing his improved longwall system of mining.

Mr. Jesse L. Eddy will retire from the Utica Agency of the Delaware & Hudson Canal Company on December 31st, and will be succeeded by Mr. Edward J. Millspaugh, who has been connected with the Utica office for several years.

Mr. William S. Jacques, whose resignation as president of the New Central Coal Company, of Maryland, was announced in the ENGINEERING AND MINING JOURNAL last week, has opened an office for himself in the Washington building, Room 200, No. 1 Broadway, New York City. Mr. Jacques' long and valuable experience in the coal trade would seem to guarantee a prosperous future for him as an individual operator.

Calvin Pardee, the well-known coal and iron miner of Hazleton, Pa., who recently bought a tract of 200 acres at Perth Amboy, is about to establish on it an extensive factory for the manufacture of terra cotta, brick, etc., and the work of erecting the buildings has begun. They will be built on the bank of the Raritan River, and will also be reached by a spur from the Lehigh Valley Railroad, which crosses the northern part of the property.

Mr. H. A. Van Tassel has become a member of the Consolidated Stock and Petroleum Exchange, and proposes to take an active interest in mining speculations. Mr. Van Tassel for a number of years occupied an official position at the Atlantic copper mine in Michigan, and is therefore familiar with the prospects of the various copper mining stocks, which he hopes will hereafter be more largely dealt in in this market. Mr. Van Tassel was introduced as a member by Mr. John Stanton, of the Allouez, Atlantic, and Central mining companies, and one of the founders of the Consolidated Exchange.

The fifty-sixth meeting of the American Institute of Mining Engineers (being the annual meeting) will be held at Washington, D. C., beginning on Tuesday evening, February 18th, 1890. At one of the sessions of this meeting, the manufacture, properties and uses of aluminum will be specially considered. Papers in this connection from Messrs. A. E. Hunt, F. P. Dewey and W. J. Keep have been already announced, and others of suitable character will be welcome. Opportunity will also be given for the discussion of Mr. Keep's paper on "Aluminum in Cast Iron," read by title at the Ottawa meeting, and recently distributed. Written communications from members interested in the subject, but unable to be present at the meeting, are invited.

Mr. W. C. Price has resigned from the superintendency of the following mines of Tuscarora District, Nevada: Navajo, Belle Isle, North Belle Isle, North Commonwealth and Del Monte. At a meeting of the directors, held in San Francisco last week, the resignation was accepted, and votes of thanks were given to Mr. Price for his past services. R. M. Catlin, formerly assistant superintendent and civil engineer, connected with these mines, will be appointed superintendent of the Belle Isle, North Belle Isle and Navajo. F. F. Coffin will be appointed superintendent of the North Commonwealth and Del Monte. Mr. Price has been prominently identified with the Tuscarora district, both as a superintendent, shareholder and mine owner, since 1881. When he went there all the mines except the Navajo were closed down. He has resigned, it is stated, because he needs rest and a vacation, but says he will retain large interests in several of the mines.

OBITUARY.

Henry D. Harvey, President of the Merchants' Shot Tower Company, in Baltimore, died this week in the 77th year of his age.

Dispatches from El Paso, Tex., dated the 18th inst., state that Captain Webster, superintendent of the La Blanca Mine, near Pachuca, Mex., was waylaid and stabbed to death in the Santa Gertrudis Cañon on the 17th inst.

Dr. Quesneville, the French chemist, died on November 14th, at the age of 80. He took his degree of doctor of medicine in 1834, having studied chemistry under Chevreul. In 1840 he started the *Revue Scientifique*, a monthly periodical, which he afterward called the *Moniteur Scientifique*. This periodical came to an end in October last, Dr. Quesneville explaining that the task was rendered too severe by the infirmities of old age.

INDUSTRIAL NOTES.

The Pittsburg Metallurgy Company has been formed for the manufacture and sale of specimens for metallurgical operations. The capital stock is $10,000, divided into 100 shares at $100 each. The directors are H. H. Byram, John A. Wilson, J. G. Siebeneck, A. J. Lennox and W. C. Magee.

The Schoen Manufacturing Company, of Philadelphia, Pa., engaged in the manufacture of pressed steel articles for railroad equipment, is reported to have decided to move its plant to Pittsburg, Pa., where iron buildings for it are in course of erection. The new works, it is stated, will be furnished with a complete hydraulic system, and are expected to turn out about fifty tons of the manufactured product daily. The capital stock of the company has been increased to $300,000. C. T. Schoen, of Philadelphia, is president, and Henry W. Oliver, of Pittsburg, vice-president.

The Jackson Wheel Company, of Jackson, Mich., has been merged into an organization composed of six of the largest wheel establishments in the country, consisting of the Sandusky Wheel Company, Sandusky, O.; Keyes Wheel Company, Terre Haute, Ind.; N. G. Olds Wheel Company, Fort Wayne, Ind.; Woodburn & Sannen Wheel Company, Indianapolis, Ind.; Wapakoneta Wheel Company, Wapakoneta, O., and the Hopper Bros. and Garlington Company, of West Chester, Pa. The new company will be known as the American Wheel Company, and its main offices will be in Chicago.

We are advised by the Pittsburg Steel Casting Company, of Pittsburg, Pa., that it is about to make an extensive addition to its equipment. Work will begin at once on a Bessemer steel plant in connection with its foundry, so that Bessemer steel castings can be made up to 16,000 pounds in weight. An 8-ton converter will be erected, and the new plant will probably be in operation early in April. The increased activity in the iron and steel business, and the large demand for heavy castings has made the addition absolutely necessary, as the company now has all the work on hand which it can handle with its present capacity. One of the principal products of the new department will be heavy steel rolls.

The producers made by the Taylor Gas Producer Company, of Philadelphia, have been used by the Lehigh Zinc Company on a spelter furnace for the past six months with such excellent results that they are now preparing to enlarge the plant and use them on other furnaces. The Bethlehem Iron Company have eight in use and two more building. One is being erected at Steelton, Pa., for the Pennsylvania Steel Company, and a plant of six large producers is nearly ready for shipment to Bolivia, South America, for the Huanchaca Company, which is the great gold and silver mining company of South America. The company is also erecting producers in the neighborhood of Pittsburg and in Alabama, California and other places.

It is reported from Cleveland, via Chicago, that the Globe Iron Works company, of the former city, the most extensive steel shipbuilders on the Lakes, "have joined hands" with the Illinois Steel Company in the organization of a company to construct steel ships in Chicago. The new corporation will be known as the Chicago Ship-building Company, and six big steel steamers will be on the stocks in its yards within a few months. The yard will be located on the east side of the Calumet River in South Chicago. The following are the directors of the company: M. A. Hanna, H. M. Hanna, John F. Pankhurst, and Luther Allen, of Cleveland, and W. L. Brown, Robert Forsyth, and W. I. Babcock, of Chicago. The officers are: John F. Pankhurst, president; Luther Allen, vice-president and treasurer; and W. I. Babcock, manager.

CONTRACTING NOTES.

There was but one bid received at the Navy Department on Monday last for the 661 tons of protective deck plating for the battle ship Texas, that of the Linden Steel Company, Pittsburg, Pa., at $102,164.16 for the whole amount.

MACHINERY AND SUPPLIES WANTED AT HOME AND ABROAD.

If any one wanting Machinery or Supplies of any kind will notify the "Engineering and Mining Journal" of what he needs, his "Want" will be published in this column.

Any manufacturer or dealer wishing to communicate with the parties whose wants are given in this column can obtain their addresses from this office.

No charge will be made for these services.

We also offer our services to foreign correspondents who desire to purchase American goods, and shall be pleased to furnish them information concerning American goods of any kind, and forward them catalogues and discounts of manufacturers in each line, thus enabling the purchaser to select the most suitable articles before ordering.

These services are rendered gratuitously in the interest of the subscribers and advertisers; the proprietors of the "Engineering and Mining Journal" are not brokers or exporters, nor have they any pecuniary interest in buying or selling goods of any kind.

GOODS WANTED AT HOME.

433. Corn mill, 32-inch, old style. Alabama.

434. Small farm grist mill that will make the very best meal. South Carolina.

435. Prices and illustrations of railroad rolling stock and iron. South Carolina.

436. Corliss engine. North Carolina.

437. Electric light plant; 100 incandescent lights. North Carolina.

438. A complete ten-stamp mill. Georgia.

439. Engines. Hoisting engine, single drum, two cylinders, capacity, 1,500 lbs., 250 feet a minute, shaft 400 feet deep; also a 40 H. P. engine. Georgia.

440. Boiler, 50 or 60 H. P. Georgia.

441. Pump to raise 100 gallons a minute, 200 feet vertical. Tank pump, 100 gallons a minute, 40 feet. Georgia.

442. Silver-plated copper plates. Georgia.

443. Railway material. Second-hand dummy locomotive, standard gauge; two second-hand dummy passenger cars; one second-hand flat car, six miles second-hand steel rails. Tennessee.

444. Wire tramway, for conveying ore from mine to mill, one mile distant. Arizona.

445. A resaw. Tennessee.

446. Wood-working machinery. Flooring machine that works four sides; a surfacer that works 26 inches wide and six inches thick; one 24-inch resaw; 36-inch band saw; mortising machine, for blind stiles. North Carolina.

447. Hammer-handle and spoke machine, second-hand, in good order. Connecticut.

448. A core drill that can be operated by hand power. Idaho.

451. Electric light plant. Texas.

452. Engine 65 H. P. and a steel boiler 100 H. P. Alabama.

453. Heater and purifier of capacity of two engines, one 65 H. P. and the other 85 H. P. Alabama.

454. Marine engine and boiler; shafting and belting. Florida.

455. Pump. Florida.

456. Outfit for manufacturing rubber name stamps. Georgia.

457. Five-ton ice plant. Texas.

458. Boiler. Texas.

459. Pump, 3-inch stroke, 2½-inch discharge. Texas.

460. Tools. Two lathes, 12-inch and 24-inch swing; 28-inch drill press; 24-inch shaper. Texas.

461. Corliss engine, 40 H. P., or double compound. State price and amount of coal per horse power. Maryland.

462. Tools. Full line for foundry, machine shop, and blacksmith and boiler shop. Georgia.

463. Rock and ore crusher, with a capacity of two tons per hour, in blue limestone, containing zinc blende, to nine mesh, or about the size of peas. Arkansas.

464. Five-stamp pony battery. New York.

465. Pipe. Six hundred feet 2½-inch iron pipe. Texas.

466. Rollers, shaftings, pulleys, belts, etc., for roller flour mill; capacity, 30 bbls. per dry. West Virginia.

467. Engine and boiler of about 3 or 4 H. P.

468. Moss picker; one that will pick wool, hair, excelsior, jute, or any kind of bedding material. South Carolina.

AMERICAN GOODS WANTED ABROAD.

393. Information about nail-making machines, with estimates and cuts of same. Turkey.

415. Brick pressing machine, which presses the brick in such a way as to save further artificial or natural drying before burning them. Germany.

423. Spades and shovels. Queensland.

424. Cypress moss. Nos. 1, 2, 3 and 4, dyed and undyed, packed in 400-lb. bales. Queensland.

425. Refrigerators, in large lots, for an ice company to lend out to customers. Queensland.

426. Tram car parts for 500 cars. Wheels, axles, springs, window fasteners and catchers for the same. Decorated material for roof of railway cars. Decorated panels for tram cars. Queensland.

427. Well boring machinery. Queensland.

428. Hardware specialties and patented goods. New South Wales.

429. Hams, provisions, food stuffs, etc. West Indies.

430. Paints in small packages, ¼ and ½-lb. cans for household use. West Indies.

431. Agency for American goods patented in the colonies; hardware, machinery and mills, more particularly. New Zealand.

432. Refrigerators of good quality. Queensland.

449. Dry lubricant for the journals of the bearing rolls of a revolving calcining furnace. The journals are 6 inches × 3¾ inches, resting in half brass; the movement is a very slow one, only about 1¼ revolutions a minute. South Australia.

450. Turning lathe with bed long enough to turn a stick of timber 30 inches long; also a frame for circular saws, one rip saw and one cross-cut saw, each 10 inches in diameter. West Africa.

GENERAL MINING NEWS.

TENNESSEE COAL, IRON, AND RAILROAD COMPANY.—Official reports for November shows that the coal received directly from the mines, Tracy City Division, amounted to 14,542 tons of coal and 10,943 tons of coke, a total for the eleven months of 1889 of 156,350 tons of coal and 115,727 tons of coke. The Tracy City division of the company mined during the month 33,504 tons of coal, and for the year to December 1st 364,455 tons of coal.

ARIZONA.

YAVAPAI COUNTY.

ROBERTS.—The sale of this mine, in Castle Creek, near Prescott, for $40,000 is reported. The purchaser. it is stated, will at once purchase or lease a mill near the mine and develop their property.

CALIFORNIA.

JULIAN GOLD MINING AND MILLING COMPANY.—Articles of incorporation of this company have been filed at East St. Louis, Ill., for mining and milling in California. The capital stock is $6,000,000. The incorporators are Charles Wiesler, Byron Obear, David C. Kling and others.

AMADOR COUNTY.

PLYMOUTH CONSOLIDATED MINING COMPANY.—In conversation with a representative of the ENGINEERING AND MINING JOURNAL this week, Mr. Warner Van Norden, the president of this company, stated that development work in the mine was progressing steadily, but no new features of interest have developed. The No. 2 south drift, according to advices received from the superintendent under date of December 8th, is now in 615 feet. The drift, it will be remembered, runs into the Indiana ground, and is being extended from the Pacific shaft. The No. 3 north tunnel which is being extended from the same shaft is now in 165 feet. In this tunnel there is stated to be quite a body of ore, but as the mill is not running at present, it has not been determined whether or not this ore would pay for extraction.

SUTTER CREEK GOLD MINING COMPANY.—The superintendent telegraphs to the New York office that five more stamps were started on the 16th inst., making ten stamps that are now in operation at the company's mill.

NEVADA COUNTY.

BRUNSWICK GOLD MINING COMPANY.—The following circular has been issued to stockholders: "There having been certain judgments entered against this company in the Superior Court of Nevada County, California, aggregating upward of $24,000, including court and other costs, the assignee of said judgments now demands their satisfaction, and in the event of non-compliance threatens execution and sale, and there being no funds in hand with which to effect their liquidation, it is deemed important that a plan be devised whereby the mining property may be saved to the stockholders; and as under the present organization of the company it is impossible to levy a forced assessment for the purpose of paying the debts or the working of the company's mine, therefore it is thought advisable (the consent of the assignee of the judgments having been obtained), and to avoid the unnecessary and heavy expenses attendant on a sheriff's sale, that a new company be organized under the laws of the State of California, in which State the property is situated, with a capital of 500,000 shares of the par value of $1 each (which is a three-quarter lower capital than the present company of $2,000,000, although the number of shares exceeds by 100,000), and of which total number of new shares the assignee of the judgments has agreed to and will accept 100,000 shares in full satisfaction of all claims and demands, and will transfer to the new company all of his right, title and interest in and to the judgments so held by him. And of the remaining 400,000 shares of the stock of the new company it is proposed to exchange share for share for present stock through Mr. H. R. Lounsbery, No. 57 Broadway, New York, who has consented to act as trustee for this company, and to whom all stock must be delivered on or before February 1st, 1890, in order to participate in this plan, taking his receipt therefor, and also pay unto him a voluntary assessment of 5 cents per share on their present holdings, which are to be exchanged for new stock, and shall also deposit with Mr. H. R. Lounsbery all of their holdings of stock for the term of six months from February 1st, 1890, in pool for the purpose of creating a better market value for their stock and to avoid the throwing on the market of large blocks of stock and thus depreciating its value.

A failure to surrender all stock of the present company, and payment of assessment and pooling as above mentioned within the time specified, will result in the loss of all value which the stock of this company may represent, through forced sale of the property to satisfy aforesaid judgments. The voluntary assessment to be used for the purpose of further sinking the main shaft, opening up new drifts and otherwise developing the mine, and adding water power and concentrators to the 20-stamp mill no w on the property.

Therefore, under all the above circumstances, we deem it important to call your attention to the great prospective value of your property, and to its location among the many gold producers of California, and which by careful and judicious expenditure of perhaps a very trifling amount of money may soon be worth many times its par value. At the present time the Idaho mine, which lies but 1,400 feet from the westerly line of your property, is reported to have at least a 5 years supply of ore in sight of a value of $20 per ton, the owners of which are now adding new improved milling facilities to their present plant, so as to give this new bullion to the world. Quite a number of other mines, which have been lying idle for lack of capital or on account of expensive cost of extraction by steam, are now starting up, having introduced water power, with which the Brunswick is now equipped, all tending to make Grass Valley District the booming gold district of California. Signed, J. J. Halpin, president; J. Clem't Uhler, secretary. Office room 24, 39 Broadway.

As the above statement of reorganization was not quite explicit enough, the ENGINEERING AND MINING JOURNAL addressed the following questions to Mr. Lounsbery, who has furnished the answers given herewith. The scheme now appears satisfactory and worthy of confidence.

With regard to the third question, Mr. Lounsbery informs us that while all the stock of the company will be placed in his hands until August, 1890, only the judgment holders' stock will be traded in.—EDITOR ENGINEERING AND MINING JOURNAL.

1. Are the judgment holders to receive $100,000 (shares) full paid, or assessable, and if assessable, how much paid up in full satisfaction of all claims against the company?

2. If all the present stockholders do *not* come in and pay the assessment on the new stock (five cents a share) does the lapsed stock go into the treasury of the company, or does it go to the judgment holders? and if to these, then is it "full paid" or assessable, and if assessable, how much is paid upon it?

3. Is the judgment holders stock to go into the pool also? and are all sales of stock to be for common account of all the stockholders?

ANSWERS.—1. The judgment holders to receive the entire capital stock of a new company to be organized under the laws of California for their judgments against the present company, at the rate of $25,000, or five cents per share paid (still leaving 95 cents per share assessable).

2. The holders of the entire capital stock of the new company agree to exchange share for share of the old for the new on the payment by the old of five cents, and the money received from the voluntary assessment on the old, less expenses, to be donated to the new company for the development of its property. All lapsed stock goes to judgment holders.

3. The entire capital stock of the new company is to be deposited with me until August 1st, 1890.

(Signed) H. R. LOUNSBERY.

NEW YORK, December 20th, 1889.

SAN BERNARDINO COUNTY.

WATERLOO MINING COMPANY.—This company, on December 7th, filed a suit in the United States Circuit Court of California, at Los Angeles, against John S. Doe, a San Francisco capitalist, asking damages, according to reports, of $2,000,000. In the petition the company set up that they own a ledge in the Calico Mining District, in San Bernardino County, from which defendant has been taking mineral since February 11th, 1889.

COLORADO.

BOULDER COUNTY.

CARL GARDNER.—This mine on Left Hand Creek, which was located by B. G. Strock last March, has been sold, it is reported, to W. L. Seeley & Co. for $22,000.

CHAFFEE COUNTY.

SILENT FRIEND MINING COMPANY.—This property, which is located in the Monarch mining district, will be listed on the Denver exchange shortly. The owners are E. R. Holden, Richard Cline and John L. McNeil, president of the State national bank. It is capitalized at $500,000.

A report that was made several months ago by A. F. Wuensch, mining engineer, upon the district and property, says in substance: This group of mining claims is situated on the southeast slope of the Lime mountain, about half a mile from the Madonna mine. The distance to the Rio Grande track is a mile, and ore is moved from the bins to the cars at $1 a ton. The property consists of three claims, the Silent Friend, B. & O. and Surprise, covering eighteen acres. This territory covers the outcrop of the vein and the underlying ore. The vein at the outcrop is an interstratified ore body. In the vein or zone near the outcrop, disclosed by a tunnel, was found two distinct ore channels. The strongest had a maximum width of 40 feet and a thickness of 2 to 12 feet. After following these 300 feet at 25 degrees dip a fold was uncovered. A tunnel was driven from the side of the mountain 300 feet beneath and to the northwest of the original workings, and this at 212 feet encountered the fold in the vein. An incline was then driven for 77 feet, when the ore body suddenly left the stratification of the limestone and descended perpendicularly. A winze was sunk on the fissure from the foot of the incline, 168 feet deep. The ore body at the top of the winze was 2 feet wide. At 25 feet it widened to 6 feet and at 58 feet 22 feet, with 12 feet 6 feet from the bottom. The ore consists of galena, carbonate of lead and oxide of iron, and the only cost in connection with its reduction is transportation, about $3 per ton. Mr. Wuensch placed the ore in sight at $145,000.

GILPIN COUNTY.

CASHIER MINING COMPANY.—The ENGINEERING AND MINING JOURNAL has received advance proofs of the following circular which will be issued to stockholders of this company: "On August 24th, 1889, the property of the Cashier Mining Company was sold under foreclosure. Its bondholders were the purchasers of the property at the foreclosure sale, and have recently incorporated a company under the laws of the State of Kentucky, with a capital of $600,000, divided into 600,000 shares, of the par value of $1 each. The corporate name of said company is the "Brooklyn Mining Company," and has issued its entire capital stock in the purchase of all the property, real and personal, formerly owned by the Cashier Mining Company. In view of these facts, the Board of Directors of the Brooklyn Mining Company has empowered its president and secretary to issue out of its treasury stock, which is full paid and unassessable, to the holders of the stock of the Cashier Mining Company an equivalent amount of stock of the Brooklyn Mining Company, upon the surrender to the Brooklyn Mining Company, of such stock and the payment of an assessment thereon of seven cents per share. Upon the basis of an assessment of seven cents per share, a working capital can be secured of from $40,000 to $45,000, and thus the new company will be assured of success, as all of the principal stockholders of the Cashier Mining Company have expressed their willingness to exchange their stock for the Brooklyn Mining Company, upon the terms proposed. The following is a brief statement in the relation to the present and future condition of the property: depth of main shaft, 350 feet; depth of east shaft, 120 feet. Levels have been run from these shafts over 700 feet. Since operations were commenced, some $45,000 have been expended in the development of the property. This company is advised that there is no mine on the mining belt, in which the Cashier is located, that has not proved capable of paying dividends after sinking a depth of 450 feet, and the conviction is only reasonable that the Cashier will also be upon a dividend-paying basis after its shaft shall have been sunk to that depth. When the mine was shut down, for the want of capital, the company was running into ore of very high grade. The present organization, however, will have abundance of capital to demonstrate to its stockholders the great value of the Cashier mine. The books for receiving assessments will be opened at the office of the Brooklyn Mining Company, No. 35 Pine street, New York City, on December 14th, 1889, at 10 o'clock A. M., and closed on February 14th, 1890, at 3 P. M. The stock of the Cashier Mining Company must accompany the assessment in every case. After February 14th, 1890, the privilege of exchanging the Cashier stock for the stock of the Brooklyn Mining Company on the terms offered will cease.

BROOKLYN MINING COMPANY,
By H. G. Romaine, Secretary.

The officers of the Brooklyn Mining Company are, R. H. Parker, president; S. M. Hibbard, vice-president; S. W. Curtis, treasurer; H. G. Romaine, secretary. The Board of Directors is composed as follows: S. B. French, R. H. Parks, S. M. Hibbard, T. L. Mathez, Jr., S. W. Curtis.

LAKE COUNTY.

MORNING STAR MINING COMPANY.—This company has given a lease to John F. Campion, *et al.*, of all its ground situated west of the Carbonate Hill fault.

PITKIN COUNTY.

(From our Special Correspondent.)

The ore shipments for the week ending December 6th were 1,573 tons, an increase of 265 tons over last week. For the month of January, 7,321 tons; for February, 8,867; March, 9,862; April, 8,848; May, 14,859; June, 13,885; July, 9,495; August, 12,998; September, 11,269; October, 6,955; November, 5,866 tons; total, 119,225 tons for eleven months, averaging $55 per ton, or a total of $6,557,375.

ASPEN MINE.—Dr. Henry Paul has let a contract to deliver 50 tons per day to the Omaha and Grant Smelting and Refining Company, Denver, Col.

ASPEN MINING AND SMELTING COMPANY.—The product for November, same grade and character as October, was 1,180 tons; shipped to the American Smelting Company, Leadville, Col. The production of the mines for six months, beginning with January 1st, 1890, is contracted for by the Globe Smelting Company, of Denver, Col., at better rates than a year ago.

EDISON.—Four feet of 40-ounce ore was encountered on the southwest side of the main incline.

MOLLIE GIBSON CONSOLIDATED MINING AND MILLING COMPANY.—The first meeting of this company, to the organization of which we referred last week, was held on December 9th for the election of officers, resulting as follows: J. J. Hagerman, president; H. B. Gillespie, vice-president; Benjamin Ferris, secretary and treasurer; Frank Bulkley, general manager. The success of the concentration mill, which is now running on ore from the Smuggler mine, is assured, judging from following returns: Amount of ore milled. 1,273,770 lbs.; concentrates, 384,170 lbs. This shows the concentration was as the proportion of 3·31 is to 1. The average silver value of the Smuggler ore was 14·82 ozs. and 9·53 per cent. lead. The returns from the concentrates show 32·7 oz. to 56·6 ozs. silver and 21·4 to 23·2 per cent. lead. The actual amount of silver carried in the concentrates was 8481·83 ozs., showing that 89·84 per cent. of the silver in the ore was saved. The total amount of lead carried was 81,063·73 lbs., showing a percentage saved of 67·71.

PRINCESS LOUISE.—East side of Spar gulch, 80 feet from the surface and 25 feet from the parting quartzite in the dolomite lime, 732-ounce silver ore was reached.

SMUGGLER.—The main shaft of this mine has reached a depth of 270 feet. There is 90 feet of water in the shaft, which is too much for a No. 7 Cameron pump to throw. Increased pumping and hoisting machinery is promised. Mr. Angus Snedecker is superintendent.

SAN MIGUEL COUNTY.

WATTON AND DOWD.—The transfer of this group of mines in Turkey Creek basin to George H. Brushfield, of Chicago, is reported.

DAKOTA.

LAWRENCE COUNTY.

CALEDONIA MINING COMPANY.—The superintendent reports to the New York office, under date of December 9th, that the northern drift in the 500-foot level has advanced 9 feet, and is now in 93 feet. The south drift on the 400-foot level has advanced 11½ feet, and is now in 149 feet. The winze from the 500-foot level has gone down 5½ feet, now having a table depth of 102½ feet. Everything, Mr. Skinner reports, is now in good working order, and the mine work is progressing satisfactorily. During the week ending on the 9th inst. 1,700 tons of ore were produced and sent to the mill. There are 102 men on the pay-roll.

DEADWOOD TERRA MINING COMPANY.—The November product was 19,730 tons, from which was realized $46,944.

FAIRFIELD MINING COMPANY.—At the regular annual meeting of stockholders held in the office of John A. Gaston, at Deadwood, Dak., last week, E. C. Peterson was elected president; A. L. Reed, vice-president and treasurer, and John A. Gaston, secretary, the three composing the board of directors.

HOMESTAKE MINING COMPANY.—The November production was 22,100 tons of ore, from which was realized $77,015. It will be noticed that the grade of the ore shows a falling off of about 50c. per ton.

UNCLE SAM.—On this property 30 stamps are at present in use, out of the 60 in the mill. The main shaft in the mine is now down 240 feet, from the bottom of which the incline commences, and is now down 135 feet. About 60 men are employed

IDAHO.

ADA COUNTY.

The Boise *Statesman* gives the bullion shipments from that city for the year ending Nov. 30 as $210,095 in silver and $608,768.90 in gold, a total of $818,858.90, and adds: This, it is stated, represents but a portion of the aggregate bullion shipments, as a much larger amount goes east to the mint at Philadelphia through the transactions of the United States Assay office, and in addition to this considerable amounts of bullion leave the city in the hands of individuals.

ALTURAS COUNTY.

The mills at Rocky Bar are all running successfully. There is talk that two or three more mills will be constructed there next year. The Blaine mill, six miles north of Boise, is crushing ore from the Lucky Boy. As soon as this run is completed it will commence on ore from the Blaine mine. The latter mine is under bond to a Boston company represented by Capt. W. I. Smart.

WASHINGTON COUNTY.

SILVER BELL.—The Weiser *Leader* says that Wing & Sommer recently struck in this mine one foot of sulphurets ore, which assays 138 ounces of silver to the ton. Two tunnels have been run on the ledge a distance of 115 feet each, showing a large vein of good ore. The appearance of the mine is so encouraging that the proprietors intend to run another 200-foot tunnel into the side of the hill which will strike the ore vein about 200 feet below tunnel No. 2. They intend to ship several carloads of ore in the spring, provided they cannot make satisfactory arrangement for selling ore to some of the millowners in camp.

INDIANA.

At the meeting of the Miners' Progressive Union in Indianapolis, on the 19th inst., a resolution was passed in favor of consolidation with the Knights of Labor, and committees were appointed to attend the Columbus Convention and arrange details.

KANSAS.

RICE COUNTY.

A correspondent writes us from Lyons that investigations are now being made of the wonderful body of "Rock Salt" recently discovered at that place. The drill shows a body of over 200 feet in thickness at a depth of 785 feet. It is clear white, and almost chemically pure. A company has been organized, and 1,000 acres have been secured.

MICHIGAN.

GOLD AND SILVER MINES.

BADGER.—St. Louis investors are now devoting attention to the mines of Michigan, after having pretty thoroughly experimented with those of Montana and Colorado. A St. Louis paper has the following to say about the Badger silver mine, located near Gillis, Ontario County: "The mine is owned in Milwaukee, and, although only worked since last spring, has produced $128,882.47, while this fall they have shipped two cars, one giving $28,000 and the other $16,000, and have two more ready to ship this month. The company is stocked for 50,000 shares, at a par value a share, but only about 7,300 shares have been sold, the remainder still being in the treasury. The company own 400 acres of land, upon which the mines are located, and which they purchased from the government for $2 per acre."

IRON MINES.

CHESHIRE.—It is reported that this mine has been sold to parties in Marquette, Negaunee and Ishpeming, who intend to at once put it in condition for production, with a view to getting out ore for the market next season. The gentlemen associated in this undertaking are John F. Mack, of Marquette: E. C. Anthony, Ed. Lobb, A. Broad, S. P. Kline and J. B. Maas, of Negaunee, and John Penglase, of Ishpeming. The equipment of the mine will be overhauled and reinforced where necessary, and additional side track facilities will be supplied. The property embraces the 704 acres on which the mine is situated, and the company will explore all of its lands, in addition to working the mine. According to the Marquette *Mining Journal*, the price paid for the property was $40,000.

LUDINGTON.—At this mine, says the Norway *Current*, much preparatory work is being done for next year's mining. The new shaft, which is to be sunk to the ninth level, is now down nearly 100 feet, and drifts from the sixth and eighth levels of the mine have reached the line of the shaft, and it is the intention to rise as well as sink. No. 5, or as it is now called, "C" shaft, is being straightened as fast as possible, and, as soon as ready, two cages will be substituted for the skips now in use. At "A" shaft the sinking to the twelfth level is well under way, and it is probable that skips will be worked in this shaft instead of cages. No. 5 shaft is also being sunk and will soon reach the eleventh level. Two railroads, the M. & N. and C. & N. W., are bringing in new spur tracks to the mine.

MONTANA.

DEER LODGE COUNTY.

Among mining districts in Montana which have come into prominence during the past year, says the Helena *Mining Review*, the Oro Fino district, in this county, is entitled to first place. Two years ago there was comparatively little work done in the district except the developments necessary to hold the claims. There are now twelve incorporated companies operating in the district. Nine of these—the Champion, Mountain Lion, Gospel Mountain, American-Ruby, Ohio, Keystone, Oro Fino, Phoenix and Mildred have steam hoists in operation, while negotiations are pending for the construction of two other hoists to be in place within a short time. In point of richness and development the Champion is first on the list among the mines. It is developed by a perpendicular shaft which has attained a depth of some 400 feet. Levels have been run on the vein east and west at each 100 feet. The ore is silver-bearing, and will average 60 to 100 ounces per ton. Two Eastern companies, composed of Minneapolis and St. Louis capitalists, are operating in Oro Fino, but, aside from this, almost every dollar invested there has been contributed by Deer Lodge men. The owners of the Champion have shipped large quantities of ore with excellent results, and are still shipping to some extent. A 20-stamp silver mill was purchased recently, and will soon be in operation. Next in importance comes the Mountain Lion, upon which a shaft has been sunk some 300 feet. Levels and crosscuts run at different depths show some rich ore. The stock is listed on the St. Louis Exchange. The Gospel Mountain has a shaft down 200 feet, from which point the owners are drifting for the lead. This was found on the surface, but for convenience in working the shaft was started south of the discovery. The foregoing constitutes but brief mention of the properties in the district. Oro Fino district is situated 14 miles southeast of Deer Lodge, from which place it is reached by stage or by private conveyance. A railroad has been surveyed from Deer Lodge to the mines and the work of construction will begin in the early spring. The district is in the same mineral belt which follows the mountain range from Butte, extending into the Indian Creek, Cataract, Lowland and Basin districts in Jefferson County. Gold is found in some of the ores and some of them show a considerable percentage of galena. One of the best iron mines in the State, the product of which is shipped to the Helena smelter, is situated just northwest of the district.

JEFFERSON COUNTY.

COPPER BELL MINING COMPANY.—This company has been organized to work the Edna and Leslie lodes, Cataract district, near Wickes, owned by A. J. Bradley and D. F. Riggs, to which we referred inthe ENGINEERING AND MINING JOURNAL of November 9th. It has a capital stock of $5,000,000, shares of a par value of $10 each. The incorporators and first trustees are J. N. Fox, Samuel Word, C. L. Dahler, H. S. Howell, L. G. Phelps, D. F. Riggs, and A. J. Bradley.

GOLD DUST MINING COMPANY.—Articles of incorporation have been filed for this company, the incorporators being Lewis Sperry, Henry Roberts, C. M. Newberry, and Percy S. Bryan. The capital stock is fixed at $30,000; 1,200 shares, par value of $25 each. The principal office is at Hartford, Conn., and the operations of the company will be carried on in the Park mining district of this county. The sale of this mine to Hartford parties was announced in the ENGINEERING AND MINING JOURNAL of November 30th.

LEWIS & CLARKE COUNTY.

MONTANA COMPANY, LIMITED.—The report for November shows that the total weight of ore crushed amounted to 6,431 tons; yield from the three mills, $90,600; working expenses for the month, $55,000; the estimated number of ounces contained in returns by assay being, gold, 2,825 ounces; silver, 24,961 ounces. The total run is less than expected, but we are now working very good quality of ore, and there is every reason to believe December will show further improvement. Mr. Robinson, after a careful inspection of the various workings in the mine, informs the directors that the falling off in the monthly runs for October and November was owing to the ore being of lower grade than formerly, and that it would take some little time to pass the low-grade ore lying in the stopes through the mills before better ore could be treated.

SILVER BOW COUNTY.

ANACONDA COPPER COMPANY.—The smelter, according to the Butte *Inter-Mountain*, is now handling about 1,500 tons of ore per day. Since the starting up of the lower works, and up to the time of the fire in the mine, the smelter handled about 2,500 tons per day. As soon as everything is in shape again, the smelter will dispose of 3,500 to 4,000 tons every 24 hours.

BOSTON & MONTANA CONSOLIDATED COPPER AND SILVER MINING COMPANY.—In the Mountain Vein mine of this company the main shaft is being sunk for the 1,000-foot level. The present depth of the shaft is 965 feet. Crosscuts are being run on the 900, the stations being completed.

BUTTE AND BOSTON MINING COMPANY.—Work is progressing in good shape at all the mines of this company, says the Butte *Inter-Mountain*. The work of doubling the capacity of the smelting furnaces is almost completed. These furnaces will be shortly handling 200 tons of ore per day. At the Silver Bow shaft No. 2, located just east of the mill, the shaft is at a depth of 75 feet. This shaft will be sunk without interruption to the 175-foot level, which will be directly opposite the 300 on the Silver Bow shaft No. 1. A cross-cut will then be driven north to cut the vein.

MAPLETON.—The mine is operated by a lease and its shaft is down 115 feet. Two hundred tons of ore were shipped to the Lexington mill for reduction during the past month. The mine has recently shut down. It is said that the Lexington company has purchased the interest held by Kerrick Brothers, but Mr. Curtis retains his one-fourth interest. The company has a vertical shaft 60 feet in depth, and then from its terminus an incline 75 feet deeper. The company, it is stated, has a strong body of manganese ore in the drifts in the bottom which are run both east and west. The mine is situated north of the Nettie and in the vicinity of the Roudebush & Young old mill.

SOUTHERN CROSS GOLD MINING COMPANY.—This company has made a clean-up from its first run in the new ten-stamp mill just completed by Salton Cameron, a half mile below the mine, to which reference was made in the ENGINEERING AND MINING JOURNAL of November 30th. The mill had been running twenty-four days, but in the early part of the run five of the stamps were idle a part of the time, owing to the rock-breaker not been ready for work. The saving shown in the milling is stated to be about $10 per ton, or from 60 to 70 per cent. of the assay value of the ore milled. The efficiency shown by the mill in this run will be considerably increased by the addition of more tables, and it is also probable that Frue vanners will be added. Experiments to determine their utility will be made, and it expected in the end to increase the saving 75 or 80 per cent. The mill is under contract to work on Southern Cross ores until the 1st of June. Arrangements are now making for stoping on the 250-foot level, and six sets of timbers have been put in across the vein without yet finding the foot wall, showing a width of ore body at that depth, it is stated, of at least twenty-seven feet.

NEVADA.

ELK COUNTY.

Several of the Tuscarora mines, chiefly the Commonwealth, are reported to be increasing their working forces. It is expected that the Union will be started on Commonwealth ore January 1st.

EUREKA COUNTY.

It is reported that the Star of Eureka, Frankie Scott, Ida, and Charlotte mines, on Prospect Mountain, in the Eureka district, have been sold to Richard MacIntosh, of Salt Lake, for $13,000.

STOREY COUNTY—COMSTOCK LODE.

COMSTOCK TUNNEL COMPANY.—The Virginia City *Chronicle* makes the following statement: "The prospect is favorable that the question of the payment of the royalty to the Comstock Tunnel Company, on ore extracted from the leading mines on the lode, will speedily be settled without resorting to litigation. The mining companies do not deny their liability to pay royalty under the act of Congress, delegating the power to collect it to the Sutro Tunnel Company. All the mining companies request is to be indemnified against loss, if the royalty is paid to the Comstock Tunnel Company, and this will probably be done—the receiver giving bonds to secure the several companies paying it against loss, should action subsequently be brought by the shareholders of the Sutro Tunnel Company to collect it. The adjustment of the royalty question will speedily be followed by the extension of the tunnel westward.

CONSOLIDATED CALIFORNIA AND VIRGINIA MINING COMPANY.—After paying November operating expenses and the December dividend, this company carries over a balance of $78,000 in coin to the credit of the current month. The sum for the monthly royalty on ore, due the Sutro Tunnel Company, is set aside until the courts decide to whom it shall be paid. This sum is placed on special deposit and now aggregates $22,000.

CROWN POINT MINING COMPANY.—This company shipped during the month of November $33,-934 to the Carson mint.

MEXICAN MINING COMPANY—At the annual meeting in San Francisco last week, the following directors and officers were elected: Charles N. Fish, president; A. W. Havens, vice-president; C. O'Connor, C. Hirschfeld and H. Zadig; C. E. Elliott, secretary; D. B. Lyman, superintendent, and the Nevada Bank, treasurer. The secretary's report showed receipts during the year of $73,442.64, all from assessments, and disbursements of $68,547.05, leaving a cash balance on hand of $4,905.59. The superintendent's report shows that during the year the work in the mine has been confined to the 1,465 level, which had been opened by a lateral drift from the south line to the north line. In west crosscut No. 1, which was started from this lateral drift at a point 140 feet north of the south line, some streaks of good ore were found 163 feet in, but subsequent explorations have not shown that they belonged to any regular body of ore. At a point in this west cross-cut, 200 feet in from the lateral drift, a north drift was started and run 497 feet to the north line of the mine, passing through streaks of quartz and porphyry. From this second drift, at a point 50 feet south of the north line, a west cross-cut has been run 61 feet, passing through porphyry, showing clay separations and some quartz.

OCCIDENTAL CONSOLIDATED MINING COMPANY. The miners employed at this mine have been temporarily laid off pending a run of the mill on North Occidental ore. In the meantime the track and ore chutes in the Occidental Consolidated will be put in good order and two new levels opened. It is estimated that it will take at least thirty days to accomplish this work. The company has under consideration the advisability of increasing the capacity of the mill.

SAVAGE MINING COMPANY.—The bullion yield of this mine for the month of November was $38,-392, of which $13,833 was in gold and $25,079 in silver.

NEW MEXICO.

BLACK OAK MINING AND MILLING COMPANY.—At the annual meeting of the Black Oak Mining and Milling Company held in East St. Louis yesterday the following were elected to serve as directors for the ensuing year: Minot S. Wasson, George W. Campbell, John B. Woostman, Nathan Frank, Charles E. Flack, George Shields and George F. Baker. A resolution was unanimously adopted authorizing the board to place a new bond for three years upon the property for $50,000, the money to be used to pay off all the company's debts, put in power drills and to add five stamps to the mill. Before the meeting adjourned $20,500 was subscribed by those present. The permanent improvements made during the year were fully approved of by the stockholders.

SANTA FE MINING COMPANY.—This company's affairs have taken on a new phase. Leonard Lewissohn, who was to succeed Jay A. Hubbell as president, declined to accept the office at a meeting of the directors this week. The condition of Mr. Lewissohn's health is given as the reason. Arrangements have been completed whereby the Santa Fe company's office will be kept in Boston, and will be moved to the office of Albert S. Bigelow, who is elected treasurer. Horace S. Stevens is elected president, and Mr. Lewissohn vice-president.

PENNSYLVANIA.

COAL.

A dispatch from Punxsutawney, Pa., says that the miners of Walston and Adrian, numbering 1,200, recently notified the company that they would go on strike if certain demands were not complied with. The company prepared for a strike by letting the fires die out in the coke ovens, and have notified the men that they are discharged.

The Black Diamond, Lancaster and North Franklin collieries, at Shamokin, have suspended operations for an indefinite period. A large number of miners are now idle in the Shamokin region.

OIL.

Exports of refined, crude, and naphtha from the following ports, from January 1st to December 14th, were as follows:

	1889. Gals.	1888. Gals.
From Boston	4,378,913	4,437,990
Philadelphia	155,362,636	130,361,869
Baltimore	8,335,244	6,836,325
Perth Amboy	15,775,196	20,533,872
New York	422,492,730	357,489,629
Tota exports	606,344,719	519,659,685

VIRGINIA.

The Douthat Survey, in Alleghany and Bath counties, comprising 102,000 acres, has been sold by Semper & Altemus, of Philadelphia, the trustees, to Peter McClaren, of Perth, Ontario, Can. The price was $300,000, one-third cash, balance in three annual payments. H. G. Merry, of Low Moor, Va., was the holder of the option, and, by the terms of the sale, becomes part owner. Mr. McClaren, associated with Mr. Nathaniel Moore, of Gogebic fame, are the owners of the Ferrol Mines, near Staunton, Va.

WEST VIRGINIA.

FAYETTE COUNTY.

GAULEY MOUNTAIN COAL COMPANY.—Mr. William N. Page has leased the Hawk's Nest coal property and plant at Ansted, Fayette County, W. Va., for a period of 15 years, with the option of purchase. He has organized the above company, and is preparing for an output of 1,000 to 1,500 tons per day. The present capacity of the mine, which has been idle for several years, is about 500 tons. The Chesapeake & Ohio Railroad has agreed to replace the narrow with a standard gauge, which is to be operated free of expense to the company. This completion is promised by the 1st of March. The Gauley Mountain seam is 11 feet thick, and, like the Connellsville coal, can be mined easily without the use of powder or the expenditure of much labor in undercutting. An ordinary miner will average 12 tons daily, while some will load from 15 to 20 tons, so that at 25 cents per ton the wages range from $3 to $5, with little but oil to be deducted.

WISCONSIN.

AURORA MINING COMPANY.—It is stated from Boston that the purchase of the Aurora mine, on the Gogebic range, has been made in the interest of Wisconsin Central people, and not of the railway company. Subscriptions are now being quietly offered. Mr. Rockefeller is said to have subscribed $250,000. Stock will be held in trust. Price of purchase not given.

FOREIGN MINING NEWS

BELGIUM.

Cable dispatches state that the strike of the Belgian miners has ended. The men are resuming work.

CANADA.

ONTARIO—PORT ARTHUR DISTRICT.

(From our Special Correspondent.)

The rails of the Port Arthur, Duluth & Western Railway are now laid to the crossing of the Kaministigua River, which point is about five miles this side of the Beaver mine. It is not anticipated that the bridging of the river will cause any delay in the rapid construction of the road. The contractors intend to have the road in running order as far as Whitefish Lake, 40 miles distant from Port Arthur, on the 1st of September next.

All indications point to the conclusion that next year will see a great impetus given to mining throughout the entire Port Arthur district. The construction of the railway will so facilitate the transportation of supplies and products of the mine, that many of the claims now located with nothing being done to develop them, will be actively prospected and their true worth made manifest. The iron ore ore deposits of Pewabic Mountain and Gunflint Lake will be accessible by rail before the end of next year.

The Canadian Pacific Railway Company are contemplating the building of a branch line from at or near Savanne, on their main line, to the Atic-Okan and Magnetic Lake iron fields, which are said to be second to none on the continent. If this project is carried out, Port Arthur would become the greatest iron ore shipping point on Lake Superior, as well as a center of iron manufacturing and kindred industries. Two large deposits of carbonate of iron "siderite" lies within easy distance of the town, three to seven miles, and would do admirably to mix with the richer oxide ores in smelting. One of the carbonate deposits carries from 2¾ to 8¾ ounces of silver to the ton. This point is particularly well adopted for the production and manufacture of iron. Fuel can be laid down here from Ohio ports for 45 cents per ton freight. The siderite deposits of the neighborhood would furnish all the lime necessary for fluxing the ore. On the completion by the railway to the iron fields, it is confidently expected that iron smelting furnaces will be erected here.

BADGER.—A large force of men are working in the mine. The mill is kept running night and day. Their usual monthly hipments will be ready about the 25th inst. Some magnificent specimens from this mine were on exhibition at the Silver Convention held in St. Louis, Mo., recently.

BEAVER.—Stoping is being vigorously carried on, and large quantities of the richest ore is being barreled for shipment. When the mill is put in operation in the spring the production of this mine in 1887 will be equaled if not excelled. A reference to their books shows that they shipped between July 17th, 1887, and March 30th, 1888, ore carrying 383,630 ounces of silver, and 21,600 ounces of silver bullion.

MURILLA.—Mr. Lowman has arrived from London, England, to take charge of the property; and is at present engaged in erecting the necessary buildings preparatory to active mining operations in the beginning of the new year.

MINK MOUNTAIN (R. 213).—Operations have ceased at this mine, owing to the death of the late

Thomas H. Hulbert, who was the principal owner. It is understood that guardians have been appointed, and that they will dispose of the property, having received an offer of $250,000 one-half cash and the balance in stock.

Rabbit Mountain.—An option has been obtained on this property recently, and it is to be hoped that a sale will be effected. Owing to some legal or other entanglements among the present owners, it has been lying idle since 1887. The Rabbit is one of the "old reliables" of the district, and in the interest of all concerned should be in operation.

Silver Glance (R 230.) adjoins Mink Mountain on the west. This property is now on the market in Paris, France, and there is every likelihood of of the sale going through at a reasonable figure.

Silver Wolverine (36 E.) .—Here Captain Gilbert isincreasng his force of men, and has laid in large supplies for the winter, all of which shows the company's confidence in their property.

The Queen Mine (173 T.) has closed down operations for the present, Mr. Kimball having sold it for $100,000. As soon as all matters in connection with the transfer are made, active work will be commenced on a larger scale. This mine is on the Mink Mountain range, and the development work carried on by the late owner gives good promise for the future.

West End Mining Company shipped since October 1st, thirteen tons high-grade ore, and will ship, by the end of December, twenty tons more. The ore will average $1,000 per ton. One barrel of the thirteen-ton lot gave an assay value of $19,640 per ton. No stoping has been done as yet on this property. They have 800 feet of drifting and 250 feet of sinking. They propose to sink a winze in drift west from shaft No. 2, to open up bodies of high-grade ore known to exist. The vein extends the entire length of the property, three-quarters of a mile, average width 7 feet. The gangue consists of calcite, baryta, fluorite, and quartz with silver in the form of native and argentite and zinc blende.

Copper.—Excitement still runs high over the copper discoveries in the townships of Blake and Crooks. In one instance in Blake a conglomerate dyke, averaging over 30 feet in width, outcrops for nearly a mile and assays from 7.35 to 15 per cent. copper on the surface. Numerous silver bearing veins have been discovered in the same vicinity, surface assays showing all the way from $10 up to $2,960 per ton.

MEXICO.

SONORA.

Imuris Mines.—A press dispatch has the following: One of the most important mining sales ever made in the Southwest has just been closed by James Farrell, of San Francisco. He has sold to an English company, of which James Whittall, of the London, Paris and American Bank, is president, the Cerro Blanco group of mines nine miles from Imuris Station, on the Sonora Railroad, for $1,500,000, half c ash and half in shares. President Whittall, accompanied by George Thompson, manager of the New Jersey Extraction Works, Elizabeth, N. J., and Andrew B. Ferris, manager of the Arizona Copper Company, have returned from a trip through the mines for the purpose of thoroughly examining them. Mr. Whittall has telegraphed to the solicitors in London to pay over the money. The company is called the Imuris Mines limited, and is a London incorporation with a large capital stock. It is the intention of the purchasers to erect at once large works on the Magdalen River, and already engineers are in the field running a line for a railroad from the site of the works to the mines. Farrell has owned the mines about two years, during which time he has spent $40,000 in developing them. He has shipped only a few cars of ore, simply to determine the best method of treatment.

MEETINGS.

American Coal Company, No. 1 Broadway, New York, December 26th, at 12 o'clock noon.

DIVIDENDS.

Colorado Fuel Company, quarterly dividend of 1½ per cent., payable December 20th, at No. 18 Broadway, New York City.

Daly Mining Company, dividend No. 34, of 25 cents per share, aggregating $37,500, payable on December 31st, at the office of Lounsbery & Co. Transfer books close December 26th.

Edison General Electric Company, quarterly dividend of 2 per cent., payable January 3d, at No. 44 Wall street, New York City. Transfer books close December 20th and reopen January 4th.

Evening Star Mining Company, dividend No. 59, of 2½ per cent., aggregating $12,500, payable December 23d.

Franklin Mining Company, dividend of $2 per share, aggregating $800,000, payable January 1st, to stockholders on record December 21st.

Homestake Mining Company, dividend No. 137, of 10 cents per share, aggregating $12,500, payable December 24th, at the office of Lounsbery & Co., Mills Building, New York City.

Monitor Mining Company, dividend No. 3 of five cents per share, aggregating $37,500, payable December 31st.

Morning Star Mining Company, dividend No. 34 of two per cent., aggregating $200,000, payable December 23d.

Ontario Silver Mining Company, dividend No. 163, of 50 cents per share, aggregating $75,000, payable December 31st, at the office of Lounsbery & Co., Mills Building, New York City. Transfer books close December 26th.

Pennsylvania Gas Coal Company, quarterly dividend of 1½ per cent., payable December 26th.

United States Equitable Gas Company, dividend of one per cent., payable December 21st at No. 45 Broadway.

Ward Consolidated Mining Company, dividend No. 3 of five cents a share, aggregating $10,000, payable December 23d.

ASSESSMENTS.

Company.	No.	When levied.	D'l'nq't in office.	Day of Sale.	Amn't per share.
Bodie	11	Nov. 11	Dec. 7	Jan. 22	.25
Chollar, Nev	28	Nov. 1	Dec. 4	Dec. 24	.50
Con. Imperial	26	Nov. 22	Dec. 27	Jan. 15	.05
Con. Pacific, Cal	11	Nov. 1	Dec. 5	Dec. 28	.10
Del Monte, Nev	2	Oct. 28	Dec. 3	Dec. 26	.20
Grand Prize	23	Nov. 21	Dec. 24	Jan. 15	.30
Locomotive	5	Oct. 17	Nov. 25	Dec. 17	.05
Mono	29	Nov. 18	Dec. 23	Jan. 24	.25
Mongold, Cal	29	Nov. 18	Dec. 23	Jan. 24	.25
Nevada Queen Nev	6	Oct. 31	Dec. 4	Dec. 30	.20
N. Gould & Curry, Nev	11	Nov. 6	Dec. 7	Dec. 27	.20
Palisade, Nev	2	Nov. 1	Dec. 16	Jan 9	.05
Ruby Hill, Nev	18	Nov. 12	Dec. 16	Jan. 16	.01
Russell, Cal	5	Nov. 11	Dec. 16	Jan. 8	.05
Savage, Nev	74	Nov. 5	Dec. 10	Dec. 30	.50
Summit	11	Nov. 14	Dec. 20	Jan. 14	.05
Trinity River, Cai	2	Nov. 27	Jan. 6	Jan. 28	.50

MINING STOCKS.

[For complete quotations of shares listed in New York, Boston, San Francisco, Baltimore, Denver, Kansas City, St. Louis, Pittsburg, Birmingham, Ala.; London and Paris, see pages 559 and 560.]

New York.

Friday Evening, Dec. 20.

An advance of nearly 50 cents per share in El Cristo this week has brought about a revival of interest in the mining share market. The volume of business has not materially increased, but there has been a much better feeling apparent in the market, and the attendance at the various calls has been much larger than for several weeks past. The advance in El Cristo cannot be called surprising, as for some time past—in fact, ever since the memorable break in the stock on March 25th, 1887 — its supporters have been prophesying another boom for it; until within the past week, however, transactions in it have been more or less restricted, and the officers of the company have complained of unexpected obstacles in the transportation of the ore, arising from the inadequate transportation facilities and the long distance to be traversed. The ore, it is stated, after being boated down the river to the coast of Columbia, is brought to New York by somewhat irregular steamers, and is then sent to the Chicago Smelting Works, at Chicago, Ill. Whatever the difficulty may have been, the fact remains, that the promised "boom" has been long delayed. Everything, however, now indicates that the supporters of the stock, at last are ready to move it up again, and all that remains to be seen is how largely the public will take hold of it. Traders all agree that an advance in this stock will infuse life into the entire list, as was the case when the stock reached $9.63 per share early in 1887. The prediction is made by those interested in the company, and may be taken for simply what it may be worth from that source, that the stock will sell at $10 per share on the anniversary of its drop two years ago.

Altogether December has been an unusually encouraging month for investors. Dividends have or will be paid during this month by the following mines: Alice, Horn Silver, Homestake, Daly, Ontario, Morning Star, Evening Star, Ward Consolidated, in addition to the dividends paid by the copper mining companies of Boston.

During the week the principal event in the market for Comstock shares has been the continued weakness of Consolidated California and Virginia. The apparent cause is not difficult to discover. For some time past it has been stated that the ore resources of this mine have now reached a limit where they must be carefully husbanded in order to secure any profit over the cost of extraction and reduction. Advices received in this city from San Francisco during the week make the further statement that the mine is being rapidly stripped of pay-ore. It is doubtful if the dividend will be paid on the shares in January. Bears on the stock point out that if the mine was capable of continuing its regular monthly dividends of 50 cents per share, it would pay during the year more than its present price per share, and therefore they reason that the magnates of the Pacific Coast have come to the conclusion that it will not be able to continue dividends. This, of course, would explain the weakness of the stock. On the other hand, those more optimistically inclined reason that the weakness in the stock is only a "deal," and that the insiders are depressing the stock for purposes of their own. Among the other sales of Comstock during this week were Crown Point at $1.90; Gould & Curry, $1.60; Hale & Norcross, $2.55; Ophir, $3.45@$3.15; Savage, $1.60; Sierra Nevada, $2.05@$2; Alpha, $1.30; Alta, $1.30; Andes, 85c.; Best & Belcher, $2.65@$2.45; Bullion, 59@75c.; Chollar, $2.45; Exchequer, 70c.; Julia, 30c.; Mexican, $2.75; Occidental, $1@85c.; Overman, $1.15; Potosi, $2@$1.05; Silver Hill, 50c.; Union Consolidated, $2; Utah, 65@90c.; Common stock of the new Comstock Tunnel Company, sold at 18@20c., and Comstock Tunnel scrip, 37c.

Among the ales of Tuscaroras were: North Belle Isle at $1.15; Navajo, 33@35c.; Belle Isle, 20c.

Barcelona has also weakened, but at lower prices than those last reported. Sales were made at 30c. on Monday and 25@26c. yesterday.

Eureka Consolidated has suddenly displayed a weakness which is apparently inexplicable. Sales have been made at $2.88@$3.25 at a decline of one dollar per share from the quotations of last week. Inasmuch as the last news from the mine indicated dividends rather than assessments, this break is, of course, surprising.

Bodie stocks are being left severely alone. Standard Consolidated is firmer, however, selling at 65 cents. Bodie Consolidated sold at 70 cents. Nothing was done in Mono. A single transaction of Bulwer is reported at 45 cents.

Plymouth Consolidated is steady at $3.00, a sale being made at that figure on Tuesday. There is no news of importance from the mine forthcoming, save what is printed in our mining news columns Astoria is still being made active with a slightly lower tendency toward the close of the week. Sutter Creek continues to advance slowly.

Several thousand shares of Brunswick sold at 1c. The details of a plan for the reorganization of the company are given in our mining news columns, together with answers to certain pertinent queries that the Engineering and Mining Journal has placed before the promoters of the enterprise. Stockholders should give this matter careful consideration before assenting to the reorganization on the terms proposed.

Horn Silver is weaker, sales being made ex-dividend at $2. Now that the stock is apparently entering the ranks of investment securities, there is less speculation in it and its value is consequently steadier. Ontario sold at $36 on Wednesday. Conspicuous among the Colorado stocks has been Freeland. There is every evidence of a deal in this stock. The quotations reported this week are 45@50c. per share. Little Chief is weaker at 28@29c. Leadville Consolidated is quiet at 12c.

Traders are much perplexed over the weakness that is displayed by Alice. Quotations are lower than they were a fortnight ago. There have been sales of the stock at $1. The lack of definite information concerning the financial condition of the company, places it at a comparative disadvantage in the eyes of many investors. The annual meeting will be held, however, in January, and the value of the shares will be more easily ascertained at that date.

Among the sales of miscellaneous stocks during the week have been; Rappahannock, at 3@5c.; San Sebastian, at $1.70; Mutual Smelting & Mining Company, $1.60@$1.65.

Phœnix of Arizona continues active at higher figures, at 39@45c.

Silver King sold at 40@50c. A stockholder who was seen this week said that the present management of the company had agreed to give the Eastern shareholders a transfer office in New York next year, and two directors in the new board. This, however, is the minority that they have had for some time past, and will not enable them to effect any change in the methods of managing the company.

Dakota stocks have been generally quiet and uninteresting. Homestake is quoted at $9 bid, Deadwood Terra at $1.40 bid, and Caledonia at $1.75 asked. No sales are reported for the week.

Boston. Dec. 19.

[From our Special Correspondent.]

The market the past week has been rather dull, and prices irregular. There does not seem to be much disposition to load up on copper stocks, neither is there any pressure to sell them. We believe the market a purchase on all reactions, and look for much higher prices during the coming year. The feature of the week has been the dealings in Sante Fe transactions, which have aggregated over 30,000 shares. Early in the week the stock was steady at about $1.05, but later a raid was made upon it, evidently for the purpose of depressing the price so as to cover shorts or get some cheap stock, which resulted in sending it down to 85c., a rally soon followed, and on the announcement of the new organization in the management orders to purchase forced the price up again to $1.25, and it is very strong at that price, with prediction that it will sell up to $2 before January 1st and much higher later on.

Calumet & Hecla was steady at $2.45 but advanced to-day to $2.48 on small sales.

Tamarack declined from $145 to $137, with later sales at $140.

Boston & Montana has been very dull this week, with sales at $43½@$44¾, closing at $44; less than 1,200 shares were dealt in. The smallest sales for many weeks.

Quincy sold at $67 for 120 shares, a decline of $3 from last sale.

Osceola has seen quite a number of "ups and downs" this week, at one time selling as low as $16½ and then at $19½, same day. Later it declined to $18¼, and to-day is up again to $19½. Conflicting rumors regarding the condition of the mine may account for its erratic course.

Franklin sold from $16½ to 17¼; latest sales at $16¾. The directors have declared a dividend of $2 per share payable January 1st, 1890. It was generally thought that the dividend would be $3, but the directors concluded it would be more conservative to retain a good surplus in the treasury to meet any exigency which might arise in the near future.

Atlantic was in better demand, and advanced from $13⅝@$14⅜.

Kearsarge was very quiet this week, and declined to $6½, ex div. The advance in this stock was rather too premature, and many holders were anxious to realize.

Huron & National dull but firm at $2½.

Pewabic steady at $7. Allouez at 90c.@$1; small sales.

Bonanza declined to 75c.

South Side sold at 20c., as before.

Silver stocks dull; Dunkin sold at 65c.; Catalpa at 11c.; Crescent at 5c.

3 P. M.—At the afternoon call Santa Fe sold up to $1.30, closing at $1.27½.

Boston & Montana advanced to $44¾, and closed strong.

Tamarack advanced $1; sales at $141.

Market closed firm.

Lake Superior Gold and Iron Stocks.

(Special Report by David M. FORD, Houghton, Mich.)

There is much activity in the gold stocks; there is no change in prices. In the iron stocks, Pittsburg & Lake Angeline, Chandler & Chicago and Minnesota Ore Company are in active demaad.

GOLD MINING STOCKS. Dec. 19.

Name of Company	Par value.	Lowest.	High.
Grayling Gold & Silver Co	$25.00	$0.90	$1.00
Michigan Gold Co	25.00	2.50	3.50
Peninsula Gold & Silver Co	25.00	.75	.90
Ropes Gold & Silver Co	25.00	2.25	2.50

IRON MINING STOCKS.

Name of company.	Par value.	Bid.	Asked.
Ashland Iron Co	$25.00	... ..	$65.00
Aurora Iron Co	25.00	......	7.75
Champion Iron Co	25 00	$100.00	110.00
Chandler Iron Co	25.00	39.00	41.00
Chapin Iron Mining Co	25.00	25.00	33.00
Chicago & Minn. Ore Co	100.00	105	110.00
Cleveland Iron Co	25.00	19.00	20.00
Jackson Iron Co	25.00	100.00	110.00
Lake Superior Iron Co	25 00	66.00	6.00
Milwaukee Iron Co	25.00	4.00	6.00
Minnesota Iron Co	100.00	80.00	85.00
Montreal Iron Co	25.00	......	5.50
Norrie (Metropolitan)	25.00	......	55.00
Odanah Iron Co	25.00	......	6.25
Pittsburg Lake Angeline Co.	25.00	140.00	135.00
Republic Iron Co	25.00	48.00	49.00

PIPE LINE CERTIFICATES.

(Special Report by Messrs. WATSON & GIBSON.)

The petroleum market this week has been entirely without feature, and it does not enlist the attention of commission brokers, or even interest room traders who stand around the bull ring. In its present condition of inertia nothing whatever can be said concerning the market that is different from what we have previously said concerning the general condition surrounding it.

NEW YORK STOCK EXCHANGE.

	Opening.	Highest.	Lowest.	Closing.	Sales.
Dec. 14	103⅝	104	103⅝	104	58,000
16	103¾	104⅜	103⅝	104⅜	113,000
17	104¾	105	104¼	105	250,000
18	106¼	106¼	105	105¼	102,000
19	104⅞	104⅞	103⅜	103½	301,000
20	103⅜	104¼	103⅜	103⅞	219,000
Total sales in barrels					1,043,000

CONSOLIDATED STOCK AND PETROLEUM EXCHANGE.

	Opening.	Highest.	Lowest.	Closing.	Sales.
Dec. 14	103½	104¼	103½	104¼	115,000
16	105	105⅛	104⅜	105	125,000
17	104¼	105½	104¼	105½	198,000
18	106¼	106¼	105	105¼	102,000
19	105	105	103	103½	425,000
20	103⅛	104¼	103	103¾	162,000
Total sales in barrels					1,127,000

COAL TRADE REVIEW.

NEW YORK, Friday Evening, Dec. 20.

Statistics.

PRODUCTION OF ANTHRACITE COAL for week ended December 14th and year from January 1st.

Tons of 2,240 lbs.	1889. Week.	1889. Year.	1888. Year.
P. & Read. R.R. Co	161,949	6,972,941	6,973,713
Cent. R.R. of N. J	126,073	5,822,218	5,558,094
L. V. R.R. Co	175, 00	7,182,330	6,462,402
D., L. & W. R.R. Co	120,000	5.060,240	6,713,906
D. & H. Canal Co	62,100	3,642,383	4,336,190
Penna. R.R	67,788	3,063,555	4,426,059
Penna. Coal Co	21,559	1,301,894	1,597,473
N. Y., L. E. & W	13,250	919,824	929,983
Total	747,719	33,964,485	36,997,820
Decrease	......	2,033,335	......

The above table does not include the amount of coal consumed and sold at the mines, which is about six per cent. of the whole production.

These figures are subject to corrections for duplications.

Production for corresponding period:

1884	30,863,856	1886	31,566,047
1885	30,431,870	1887	33,357,426

PRODUCTION OF COKE on line of Pennsylvania R. R. for week ending December 14th, and year from January 1st, in tons of 2,000 lbs.: Week, 115,877 tons; year, 4,327,088 tons: to corresponding date in 1883. 3,944,630.

PRODUCTION OF BITUMINOUS COAL for week ended December 14th and year from January 1st:

EASTERN AND NORTHERN SHIPMENTS.

Tons of 2,240 lbs.	1889. Week.	1889. Year.	1888. Year.
Phila. & Erie R.R	2,263	83,698	63,611
Cumberland, Md	68,421	2,953,686	3,465,483
Barclay, Pa	5,100	121,392	153,421
Broad Top, Pa	11,476	350,563	364,489
Clearfield, Pa	77,341	763,620	3,250,047
Allegheny, Pa	22,004	887,134	780,051
Beach Creek, Pa	39,678	1,476,930	1,331,869
Pocahontas Flat Top	40,207	1,647,383	1,331,869
Kanawha, W. Va	34,730	1,751,528	1,562,384
Total	301,220	10,035,934	12,303,224

WESTERN SHIPMENTS.

Pittsburg, Pa	18,324	652,187	700,487
Westmoreland, Pa	37,955	1,488,386	1,510,121
Monongahela, Pa	4,888	358,244	370,241
Total	61,167	3,498,817	2,580,849
Grand total	362,387	13,534,751	14,884,073

Anthracite.

The anthracite coal trade keeps up the even tenor of its more or less uninteresting way. Coal continues to accumulate in the hands of the producers, and naturally there is a visible lack of strength in the situation. Neither does the weather contribute any vitality to the trade. Representatives of the producing interests, however, philosophically console themselves by the reflection that notwithstanding the many pessimistic predictions that have found utterance, there has been a fairly large consumption of coal, and a prospect of a combination of less coal and more frost during the coming month. A stray blizzard, possibly, may impart to the trade the long-looked-for briskness.

Quite a number of cargoes of coal afloat have been on the market recently, and, naturally, do not lend any firmness to prices.

The so-called news-gatherers of Wall street have renewed their periodical discussion of Coxe Bros. & Co.'s suit against the Lehigh Valley Railroad Company, now pending before the Interstate Commission. These energetic purveyors to Wall street's credulity now tell us that no official decision will be formally rendered. There will simply be a compromise between the parties in interest, involving a modification of the rates of transportation, so that there may be less disparity between the charges on hard and soft coals. Of course the presumption is inevitable that the information was furnished *exclusively* to a reporter of a news agency by the members of the commission charged with the regulation of our interstate commerce, but nevertheles the opinion may be ventured that this is about as far from the truth as the rest of the innumerable rumors in circulation during the year.

We have no doubt that in due time a decision will be announced, and we have little more doubt that it will be substantially in favor of Coxe Brothers & Co.

Mr. John H. Jones, Chief of the Bureau of Anthracite Coal Statistics, sends us the following corrected statement of anthracite coal production for month of November 1889, compared with same period last year, compiled from returns furnished by the mine operators:

	Nov., 1889.	Nov., 1888.	Difference.
From Wyoming Region	1,803,649	1,952,029	Dec. 148,379
From Lehigh Region	569,488	601,893	Dec. 32,404
From Schuylkill Region	999,675	1,164,729	Dec. 165,053
Total tons	3,372,814	3,718,651	Dec. 345,837

	For year, 1889.	For year, 1888.	Difference.
From Wyoming Region	17,255,895	20,327,786	Dec. 3,071,891
From Lehigh Region	5,802,756	5,120,061	Inc. 682,695
From Schuykill Region	9,613,323	9,993,946	Dec. 380,623
Total	32,671,975	35,441,795	Dec. 2,769,819

The stock of coal on hand at tide-water shipping points, November 30th, 1889, was 771,334 tons; on October 31st, 1889, 704,999 tons; increase, 66,425 tons.

According to Mr. Jones' statistics the shipments for the week ending on Saturday last were 728,845 tons, an increase of 16,555 tons over the production of the corresponding week last year. The tonnage for the year to the 14th inst. was 54,076,825 tons, a decrease of 2,914,649 tons, as compared with the shipments for the corresponding period in 1888.

Bituminous.

In the absence of any new features in the soft coal trade interest is centered principally upon the plans now under consideration for another combination of producers. Concerning this matter, the Philadelphia *Ledger* gives the following more or less imaginary plan: "The recent decisions against monopolistic trusts by the courts of New York and Illinois, and the introduction recently of several bills in Congress to suppress them, do not appear to deter the bituminous coal mining, shipping, and carrying interests from organizing another trust similar in character to the Standard Oil, Sugar and Lead Trusts. A movement is actively on foot to establish a 'Soft Coal Trust' to regulate the tidewater bituminous coal trade during the coming season. The 'Seaboard Steam Coal Association' has failed to realize the expectations of its projectors, and now this new scheme is put forward as 'the only practicable arrangement' by which the production and prices of bituminous coal can be regulated. It is proposed to establish a general sales agency to buy from all the operators who market bituminous coal at tidewater their entire production of coal, and this agency will control the sales, fixing the prices according to the quality of the coal. By this method it is expected the output will be limited and higher prices obtained for the coal. There have been several meetings of representatives from the Clearfield, Cumberland and Southwestern Virginia mining regions held in this city recently, when the arrangements for the new trust were discussed, but no details have yet been agreed upon. The amount of the proposed capital of the Seaboard Steam Coal Trust has not yet been determined, but is variously estimated at from $7,000,000 to $10,000,000. The general plan will be based on that of the 'Standard Oil Trust.' All the Atlantic steamship and Eastern railroad and mill contracts for soft coal are to be negotiated through the Trust, which will supply the particular brand of coal desired at such price as the managers of the scheme may determine. We understand that while these plans are being discussed the agents of several of the leading soft coal shipping firms are actively canvassing the New York and New England markets for contracts for the ensuing year."

Boston. Dec. 19.

(From our Special Correspondent.)

Coal dealers have spent more time lately in discussing the question as to whether New England's climate is changing than in buying coal or in sounding the wholesale market. To-day is mild and balmy as in April. There has been winter weather enough to give every other man one meets a bad cold, but apparently nothing more. Retailers are not utilizing 25 per cent. of their teams. Yet, if there should be a cold wave tomorrow every one now running on short supply would want a little coal at once, and delivering capacity would be taxed to the utmost. It is this state of affairs which makes the retailers unhappy. Stocks here in the city yards are not large. A week's run on the dealers would create a good wholesale demand. At present there is next to no demand at wholesale for anthracite. Prices are nominal. Good stove coal may still be had as low as $4, and from that to $4.25. Egg and broken are weak and in buyer's favor. The small steam sizes are firmer than the domestic sizes, and there is a chance that there may be a lively demand for pea and buckwheat if bituminous remains so scarce. Freights, particularly from New York are from 15 to 25 cents lower than they were, and this is in effect a reduction in the price of coal to just that extent, but it is no inducement to the dealer who is not selling any coal to speak of, at any price. Unless consumption of coal increases, owing to the advent of cold weather, f.o.b. prices will be weaker than they now are.

The bituminous situation is nothing less than a first-class nuisance to all concerned. The railroads are short of cars, the shippers cannot load vessels with any sort of dispatch, and the mills and factories are beginning to run out of coal, or to run very short. Some of the largest consumers are reported as having no coal afloat. From ten days to three weeks is required to load vessels at soft coal ports, and no one will sell Cumberland except without qualification as to arrival. Some Clearfield is to be had at $2.60 f.o.b. It is hoped that more cars will be put into the coal carrying service right away.

Freights remain easier at 90@95c. at New York; $1.40@$1.50 at Philadelphia, and $1.50@$1.60 at Baltimore.

The receipts for the week have been 35,160 tons of anthracite and 14,101 tons of bituminous, against 1,754 tons of anthracite and 10,433 tons of bituminous for the same week of 1888. Since January 1st receipts have been 1,610,338 tons of anthracite and 906,047 tons of bituminous.

Buffalo. Dec. 19.

(From our Special Correspondent.)

The weather continues very mild. Trade in anthracite and bituminous coal without any new features. As far as temperature and atmospheric conditions are concerned the navigation of the lakes might have been continued up to the present time. Railroad shipments and receipts are fair and without incidents worth noting. Manufacturers closing the year's business with considerable activity in their workshops.

The sad death of Mr. Franklin B. Gowen and the strikes in the coal regions of Pennsylvania have been topics of discussion all the week. Your readers are, doubtless, well posted on these interesting subjects, therefore need not enlarge thereon.

Yesterday a car service association was organized in this city, and will commence its operations February 1st, 1890. It is designed to effect the abolition of an evil from which railroads all over the country have suffered severely, that of the detention of cars in consequence of the neglect of the consignees to unload them promptly. So-called "car famines" are mostly traceable to this cause. Similar associations have been and are now being formed in all parts of the United States. The law, it appears, does not permit demurrage charges to be made, and what is known as the car service collection was devised. It is a penalty for the failure of consignees to unload cars after a certain reasonable time. The general charge will be $1 per day per car after forty-eight hours. A clause of article 4 says: "It is agreed that the charge of $1 per day per car shall not begin on cars loaded with anthracite coal until seventy-two hours have elapsed after the usual forty-eight hours allowed for unloading." Mr. Edgar Van Etten (late of the New York, Lake Erie & Western Railroad), was elected manager of the association at a salary of $3,000 per annum.

After a long and exciting debate last Monday, the Common Council finally adopted the report accepting the bids of the gas and electric light companies for lighting the city during the current year. The fight of our citizens for cheap light for the time being has come to naught. The terms of the contracts were $1.25 per 1,000 cubic feet for gas and 42½ cents per night for electricity.

A dispatch from Washington, D. C., says that "the case before the Interstate Commerce Commission involving coal freight rates over the Lehigh Valley system, in which it was charged that discrimination in favor of the tonnage represented by Eckley B. Coxe and against the smaller shippers, may be settled without an opinion from that tribunal." The Commission has been placed in possession of information to the effect that the railroad company has reduced its rates on anthracite coal for Eastern traffic from $1.80 to $1.70, and for Western traffic from $2.25 to $2 per ton. Buffalo is the terminus of the Western schedule. The dispatch further stated "the question of bituminous freights was not involved except by comparison. It is evident "that the Commission expect that parties in interest may adjust their differences, but should further complaints be made the Commission will then take action."

Merry Christmas to all readers of the Engineering and Mining Journal.

Pittsburg. Dec. 19.

[From our Special Correspondent.]

Coal.—The market continues in a very unsatisfactory condition, but it is reported this P. M. that the operators have about agreed to pay three cents for mining, which will start most of the mines at once. The stock of coal officially in the Southern markets November 1st was 10,800,000 bushels. There has been a run of fully 5,000,000 bushels since that time. These facts show for themselves. The ports are full of empty boats. Our wharfs are crowded with towboats.

The nominal rates are:

PRICE OF COAL PER 100 BUSHELS = 7,600 LBS.

First pool	$4.75	Fourth pool	$3.25
Second pool	4.50	Railroad coal	5.00@5.50
Third pool	3.90		

Connellsville Coke.—Trade continues active, with a good demand. The prospects were never better; a continuance will all depend on the wage question. Prices will certainly be advanced to $2, and may go higher. Operations last week. 13,600 active and 405 idle ovens; production, 138,684 tons; increase, fully 15 per cent. Stock coke was reduced 3,500 tons, leaving about 71,000 tons in the yards. Last week's shipments, 7,900 cars, exceeding previous week 400 cars; daily average shipments, 800 cars. Quoted rates are: Furnace, f.o.b., $1.75; foundry, $2.05; crushed, $2.55.

Freights.—Pittsburg, 70c.; Mahoning and Shenango valleys, $1.35; St. Louis, $3.65; Chicago, $2.75; Cleveland, $1.70.

FREIGHTS.

From Baltimore to: Boston, Mass., 1.60; Bridgeport, Conn., 1.40; Charleston, .90; Fair Haven, Mass., 1.40; Fall River, 1.40; Galveston, 3.00; New Bedford, 1.40; New Haven, 1.40; New London, 1.40; New York, N. Y., 1.10; Portland, 1.60; Portsmouth, 1.65@1.70; Providence, 1.40; Quincy Point, 1 80; Richmond, Va., .85; Salem, Mass., 1.60; Savannah, 1.00; Williamsburgh, N. Y., 1.15@1.20.

From Philadelphia to: Alexandria, Va., 1.00†; Boston, Mass., *1.40@150; Charleston, .75; Galveston, 3.05; Georgetown, D. C., 1.00†; New York, .90†; Norfolk, Va., .90†; Providence, R. I., *1.20@1.30; Richmond, 1.00; Savannah, .90; Washington, †1.00; Wilmington, N. C., *1.00.

* And discharging. † Alongside. ‡ And towage.

METAL MARKET.

New York, Friday Evening, Dec. 20.

Prices of silver per ounce troy.

Dec.	Sterling Exch'ge.	Lond'n Pence.	N. Y. Cts.	Dec.	Sterling Exch'ge.	Lond'n Pence.	N. Y. Cts.
14	4.824	44	95⅜	18	4.84	43⅞	95
16	4.824	44	95½	19	4.84	43 15-16	95⅛
17	4.824	43 15-16	95⅛	20	4.84	44	35⅜

Council bills declined $\frac{1}{32}$d. on Wednesday's allotment.

The tendency of the silver market has been rather downward, owing to an uncertain feeling abroad caused by recent expressions of the present administration on the silver question.

The market closes firmer, with some very large shipments to London.

United States Assay Office at New York reports total receipts of silver for the week 64,000 ounces.

Foreign Bank Statements.

The governors of the Bank of England at their weekly meeting made no change in its minimum rate for discount, and it remains at five per cent. During the week the bank lost £666,000 bullion, and the proportion of its reserve to its liabilities was reduced from 39·10 to 37·90 per cent., against a reduction from 40·32 to 39·78 per cent. in the same week of last year, when its rate for discount was five per cent. The weekly statement of the Bank of France shows a gain of 1,875,000 francs gold and a gain of 1,700,000 francs silver.

Domestic and Foreign Coin.

The following are the latest market quotations for American and other coin:

	Bid.	Asked
Trade dollars	$ .75	$ —
Mexican dollars	.75¼	.76
Peruvian soles and Chilian pesos	.73	.74
English silver	4.83	4.88
Five francs	.94	.95
Victoria sovereigns	4.85	4.88
Twenty francs	3.85	3.90
Twenty marks	4.74	4.78
Spanish doubloons	15.55	15.70
Spanish 25 pesetas	4.80	4.85
Mexican doubloons	15.55	15.70
Mexican 20 pesos	19.50	19.65
Ten guilders	3.96	4.00

Copper.—The tone of the market continues very firm, although business has been rather quiet during the past week. The quotation for Lake copper still stands at 14½c., and casting brands at 12⅞@13c., according to quality.

Consumption of all kinds of copper goes on at a very satisfactory rate in this country, and from the European markets reports are still of an encouraging nature. The London market for Chili Bars and G. M. B. copper has shown a gradually hardening tendency during the week, the opening quotations on Thursday being £49 12s. 6d. to £49 15s., spot, to £49 7s. 6d., three months, and the last quotations received by cable to-day giving the prices for both spot and futures at £49 15s. to £50.

For refined and manufactured copper the latest quotations in London are: English tough, £56 to £57; best selected, £57 to £58; strong sheets, £65; India sheets, £60 to £62, and yellow metal, 6d. per pound.

The exports of copper from New York during the last week were as follows:

	Copper Matte.	Lbs.	
To Liverpool—			
By S. S. Chester	2,426 sacks	261,187	$7,500
" " Helvetia	5,093 sacks	858,067	24,900
To Hamburg—			
By S. S. Rugia	1,924 bags	224,000	20,000
To Liverpool—	Copper.		
By S. S. Chester	375 bars	105,990	7,050
" " Berlin	43 casks	56,000	5,941

Tin.—The tone of the market has been rather dull, but prices have not suffered to any important extent, and a fair amount of business has been transacted during the week. The quantities en route to this port from London and the East are reported to be comparatively small. We quote, to-day, spot at 21¼, January at 21¼, February at 21¼, March at 21¼. The London market opened firm for spot tin, at prices ranging between £97 10s. and £98, but these prices could not be maintained, and the latest cabled prices for spot is £97@£97 5s. Three months' tin opened at the beginning of the week at the comparatively cheap price of £96@£96 5s., but closed rather better at £96 5s.@£96 7s. 6d.

Lead.—After an interval of dullness and inactivity, an improved consumptive demand has suddenly arisen, and during the week 3·90 has been paid for large lots, about 1000 tons having changed hands. There are no sellers now below 3·92½ to 3·95, and even at these figures offerings are light.

The foreign markets are steady, and in London the present quotations are £14@£14 5s. for Spanish and £14 5s.@£14 10s. for English.

The St. Louis Market.—Messrs. John Wahl & Co. telegraph us as follows: "Lead during past week has ruled firm, with inquiries more liberal, but amount of business consummated has been only moderate. Sellers generally have been asking advanced rates, to which buyers felt loth to respond. Sales will probably aggregate 600 tons, at 3·60@3·62½c. for common, and 3·65c. for argentiferous.

The Chicago Market.—Messrs. John Wahl & Co. telegraph us to-day as follows: Our lead market rules entirely nominal, and though offerings are not heavy the demand is also very light. At the close 3·67½c. is the asking price, and last sale reported is at that figure.

Spelter has again experienced a slight improvement in price, and we have now to quote prime Western at 5⅜@5·40. The foreign markets continue very firm, the latest quotation in London being £23 12s. 6d.@£23 15s. for ordinaries, and £23 15s.@£24 for specials.

Antimony.—This metal fully maintains its recent advance as far as Hallett's is concerned, and which brand we have now to quote 21 to 21½c. Owing to some recent arrivals of Cookson's the quotations for that brand (which are still out of proportion to the price of Hallett's) have now to be reduced to 27@28c.

Quicksilver.—Steadiness has prevailed in this market. London cables still quote £9 15s., and local dealers maintain their asking prices at 66@67c.

Nickel.—An importation of 3,500 pounds was reported to-day. The market presents no features worthy of comment, and shows no signs of broadening. Quotations range from 75c. to 80c., according to quantity.

IRON MARKET REVIEW.

New York, Friday Evening, Dec. 20.

Pig Iron.—The elements of uncertainty which for a few weeks past have characterized this market, are now being gradually removed. Large sales of Lake Superior ores have recently been made, and many furnaces have apparently secured the greater part of their supply of raw material for the coming year. This, together with the fact that many large consumers have recently placed contracts for 1890, gives the market firmness, and decidedly strengthens sellers in their position. Prices, on the average, seem to have settled down to about $20 for No. 1 Foundry iron. This price is, of course, subject to variations, according to the brand.

Another feature which tends toward higher prices for foundry irons is the fact that many furnaces next year have concluded to make Bessemer pig instead of foundry irons as heretofore. The high prices ruling for Bessemer, together with numerous other considerations, are sufficient to induce many shrewd furnacemen to devote their attention to this product.

An event of no little significance was an inquiry received this week from an English source for a quantity of 10,000 tons of American pig iron. The idea is apparently to engage in speculation in pig iron on this side, having been successful in similar operations in the Glasgow market. The proposition is to deposit a margin of four dollars per ton upon all iron thus purchased. English investors of late, have displayed a particular fondness for American industrial enterprises, and if they now venture into pig iron speculation on this side, there would be nothing strange in it. Locally the market is very quiet.

Forge irons continue very firm. Since the sales aggregating 20,000 tons of Lehigh brands, at $17.50 at tidewater, reported in this column three weeks ago, there have been sales of about 10,000 tons more at the same figure.

Scotch Pig.—A strange reversal of long existing conditions has taken place in this market. We have now to note signs of an increased inquiry for Scotch Pig, not on account of its superiority in quality, but because the makers of American so-called Scotch, or softening irons, are unable to supply the needs of American furnaces. Consumers complain of great delay in deliveries of Ohio Scotch Iron; and, moreover, it has now risen in price to at least $22@$23. Prices for leading brands of Scotch Irons are about $27@$27.50. The Glasgow market continues very firm. Quotations for Glasgow, wired by cable to-day, to the metal Exchange, were 60s. 9d.

Spiegeleisen and Ferro-Manganese.—The week has been very quiet in this article, but prices show a further advance. For 20 per cent. spiegeleisen as high as $38 is now asked, and importers quote for ferro-manganese, 80 per cent., from $100 to $105 per ton. No transactions, however, are reported at these figures.

Billet, Slabs and Rods.—Being so full of work, mills are now asking high prices for new business. During the week large sales of billets are reported at an advance of about $2 per ton from former figures. These, however, were a special size; for ordinary sizes the advance would probably not be so great.

American wire rods are quoted at $52.50 at seller's works. Cable advices received yesterday quote foreign wire rods at a price equivalent to $57.50, ex-ship New York.

Steel Rails.—There is now more firmness in the asking price of $35 at mill than there has been since the advance was decided upon. We are informed that the amount of rails booked for 1890 deliveries are about 600,000 tons. According to one estimate, shipments of rails so far this year have been 1,116,017 tons, against 1,116,788 tons in 1888. The production of light rails according to the statistics of the Board of Control this year, show a much larger increase over 1888. So far as can be learned, the Missouri, Kansas & Texas inquiry for 10,000 tons, to which reference was made in this column last week, has not yet been placed. The successful reorganization of the Atchison, Topeka & Santa Fe leads sellers to believe that before long this road will also be in the market for a large amount of rails.

Structural Iron and Steel.—While the consumption of most manufactured iron and steel products continues unusually active and large, the bar iron business is rather an exception to the rule. In fact, trade in this market is very quiet and even approaches dullness. Prices are not changed. We quote as follows:

On wharf, bridge plate, 2·30c.; iron angles, 2·25@2·35c.; iron tees, 2·80@2·85c.; steel angles, 2·35c.; beams and channels on wharf, 3·1c.

Steel plates on wharf: Tank and ship, 2·6c.; shell, 2·8c.; flange, 3@3·1c.; fire-box, 4@4·1c.

Iron plates on wharf: Common tank, 2·25c.; refined, 2·35@2·45c; shell, 2·5@2·6c.; flange, 3·5@3·7c.; extra flange, 3¾@4c.

Bar iron at mill is quoted at 1·8c. for common and 1·8@1·9c. for refined. Deliveries from store are quoted as follows: Common, 2·1c. base; re fined, 2·3c. base; "Ulster," 3c. base; Norway bars 4c.; shapes, 5c., and Norway nail rods, 5½c.

Merchant Steel.—Prices are as follows: Best English tool steel, 15c. net; American tool steel, 7½@10c.; special grades, 13@20c.; crucible machinery steel, 5c.; crucible spring, 3¾c.; open-hearth machinery, 2¾c.; open-hearth spring, 2¾c.; tire steel, 2¾c.

Pipes and Tubes.—Rates of discount on wrought-iron pipe remain as follows: Butt welded, plain and tarred, 50 per cent. discount; galvanized, 12½ per cent. discount; lap-welded, plain and tarred, 62½ per cent. discount; galvanized, 50 per cent. discount. A discount of 57½ per cent. is allowed on boiler tubes of 2 inches and larger, and 52½ per cent. on 1¾ inches and smaller.

Cast-iron pipes remain at $25@$28, according to size.

Rail Fastenings.—Recent developments have led buyers to conclude that the recently announced advance in rail fastenings was, to some extent, artificial. There is at least one thing certain, and that is, notwithstanding the meeting of bolt manufacturers last week in this city, quotations show a very wide variation. An inquiry for 500 kegs of bolts with hex. nuts this week for Savannah delivery, brought quotations lower than 3·10c. An inquiry for the same amount for New York delivery brought quotations from 3·10@3·40c. Prices for angle fish plates and spikes, however, seem to be more uniform. Ruling prices may be quoted as follows: Spikes, 2·25c.; angle fish plates, 2·15@2·25c.; bolts and square nuts, 3c.; hex. nut, 3·25c.

Old Material.—In accordance with the prediction frequently made in these columns, old iron rails continued to advance; an offer of $27 per ton for old tees was refused this week. Nominally sellers are asking $27.50@$28.50 for tees. Double heads are not quoted. The demand for old material continues very large.

Louisville.

(Special report by Hall Brothers & Co.)

There is nothing especially new to be said about the market; it remains practically unchanged since our last report, though some encouraging prospects for the future have recently developed. It is reported that about 2,500,000 tons of Lake Superior iron ore have been contracted for, at about $1 per ton advance in price. Furnace companies are offering in limited quantities, but the lots are mainly composed of special grades, for short delivery.

Hot Blast Foundry Irons.

Southern Coke No. 1	$19.00@ 19.50.
" " No. 2	18.75@ 19.00.
" " No. 3	18.00@ 18.75.
Mahoning Valley, Lake ore mixture	20.00
Southern Charcoal No. 1	18.50@ 19.00.
" " No. 2	18.00@ 18.50.
Missouri " No. 1	19.50@ 20.00.
" " No. 2	19.00@ 19.50.

Forge Irons.

Neutral Coke	17.50@ 18.50.
Cold Short	16.75@ 17.00.
Mottled	15.50@ 16.00.

Car Wheel and Malleable Irons.

Southern (standard brands)	23.50@ 24.25.
" (other brands)	19.50@ 20.50.
Lake Superior	23.00@ 23.50.

Pittsburg. Dec. 19.

(From our Special Correspondent.)

Raw Iron.—While the market shows no falling off in values, there is a perceptible falling off in the volume of business. This, however, is no more than was to be expected when the facts are taken into consideration. Transactions for future delivery have beaten all previous records, which places the consumer in a good position to talk about lower prices, but in this case talk don't count for much. Still most of them are in a position to hold off, so as to give the market a dull appearance, but makers of iron are well aware that consumption is going on at a rate that was never dreamed of before; that it is only a question of time when buyers will have to load up. Trade always shows a falling off during the holiday season, and as business of all descriptions has been very active, dealers have, no doubt, made up their minds to have an enjoyable time.

In the next place, the first of the new year is the time for settling up, closing the old books and accounts, and opening up a new set to contain the transactions of the year 1890. The year past has been a memorable one so far as values are concerned. On the 4th of January, Grey Forge sold $15.50 cash; Bessemer-Pittsburg, $16.75 cash. At Valley furnaces, $15.90 cash; steel billets and slabs, $28.00@$28.50 cash; bloom ends, $19.50; Ferro-manganese, 80 per cent., $54.50@$55, the advance in this article being $50 per ton. Comparing the January prices with those current to-day, the reader will be astonished at the low rates that prevailed at the opening of the year, and, later on, prices exhibited a further decline.

Grey Forge sold as low as $13.50@$13.75, and other descriptions in the same proportions. Those prices have all been laid away. It will certainly be a long time before they will be repeated.

The Valley furnace men have sold so much iron for next year's delivery that they are in doubt what rates to demand. Some are asking $25 for Bessemer and $19 for Grey forge at the furnace. These are holiday prices and will not hold out. The Valley men are in a very happy humor over the continued improved condition of trade. After the holidays are over they will resume business again.

The situation holders of standard brands are firm in their views, and are not anxious to sell even at present rates. Most of them are of the opinion that higher prices will prevail in the near future.

Coke and Coal Smelted Lake Ore.

5,000 Tons Bessemer, February, March, April, f.o.b. Valley Furnace	$23.50 cash.
3,000 Tons Bessemer, January and February	24.00 cash.
4,500 Tons Gray Forge, January and February	18.50 cash.
1,500 Tons Gray Forge	18.00 cash.
1,500 Tons Bessemer, Jan. Feb. and March	24.25 cash.
1,000 Tons Gray Forge	19.00 cash.
1,000 Tons Bessemer, January and February	24.00 cash.
1,000 Tons Gray Forge	18.50 cash.
500 Tons Gray Forge	18.25 cash.
500 Tons Gray Forge, at Gurnace	17.00 cash.
500 Tons Gray Forge at Furnace	16.80 cash.
500 Tons Mottled and White	20.00 cash.
500 Tons Bessemer	24.50 cash.
500 Tons Bessemer Valley Furnace	23.62 cash.
300 Tons No. 2 Foundry	19.25 cash.

Coke, Native Ore.

1,000 Tons Gray Forge	18.25 cash.
200 Tons Gray Forge	18.00 cash.
100 Tons Gray Forge	18.25 cash.
100 Tons Mottled and White	17.00 cash.

Muck Bar.

4,000 Tons Good Neutral	31.75 cash.
1,000 Tons Neutral	30.50 cash.
1,000 Tons Neutral, January	31.00 cash.
750 Tons Neutral, February	31.50 cash.
500 Tons Spot	31.00 cash.

Steel Slabs and Billets.

4,000 Tons Billets	34.50 cash.
1,500 Tons Billets and Slabs, Jan., Feb., March	37.50 cash.
1,000 Tons Billets, December, January	36.50 cash.
1,000 Tons Billets	35.50 cash.

Steel Wire Rods.

750 Tons American Fives	51.50 cash.
750 Tons American Fives	52.50 cash.

New Steel Rails.

3,500 Tons, Spring delivery	35 50 cash.

Spiegel.

5,000 Tons 20 per cent., at seaboard	36.00 cash.
1,000 Tons 30 per cent., at Pittsburg	41.00 cash.
50 Tons 20 per cent., at seaboard	37.00 cash.
50 Tons 10 to 12 per cent., at seaboard	32.50 cash.

Ferro-Manganese.

200 Tons 80 per cent., February and March	102.40 cash.
750 Tons 79 and 80 per cent., January	105.00 cash.
140 Tons 80 per cent., at seaboard	100.00 cash.
100 Tons 80 per cent., February and March	104.00 cash.
40 Tons 80 per cent	105.00 cash.

Skelp Iron.

300 Tons Narrow Grooved	1.77½ 4 mo.
275 Tons Wide Grooved	1.82½ 4 mo.
200 Tons Sheared Iron	2.15 4 mo.

Bloom Ends.

100 Tons Bloom Ends	26.00 cash.
500 Tons Bloom Ends	26.50 cash.
500 Tons Bloom Ends	26.50 cash.
375 Tons Bloom Ends, February	26.00 cash.

Scrap Material.

600 Tons Wired Steel	gross	22.00 cash.
200 Tons Crucible Steel	net	30.00 cash.
200 Tons Iron Axles	net	28.50 cash.
200 Tons No. 1 Wrought Scrap	net	22.00 cash.
200 Tons No. 2 Wrought Scrap	net	19.00 cash.
200 Tons Cast Scrap	gross	16.50 cash.
200 Tons Wrought Iron Turnings	net	15.00 cash.
200 Tons Cast Borings	gross	13.00 cash.
200 Tons Scrap Steel	gross	20.00 cash.
200 Tons Old Car Wheels	gross	21.00 cash.
200 Tons Leaf Steel	net	24.00 cash.
150 Tons Iron Axles	net	29.00 cash.
150 Tons Cast Scrap	gross	16.50 cash.
100 Tons Locomotive Ties	net	23.50 cash.
100 Tons Leaf Steel	net	24.50 cash.

Prices.

Coke or Bituminous Pig—

Foundry No. 1	$20.00@20.25
Foundry No. 2	19.00@19.25
Gray F. No. 3	18.00@18.50
" No. 4	17.50
White	16.75@17.00
Mottled	16.75@17.00
Silvery	17.50@20.00
Bessemer	23.50@24.00
Low Phos	27.00@28.00

Charcoal Pig—

Foundry No. 1	23.50@24.50
Foundry No. 2	22.00@22.25
Cold-Blast	25.00@28.00
Warm Blast	24.00@25.00
10 + 12% Spiegel at seaboard	@30.00

20% Spiegel at seaboard	37.00@40.0
Muck-Bar	31.00@31.5
Steel Blooms	36.00@37.00
Steel Slabs	35.75@36.0
Steel Cr'p Ends	25.00@26.0
Steel Bl. Ends	26.00@26 50
Ferro-Man., 80%	102.50@105.00
Steel Billets	35.50@36.00
Old Iron Rails	27.00@28.00
Old Steel Rails	22.00@24.00
No. 1 W. Scrap	22.00@23.00
No. 2 W. Scrap	@19.00
Steel Rails	@35.00
" light sec	35.00@38.00
Bar Iron, nom	1.90@ 1.95
Iron Nails	2.25@ 2.30
Steel Nails	2.25@ 2.30
Wire Nails	3.00@ 3.15

Philadelphia. Dec. 20.

[From our Special Correspondent.]

Pig Iron.—Pig iron brokers and makers admit this week that a much larger business has been quietly done than had been supposed, particularly in mill irons, by the renewing of expired and expiring contracts. It is impossible to even approximately estimate the amount of business of this kind that has been done, owing chiefly to the fact that much of it is continuous, rather than specific; that is to say, a number of large buyers have arranged for large deliveries each month, in some cases at fixed prices, and in other cases at prices to be named hereafter. This week several large negotiations will be closed for iron, for delivery during the first three or four months of next year. Blast furnace people are quite willing to make contracts, and buyers are willing to yield to their claims on price. Gray forge has been contracted for in a large way at $17.50; in a small way at $18. No. 2 iron has not been dealt in very extensively for forward delivery, but there is no pressure to sell. The best brands are $19. No. 1 is in about the same condition, there being but little urgency upon the part of companies to sell, and $20 is the ruling price for good brands. Makers of Bessemer iron have sold large blocks at $21 to $21.50, and buyers are urging their claims for larger supplies for still more remote delivery. This is leading to an enlargement of capacity. Pipe founders have also undertaken to buy largely, but, so far as this market is concerned, have not done so.

Foreign Material.—This has been a quiet week in foreign material, and prices remain about where they were, viz., $36.50@$37 for spiegel, and in the neighborhood of $100 for ferromanganese.

Billets and Blooms.—Scarcely any business has been done. In fact, mills are so far oversold that there is very little room for new business at any price. Nail slabs are quoted at $37; tank at $38; charcoal blooms at $54; anthracite at $44@$45, and scrap blooms $10 less. To all appearances there will be a further advance in steel blooms.

Muck Bars.—Large buyers are anxious to place contracts, but hesitate to do so at the present asking price, viz., $31.

Merchant Iron.—The association advanced prices to 2c. in large lots, but some mills are getting 2·10 in small lots, and stores are selling at 2·20. Certain large buyers have offers under consideration at a little under 2c., which they think will be accepted, because of the amount of business they have at their disposal. There is a good deal of business to be executed yet at 1·80@1·90.

Nails.—Everything is quiet this week, and there will be no business of importance until January. Iron nails are held with the usual firmness, at $2.10 and $2.20; steel, $2.30@$2.40.

Skelp Iron.—Skelp is quiet. Grooved, 1·90c.; sheared, 2·15@2·20c.

Wrought Iron Pipe.—The mills have a full supply of work, and managers who are watching for new business express the opinion that for small pipes and tubes there will be a heavy demand next month.

Sheet Iron.—All trade conditions point to an advance after the holidays on small lots, particularly for light sheets. Galvanized will also sell to better advantage. Very little business is solicited.

Plate and Tank Iron.—The manufacturers, and those interested in effecting sales of plate mill products, report a generally quiet market, and do not look for much new work before the middle of January. Buyers of plate and tank iron have been obliged, for the past two or three months, to break up their orders into small lots; but there is now an inclination to place large orders in bulk, and mill men are inclined to do business this way, provided some little scope will be allowed them in delivering. Quotations for ordinary plate are 2·30; universal plates, 2·40;

shell, 2·65; flange, 3·25; fire-box, 3·75 to 4c. Steel flange is booked at 3·20; fire-box, 4 to 4½.

Structural Iron.—Orders for steel plates have been booked this week at 2·50; iron plates, 2·35; angles, 2·30, and tees, 2·75; beams, 3·10. We are promised some important developments in structural iron business before long. This hint probably refers to the heavy orders that will be placed by promoters of large construction enterprises now about ready for execution.

Steel Rails.—News concerning the movements of steel rail buyers is scarce. Quotations are firm at $35. A good many light rails will be wanted before spring, and makers are looking up business of this kind, because there is a fair margin in it. Rail makers say that much of the business for steel rails next year will be for very heavy sections.

Old Rails.—Quotations, $27@$28. There are many buyers, and few sellers.

Scrap.—Car lots are wanted to-day at $25; choice, $26. Old steel rails and fish plates are wanted, but there are none to be had.

CHEMICALS AND MINERALS.

New York, Friday Evening, Dec. 20.

Heavy Chemicals.—We have to review a quiet and uneventful week in this market. The volume of business has been rather light. Consumers at last seem to have supplied their immediate requirements. The available supply of alkali on the spot is not large, but there is no positive scarcity, as the bottle-makers, not having resumed work as yet, are still out of the market. Had the demand from this source been as large as was expected, there is no doubt that we would have had a further advance in prices and the scarcity that was apprehended some two weeks ago. The approaching holidays, as might be expected, are exercising their usual effect upon the trade.

Actual prices for alkali are not quotably changed. For 58 per cent. $1.45 is still asked. It is reported that contracts have been placed during the week for delivery over 1890 on the basis of about $1.30 for 58 per cent. Importers quote for carbonated soda ash, 48 per cent., $1.45, and for 58 per cent. $1.40.

Caustic soda ash is quiet and unchanged, with quotations nominally on the basis of $1.30 for 48 per cent.

Caustic soda is a trifle firmer than at the date of our last report, in sympathy with more sanguine reports from Liverpool. For higher tests, 70 to 74 per cent., $2.30 to $2.32½ is now asked. The supply on the spot is limited, and for lots in this position a slight advance over these figures would probably have to be paid.

In consequence of the advance in the prices of English sal soda, American makers have raised their prices to .95 to 1c. This has the effect of strengthening the English market as well. The transactions reported are not of noteworthy importance, but the demand is generally termed fair.

Bleaching powder continues depressed. As will be seen by reference to our Liverpool letter in another column, English makers are anxious enough to book orders, but consumers are reluctant to operate on account of the great uncertainty prevailing as to the future of the market. On the spot, nominally, $1.50 is asked, and the same figure will, probably, represent the usual asking price for 1890 contracts. The real condition of this market is frequently very difficult to ascertain, on account of certain peculiar conditions arising from private competition, with which only the initiated are familiar.

Acids.—The members of the New York Chemical Club are gradually perfecting their combination. This of course requires a great deal of time, and, notwithstanding the delay, those interested show little impatience. They believe that the excellence of the plan upon which they have agreed will justify the time that has been required for its perfection. A special meeting of the members of the club for the election of officers of the Knickerbocker Chemical Company was held on Tuesday afternoon, but it was finally deemed best to defer this election until the meeting which is in progress this afternoon. The plan of the combination is substantially the same as has been outlined in these columns. All the members of the combination will make monthly reports of their sales to the Knickerbocker Chemical Company, and will pay a certain percentage on them for the purpose of accumulating a trust fund to be held by the controlling company. This, of course, will serve as an inducement to those interested to maintain the combination, and in addition thereto, there will be severe penalties involved, which would make a failure to adhere to the agreement a serious matter.

Trade continues brisk, in fact a manufacturer reports that he has sold more acid up to the 18th of this month than he did in the whole month of December of 1888, and another maker states that this December has been the most prosperous month he has seen in the acid trade for years.

At a recent meeting the acetic acid makers revised their price list and agreed upon certain matters which will tend to perfect their organization. No change was made in the price for bulk contracts, which remains at 1·75c. per lb. The new price list will be issued shortly.

Muriatic is in lighter demand than sulphuric acid.

Oxalic is unchanged.

Fertilizing Chemicals.—News was received in this city this week from Charleston, S. C., to the effect that the Ways and Means Committee of the House of Reprentatives of that State has reported favorably on a bill to authorize the State Comptroller to advertise for the sale of the immense river phosphate deposits now owned by the State and worked under royalty by a number of large mining companies. While this news cannot be termed surprising—as there have been rumors concerning it in circulation for some time past—it, nevertheless, is of a great deal of importance to the fertilizer trade.

It was at first thought that the State of South Carolina would refund the State bonded indebtedness of $6,000,000 at 4 per cent., and the phosphate royalty was proposed to be pledged in addition to the State's integrity for the interest on these bonds, but for some reason or other it appears probable that the House of Representatives has now decided to sell its phosphate property and extinguish the State debt by this means rather than by the refunding of its bonds. The influences which have led to this change of plan are the subject of much speculation in the fertilizer trade at present. It seems to be generally believed that those who during the past year or two have made several attempts to absorb all the South Carolina deposits in the interest of certain syndicates, have induced the South Carolina legislators to authorize this sale, which will secure to the syndicate the control so long desired. Of course there will be considerable opposition to the passage of the bill from those who are at present interested in the river mining, as well as those who are consumers or manufacturers of fertilizing materials, and who believe that if the deposits pass out of the control of the State higher prices may ensue. At any rate, the outcome of the proposition will be waited for with a great deal of interest.

For years past there have been reports that the Standard Oil Company had finally decided to utilize its so-called sludge acid, the residuum of its oil refining process, in the manufacture of fertilizers on its own account; at last, there is some basis for this belief. A company, which has recently been organized under the laws of the State of New Jersey as the Liebeg Manufacturing Company, is now erecting fertilizer works on Staten Island Sound, convenient to the oil refineries of the Standard Oil Company. It is hoped that these works will be completed early next year. Their capacity, it is understood, will be very large, and as they will utilize the waste acid of the Standard Oil Company, probably having the backing of that powerful organization, it is evident that they bid fair to become a very powerful factor in the fertilizer market. The officers of the company are: Paul Babcock, Jr., president; John F. Gibbon, vice-president; and Albert French, treasurer. Mr. Gibbon is well known to the trade as having been associated with Dr. Liebeg, of Baltimore, in the fertilizer business. As the name of the company indicates, Dr. Liebeg is largely interested in it. Mr. Gibbon when seen this week disclaimed any connection with the Standard Oil Company, and said that his company would simply utilize any materials that it found cheap and suitable for the manufacture of fertilizers. We start out, he said, with no other object in view than the manufacture and sale of fertilizers at the ruling market prices.

The two items of news above presented suggest a possibility which, although rather improbable, is nevertheless extremely interesting. The Standard Oil Company in times past has manifested an unmistakable tendency to monopolize any business in which it has engaged or has been interested; now, if it should undertake to absorb the South Carolina phosphate rock deposits and to utilize the immense lot of acid which becomes a bi-product in its refining business, it would have a very strong hold upon the market for manufactured fertilizers, an industry which is at present reaching such proportions as to invite the attention of the management of the Standard Company. In view of the result of past efforts to form a fertilizer trust, however, it must be admitted that this scheme is rather more interesting than practicable.

During the week trade in fertilizing materials has considerably improved. Prices for wholesale lots are about as follows; large buyers may be able to obtain a small discount: Azotine, $2.05@$2.12½; dried blood, low grade, $2.05; high grade, $2.10. Tankage, high grade, 9 to 10 per cent. ammonia and 15 to 20 per cent. phosphate, $20.50@$21 per ton, and low grade, 7 to 8 per cent. ammonia and 25 to 30 per cent. phosphate, $20@$20.50. Fish scrap, $21.50@$22 per ton, f.o.b. factory. Sulphate of ammonia at $3.15@$3.20 per cwt. Concentrated tankage, $2@$2.05. Refuse bone-black, guaranteed 70 per cent. phosphate, $20 per ton. Dissolved bone-black is $1 per unit for available phosphoric acid, and acid phosphate 80c. per unit for available phosphoric acid. Steamed bones, unground, $20@$23; ground, $25@$26.

Charleston rock, undried, $5.75 per ton; kiln dried, $6.75@$7 per ton, both f.o.b. vessels at the mines. Freights by sail from Charleston to New York, $3@$3.25 per ton. Charleston rock, ground, $11.50@$12, ex-vessel at New York.

There has been a free movement, particularly in potash salts. Buyers have been quick to take advantage of the prices offered by the syndicate for orders placed before December 21st, and consequently a number of large transactions have been effected. The activity in double manure salts has been particularly noteworthy. We quote the following official prices: Double manure salts, 48 to 51 per cent sulphate of potash, for 1890 shipment, $1.12½ per 100 pounds: high grade manure salts, basis 90 per cent. sulphate of potash, $2.37½ per 100 pounds. These prices take effect to-day, the 21st inst., and are for invoices of 50 tons, based on foreign analyses and foreign invoice weights.

Muriate of potash.—Arrivals of 350 tons at Charleston are all that are reported this week. The syndicate prices taking effect to-day are $1.77½ per 100 pounds at New York.

Kainit is very quiet. For shipment, $10 per ton foreign invoice weight is asked.

Nitrate of soda is now apparently rather stiffer, on account of the decreased supply on the spot. For lots in this position $1.95 is now asked. For February arrivals $1.87½ is quoted, and January shipment can be obtained at $1.77½@$1.82½. The market now seems to be recovering from its recent depression, during which, it is said, cargoes for forward shipment were sold as low as $1.75.

Mr. F. B. Nichol's nitrate of soda statistics, issued this week, show that there were no arrivals during the fortnight ending the 15th inst. Deliveries during the same period aggregated 9,051 bags, in addition to which there are 2,000 bags afloat or in store in Philadelphia and Baltimore, making the aggregate spot supply 28,530 bags. Deliveries for the year to the 16th inst. amount to 517,161 bags as compared with 419,906 bags and 445,468 bags during the corresponding periods in 1888 and 1887 respectively. In speaking of the market Mr. Nichols says: "A better business than usual at the close of the year was done in the fortnight, proving, as we believe, that the deliveries are the result of a largely increased consumption in the ordinary channels which is likely to be increased in agricultural use in consequence of its lower cost. Our spot market has hardened with a steadily reduced supply, and it has helped the near by parcels on the way. The demand to arrive is active, particularly for the earlier shipments, but for late shipments the case is different. At last the nitrate magnates in London have realized that consumers wil not accept their domination of value with an unstinted production. When the shipments to Europe in November were announced at 120,000 tons on top of a steadily augmented supply, the buyers cried a halt. Now, we hear the cry of producers, or rather their agents in London, resolving on a decrease of production. If, instead of resolving, an actual curtailment had been effected two or three months ago, if it were possible, the producers would have been spared the distress of which the resolution is an obvious sign. If a wiser course had been pursued, such as adopting means for increasing the consumption in this country, which offers a splendid field for their effort, the producers would have a large help in using their improved method of production. The effect of the London resolution has been stated by the bulls, but the bears have yet to be heard from."

Brimstone is still rather weak. Buyers quote nominally $19½ for best unmixed seconds on the spot, and $18.75 for the same to arrive, and $18.25 for thirds to arrive. Large buyers of brimstone, however, claim to have received offers of quite large quantities at much lower figures than these.

NOTES OF THE WEEK.

In the Engineering and Mining Journal of January 4th next the usual annual review of the chemical and mineral market will be published. Any statistics or suggestions of interest concerning the progress of the trade during the year, or its present condition, will be gladly received.

South Carolina legislators are certainly industrious. A press dispatch from Charleston received during the week contains the following: "The House has just passed a bill to establish the Clemson Agricultural College, by which an appropriation of $39,000 a year in perpetuity is granted, not out of the taxes, but out of other funds. The bill appropriates the sinking fund, and authorizes the sale of all the farms and buildings of the State Agricultural Department. It also takes possession of the tax on fertilizers and the State's share of the Hatch fund."

Liverpool. Dec. 11.

(Special report by Messrs. J. P. Brunner & Co.)

Chemicals.—The principal feature this week in heavy chemicals has been the considerable drop in bleaching powder, while, on the other hand, caustic soda has improved, and higher prices are asked.

Soda ash is unchanged, carbonated being still unobtainable for this month. Caustic ash steady at 1@1⅛d., according to brand and quantity, and, although the demand is small, there are few sellers.

Soda crystals steady at £2 12s. 6d.@£2 15s. per ton. Caustic soda in demand and dearer; 60 per cent. scarce at £6 5s.@£6 7s. 6d.; 70 per cent. in small compass and held for £7 5s., while it is not easy to find sellers at the lower figure; 74 per cent. advanced at £7 17s. 6d.@£8; 76, £9. Over 1890 no fresh business is reported, but makers are rather firmer in their ideas, and most of them are not inclined to entertain business at the moment, preferring to look on in the expectation that the price will improve in the early part of next year. Bleaching powder has declined considerably, and business done this week at £5 12s 6d and also to-day at £5 10s. For next year the tone is very depressed, and while most makers are anxious to book orders, buyers are afraid to operate. Chlorate of potash declined to 4½@4¾d. Makers are fully sold, but second-hand lots are being pressed for sale. Bicarb. soda scarce and firm at £5 5s. per ton and upward for one cwt. kegs, according to brand and quantity, with usual allowances for larger packages. Sulphate of ammonia quiet at £12 per ton; nearest value for good gray 24 per cent. f.o.b. Liverpool.

BUILDING MATERIAL MARKET.

NEW YORK, Friday Evening, Dec. 20.

Bricks.—The weather is still a source of much complaint in building material circles, but on the whole the market for common hards has somewhat improved during the week. Navigation is likely to close at any moment, and in fact arrivals during the week have been rather light. It is estimated by competent authorities that the surplus supply carried over from day to day will not aggregate over 500,000 to 1,000,000 brick. The demand is, of course, irregular on account of frequent stoppage of work occasioned by the weather, but in general has been fair during the week. For Haverstraws $6.25@$6.75 is quoted; Up-Rivers are held at $5.50@$6.50; Jerseys at $5.50@$6.50, and Pales are a trifle stronger and in better demand, at $3@$3.75. No Long Island brick is expected until after the closing of river navigation.

Lime.—At the last meeting of the Rockland, Rockport and Thomaston makers, constituting the Knox County Lime Manufacturers' Association, it was decided to make no further allowance for production, and the only lime now produced will consequently come from those makers who up to date have not produced their full quota of the association. The demand, on the other hand, has been rather light. Very little St. John lime is coming forward, and, in fact, it is very difficult to obtain any trace of sales of the product of this section. State lime can now be shipped only by rail, and there is, of course, very little being received.

Cement.—All rail shipments are now in order, and, as might be expected, the volume of business has assumed the proportions usual at this season of the year. Rosendale makers are waiting with a good deal of interest for the report of the committee appointed by the State Legislature to consider the advisability of removing Sing Sing prison from its present site to one where more adequate accommodations for its inmates can be afforded. It will be remembered that it was suggested some time ago that the prison be removed to Schoharie County and that the cement deposits of that district be developed by the convicts. If this should be done the State, of course, will be able to compete with the Rosendale makers, and having pauper labor, would probably be able to place the latter at a disadvantage.

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IMPORTS AND EXPORTS OF METALS AT NEW YORK DECEMBER 7 TO DECEMBER 14, 1889, AND FROM JANUARY 1.

IMPORTS.

	Week.	Year.
Spelter.	Tons.	Tons.
Amer. Metal Co		198
Downing & Co., R. F		51
Hendricks Bros		28
Lamarche's Sons, H.		6
Lewisohn Bros		84
Naylor & Co	10	435
Total	10	804
Corres. date, 1888		2,178
Pig Lead.	Lbs.	Lbs.
Bruce & Cook		111
Caswell, E. A		10
Erie Dispatch		9
Foley, E		43
Henderson Bros		11
Hendricks Bros		78
Total		262
Corres. date, 1888		1,944
Tin.	Tons.	Tons.
Abbott & Co		80
Amer. Metal Co		1,519
Bidwell & French		1,460
Bruce & Cook		40
Bursley, Ira		75
Carter, Hawley & Co		46
Cohn & Co., A		12
Crooke S. & R. Co.		10
Crooks & Co		490
Davol & Son, John		29
Hendricks Bros		214
Herold, Emil		20
Knauth, N. & Kuhne		10
Lehmarer, S. & Co.		197
Mendel & Tompkins		1
Muller, Schall & Co		1,140
Naumann, F		2
Naylor & Co		1,965
Nissen, Geo		73
Phelps, Dodge & Co		3,510
Pope, J. E., Jr		293
Sehmarer & Co		11
Schreider, J. & Co.		10
Thomsen, A. A		151
Thomsen, D		196
Townsend, J. R		135
Unnamed		285
Wheeler & Co		1
Total		11,866
Corres. date, 1888	83	15,160
Tin Plates.	Boxes.	Boxes.
American Metal Co.		477
American Metre Co.		620
Brown & Co., V. H.		350
Bruce & Cook	2,152	89,453
Byrne & Co., J		8,392
Central Stamp. Co.		75,480
Coddington & Co	3,148	156,087
Cohen, S. M		272
Cohn & Co., A	1,393	36,091
Con. Fruit Jar Co.		2,387
Cort & Co., N. L	3,892	158,465
Corbier, F. & S		6,790
Crooks & Co	1,312	81,202
De Milt & Co		14,392
Dickerson, V. D	24,672	372,337
Downing & Co		366
Erie Dispatch		244
Fenton, D. U	218	6,108
Foley, E		74
G. L. N		75
Holder & Herrick		271
Iron Clad M. Co	120	403
Ismay, J. B		500
Lalance & G	495	9,224
Lazard Bros		2,356
Lombard, Ayres		3,000
Merchant & Co	3,022	29,986
Mersick & Co	1,311	13,537
Morewood & Co		7,568
Mulholland & H		767
Newell Bros		294
Payne & Son		313
Phelps, Dodge & Co	16,161	642,481
Pratt Mfg. Co	3,090	209,482
Sanders Bros		479
Shepard & Co	614	29,986
Somers Bros		1,356
Stillwell, G. H		325
Taylor Co., N. & G	162	2,906
Thomsen, A. A	5,750	164,516
Warren & Co., J. M.		4,134
Wheeler & Co	809	21,378
Whittemore & Co	474	37,129
Wolff & Reesing		10,605
Total	69,095	2,188,137
Corres. date, 1888	55,073	2,043,201
Pig Iron.	Tons.	Tons.
Baldwin, A		766
Bartlett, N. S	100	1,300
Crocker Bros	200	7,100
Crooks & Co	100	600
Drummond, McC. & Co		3,500
Henderson Bros		3,416
Godwin & Son, A. G		390
Irvin & Co., R	50	350
Lilienberg, N		350
Martin, W. T		200
Naylor & Co		50
Page, Newall & Co.		469
Perry & Ryer		125
Pierson & Co		500
Pope, Sons & Co		250
Sheldon & Co., G. W		200
Stetson & Co		5,750
Topper & Beattie		100
Walbaum & Co		275
Whittemore & Co., H		50
Williamson & Co		4,200
Total	250	30,844
Corres. date, 1888	1,260	58,049
Steel Sheets, Billets, Forging, etc.	Tons.	Tons.
Abbott & Co		2,450
Ames, W. T	50	351
Austin & Co	50	80
Baldwin Bros. & Co.		15
Belcher, H. W		95
Boker, C. F		131
Carey & Moen		118
Carter, G. F		200
Coddington & Co		24
Crenshaw, Hugh		27
Crooks & Co		292
Cortis, R. J		408
Curran, J		5
Dana & Co		14,846
Downing & Co		171
Erie Despatch		40
Galpin, S. H		497
Hugill, Chas		95
Ismay, J. B		174
Lalance, & G		106
Lazard Bros		6
Leng's Sons, J. S		411
Lublin & Estey		7
Lundberg, G		51
Mersick & Co		5
Milne & Co	30	3,171
Montgomery & Co.		5
Naylor & Co		2,750
Newton & S		35
Oelrich & Co		389
Pierson & Co		323
Pilditch, F. S		75
Power, C. W		36
Prosser, Thos		496
Roebling's Sons		355
Schulze & R		13
Standard Oil Co		222
Stetson & Co		11
Strouse & Co., M		25
Temple & L		15
Wagner, W. F		373
Wallace & Co		5
Wetheral Bros		2
Whitney & W		30
Wiel Elie		44
Wiell & Co		7
Williams, W		73
Williams & W		95
Wolff, R. H		347
Wright, P. & Son		4
Total	130	28,321
Corres. date, 1888	1,041	37,903
Bar Iron.	Tons.	Tons.
Abbott & Co., J.	90	3,627
American Metal Co		125
Bacon & Co	207	1,541
Dana & Co		25
Downing & Co	136	845
Froment, F		10
Fuller, Dana & Fitz		23
Haines, C. A		2
Holt & Co., H. N		374
Jacobus, E. G		35
Lang & Co		3
Lilienberg, N		8
Lundberg, G	187	1,980
Lundell, C. G		160
Merchants' Dispatch		15
Milne & Co		2,748
Muller, Schall & Co.		601
Naylor & Co		571
Ogden & W		7
Page, N. & Co		2,004
Plenty, John		2
Roebling's Sons	77	77
Troment, F		440
Wells, F., & Co		15
Total	697	14,930
Corres. date, 1888	2,837	8,460
Steel and Iron Rods.	Tons.	Tons.
Abbott & Co., J	357	6,298
American S. Co		1,071
Bacon & Co	50	557
Baker, H		3
Belcher, H. W		14
Boker, H		35
Bruce & Cook		20
Carey & Moen	55	1,112
Cooper, H. & Co		58
Crabb & Co., W		17
Dana & Co.		2,203
Downing & Co	269	1,074
Durbrow, Walter		829
Eckstein, G. C		298
Fuller, D. & T		15
Galpin, S. H	80	1,527
Greeley & Co		8
Hazard Mfg. Co		20
Heyn, A		2,124
Hugill, Chas		27
Jansen, J. A		150
Lee & Co., James	310	415
Lilienberg, N		56
Lundberg, G	80	1,200
Lundell, C. G	50	298
Merritt, A		3
Milne & Co	150	2,498
Montgomery & Co		120
Muller, Schall & C.		803
Naylor & Co	200	11,836
Nichols, B. J		10
Oelrichs & Co		103
Page, N. & Co	55	756
Pilditch, F. S	65	80
Plenty, J		1
Pratt Mfg. Co		30
Roebling's Son	184	2,669
Wagner, W. F		8
Wetherall Bros		2
Wheeler & Co., E. S.		120
Whitney & Co	152	1,297
Williams & W		5
Wolf & Co	16	4,813
Wright P. & Co		3
Total	2,073	45,713
Corres. date, 1888	4,440	56,452
Old Rails.	Tons.	Tons.
Baldwin Bros. & Co		240
Bowring & A		57
Crossman & Bro		2,162
Frankfort, M	200	920
Henderson Bros		150
Neumark & Gross		6,115
Perkins, C. L		535
Perry & Ryer		177
Sheldon & Co		203
Ward & Co., J. E		21
Wolff, H		259
Total	200	10,391
Corres. date, 1888		10,097
Scrap Iron.	Tons.	Tons.
Bowring, A		25
Burgass & Co		162
Crossman, W. H. & Bro		500
Downing & Co		321
Funch, E. & Co		397
Henry, A. F		100
Muller, Schall & Co		24
Neumark & Gross		500
Ruger, Theo		445
Spaulding & Co		172
Ward & Co., J. E	224	884
Watjen, T. & Co		152
Total	224	4,182
Corres. date, 1888	328	3,293
Charcoal Iron.	Tons.	Tons.
Bacon & Co		97
Downing & Co		671
Lilienberg N		6
Milne & Co		94
Muller, S. & Co		135
Naylor & Co		45
Page, N. & Co		754
Total		1,802
Corres. date, 1888	50	2,183
Sheet Zinc.	Lbs.	Lbs.
Crooks & Co		441,814
Lemarch's S's, H		1,554
Total		443,368
Corres. date, 1888		735
Spiegeleisen.	Tons.	Tons.
Abbott & Co		3,234
Blakely & McLellan		5,507
Crocker Bros	961	20,121
Dana & Co		14,269
Farris & Co		325
Geisenheimer & Co		310
Hernsheim, L	600	3,619
Jansen, J. A		10,466
Naylor & Co	1,000	15,620
Perkins, C. L		4,860
Pierson, C. L		45
Walbaum Bros		675
Total	2,561	67,122
Corres. date, 1888	458	43,343
Sheet Iron.	Tons.	Tons.
Coddington & Co		456
Downing & Co		16
Kelly, Hugh		5
Total		477
Corres. date, 1888	25	2,332
Iron Ore.	Tons.	Tons.
Bergen Pt. Chem. Co		9,951
Bowring, A		1,300
DeFlores, R		200
Earnshaw, A		5,496
Lawrence, Johnson & Co		180
Sheldon & Co., G. W.		25
Total		10,201
Corres. date, 1888		26,394

EXPORTS.

	Week.	Year.
Copper.	Pounds.	Pounds.
Abbott & Co	171,941	1,126,645
Amer. Metal Co	267,970	5,062,957
Am. & Patterson		2,897,706
Ansonia B. & C. Co		57,250
Barber & Co		100,000
Belmont & Co		987,500
Friedenstein, Jas		2,258
Fyfe, Robert		100,000
Hurst, F. W. J		113,000
Lewisohn Bros		1,653,713
Naylor & Co		1,570,500
Orford, C. & S Co.		112,013
Piper, D. & Co		3,898
Raftery, T. E		362,000
Seaman, Sam'l H		234,615
Ward & Co., J. E		11,250
Wil'ms & T'hune	115,036	958,606
Total	554,947	15,333,311
Corre. date, 1888	335,000	34,595,086
Copper Matte.		
Abbott & Co		427,613
Amer. Metal Co		4,517,187
Am. & Patterson		1,670,379
Clark, W. A		879,017
Cortis, R. J		240,000
Henriott, F		5,093,390
Lewisohn Bros	224,000	1,162,184
Nichols & Co., G. H	182,430	[illegible]
Oelrichs & Co		[illegible]
Paulsen, Wm	497,982	497,982
Seaman, Sam'l H		19,400
Wil'ms, T'hune	856,253	19,534,339
Total	1,362,683	34,944,729
Corres. date, 1888		56,872,848

DIVIDEND-PAYING MINES.

	Name and Location of Company.		Capital Stock.	Shares. No.	Par	Assessments. Total levied.	Date and amount of last.			Dividends. Total paid.	Date and amount of last.		
1	Adams, s. L.	Colo.	$1,500,000	150,000	$10	*				$555,000	Jan.	1887	.15
2	Alice, s. c	Mont	10,000,000	400,000	25	*				825,000	Dec.	1889	.06¼
3	Alma Cons., G	Idah.	300,000	30,000	10	*				45,000	Dec.	1888	.50
4	Alturas, G	Idah.	1,500,000	300,000	5					262,500	Jan.	1888	.37½
5	Amy & Silversmith, s.	Mon.		341,419						247,530	Aug.	1887	.12½
6	Atlantic, C	Mich	1,000,000	40,000	25	$280,000	Apl.	1875	$1.00	520,000	Feb.	1889	2.00
7	Argenta, s	Nev.	10,000,000	100,000	100	335,000	July	1889	.10	40,000	Feb.	1880	.20
8	Aspen Mg. & S., s. L.	Colo.	2,000,000	200,000	10	*				360,000	July	1889	.20
9	Aurora, I	Mich	2,000,000	100,000	20					155,000	Oct.	1887	1.87½
10	Bassick, G. s	Colo.	10,000,000	100,000	100	*				400,000	Mar.	1884	1.00
11	Belle Isle, s	Nev.	10,000,000	100,000	100	155,000	Apl.	1889	.10	300,00[illegible]	Dec.	[illegible]	.25
12	Belcher, G. s	Nev.	10,400,000	104,000	100	2,822,000	Feb.	1889	.50	15,397,200	Apl.	1876	1.00
13	Bellevue Idaho, s. L.	Idah.	1,250,000	125,000	10	88,750	May	1889	.10	187,500	Jan.	1887	10
14	Bodie Con., G. s	Cal.	10,000,000	100,000	100	575,000	Nov	1889	25	1,295,000	Apl.	1885	50
15	Boston & Mont, G	Mon.	2,500,000	250,000	10	*				520,000	Jun.	1886	.10
16	Boston & Mont., C. s.	Mon	2,500,000	100,000	25	*				1,300,000	Nov.	1889	1.00
17	Breece, s	Colo	,000,000	200,000	25	*				2,000	Feb.	1880	.01
18	Brooklyn Lead, L. s.	Utah	500,000	50,000	10					127,000	July	1887	.05
19	Bulwer, G	Cal.	10,000,000	100,000	10	130,000	Aug.	1889	.25	175,000	Jan.	1884	.10
20	Bunker Hill & Sull.	Idah.	3,000,000	300,000	10	*				150,000	Oct.	1883	.06⅔
21	Caledonia, G	Dak.	10,000,000	100,000	100	505,000	May	1885	.15	136,000	Oct.	1889	.08
22	Calumet & Hecla, C.	Mich	2,500,000	100,000	25	1,200,000				32,350,000	Oct.	1889	5.00
23	Carbonate Hill s. L.	Colo.	1,500,000	200,000	10	*				80,000	Apl.	1884	.05
24	Carlisle, G	N. M.	1,000,000	200,000	5					175,000	Dec.	1888	.12½
25	Castle Creek, G	Idah.	100,000	100,000	1					51,000	Oct.	1883	.03
26	Catalpa, s. L	Colo.	3,000,000	300,000	10	*				270,000	May.	1884	.10
27	Central, C	Mich	500,000	20,000	25	100,000	Sept	1861	.06	1,930,000	Feb.	1889	2.06
28	Chrysolite, s. L.	Colo.	10,000,000	200,000	50	*				1,650,000	Dec.	1884	.25
29	Colorado Central, s. L	Colo.	2,750,000	275,000	10	*				406,000	July	1889	.05
30	Confidence, s. L.	Nev.		24,960		287,440	Apl.	1887	.50	199,680	Apl.	1889	1.00
31	Cons. Cal. & Va., G s.	Nev.	21,600,000	216,000	100	108,000	Jan.	1885	.20	3,294,800	Dec.	1889	.50
32	Contention, s	Ariz.	12,500,000	250,000	50					†2,587,000	Dec.	1884	.25
33	**Cop. Queen Cons, C.	Ariz.	1,400,000	140,000	10					140,000	Oct.	1888	.50
34	Crescent, s. L. G.	Utah	15,000,000	600,000	25					228,000	Oct.	1888	.03
35	Crown Point, G. s.	Nev.	10,000,000	100,000	100	2,880,000	Sept	1889	.50	11,588,000	Jan.	1875	2.00
36	Daly, s. L	Utah	3,000,000	150,000	20					1,312,500	Dec.	1889	.25
37	Deer Creek, s. G	Idah.	1,000,000	200,000	5	*				20,000	Jun.	1889	.05
38	Deadwood-Terra, G.	Dak.	5,000,000	200,000	25	*				§1,000,000	Nov.	1887	.10
39	Derbec B. Grav., G. s.	Cal.	10,000,000	100,000	100	90,000	Dec.	1881	.10	180,000	May	1887	.10
40	Dunkin, s. L	Colo.	5,000,000	200,000	25	*				390,000	Sept	1889	.05
41	Dunstone, G. s. L.	Mont	1,000,000	200,000	5	*				6,000	Nov.	1888	.03
42	Eclipse	Colo.	100,000	100,000	1					20,000	Nov.	1887	.10
43	Elkhorn, G. s	Mont	1,000,000	100,000	10	50,000	July	1883	.50	170,000	July	1887	.05
44	Empire Lt., G	Mont	500,000	100,000	5					70,500	Oct.	1887	.37½
45	Eureka Con., G. s. L.	Nev.	5,000,000	50,000	100	550,000	Jun.	1880	.50	4,955,000	July	1888	.25
46	Evening Star, s. L	Colo.	500,000	50,000	10	*				1,437,500	Dec.	1889	.25
47	Excelsior, G	Cal.	10,000,000	100,000	100	560,000	Sept	1885	1.00	875,000	Oct.	1880	.25
48	Father de Smet, G.	Dak.	10,000,000	100,000	100	200,000	Nov	1878	1.00	1,125,000	Dec.	1885	.20
49	Franklin, C	Mich	1,000,000	40,000	25	220,000	Jun.	1871		1,600,000	Jan.	1889	2.00
50	Freeland, G. s. C	Colo.	5,000,000	200,000	25	*				190,000	July	1886	.10
51	Fresno Enterprise, G	Cal.	5,000,000	100,000	50		Mch	1883	.10	110,000	July	1882	.10
52	Garfield Lt., G. s	Nov.	500,000	100,000	5					85,000	Apl.	1888	.12½
53	Golconda, G. s	Idah.	1,000,000	100,000	10					120,000	May	1888	.60
54	Gould & Curry, G. s.	Nev.	10,800,000	108,000	100	4,434,600	Oct.	1889	.30	[illegible]826,800	Oct.	1870	10.00
55	Grand Central, s	Ariz.	1,000,000	100,000	10					625,000	Dec	1882	.25
56	Grand Prize, s	Nev.	10,000,000	100,000	100	715,000	Nov.	1889	.30	49[illegible]	Mar	1884	.25
57	Granite, s. L	Idah.	500,000	500,000	1	*				10,000	Jun.	1888	.02
58	Granite Mountain, s.	Mont	10,000,000	400,000	25					7,600,000	Nov.	1889	.50
59	Green Mountain, G	Cal.	1,250,000	125,000	10	*				212,000	Nov.	1881	.07½
60	Hale & Norcross, G. s	Nev.	11,200,000	112,000	100	5,086,000	July	1887	.50	1,162,000	July	1888	.50
61	Hecla Con., s. G. L. C.	Mont	1,500,000	30,000	50					1,332,500	May	1889	.50
62	Hel'a Mg & Red, G. s. L	Mont	3,315,000	663,000	5	*				197,979	July	1886	.06
63	Holmes, s	Nev.	10,000,000	100,000	100	300,000	Sept	1885	.10	75,000	Apl.	1886	.25
64	Holyoke, G	Idah	200,000	200,000	1					27,000	Feb.	1883	.10
65	Homestake, G	Dak.	12,500,000	125,000	100	200,000	July	1878	1.00	4,481,250	Dec.	1889	.10
66	Honorine, s. L	Utah	500,000	250,000	2	37,500	Apl.	1889	.05	125,000	Sept	1887	.05
67	Hope, s	Mont	1,000,000	100,000	10	*				233,252	Apl.	1888	.25
68	Horn-Silver, s. L	Utah	10,000,000	400,000	25	*				4,050,000	Dec.	1889	.12½
69	Hubert, G	Colo.	1,000,000	100,000	1	*				247,000	Dec.	1889	.00½
70	Idaho, G	Cal.	310,000	3,100	100					5,250,500	Dec.	1889	5.00
71	Ideal, s. L	Colo.	1,500,000	50,000	10					15,000	Oct.	1886	.05
72	Illinois, s	N. M.	100,000	100,000	1	*				45,000	Apl	1889	.20
73	Independence, s	Nev.	10,000,000	100,000	100	340,000	Oct.	1886	.20	225,000	Sept	1879	.25
74	Iron Hill, s	Dak.	2,500,000	250,000	10	134,000	July	1888	.03	156,250	Nov	1887	.07½
75	Iron-Silver, s. L	Colo.	10,000,000	500,000	20	*				2,500,000	Apl.	1889	.20
76	Jackson, G. s	Nev.	5,000,000	50,000	100	237,500	Nov	1880	.20	55,000	Jun.	1889	.10
77	Jay Gould	Mont	2,000,000	40,000	5	*				365,000	Apl.	1889	.04
78	Jocuistita, s	Mex.	2,500,000	250,000	10					1,200,000	Feb.	1885	.50
79	Jumbo, G	Colo.	2,000,000	200,000	10					35,000	Oct.	1887	.02½
80	Kearsarge, C	Mich	1,250,000	50,000	25	190,000	Oct.	1887	1.00	100,000	Jan.	1890	2.00
81	Kentuck	Nev.	3,000,000	30,000	100	360,000	July	1889	.30	1,350,000	Dec.	1886	.10
82	La Plata, s. L	Colo.	2,000,000	200,000	10	*				610,000	Sept	1882	.30
83	Leadville Cons., s. L. I.	Colo.	4,000,000	400,000	10	*				423,000	Apl.	1887	.05
84	Lexington, G. s	Mont	4,000,000	40,000	100	*				565,000	Jan.	1885	2.00
85	Little Chief, s. L	Colo.	10,000,000	200,000	50	*				800,000	July	1888	.10
86	Little Pittsburg, s. L	Colo.	20,000,000	200,000	100	*				1,050,000	Mch.	1880	50
87	Marion Bullion, G	N.C.	500,000							15,000	Jan.	1886	
88	Martin White, s	Nev.	10,000,000	100,000	100	1,175,000	Jan.	1889	.25	140,000	Dec.	1886	.25
89	Mary Murphy, G. s	Colo.	350,000	3,500	100	*				175,000	May	1888	5.00
90	Minnesota, C	Mich	1,000,000	40,000	25	420,000	Apl.	1886	1.00	1,820,000	Mar.	1876	
91	Mono, G	Cal.	5,000,000	50,000	100	102,850	Nov.	1889	.25	12,500	Mar.	1886	.25
92	Montana, Lt., G. s	Mont	3,300,000	660,000	5	*				2,355,285	Oct.	1889	.12½
93	Morning Star, s. L	Colo.	1,000,000	100,000	10					795,000	Dec.	1889	.20
94	Moulton, s. G	Mont	2,000,000	400,000	5	*				380,000	Dec.	1887	.07½
95	Mount Pleasant, G	Cal.	150,000	150,000	1	*				150,000	Feb.	1887	.30
96	Mt. Diablo, s	Nev.	5,000,000	50,000	100	137,500	Jun.	1880	2.00	150,000	Oct.	1889	.20
97	Napa, Q	Cal.	700,000	100,000	7					310,000	July	1889	.10
98	Navajo, G. s	Nev.	10,000,000	100,000	100	485,000	Apl.	1888	.30	365,000	Apl.	1889	.10
99	New Guston, s	Colo.	500,000	100,000	5					200,000	Oct.	1889	.50
100	N. Hoover Hill, G. s.	N. C.	300,000	120,000	2½	*				30,000	Dec.	1885	.06¼
101	Northern Belle, s	Nev.	5,000,000	50,000	100	425,000	Jan.	1884	8.50	2,400,000	Apl.	1888	.50
102	North Belle Isle, s.	Nev.	10,000,000	100,000	100	400,000	Sept	1889	.20	230,000	May	1888	.50
103	North Star, G	Cal.	1,000,000	100,000	10					00,000	Sept	1889	.50
104	Ontario, s. L	Utah	15,000,000	150,000	100					10,625,500	Dec.	1889	.50
105	Ophir, G. s	Nev.	10,000,000	100,000	100	4,159,440	May	1889	.50	1,595,800	July	1882	1.00
106	Original, s. C	Mont	1,500,000	60,000	25	*				123,000	July	1888	.05
107	Osceola, C	Mich	1,250,000	50,000	25	480,000	Apl.	1876	1.60	1,222,500	Mar.	1889	1.00
108	Oxford, G	N. S.	125,000	125,000	1	*				73,500	Sept	1888	.02
109	Paradise Valley, G. s.	Nev.	10,000,000	100,000	100	57,000	Apl.	1888	.15	150,000	Apl.	1887	.10
110	Parrot, C	Mont	1,800,000	180,000	10					480,000	Oct.	1889	.05
111	Peacock, s. G. C	N.M.	2,000,000	200,000	10	*				60,000	Nov.	1886	
112	Plumas Eureka, G	Cal.	1,406,250	140,625	10					2,548,046	Oct.	1889	.37½
113	Plutus, G. s. C. L.	Colo.	2,000,000	200,000	10	*				20,000	Feb.	1886	.10
114	Plymouth Con., G	Cal.	5,000,000	100,000	50	*				2,280,000	Feb.	1888	40
115	Quicksilver, pref., Q.	Cal.	4,300,000	43,000	100					1,728,462	Oct.	1889	1.50
116	" com., Q.	Cal.	5,700,000	57,000	100					643,867	July	1882	.40
117	Quincy, C	Mich	1,000,000	40,000	25	200,000	Dec.	1862		5,250,000	Aug.	1889	2.00
118	Richmond, s. L	Nev.	1,350,000	54,000	25	*				4,312,587	Jun.	1887	1.25
119	Ridge, C	Mich.	500,000	20,000	25	219,939	Mar	1886	.50	99,785	Feb.	1880	.50
120	Robinson Con., s. L	Colo.	10,000,000	200,000	50	*				585,000	Mar.	1886	.05
121	Robert E. Lee, s. L	Colo	10,000,000	500,000	20					100,000	Dec.	1882	.50
122	Savage, s	Nev.	11,200,000	112,000	100	6,542,000	July	1889	50	4,460,000	July	1869	3.00
123	Shoshone, G	Idah.	150,000	150,000	1					7,500	Apl.	1883	.01
124	Sierra Buttes, G	Cal.	2,225,000	122,500	10					1,568,145	Apl.	1888	.12½
125	Sierra Nevada, G. s.	Nev.	10,000,000	100,000	100	6,250,000	Oct.	1889	.50	102,000	Jan.	1871	1.00
126	Sierra Nevada, s. L.	Idaho	1,000,000	¶	1	*				40,000	May	1889	.02
127	Silver Cord, G. s. L.	Colo.	4,500,000	450,000	10					270,000	Apl.	1889	.10
128	Silver King, s	Ariz.	10,000,000	100,000	100	50,000	Jun.	1888	.50	1,950,000	July	1887	.25
129	Silver Mg. of L. V.	N. M.	500,000	500,000	1					50,000	June	1889	.05
130	Silverton, G. s. L.	Colo.	2,000,000	200,000	10	*				50,000	Nov.	1886	.02
131	Small Hopes Cons., s.	Colo.	5,000,000	250,000	20	*				3,137,500	Jun	1889	.10
132	Smuggler, s. L	Colo.	600,000	60,000	10					66,700	Aug.	1883	.25
133	Spring Valley, G	Cal.	200,000	200,000	1	50,000	Oct.	1886	.25	50,000	Jan	1881	25
134	Standard, G. s	Cal.	10,000,000	100,000	100	25,000	Oct.	1884	.25	3,595,000	Jun.	1888	.05
135	Stormont, s	Utah	500,000	500,000	1	*				155,000	Nov.	1881	.05
136	St. Joseph, L	Mo.	1,500,000	150,000	10	*				844,000	Dec	1887	.20
137	Surinam, G	D. G.	3,000,000	600,000	5					105,000	Nov	1887	.05
138	Swansea, G	Colo.	600,000	60,000	10	*				9,000	Apl.	1888	.02½
139	Syndicate, G	Cal.	10,000,000	100,000	100	38,729	July	1882	.15	48,308	Sept	1885	.10
140	Tamarack, C	Mich.	1,000,000	40,000	25	520,000	Apl.	1885	3.00	1,200,000	Jan.	1890	3.00
141	Tip Top, s	Ariz.	10,000,000	100,000	100	250,000	Sept	1883	.25	100,000	Nov.	1881	.20
142	Tombstone, G. s. L.	Ariz.	12,500,000	500,000	25	*				1,250,000	Apl.	1882	.10
143	United Verde, C	Ariz.	3,000,000	300,000	10‡	*				97,500	Feb.	1884	.20
144	Valencia, M	N. H.	150,000	1,500	100	*				37,500	Apl.	1886	2.50
145	Viola Lt., s. L	Idah.	750,000	150,000	5	*				272,500	Oct.	1888	.37½
146	Ward Cons., s. L	Colo.	2,000,000	200,000	10					200,000	Dec.	1889	.05
147	Yankee Girl	Colo.	2,500,000	250,000	10					1,275,000	July	1887	.10
148	Yellow Jacket, G. s.	Nev.	12,000,000	120,000	100	5,508,000	Mar	1889	.50	2,184,000	Aug	1871	1.50
149	Webb City, L. Z.	Mo.	55,000	11,000	5					3,300	Jun.	1889	.10

NON-DIVIDEND PAYING MINES.

	Name and Location of Company.		Capital Stock.	Shares. No.	Par Value	Assessments. Total levied.	Date & amt of last.		
1	Agassiz Cons., s. L.	Colo.	$2,500,000	50,000	$50	*			
2	Allouez, C	Mich	2,000,000	80,000	25	$697,000	Mar.	1889	.50
3	Alpha Con., G. s.	Nev.	3,000,000	30,000	100	588,750	July	1889	.37½
4	Alta, s	Nev.	10,080,000	100,800	100	2,248,800	Sept	1888	.50
5	Amador, G	Cal.	400,000	200,000	2	*			
6	American Flag, s	Colo.	1,250,000	125,000	10	300,000	Jun	1877	.50
7	Anglo-Montana, Lt.	Mon.	600,000	120,000	5				
8	Appalachian, Lt., G.	N. C.	1,500,000	300,000	5				
9	Astoria, G	Cal.	200,000	100,000	2				
10	Barcelona, G	Nev.	5,000,000	200,000	25	*			
11	Bechtel Con., G	Cal.	10,000,000	100,000	100	173,500	Jan.	1883	.10
12	Belmont, s	Nev.	5,000,000	50,000	100	735,000	Apl.	1886	.10
13	Best & Belcher, G. s.	Nev.	10,080,000	100,800	100	2,155,390	Sept	1889	.25
14	Big Pittsburg, s. L.	Colo.	20,000,000	200,000	100	*			
15	Bi-Metallic, s	Mon.	5,000,000	200,000	25	*			
16	Black Oak, G	Cal.	3,000,000	300,000	10	*			
17	Boston Con., G	Cal.	10,000,000	100,000	100	170,000	Nov	1883	.25
18	Bremen, s	N. M.	5,000,000	500,000	10	*			
19	Brunswick, G	Cal.	2,000,000	400,000	5	*			
20	Bullion, G. s	Nev.	10,000,000	100,000	100	4,007,000	Aug.	1888	.50
21	Calaveras, G.	Cal.	500,000	500,000	1	*			
22	Carisa, G	Wy.	500,000	100,000	5	*			
23	Carupano, G. s. L. C.	Ven.	200,000	100,000	2	*			
24	Cashier, G. s.	Colo.	500,000	250,000	2	*			
25	Cen. Contin'l, G. s. L.	C.&A	2,000,000	200,000	10	*			
26	Charles Dickens, G. s.	Idah.	1,250,000	250,000	5	*			
27	Cherokee, G	Cal.	1,500,000	150,000	10				
28	Chollar, s	Nev.	11,200,000	112,000	100	1,484,000	July	1889	.50
29	Cleveland, T	Dak.	1,000,000	500,000	2	*			
30	Colchis	N.M.	500,000	50,000	10				
31	Commonwealth, s	Nev.	10,000,000	100,000	100	170,000	Nov.	1882	.50
32	Comstock, G. s	Nev.	10,000,000	100,000	100	30,000	Mar.	1887	.15
33	Con. Imperial, G. s.	Nev.	5,000,000	50,000	100	1,802,500	Nov.	1889	.05
34	Con. Pacific, G	Cal.	6,000,000	60,000	100	192,000	Oct.	1889	.10
35	Cons. Silver, s	Mo.	2,500,000	250,000	10				
36	Courtlandt	Colo.	500,000	50,000	10				
37	Crescent, s. L.	Colo.	3,000,000	300,000	10	*			
38	Crocker, s	Ariz.	10,000,000	100,000	100	125,000	Jun.	1889	.10
39	Crowell, G	N. C.	500,000	500,000	1				
40	Dahlonega, G	Ga.	250,000	250,000	1	*			
41	Dandy, s	Colo.	5,000,000	500,000	10				
42	Dardanelles, s	Cal.	1,000,000	100,000	10				
43	Decatur, s	Colo.	1,500,000	300,000	5	*			
44	Denver City, s. L	Colo.	5,000,000	500,000	10	*			
45	Denver Gold, G	Colo.	300,000	60,000	5				
46	Durango, G	Colo.	500,000	500,000	1	*			
47	Eastern Dev. Co., Lt.	N. S.	1,500,000	150,000	10	990,000	Mar.	1886	1.00
48	El Cristo, G. s	U.S.C	1,000,000	500,000	2				
49	El Dorado, G	Cal.	1,000,000	250,000	4	*			
50	El Talento, G	U.S.C	1,000,000	500,000	2				
51	Empire, s	Utah	10,000,000	100,000	100				
52	Eureka Tunnel, s. L.	Nev.	10,000,000	100,000	100	*			
53	Exchequer	Nev.	10,000,000	100,000	100	615,000	Apl.	1889	.25
54	Found Treasure, G. s.	Nev.	10,000,000	100,000	100	30,500	Apl.	1889	12½
55	Gogebic I. Syn., I	Wis.	5,600,000	200,000	25				
56	Gold Cup, s	Colo.	500,000	500,000	1	*			
57	Golden Era, s	Mon.	2,000,000	200,000	10	*			
58	Gold Placer, G	Colo.	5,000,000	200,000	25	229,314	Dec.	1885	.25
59	Gold Rock, G	Cal.	1,000,000	500,000	2	*			
60	Goodshaw, G	Cal.	10,000,000	100,000	100	*			
61	Grand Belt, C	Tex.	12,000,000	120,000	100				
62	Grand Duke	Colo.	800,000	80,000	10				
63	Great Remance, G	U.S.C	1,000,000	500,000	2	*			
64	Gregory-Bobtail, G	Colo.	550,000	550,000	1	*			
65	Gregory Con., G	Mon.	3,000,000	300,000	10				
66	Harlem M. & M. Co., G.	Cal.	1,000,000	200,000	5				
67	Head Cent. & Tr. s. G	Ariz.	10,000,000	100,000	100				
68	Hector, G	Cal.	1,500,000	300,000	5	45,000	Jan.	1889	.15
69	Highland, C	Mich	500,000	25,000	20				
70	Hollywood	Cal.	200,000	100,000	2				
71	Hortense, s	Colo.	2,000,000	200,000	10				
72	Huron, C	Mich	1,000,000	40,000	25	280,000	May	1887	3.00
73	Iron Gold & Silver, s	N. M.	2,000,000	200,000	10	*			
74	Ironton, I	Wis.	1,000,000	40,000	25				
75	Iroquois, C	Mich	1,250,000	50,000	25				
76	J. D. Reymert	Ariz.	10,000,000	100,000	100	*			
77	Julia Cons., G. s.	Nev.	11,000,000	110,000	100	1,060,000	Jan.	1889	.10
78	Lacrosse, G	Colo.	1,000,000	100,000	10	*			
79	Lee Basin, s. L.	Colo.	5,000,000	500,000	10	*			
80	Mammoth Bar., G.	Cal.	10,000,000	100,000	100	50,000	Dec.	1881	
81	May Belle, G	Cal.	10,000,000	100,000	100	84,000	Mar.	1884	.15
82	Mayflower Gravel	Cal.	1,000,000	100,000	10	485,000	Jan	1889	.50
83	Medora, G	Dak.	250,000	250,000	1				
84	Mexican, G. s	Nev.	10,000,000	100,000	100	2,775,760	July	1889	.25
85	Middle Bar G	Cal.	400,000	200,000	2	*			
86	Mike & Starr, s. L.	Colo.	1,000,000	200,000	5	*			
87	Monitor, G	Colo.	100,000	100,000	1	*			
88	Moose Silver, s	Colo.	3,000,000	300,000	10	*			
89	Mutual Mg. & Sm.	W'sh	100,000	100,000	1	*			
90	Native, C	Mich	1,000,000	40,000	25				
91	Neath, G	Colo.	1,000,000	100,000	10				
92	Nevada Queen, s	Nev	10,000,000	100,000	100	250,000	Oct.	1889	.20
93	New Germany, G	N. S.	100,000	100,000	1	*			
94	New Pittsburg, s. L	Colo.	2,000,000	200,000	10	*			
95	N. Commonw'h, s	Nev.	10,000,000	100,000	100	60,000	Apl.	1889	.30
96	North Standard, G	Cal.	10,000,000	100,000	100	20,000	Nov		
97	Noonday	Cal.	600,000	60,000	10	208,000	Dec	1881	.10
98	Oneida Chief, G	Cal.	500,000	125,000	100	*			
99	Oriental & Miller, s.	Nev.	10,000,000	400,000	25				
100	Osceola, G	Nev.	5,000,000	500,000	10	*			
101	Overman, G. s	Nev.	11,520,000	115,200	100	3,794,600	July	1889	.25
102	Park, s.	Utah	2,000,000	200,000	10				
103	Peer, s	Ariz.	10,000,000	100,000	100	155,000	Sept	1889	.10
104	Peerless, s	Ariz.	10,000,000	100,000	100	370,000	Mar.	1889	.25
105	Phoenix	Ariz.	500,000	500,000	1	*			
106	Phoenix, G. s.	Ark.	5,000,000	200,000	250	*			
107	Phoenix Lead, s. L.	Colo.	100,000	100,000	1	*			
108	Pilgrim, G	Cal.	600,000	300,000	2	*			
109	Potosi, s	Nev.	11,200,000	112,000	100	1,461,600	Sept	1889	.50
110	Proustite, s	Idah	250,000	250,000	1	*			
111	Puritan s. G	Colo.	1,500,000	150,000	10	*			
112	Quincy	Colo.	3,000,000	300,000	10				
113	Rappahannock, G. s.	Va.	250,000	250,000	1	*			
114	Red Elephant, s	Colo.	500,000	500,000	1	*			
115	Ropes, G. s.	Mich	2,000,000	80,000	25	147,200	July	1887	.50
116	Russell, G	N. C.	1,500,000	300,000	5				
117	Sampson, G. s. L.	Utah	10,000,000	100,000	100	288,157	July	1888	.06
118	San Sebastian, G	San.S	1,600,000	320,000	5	*			
119	Santa Fe, C	N. M.	5,000,000	500,000	10				
120	Santiago, G	U.S.C	400,000	200,000	2	*			
121	Security, s	Colo.	10,000,000	1,000,000	10				
122	Sheridan	N. M.	2,000,000	200,000	10				
123	Silver Queen, C	Ariz.	5,000,000	200,000	25	*			
124	South Bulwer, G	Cal.	10,000,000	100,000	100	100,000	May	1881	.25
125	South Hite	Cal.	10,000,000	100,000	100	195,000	Jan.	1883	.05
126	South Pacific	Cal.	500,000	100,000	5				
127	Stanislaus, G	Cal.	2,000,000	200,000	10				
128	State Line, s	Nev.	250,000	250,000	1				
129	St. Kevin, G. s.	Colo.	100,000	100,000	1	*			
130	St. Louis & Mex., s.	Mex.	5,000,000	500,000	10	*			
131	St. Louis & St. Elmo	Colo.	2,000,000	200,000	10				
132	St. L. & St. Felipe, G. s.	Mex.	1,500,000	150,000	10				
133	St. L. & Sonora, G. s.	Mex.	1,500,000	150,000	10				
134	St. Louis-Yavapai	Ariz.	3,000,000	300,000	10	*			
135	Sunday Lake, I	Mich	1,250,000	50,000	25				
136	Sullivan Cons. G	Dak.	600,000	200,000	3	*			
137	Sutter Creek, G	Cal.	500,000	100,000	5				
138	Sutro Tunnel	Nev.	20,000,000	2,000,000	10	*			
139	Sylvanite, s	Colo.	5,000,000	500,000	10	*			.10
140	Taylor-Plumas, G	Cal.	1,000,000	200,000	5	10,000	Feb.	1888	.25
141	Tioga Cons., G	Cal.	10,000,000	100,000	10	295,000	May	1888	.25
142	Tornado Cons. G. s.	Nev.	100,000	100,000	1	*			
143	Tortilita, G. s	Ariz.	1,000,000	100,000	110	*			
144	Tuscarora, s	Nev.	10,000,000	500,000	20	160,000	Oct.	1889	
145	Union Con., G s	Nev.	10,000,000	100,000	100	3,260,000	Oct.	1889	
146	Utah, s	Nev.	10,000,000	100,000	100	170,000	July	1889	
147	Washington, C	Mich	1,000,000	40,000	25				
148	West Granite Mt., s.	Mon.	5,000,000	500,000	10	*			
149	Zelaya, G. s	C. A.	600,000	300,000	2	*			

G. Gold. S. Silver. L. Lead. C. Copper. * Non-assessable. † This company, as the Western, up to Dec. 10th, 1881, paid $1,400,000. ‡ Non-assessable for three years. § The Deadwood previously paid $275,000 in eleven dividends, and the Terra $75,000. Previous to the consolidation in Aug., 1884, the California had paid $31,320,000 in dividends, and the Con. Virginia, $[illegible]40,-00,000. ** Previous to the consolidation of the Copper Queen with the Atlanta, Aug., 1885, the Copper Queen had paid $1,350,000 in dividends. ¶ 1,000,000.

NEW YORK MINING STOCKS QUOTATIONS.

DIVIDEND-PAYING MINES.

NAME AND LOCATION OF COMPANY.	Dec. 14. H.	Dec. 14. L.	Dec. 16. H.	Dec. 16. L.	Dec. 17. H.	Dec. 17. L.	Dec. 18. H.	Dec. 18. L.	Dec. 19. H.	Dec. 19. L.	Dec. 20. H.	Dec. 20. L.	SALES.
Alice, Mont													
Argenta, Nev			.16								1.00		500
Atlantic, Mich													
Basie, Colo													200
Belcher													
Belle Isle, Nev					.20								200
Bodie Cons., Cal					.70		.70						300
Bes. & Mont., Mont													
Breece, Colo													
Bulwer, Cal							.45						200
Caledonia, Dak													
Calumet & Hecla													
Colorado Central									1.05				500
Cons. Cal. & Va., Nev	4.75		4.75	4.65	4.65	4.50	4.50	4.40	4.50	4.30	4.50		1,710
Crown Point, Nev	1.90												100
Deadwood, Dak													
Eureka Con., Nev					2.88		3.25						200
Father de Smet, Dak													
Franklin, Mich													
Freeland, Colo	.50				.45		.50		.50		.50		3,500
Gould & Curry, Nev			1.60										100
Hale & Norcross, Nev							2.55		2.50		2.45		215
Holyoke, Id													
Homestake, Dak													
Horn-Silver, Ut	2.25		2.25				2.10	2.10			2.00		1,300
Iron Hill, Dak													
Iron Silver, Colo													
Leadville C., Colo													
Little Chief, Colo			.29	.28					.30		.30		1,400
Little Pittsburg, Colo													
Mono, Cal													
Moulton													
Navajo, Nev					.33		.35						600
North Belle Isle, Nev							1.15						1 0
North Star, Cal													
Ontario, Ut							36.00		36 00		36.00		250
Ophir, Nev	3.45				3.30		3.15				3.25		650
Osceola, Mich													
Plutus, Colo													
Plymouth, Cal					3.00						3.50		200
Quicksilver, Pref									36.00	35.00			200
" Com			5.87	5.63	6.13				6.38	6.13	6.5		1,100
Robinson Cons. Colo													
Savage, Nev					1.60		1.60						150
Sierra Nevada, Nev			2.05		2.00								400
Silver Cord											.60		3,000
Silver King	.40		.0		.50		.50						305
Silver Mg. of L. V.													
Standard, Cal							.65						100
Stormont, Utah													
Tamarack, Mich													
Ward Con													
Yellow Jacket													

NON-DIVIDEND-PAYING MINES.

NAME AND LOCATION OF COMPANY.	Dec. 14. H.	Dec. 14. L.	Dec. 16. H.	Dec. 16. L.	Dec. 17. H.	Dec. 17. L.	Dec. 18. H.	Dec. 18. L.	Dec. 19. H.	Dec. 19. L.	Dec. 20. H.	Dec. 20. L.	SALES.
Alpha							1.30						
Alta, Nev					1.30				1.40				250
Andes, Nev	.85								.75				300
Amador, Cal													150
American Flag, Colo													
Astoria, Cal	.19	.10	.18	.11	.13	.10	.13	.11	.12		.16		14,400
Barcelona, Nev			.30				.26	.25					800
Bechtel, Cal							.10						
Best & Belcher, Nev	2.65		2.65		2.45				2.50		2.45		100
Brunswick, Cal					.01								550
Bullion, Nev	.75				.59		.70						1,500
Cashier, Colo													1,150
Castle Creek, Id													
Choller, Nev							2.45						
Col. & Beaver, Id													00
Comstock T., Nev	.20		.18		.19								1,700
" scrip							.37						500
Con. Pacific, Cal													
Denver City, Colo													
Eastern Oregon													
ElCristo, Rep. of Col.	1.30	1.20	1.35	1.20	1.50	1.30	1.60	1.4	1.65	1.50	1.65	1.45	12,120
Excelsior, Cal													
Exchequer, Nev	.70												200
Gold Cup, Cal													
Julia, Nev	.30												
Kingst'n & Pemb'ke	.65												200
Kossuth, Nev											.60	.55	800
Lacrosse, Colo													
Lee Basin, Colo													
Mexican, Nev			2.75						2.60		2.40		400
Middle Bar, Cal													
Moniter, Colo													
Mutual Sm. & M. Co	1.65		1.60		1.60		1.65		1.60		1.60		600
NevadaQueen, Nev													
N. Com'nw'th, Nev													
Occidental, Nev			1.00	.95			.90	.85			.75		1,200
Oriental & Mil., Nev	.08										.06		2,200
Overman, Nev	1.15						.95						200
Phœnix of Ariz			.43	.39	.45	.40	.44	.43					1,400
Potosi, Nev					2.05						1.75		200
Rappahann'k, Va	.3		.05						.05				1,600
S. Sebastian, San S					1.70								10
Scorpion, Nev													
Shoshone, Idaho													
Silver Hill, Nev	.50												
Silver Queen													200
Stanislaus, Cal													
Sutro Tunnel, Nev									.08		.07		
" Trust Cert.									.51		.5		1,700
Sutter Creek, Cal	.58		.59	.58	.60	.59	.59	.58			.60	.59	200
Union Cons., Nev					2.00								7,200
United Copper													200
Utah, Nev	.80		.90		.6		.7		.70		.70		1,30

*Ex. dividend. †Dealt in at the New York StockEx. Unlisted securities ‡Assessment unpaid. Dividend shares sold, 17,110. Non-dividend shares sold, 53,480 Total, New York, 70,590.

BOSTON MINING STOCK QUOTATIONS.

NAME OF COMPANY.	Dec. 13. H.	Dec. 13. L.	Dec. 14. H.	Dec. 14. L.	Dec. 16. H.	Dec. 16. L.	Dec. 17. H.	Dec. 17. L.	Dec. 18. H.	Dec. 18. L.	Dec. 19. H.	Dec. 19. L.	SALES.
Atlantic, Mich	12.25		12.50				14.38	14.00					290
Bodie, Cal													
Bonanza Developm't	.83		.80		.80				.75		.75	.60	684
Bost. & Mont., Mont	44.25	44.00	44.00	43.50	44.75	43.50	44.00	43.50	44.0	43.50	45.00	44.50	1,534
Breece, Colo													
Calumet & Hecla, Mich	245		245		245½		246	245	248	246	248		173
Catalpa, Colo													
Central, Mich													
Chrysolite, Colo													
Con. Cal. & Va., Nev													
Dunkin, Colo							.65				.60		150
Enterprise													
Franklin, Mich	16.00		16⅞		17.25	17.00					17.25	16.50	680
Hale & Norcross, Nev													
Honorine, Utah													
Little Chief													
Little Pittsburg, Colo													
Martin White, Nev													
Moulton													
Napa, Cal													
Ontario, Utah													
Osceola, Mich	17.75	17.00			19 50	16.50	19.25	19 00	18.50	18.25	19 50	18.50	2,045
Pewabic, Mich	7.00						7.0						700
Quincy, Mich					69.00		67.00				67.00		120
Ridge, Mich													
Sierra Nev., Nev													
Silver King, Ariz													
Standard, Cal													
Tamarack, Mich			145	137	140		139	138	14	139	141		244

NAME OF COMPANY.	Dec. 13. H.	Dec. 13. L.	Dec. 14. H.	Dec. 14. L.	Dec. 16. H.	Dec. 16. L.	Dec. 17. H.	Dec. 17. L.	Dec. 18. H.	Dec. 18. L.	Dec. 19. H.	Dec. 19. L.	SALES.
Allouez, Mich	1 00				1.00	.90							225
Arnold, Mich													
Aztec, Mich													
Bowman													
Butte & Bost., Mont													
Canada													
Cashier, Colo													
Crescent, Colo													
Denver City, Colo													
Don Enrique, N. M.													
Everett, Mich													
Hanover, Mich													
Humboldt, Mich													
Hungarian													
Huron, Mich			2.50	2.00									125
Kearsarge	7.50	7.25	7.00		7.00	6.50	7.00				7.00		375
Mesnard, Mich													
National, Mich							2.50						10
Oriental & M., Nev													
Phœnix, Ariz													
Pontiac, Mich													
Rappahannock, Va													
Rockland													
Santa Fe, N. Mex	1.05	1.03			1.03	.87	1 23	.80	1 25	1.13	1.30	1.22	30,936
Security, Colo													
Shoshone, Idaho													
South Side, Mich													
St. Louis Cop., Mich							.20						350
Washington, Mich													

Boston: Dividend shares sold, 6,629. Non-dividend shares sold, 32,621. Total Boston, 38,650.

COAL STOCKS.

NAME OF COMPANY.	Par val. of sh'rs.	Dec. 14. H.	Dec. 14. L.	Dec. 16. H.	Dec. 16. L.	Dec. 17. H.	Dec. 17. L.	Dec. 18. H.	Dec. 18. L.	Dec. 19. H.	Dec. 19. L.	Dec. 20. H.	Dec. 20. L.	Sales.
American Coal														
Cambria Iron														
Cameron Coal & Iron Co		5	4½					4½						250
Ches. & O. RR	100													
Chic. & Ind. Coal RR	100													
Do. pref	100													
Col. & Hocking Coal	100													
Col., C. & I	100	39	38	39¼	38½	39⅛	38¾	38⅝	38	38⅝	38¼	39⅜	38½	4,950
Consol. Coal	100													
Del. & H. C	100					145⅞	145¼			145⅛	145	146⅜	145	1,893
D., L. & W. RR	50	138⅝	137⅝	138¾	137⅜	137⅞	136¾	137⅝	136⅜	137½	136⅛	138⅛	136½	159,145
Hocking Valley	100	20		20		20		20		20		19¼		1,120
Hunt. & Broad Top				17										110
Do. pref		45		45										170
Lehigh C. & N	50	52⅝		52⅝		52⅞	52¾	52⅞		52⅞				518
Lehigh & W. B. Coal														
Lehigh Valley RR	50	52¼		52¼	52	52¼	52⅛	52¼		52⅜	52¼			1,434
Marshall Con. Coal	100													
Mahoning Coal	100													
Do. pref														
Maryland Coal	100													
Morris & Essex	100			147						150				300
New Central Coal	50			10		10						11½	11	955
N. J. C. RR	100	122½	120	122		122		121½	121	120⅛		122¼	121	1,827
N. Y. & S. Coal	100													
N. Y., Susq. & Western	100			8	7¾			8						60
Do. pref	100			32										50
N. Y. & Perry C. & I	100													
Norfolk & Western R.R.	50					19¼		19⅛						110
Do. pref	50	59⅞	59⅛	59⅝	59⅛			59½	59¼	60		60⅝	60	1,750
Penn. Coal	50													
Penn. RR	50	53		53	52⅞	53		53	52⅞	52⅞	52¾			3,366
Ph. & R. RR.**		40¼	39⅞	40⅛	39	39⅝	39	39⅝	38¾	39⅛	38½	39⅜	38¼	215,705
Sunday Creek Coal														
Do. pref	100													
Tennessee C. & I. Co		76	75	76¼	75¼	76½	75¼	77	76¼	77¾	76½	77¾	77	9,650
Do. pref	100											101½	101	150
Westmoreland Coal		*70												5

*This sale occurred on the 13th inst.
**Of the sales of this stock, 52,725 were in Philadelphia, and 162,980 in New York. Total sales, 403,158.

San Francisco Mining Stock Quotations.

COMPANY	Closing Quotations. Dec. 13.	Dec. 14.	Dec. 16.	Dec. 17.	Dec. 18.	Dec. 19.
Alpha						
Alta	1 25	1.20	1.10	1.05	1.10	1.25
Belcher						
Belle Isle	.15	.10				
Best & Bel.	2.50	2.55	2.25	2.35	2.40	2.40
Bodie	.60	.60	65		.60	
Bulwer						15
Chollar	2.40	2.50	2.10		2 30	2.15
C'm'weal'h	3 00		3.00	3.00	3.00	3.00
Con. C. & V	4.45	4.60	4.20	4.10	4.50	4.35
Con. Pac					1.70	
Crown Pt	1.60		1.35	1.40	1.70	1.55
Eureka C					3.10	
Gould & C.	1.40	1.50	1.30	1.30	1.45	1 35
Grd. Prize						
Hale & N.	2.55	2.60	2.35	2.35	2.40	2.40
M. White						
Mexican	2.55	2.60	2.25	2.15	2.45	2.30
Mono	.25				.15	.40
Mt. Diablo						
Navajo	.30					
Nev. Queen	.85		.80	.85	1 00	
N. Belle I	1.20	1.10	1.10	1.00	1.15	1.10
Occidental						
Ophir	3.35	3.40	3.05	3.05	3.25	3.15
Potosi	2.15	2.15	1.85	1.80	1.90	1.90
Savage	1.65	1.70	1.40	1.40	1.50	1.45
Sierra Nev	2.05	2.05	1.75	1.25	1.90	1.85
Union Con.	2.[illegible]0	2.55	2.10	2.10	2.25	2.10
Utah	.70		.50	.55	.60	.60
Yellow Jkt.	2.05	2.05	1.85	2.70	2.85	1.80

STOCK MARKET QUOTATIONS.

Baltimore, Md.

Company.	Bid.	Asked.
Atlantic Coal	1.00	....
Balt. & N. C.	.05	.10
Big Vein Coal	....	1.50
Conrad Hill	....	....
Cons. Coal	.22	....
Diamond Tunnel	.35	.45
George's Crk. C	....	1.12½
Lake Chrome	.08	.12
North State (Balt.)	....	.22
Silver Valley	.35	....

Prices bid and asked during the week ending Dec. 17th, 1889.

Birmingham, Ala.

Company.	Bid.	Asked.
Ala. Con. C. & C. Co.	....	$20
Ala. R. Mill Co.	....	$60@$190
*Alice Furnace.	$102	....
Anna Howe G. Mg. Co.	$¼	$⅜
Bir. Mg.& Mfg.		$120
Broken Arrow.	....	$3¾
Cahaba Coal Mg. Co.	....	$70@$77½
Camille Gold Mg. Co.	$½	$¾
De Bardeleben C. & I. Co.	$70@$72½	$73¾@$74
Decat. L. Imp.	$10@$11	$11½@$12
Decatur Min. L.	$20@$20½	$21½@$22
*Eureka	$100	....
Florence L. & Mg. Co.	$23¾	....
Hecla Coal Co.	$30	....
Hen. S. & M. Co	$50@$59	$60@$62
Jagger Towley C. & C.	$11@$11½	....
Mag-Ellen	$92	....
Mary Lee C. & R. Co.	$30	$50
Sheffield C & I. Co.	$56½	$56¾@$60
Sloss I. & S.	....	$58
†Sloss I. & S.	....	$95
††Sloss I. & S.	$74	$80
Tuscaloose C. I. & L. Co	$20½	....
Tenn. C. & I. Co.	$74	$75½
" pref.	$100	...
Woodstock I. Co.	$56	$60

Prices bid and asked during week ending Dec. 17th.

* Bonds. † First mortgage. †† Second mortgage.

Denver, Colo.

Company.	H.	L.	Sales.
Allegheny, Colo	.37½	.25	21,600
Amity "	.19	.16	13,300
Aspen Mutu'l "	.50	.17	1,327,000
Big Indian "	33	.20	105,600
Brownlow "	.47½	.40	7,300
Calliope "	.50	.45	1,100
Claudia, J., "	.35	.15	34,700
Clay County "	.67½	.50	9,200
Hard Money "	.10	.06	100
Legal Tender "	.09½	.06½	21,600
Matchless "	1.82½	1.55	32,700
May-Mazeppa "	.65	.55	69,200
Mollie Gibson "	.55	.50	....
Morning Glim "	.27½	.23	41,300
Puzzler "	.18	.16	19,800
Silver Cord "	.72½	.65	100
Whale "	.34	.29	17,400
Total		....	527,700

Prices during the week ending Dec. 11, 1889.

Kansas City, Mo. Dec. 17.

Company.	Par value.	Bid.	Asked.
Ben Harrison	..	$25.00	$35.00
Burch, L. & Z., Mo.	1	.20	.30
Express Group	...	.75	1 00
Hillsboro Gold	...	..	....
Farmers' Coal Co	...	50.00	75.00
Ida Hill, S., N. Mex	100	90.00	100.00
Kansas City L. & Z.	...	....	....
Kan. City M. & M. Co.	...	.60	3.00
K. C., Colo.	..	2.90	1.00
Kentuck, Z., Mo	1	....	.02
La Motte, Mo	100	...	100.00
Maverick, S., Colo.	10	.97	1.00
Minnequa Zinc	...	.25	.45
Quartz Mt.	...	.60	1.00
Ruby Silver	...	1.12	1.26
Sonora, G. & S., Mex.	10	1.00	1.02
Standard, S. S., Colo.	...	10.00	....
Silver Monument	...	....	3.00
Templar, N. Mex.	1	....	.20
The Sylph	...	...	2.50
Webb City, L. Z., Mo.	5	5.65	....
Wichita, L. Z., Kan.	100	....	.40

Pittsburg, Pa.

Company.	H.	L.	Closing
Allegheny Heat. Co.	$100.00	$100.00	$100.00
Bridgewater Gas Co.	29.00	25.00	29.00
Chartiers Val. Gas	46.00	39.00	43.50
Columbia Oil Co.	3.00	2.25	3.00
Consolidated Gas Co.	38.00	38.00	38.00
Forest Oil	115.00	108.00	108.00
Haziewood Oil Co.	51.00	50.00	51.00
La Noria Mining	*.75	*.67	*.75
Luster Mg. Co.	*25.00	*18.00	*19 00
Manuf'turers Gas Co.	25.00	25.00	25.00
Nat. Gas Co. of W. Va	.....	.....	.....
N. Y. & Clev. Gas Coal.	37 00	35.00	36.00
Ohio Valley Gas	32.67	32.00	33.67
Pennsylvania Gas	*15.25	*13.25	*13.25
People's N. G. & P. Co.	15.50	15.00	15.50
Philadelphia Co.	*30.25	*29 87	30.12
Pine Run Gas Co.	85.00	85.00	85.00
Pittsburg Gas	80.00	65.00	80.00
South Side Gas	24.00	24.00	24.00
Tuna Oil Co.	70.00	69.00	69.00
Union Gas	.....	.....	.....
Washington Oil Co.	85.00	75.00	75.00
W'house Brake Co.	62.75	62.75	62.75
W'house A. B. Co.	120.00	114.00	117.00
W'house E. Light.	*47.50	*46.33	*47.50
Wheeling Gas	*27.50	*20.00	*25.00
Yankee Girl Mg.	3.50	2.50	3.50

* Actual selling price.

Sales during the week ending Dec. 17: Chartiers .... 50 shares $44.00; Philadelphia .... 30 shares. $29.87@$30.25

St. Louis. Dec. 18.

CLOSING PRICES.

Company.	Bid.	Asked.
Adams, Colo.	$ .25	$ .32½
American & Nettie	2.02½	2.17½
Anderson	....	.....
Aztec, N. Mex	....	.17¼
Black Oak, Cal	.05	.05½
Black Spar	.....	.....
Bremen	.01½	.02½
Buckskin	.....	.....
Carriboo, Idaho	.....	.....
Central Silver	.15	.17½
Cleveland, Colo	.03	.04
Cleveland, Idaho	.....	.....
Cœur d'Alene	.92½	.95
Dinero	.....	.....
Golden Era, Mont	.....	.....
Golden King	.12½	.15
Gold Run	.....	.03
Granite Mountain, Mont.	41.00	43.50
Hope	2.50	4.00
Ingram	.....	.....
Iron Clad	.....	.....
Ivanhoe, Colo	.16¼	.....
I. X. L., Colo	.04½	.06
Jumbo	.02	.01½
Keystone	.01½	.02½
La Union	.04	.04½
Little Giant	.02½	.06
Major Budd, Mont	.26¼	.26½
Mexican Imp., Mex	.	.....
Michael Breen	1.15	1.20
Montrose Placer	.45	.50
Mountain Key	.62½	.70
Mountain Lion	.14½	.15
Neath, Colo	.06	....
Old Colony	.....	.....
Old Jesuit	.02	.02½
Pat Murphy, Colo	.05	.08
Phillips, Colo	.15	.20
Pine Grove, Idaho	.02	.03
Queen of the West, Idaho	.....	.....
Raspberry, Mont	.45	.50
Rosalis	.....	.....
San Francisco, Mont	.02	.03
San Pedro	.00½	.01
Silver Age, Colo	1.80	1.85
Silver Bell	.03	.....
Small Hopes, Colo	.....	.92½
Tourtelotte, Colo	.04½	.05½
West Granite, Mont	.82½	.85
Wire Patch	.12½	.15½
Yuma, Ariz	.48¾	.60

Trust Stocks. Dec. 20.

The following closing quotations are reported to-day by C. I. Hudson & Co., members of New York Stock Exchange:

Certificates.	
American Cotton Oil	$30 @$30¾
Cattle Trust	10 @ 12
Distillers' & Cattle Feeders'.	40½@ 41
Linseed Oil	43 @ 44½
National Lead	19¼@ 19⅜
Natural Gas	115 @120
Standard Oil	....@164
Sugar Refineries.	58⅝@ 58¾

Sales at the New York Stock Exchange week ending Dec. 13:

	Sales.	Price H.	Price L.
American Cotton Oil	9,672	31	29⅞
National Lead	20,135	19⅞	18
Sugar	179,467	63⅜	55

Foreign Quotations.

London. Nov. 30.

Company.	Highest.	Lowest
Almada, Mex	1s. 9d.	1s. 3d.
Alturas Gold, Idaho	.	....
Amador, Cal	1⅛s.	⅞s.
Appalachian, N. C	1s. 6d.	1s. 3d.
Arizona Copper, Ariz.	....	....
California Gold, Colo.	....	....
Callao Bis, Venz	....	
Canadian Phos. Canada.	£⅜	£⅛
Carlisle, N. Mex	4s. 3d.	2s. 9d.
Colorado, Colo	3s. 3d.	2s. 9d.
Comstock, Utah		...
Condova	....	....
Cons. Esmeralda, Nev.	4s. 6d.	4s.
Denver Gold, Colo.	1s 3d.	9d.
Dickens Custer, Idaho.	4s. 3d.	3s. 9d.
East Arevalo, Idaho.	3s. 6d.	2s. 6d.
Eberhardt, Nev	....	...
El Callao, Venezuela	....	...
Elmore, Idaho	4s. 9d.	4s. 3d.
Empire, Mont	..	⅛s.
Flagstaff, Utah	1s. 6d.	1s.
Garfield, Nev	4s.	3s.
Hambley Freehold N.C.	...	....
Ilex, Cal	...	....
Jay Hawk Mont	4s.	3s.
Josephine, Cal	7s.	5s.
Kohinoor, Colo	2s 3d.	1s. 9d.
La Luz, Mex	2s. 6d.	2s.
La Trinidad, Mex	3s. 6d.	2s. 6d.
La Valera, Mexico	1⅛s.	⅞s.
Montana Lt., Mont	£1⅜	£1¼
New California, Colo	12s.	11s.
New Consolidated	1s.	6d.
New Eberhardt, Nev.	1s. 6d.	1s.
New Emma, S., Utah	3s. 6d.	3s.
New Flagstaff, Utah	2s. 9d.	2s. 3d.
Newfoundland, N. F.	3s.	2s. 6d.
N. Gold Hill, N. C.	....	....
New Hoover Hill, N. C.	2s. 3d.	1s. 9d.
Old Lout, Colo	£¾	£¾
Palmarejo, Mex	21s. 6d.	20s. 6d.
Pinos Altos, Mex	13-16	11-16
Pittsburg Orig., Cal.	£⅜	£¼
Pittsburg Cons., Nev.	£⅜	£¼
Quebrada, Venezuela		....
Richmond Con., Nev.	1⅞s.	1⅝s.
Ruby & Dunderberg, Nev	1s.	6d.
Sam Christan, N. C.	2s. 6d.	2s.
Sierra Buttes, Cal.	£⅜	£¼
Sonora, Mex	9d.	3d.
Stanly, N. C	7s. 6d.	6s. 6d.
United Mexican, Mex.	7s.	5s.
U. S. Placer, Colo	5s. 6d.	4s. 6d.
Viola Lt., Idaho	1s. 6d.	1s.

Paris.* Nov. 28.

Belmez, Spain	550.00	550.00
Callao, Venez	93 75	93.75
Callao Bis, Venez	4.00	4.00
East Oregon, Ore	19.00	19 00
Forest Hill Divide, Cal	220.00	220.00
Golden River, Cal	390.00	390.00
" " parts	65.00	65 00
Lexington, Mont.	125.00	125.00
" parts	4.00	4.00
Ouray, Colo	......	......
Rio Tinto, Spain	518 75	518 75
Tharsis, Spain	119 50	119.50

* Francs.

CURRENT PRICES.

These quotations are for wholesale lots in New York.

CHEMICALS AND MINERALS.

Acid—Acetic, ⅌ 100 lbs	$1.75@$2.00
Muriatic, 18°, ⅌ 100 lbs	1 00@1.50
Muriatic, 20°, ⅌ 100 lbs	1.12½@1.75
Muriatic, 22° ⅌ 100 lbs	1.37½@2.00
Nitric, 36°, ⅌ 100 lbs	4.00@4.25
Nitric, 42°, ⅌ 100 lbs	6.00@6.25
Oxalic, ⅌ 100 lbs	6.50@10.50
Sulphuric, 60°, ⅌ 100 lbs	80@1.25
Sulphuric, 66°, ⅌ 100 lbs	1.00@1.75
Alkali—	
Refined, 48 p. c	1.50@1 55
Refined, 58°	1.40@1.45
Alum—Lump, ⅌ lb	1¾
Ground, ⅌ lb	1⅞@2
Lump ⅌ ton, Liverpool	£4 17 6
Sulphate of Alumina, ⅌ ton	£4 10
Aqua Ammonia—18°, ⅌ lb	4¾
20°, ⅌ lb	6
22°, ⅌ lb	6@7
26°, ⅌ lb	10@11
Ammonia—Sul., ⅌ 100 lbs	3.15
Carb., per lb	7½@8½
Arsenic—White, powdered, ⅌ lb	3¼@3½
Red, ⅌ lb	5¾@6¾
White, at Plymouth, ⅌ ton	£12 2 6d.
Asbestos—Am., p. ton	$50@$300
Italian, p. ton, c. i. f. L'pool	£18@£60
Asphaltum—P. ton	13.00
Prime Cuban, ⅌ lb	4½@5½c
Hard Cuban, ⅌ ton	$28.00
Trinidad, refined, ⅌ ton	$30.00
Barytes—Sulph., Am. prime white	17@20
Sulph., foreign, floated, p. ton	19½@21.50
Sulph., off color, p. ton	11.50@14.00
Carb., lump, f.o.b. L'pool, ton	£6
No. 1, casks, Runcorn "	" £4 10 0
No 2, bags, Runcorn "	" 3 15 0
Bleach—Over 35 p.c., ⅌ lb	1.70@1.75
Borax—Refined, ⅌ lb	9⅛@9⅝
Concentrated	7¾@8⅜
Refined at Liverpool, ⅌ ton	£29
Brimstone—*See Sulphur.*	
Bromine—⅌ lb	37@38
Chalk—⅌ ton	1.75
Precipitated, ⅌ lb	4¾@5
China Clay—English, ⅌ ton	13.50@18.50
Southern, ⅌ ton	13.50
Chrome Yellow—⅌ lb	10@25
Cobalt—Oxide, ⅌ lb	2·60@2·90
Copper—Sulph. English Wks, ton	£20@£21
Copperas—Common, ⅌ 100 lbs	70
Best, ⅌ 100 lbs	75@1.00
Liverpool, ⅌ ton, in casks	£1 15s.
Cream of Tartar—Am. 99%	22½
Powdered, 99 p. c	23
Emery—Grain, ⅌ lb	4½@5
Flour, ⅌ lb	3¾@3½
Feldspar—Ground, ⅌ ton	15.00
Fuller's Earth—Lump, ⅌ bbl.	.90@95
Powdered, ⅌ lb	1⅞@2
Gypsum—Calcined, ⅌ bbl.	1.25@1.50
Iodine—Resublimed	2.75
Kainit—⅌ ton	10.00
Kaolin—*See China Clay.*	
Lead—Red, ⅌ lb	6¾@9
White, American, in oil, ⅌ lb	6¾@7¼
White, English, ⅌ lb	8½@8¾
Acetate, or sugar of, white	12@13
Lime Acetate—Amer. Brown.	.95@1.00
" Gray	1.75@1.87½
Litharge—Powdered, ⅌ lb.	6½@6¾
English flake, ⅌ lb	9@9½
Magnesite—Greek, ⅌ ton	20.00
Manganese—Crude, per unit	.23@.28
Oxide, ground, per lb	2½@6½
Mercuric-Chloride—(*Corrosive Sublimate*) ⅌ lb.	70@72
Mineral Wool—⅌ lb	2
Mica—In sheets according to size, 1st quality, ⅌ lb	25@$6.00
Ochre—Yellow, "B. F.," ⅌ ton, f.o.b. mill	30.00
"J. F. L. S.," ⅌ lb. ex dock	2⅛
Phosphate Rock—S. Carolina. per ton f. o. b. Charleston.	5.75@7.00
Ground, ex vessel New York.	11.00
Canadian Apatite, lump, f. o. b. at Montreal, ⅌ ton	16.00
Phosphorus—⅌ lb	70@75
Plumbago—Ceylon, ⅌ lb.	4@5
American, ⅌ lb	5@7
Potassium—Cyanide, ⅌ lb	.39@40
Bromide, ⅌ lb	33
Chlorate, ⅌ lb.	13@14
Carb. ⅌ lb	4.70@5.50
Caustic, ⅌ lb	7⅛@8
Iodide	2.65@2.70
Muriate, ⅌ 100 lbs	1.80
Nitrate, refined, ⅌ lb	6@8
Bichromate, ⅌ lb	10⅛@11
Sulphate, ⅌ 100 lbs	2.30@2 35
Yellow Prussiate, ⅌ lb	17½@18
Red Prussiate, ⅌ lb	42@45
Pumice Stone—Select lumps, lb.	3¼
Original cks., ⅌ lb	1¾@2
Powdered, pure, ⅌ lb	2¼@2⅛
Pyrites—Non-cupreous, p. units	10d
Quartz—Ground, ⅌ ton.	14.00@16.00
Rotten Stone—Powdered, ⅌ lb.	3¼@3¼
Lump, ⅌ lb	6@10
Salt—Liverpool, ground ⅌ sack.	75@80
Turk's Island, ⅌ bush	2 5@2
Salt Cake—⅌ lb	60@62½
Saltpeter—Crude, ⅌ lb.	5¼@5⅛
Refined, ⅌ lb	6@8
Soda Ash—Carb., 48% 100 lb	1.45
Caustic, 48%	1.30
Soda Caustic, 60%	2.50
" " 70%	2.27½@2.35
" " 74-6%	2.27½@2 35
Sal, English, ⅌ 100 lbs	1.00
Sal, American, ⅌ 100 lbs	.90
Nitrate, 100 lbs	1.90@1.95
Strontium—Nitrate ⅌ lb.	9@9⅛
Sulphur—Roll, ⅌ lb	1¾
Flour, ⅌ lb	2
Crude Brimstone, 2s., ⅌ ton	19.50
Crude Brimstone, 3ds, ⅌ ton.	19 00
Talc—Ground French, ⅌ lb	1¼@1½
Domestic, ⅌ ton	$18@$20
c. i. f. Liverpool, ⅌ ton	£4 5
Vermillion—American, ⅌ lb.	61
English, ⅌ lb.	82@85
Vitriol—(Blue), Ordinary, ⅌ lb.	5½@5⅝
Extra, ⅌ lb.	7
Zinc Oxide—Am., Dry, ⅌ lb.	4½
Antwerp, Red Seal, ⅌ lb	6@6½
Paris, Red Seal, ⅌ lb.	6⅛@7

* Spot

THE RARER METALS.

Aluminum—(Metallic), ⅌ lb.	$2.@$4.00
Sheet, per lb.	6.00@8.00
Arsenic—(Metallic), per lb.	.40
Barium—(Metallic), per gram	$4.00
Bismuth—(Metallic), per lb	2.75
Cadmium—(Metallic), per lb	1.00
Calcium—(Metallic), per gram	10.00
Cerium—(Metallic), per gram	7.50
Chromium—(Metallic), per gram	1.00
Cobalt—(Metallic), per lb	6.00
Didymium—(Metallic), per gram	9.00
Erbium—(Metallic), per gram	7.50
Gallium—(Metallic), per gram	140.00
Glucinum—(Metallic) per gram.	12.00
Indium—(Metallic), per gram	9.00
Iridium—(Metallic), per oz.	7.00
Lanthanum—(Metallic), per gr.	10.00
Lithium—(Metallic), per gram	10.00
Magnesium—Per lb	4.50
Manganese—Metallic, per lb	1.10
Chem. pure, per oz.	10.00
Molybdenum—(Metallic), per gm.	.50
Niobium—(Metallic), per gram	5.00
Osmium—(Metallic), per oz	65.00
Palladium—(Metallic), per oz.	35.00
Platinum—(Metallic), per oz.	9.00
Potassium—Metallic, per lb	28.00
Rhodium—(Metallic), per gram.	5.00
Ruthenium—(Metallic), per gm.	5.50
Rubidium—(Metallic), per gram	2.00
Selenium—(Metallic), per oz.	1.80
Sodium—(Metallic) per lb.	2.50
Strontium—(Metallic), per gm.	.60
Tantalum—(Metallic) per gram	9.00
Telurium—(Metallic) per lb.	5.00
Thallium—(Metallic) per gram.	.25
Titanium—(Metallic) per gram.	2.25
Thorium—(Metallic) per gram.	17.00
Tungsten—(Metallic) per oz.	2.25
Uranium—(Metallic), per lb.	5.00
Vanadium—(Metallic), per gm.	22.00
Yttrium—(Metallic), per gram.	9.00
Zirconium—(Metallic), per oz.	65.00

BUILDING MATERIAL.

Bricks—Pale, ⅌ 1,000	3 25@3.75
Jerseys, ⅌ 1,000	5.50@6.50
Up Rivers, ⅌ 1000	6 00@6.50
Haverstraw seconds, ⅌ 1000.	6.50@6.75
Haverstraw firsts ⅌ 1,000.	6.75@7.00
Fronts, nominal, ⅌ 1000.	
Croton	14.00@16.00
Wilmington	20.00@21.00
Philadelphia	@22.00
Trenton	@22.00
Baltimore	....
Building Stone—Amherst freestone, ⅌ cu. ft.	95@1.00
Brownstone, ⅌ cu. ft.	1.00@1.35
Granite, rough, ⅌ cu. ft	45@1.25
Granite, Scotch ⅌ cu ft.	1.00@1.15
Cement—Rosendale, ⅌ bbl	.85@1.10
Portland, American, ⅌ bbl.	2 15@2.45
Portland, foreign, ⅌ bbl.	2.30@2.40
Portland, " special brands.	2.45@2.75
Roman, ⅌ bbl.	2.65@2.85
Keene's coarse, ⅌ bbl.	4.50@5.50
Keene's fine, ⅌ bbl.	7.00@8.25
Slate—Purple and green roofing, ⅌ 100 ft	7.00@7.50
Red roofing, ⅌ 100 sq. ft.	12.00
Black, roofing, ⅌ 100 sq. ft.	4.25@5.50
Lime—Rockland, common ⅌ bbl.	1.00
Rockland, finishing, ⅌ bbl	1.20
St. John, com. and finish, ⅌ bbl.	.90@.95
Glens Falls, com. and fin., ⅌ bbl	.85@1.10
Labor—Ordinary, ⅌ day	1.50@2.00
Masons, ⅌ day	4.00
Plasterers, ⅌ day	4.00
Carpenters, ⅌ day	3.50
Plumbers, ⅌ day	3.50
Painters, ⅌ day	2.50@3.50
Stonesetters, ⅌ day	3.50@4.00
Tilelayers, ⅌ day	3.50@4.50
Bricklayers, ⅌ day	4 00

THE ENGINEERING AND MINING JOURNAL will thank any one who will indicate any other articles which might with advantage be quoted in these tables or who will correct any errors which may be found in these quotations.

(CONTINUED FROM SUPPLEMENT PAGE 262.)

$166, total $1,000: output from $40,000 worth of plant $300 \times \frac{40,000}{1,000} =$ - - - - - - - - - - - - 12,000 tons.

Siemens' Rotator: Holley's estimate that four rotators, with crusher and hammer, but without buildings, cost $40,000, with an output of 125 tons per week. Output $125 \times 52 =$ - - - - - - - - - - - - - - 6,250 tons.

Blair Sponge-making Plant, to turn out 60 tons of sponge, or say 50 tons of iron in sponge, per 24 hours, $75,000, - - - - - - - - - - - - - - - 8,180 tons.

Blast-furnace 16' × 70', turning out say 48,000 tons per annum, and costing, excluding buildings, $180,000; $40,000 worth of plant would turn out $48,000 \times \frac{40,000}{180,000}$ = - - - - - - - - - - - - - - - - - 10,667 tons.

I infer from these numbers that any difference between the cost of installation for the direct and for the blast-furnace process is a relatively unimportant factor in forecasting the future of the direct process.

§ 315. THE DIFFICULTIES OF THE DIRECT PROCESS, some of them already touched on, are

1, Loss of iron through re-oxidation or imperfect deoxidation,

2, Heterogeneousness and carburization of product,

3, Absorption of sulphur, and

4, Heavy outlay for labor, can I think be best studied by examining certain general divisions of the direct process, to wit, those carried out at a sponge-making, a welding and a steel-melting heat respectively: at the same time we learn the characteristics of these classes.

A. *Sponge-making Processes.*—If the temperature be low, so that unmelted, unwelded spongy iron results, deoxidation is slow, the output of given plant small, and hence the outlay for labor is large. The spongy product absorbs sulphur greedily, hence it is better to use sulphurless or desulphurized fuel, for we lack the sulphur-absorbing lime of the blast-furnace: it reoxidizes readily, hence the loss of iron is likely to be excessive without special preventives, which must cost something. The gangue of the ore is not eliminated, but remains to swell the cost of subsequent operations. The phosphorus of the ore is not indeed deoxidized, but it remains in the spongy metal, and, if this is later melted in presence of an acid slag, as in the acid open-hearth and crucible processes, the phosphorus enters the iron. Here is a tremendous obstacle which many promoters of direct processes have completely lost sight of: but to-day the basic open-hearth process promises to overcome it. However, it must be clearly understood that sponge-making processes do not in themselves guard against the deoxidation and absorption of phosphorus: they are not dephosphorizing processes in any sense, nor do they help towards dephosphorization.

When the ore is heated in reverberatory furnaces, in externally heated retorts, etc., and so does not come into contact with the heating fuel, the excess of the deoxidizing fuel need not be so great as to cause more than moderate, or at most locally serious carburization, which does little harm when the product is to be used for the open-hearth or crucible process. When the ore is heated by the passage of the hot reducing gas through it, one would expect that this would deposit carbon abundantly, and might thus lead to carburization.

To purposely carburize the product, the use of hydrocarbon reducing gases (Gurlt, Blair, §§ 325, 333 A) has been proposed. Another plan is to compress the spongy iron together with carbonaceous matter (Chenot § 332), in the hope that the iron will combine with the carbon in the open-hearth or crucible process before fusion actually occurs.

I. *For Slow Deoxidation,* two remedies suggest themselves, the use of lime, as practiced by Blair (Cf. § 333, A) and that of natural gas or of artificial hydrogenous gas. The former, rich in ethylene, should deoxidize much more rapidly than the carbon or carbonic oxide generally used. Bell[a] found that, while pure carbonic oxide removed only 9·4% of the total oxygen from calcined Cleveland ore in seven hours at about 427° C. (800° F.), a mixture of 100 parts of carbonic oxide with 12 of hydrogen removed 68% in ninety minutes at approximately the same temperature,[b] thus acting 34 times as fast, roughly speaking. At bright redness the same mixture removed about 70% of the total oxygen in one hour.

II. *The Absorption of Sulphur.*[c]—By placing the ore within retorts, etc., it may be protected from the heating fuel, but this of course increases the consumption of fuel: this procedure should be desirable chiefly in places where sulphurous is much cheaper than sulphurless fuel. But the ore must necessarily come in contact with the deoxidizing fuel, and of this at least 16 parts must be used per 100 of iron, supposing that by some regenerative contrivance or other the ore oxidizes the whole of the carbon to carbonic acid, and at least 21·92 parts per 100 of iron if we assume that the ore cannot oxidize the carbon farther than to make the ratio $\frac{CO_2}{CO} = 1{\cdot}34$.

We have two common sulphurless deoxidizing agents, charcoal, which is usually very expensive, and natural gas,[d] which is often cheap. Even if solid mineral fuel be used, the absorption of sulphur may perhaps be prevented by gasifying the fuel and desulphurizing the gas by passing it through lime or over spongy iron, as in Tourangin's process (§ 327). The practicability of this plan on a large scale is not yet shown.

III. *Reoxidation* may be *prevented* by cooling the spongy iron before exposing it to the air, as in Chenot's process, and probably as contemplated by Lucas in 1792. The sponge should then be compressed powerfully, to lessen the surface exposed to oxidation. Or reoxidation may be *cured* as in Gurlt's process by balling the sponge under strongly deoxidizing conditions, *e. g.*, in a charcoal-hearth. But we cannot re-deoxidize in the necessarily strongly oxidizing atmosphere of the puddling or other open reverberatory furnace—without adding much solid deoxidizing matter, and even then a considerable quantity of iron will remain oxidized. As already pointed out, a

[a] The temperature when the mixed gases were used was below redness: incipient redness may be taken at about 525° C.

[b] Princ. Manuf. Iron and Steel, p. 310, 1884.

[c] There is a belief that only part of the sulphur of the fuel is liable to be evolved during combustion, at least when this occurs in gas-producers. It is true that only part of the sulphur of the pyrites of the fuel is volatilized as such: but the rest will be expelled almost completely as sulphurous anhydride or otherwise by the time that the fuel itself is completely burnt, quite as in the roasting of pyritiferous ores, and relatively little will remain in the ash if the combustion of the fuel is thorough.

[d] I have met no authoritive statements about the presence or absence of sulphur in natural gas. A chemist who has paid close attention to the natural gas supply, and whose writings on the subject are well-known, informs me that he thinks the gas brought to Pittsburgh practically free from sulphur, but that he believes that the gas in certain fields has a sulpurous smell.

little reoxidation may do no harm in case of spongy iron which is to be melted in a bath of cast-iron in the early part of the open-hearth process, for the carbon and silicon of the cast-iron should take up any slight quantity of oxygen in the sponge.

The term "reducing flame" is responsible for enormous waste of energy and money in carrying out ill advised direct processes. In a certain sense it is possible to produce in a reverberatory furnace a high temperature with a reducing flame: we can reach a white heat with a flame which is reducing towards oxide of silver, of gold, or of copper; which is reducing in the sense of being relatively reducing, or less strongly oxidizing than some other flames. If in a direct-firing reverberatory we burn carbon to carbonic oxide with exactly the proportion of air chemically required, their products would reach a temperature of about 1,500° C. if no heat were lost by radiation. But of course such a combustion could not heat the furnace highly, for its heat is distributed over much matter other than its own products. If we go a step farther and burn ever so little of this carbonic oxide to carbonic acid, the atmosphere becomes oxidizing towards iron, though still reducing towards copper, for carbonic acid oxidizes iron, even in the presence of a great excess of carbonic oxide. In a regenerative or other gas furnace using carbonic oxide no combustion whatever would be possible without yielding an atmosphere which would oxidize iron slightly.

The presence of hydrogen and of hydrocarbons in the gas of regenerative gas furnaces may modify this somewhat: but I fail to see how it is possible in common gas-furnaces, Siemens or others, to obtain a high, say a welding, heat without thereby generating an atmosphere oxidizing towards iron. By saying that it is possible to produce at will a reducing, neutral or oxidizing flame in the Siemens furnace, the admirers of this invaluable apparatus have, doubtless unintentionally, spread confusion on the subject. But in Morrell's and certain other gas-furnaces the ore may be heated by white-hot producer gas wholly unmixed with air, or with a slight quantity of air if desired. By a similar arrangement producer gas for reducing ore by direct contact in shafts and vertical retorts, and hence with better heating efficiency, might be intensely preheated without admixture of air. Furnaces of this class may be of great value in developing the direct process.

In Morrell's gas-furnace,[a] Figure 126, both gas and air

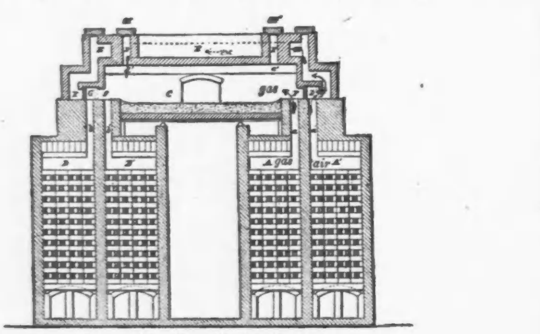


Figure 126.—Morrell's Gas-furnace.

are preheated, each in its own regenerator, quite as in the common Siemen's type, but the hot gas alone enters the laboratory or working chamber of the furnace, the hot air meeting it as at *d'*. Hot gas and hot air then burn in descending through the regenerators: in the case shown this occurs in the left-hand regenerators. On reversing the furnace the dampers F and G now shown in solid lines are moved to the position shown in dotted lines.

B. *Balling Heat Processes.*—If we use a temperature so high that the product may be welded or balled, deoxidation is more rapid, and, as the danger of reoxidation is less, it is not necessary to cool the relatively compact product before exposing it to the air: hence it would seem possible to lessen the cost of installation per unit of daily output, and the outlay for interest and labor. Further, we are saved the expense of compressing the product. Again, it is now possible to dephosphorize, but, alas, only at the cost of heavy loss of iron. On the other hand, there is danger of carburizing the product, and the consumption of fuel must be greater, at least in cases of rich ores. Indeed, we directly sacrifice one chief advantage sought by the direct process, the saving of fuel due to lower working-temperature. Finally, the liability to absorb sulphur is aggravated, both because the larger proportion of fuel brings in more sulphur, and because we can hardly avoid bringing the ore into contact with the heating-fuel, or at least with the sulphurous products of its combustion.

We will now consider some of these points separately.

I. *Dephosphorization.*—If we would dephosphorize, the slag must be basic so as to hold the phosphorus as phosphate, and so fluid that it either separates from the metal before or during balling, or can be removed by hammering or squeezing; for if it remains mechanically held in the balls, its phosphorus will be deoxidized and will unite with the iron as soon as the balls are melted in contact with acid slag, whether in the acid open-hearth or in the crucible process. But it can only be made fluid by the presence of a large proportion of iron-oxide, and this of course means large loss of iron. The silicates of the alkaline earths are not fluid enough at this temperature to be squeezed out: the alkalies and manganese-oxide are too costly to be used as fluxes: iron-oxide is the only flux available under usual conditions. Strengthening the deoxidizing conditions in order to lessen the loss of iron, not only directly opposes dephosphorization by strengthening the tendency to deoxidize phosphorus as well, and thus cause it to combine with the iron, but further and indirectly by depriving the slag of base, (iron-oxide), and so removing its dephosphorizing power, and of liquidity and so preventing it from running off with whatever phosphorus it contains.

II. *Carburization* is more likely to occur if we use a balling heat, both owing to the higher temperature and to the larger proportion of fuel employed for generating that temperature. If the operation is carried out in shafts, the same fuel both heating and deoxidizing, the product is very likely to be heterogeneous, here and there absorbing a considerable quantity of carbon, unless we permit a very heavy loss of iron: this unfits it for direct use as wrought-iron, but it is not a serious disadvantage when material for the open-hearth or crucible process is sought.

If the ore is inclosed in retorts, we may add enough carbon to deoxidixe, with no excess so considerable as to cause serious carburization: unfortunately it is not practicable to bring material within a retort to a welding heat by heat

[a] U. S. Patent, 313,754, March 10th, 1885, T. T. Morrell.

applied outside it, for we have no material of which we could make a retort that could endure the temperature to which the outside would have to be exposed. Balling processes cannot be carried out in retorts.

If deoxidation occur in open reverberatory furnaces, a certain but not excessive amount of carburization may be looked for. As the atmosphere is usually strongly oxidizing towards iron, a considerable excess of carbon must be added, so that, after deoxidizing the ore, there may be enough to re-deoxidize any iron which reoxidizes. If the balls are for the open-hearth or crucible process, it is desirable that they should retain a little carbon to deoxidize during fusion any iron reoxidized after leaving the deoxidizing furnace. Now, as different proportions of this excess will be consumed, not only in different charges but in different parts of the same charge, local excesses of carbon will remain here and there, and will carburize the metal locally.

Clearly, the more difficultly oxidizable the reducing agent, the less of it will be attacked by the atmosphere of the reducing furnace, the more will persist till the metal is formed into a solid bloom or is melted, *i. e.*, till danger of reoxidization is passed, and hence the smaller excess will it be necessary to add. To this may be attributed the encouraging yield obtained in the Eames process (§ 340), in which the difficultly oxidizable graphitic anthracite or "retarded coke" is used.

III. *Heterogeneousness.*—Wrought-iron made directly from direct-process balls should be heterogeneous not only from local carburization already dwelt on, but from the presence of slag, unless excessive loss of iron is permitted, for reason already given in considering dephosphorization. The gangue of the ore can only be converted into a slag fluid enough to be thoroughly expelled by converting it into a highly ferruginous silicate, and this except with the very richest ores means heavy loss of iron. Moreover, local excesses of carbon are likely to reduce the iron here and there from this slag, and thus remove its fluidity, and make the metal unforgeable from slag-shortness. Further, if the deoxidizing conditions are so gentle that enough iron-oxide remains to make all the slag fluid, there may be enough unscorified iron-oxide to cause red-shortness. So gentle deoxidation leads to red-shortness, and heavy loss of iron, strong deoxidation to slag-shortness, local carburization, and retention of phosphorus.

IV. *Deoxidation and Reoxidation.*—As the affinity of oxygen for the carbon with which the ore is in contact increases with rising temperature relatively to its affinity for iron, so it should be easier to deoxidize at a balling heat in shaft-furnaces, charcoal hearths, etc., in which an excess of carbon is present, than at a sponge-making heat in retorts: moreover, in balling we weld the spongy metal together, close its pores, and so remove or greatly lessen its tendency to reoxidize.

In open reverberatories the higher temperature needed for balling implies a more strongly oxidizing atmosphere (unless some device such as Morrell's succeeds), and hence more difficulty in deoxidizing and greater proneness to reoxidize, than in sponge-making processes.

In short, the loss of iron should be less in balling than in sponge-making direct processes when shafts and retorts are used, but greater when open reverberatories are used.

V. *The Fuel-Requirement.*—To raise the charge to a welding temperature we clearly need more heat than in the relatively cool sponge-making process: but this disadvantage of the balling processes, while real in case of preparation for the crucible process, disappears if the hot balls are plunged as soon as formed into the bath of the open-hearth furnace, the whole of their sensible heat being thus utilized, while in the most promising sponge-making processes (Chenot's, Blair's, Tourangin's) the heat used in heating the ore is thrown away when the spongy iron cools. Be it remembered that the sensible heat thus utilized in case of balling processes has in many of them (*e. g.* those which heat by direct contact with solid fuel), been imparted in furnaces which are much more efficient transferers of heat than the open-hearth furnace, and hence represents a much smaller outlay for fuel than would be needed to raise the metal to the same temperature in the open-hearth furnace.

This consideration, in case of rich ore, still farther increases the fuel-economy which we may hope that the direct process will effect over the blast-furnace; and the same is true in case of lean ores, if the balling heat be high enough and the loss of iron great enough to convert the gangue into a slag so liquid as to separate itself from the metal, so that the balls carried to the open-hearth furnace are nearly pure iron. But if, in treating lean ores, this be not done, then the advantage of the balling direct process over the blast-furnace,—that the sensible heat given the iron is preserved by plunging the hot balls into the open-hearth bath,—may be greatly outweighed by the fact that we now have to heat the gangue, in the open-hearth furnace, to a temperature much higher than than that of the blast-furnace, and that the efficiency of the open-hearth furnace as a heating apparatus is probably hardly one-third as great as that of the blast-furnace. The same objection applies to sponge-making processes as applied to lean ores. Hence, if this class of ore is to be treated by any direct process, it should be by one using a balling heat so high that the slag liquefies and separates.

C. *Steel-Melting-Heat Processes.*—If the process is carried out in a shaft furnace at a steel-melting heat we have at once a cast-iron-making and not a direct process. Hence a direct process at a steel-melting heat can hardly take place except in an open reverberatory, as in F. Siemens' process, or in crucibles, as in Mushet's.

I. *In Open Reverberatories.*—As a basic lining would be essential, we are brought pretty near to the pig-and-ore process in the basic open-hearth furnace. Clearly phosphorus would be removed. The sulphur of the reducing fuel would be taken up by the iron, but later removed at least in part by the lime slag. But though, as far as fluidity is concerned, the slag does not need iron-oxide, for basic lime-silicates are fluid at this temperature, yet it is hard to see how we could avoid heavy scorification and loss of iron without employing a very great excess of reducing fuel, of which at any rate a great excess should be needed to compensate for its rapid oxidation by the atmosphere of the furnace. This must be violently oxidizing to yield the extreme temperature needed to melt and keep molten the metal, which would be almost absolutely carbonless and hence extremely infusible, thanks to the continual influx of ore.

Further, this class stands at a disadvantage, compared with the balling processes, in having to heat not only the iron but the oxygen of the ore and the products of the combustion of the reducing fuel to a steel-melting heat, in a relatively inefficient heating apparatus. The thermal capacity of chemically pure ferric oxide per degree of temperature is probably about twice that of the iron which it contains. If, in addition, the ore contains much gangue, the necessity of heating this, with its very high specific heat, (on an average probably about double that of iron) to a steel-melting heat puts the process out of the race.

II. *In Crucibles* (Mushet's process).—Here the same objections apply with greater force. Moreover, the quantity of iron in the charge of ore and charcoal which could be placed in a crucible of given size, would probably be only about one-tenth as great as when we pack the crucible with metallic iron bars, taking into account the lightness and irregular shape of the iron ore and charcoal. The cost of melting by the crucible process is about $12.00 per ton of ingots, with the cheap fuel of Pittsburgh. It would cost nearly as much for fuel, crucibles and labor to melt a crucible-full of ore and charcoal as one of iron: so that the cost of such an operation might be roughly estimated as about $100.00 per ton of metal produced, in addition to the ore and charcoal, or $0.05 per pound.[a] This should frighten the wildest dreamer, as crucible steel is quoted at 4½ cents per pound.

§ 316. Classification by Mode of Heating.—The direct processes may be further classified, as in Tables 153–4, into those in which the heating fuel serves also for deoxidation, and those in which separate fuel is used for deoxidation.

The former class may be divided into those (A) which use solid and those (B) which use gaseous fuel; the latter into those (C) in which the ore is inclosed in externally heated retorts, those (D) in which it is heated by a current of hot gas passing through it, and those (E) in which it is treated in open reverberatories.

At the risk of repetition I will discuss these classes briefly, first pointing out that C is almost necessarily a sponge-making process, while the other classes may be either balling or sponge-making, if not steel-melting.

Table 153.—Direct Processes Classified by Mode of Heating.

		Order of merit (I best, V worst).				
		Fuel-economy.	Absorption of sulphur.	Absorption of carbon.	Loss of iron.	Dephosphorization.
Heating and deoxidation by the same fuel.	A. By solid fuel	I.	III.	V.		
	B. By gaseous fuel	III.	V.	IV.		
Heating fuel distinct from reducing fuel.	C. Retorts etc., heated externally	V.	I.	I.	I.	V.
	D. Internally heated vessels	II.	IV.	III.?		
	E. Open reverberatories	IV.	II.	II.?	V.	I.

A. *Fuel Economy.*—In treating relatively poor ores, in which the proportion of gangue is so considerable that we must slag it away before further treatment, and in which consequently we must reach a slag melting temperature, the direct contact of the solid heating-fuel with the ore should give class A the best fuel-economy. D is a little worse off than A in case artificial gas is used, because of the necessarily great waste of heat in gasification; and for the same reason B, in which all the fuel is gaseous, is still worse off. But as in B and D the heating is by direct contact of gas passing *through* the charge, the fuel-economy should be better than in E, in which the heating is chiefly by radiation from flame passing *over* the charge. Last of all comes C, in which the heating is by conduction, usually through fire-clay, itself heated not by direct contact with solid fuel, but less efficiently by passing flame. The order of merit then is A, D, B, E, C.

If in treating extremely rich and almost gangue-less ores B, C, D, and E were used as sponge-making processes, the order of fuel-economy would probably be the same. I will again point out that the necessarily balling division A is only under an apparent disadvantage in having to heat the charge to a higher temperature than the sponge-making processes, because the higher temperature is a great advantage when the hot product is immersed in the bath of the open-hearth furnace.

B. *Absorption of Sulphur and Carbon.*—In both respects class C stands best. Indeed, by adding only a very slight excess of carbon over that needed to deoxidize the iron by the reaction $Fe_2O_3 + 3C = 2Fe + 3CO$, or 32%, the absorption of carbon may be practically completely prevented. In B and D a considerable absorption of carbon would be looked for, since the carbonic oxide of the gas should deposit carbon if an excess of carbon over that needed for reduction is present. But it is reported that, for reasons unknown, when producer gas made from charcoal is used, the sponge is nearly or quite free from deposited carbon. When, however, natural gas is used, it deposits carbon copiously. As in many parts of this country natural gas is very cheap, some device by which the deposition of carbon from it can be prevented is urgently needed. When ore is reduced by producer-gas, carbon is found to deposit copiously.

The absorption of sulphur should be high and about alike in A, B, and D, since in all three the charge comes in contact with the whole of the fuel, though with less fuel in A than in D, and less in D than in B. In E it should be greater than in C but less than in the others, since part of the sulphur of the flame may be taken up by the charge.

The order of merit then as regards sulphur absorption, should be, C, E, A, D, B.

In A, D and B the opportunity for absorbing sulphur is so great that it is extremely desirable, if not almost absolutely necessary, to use sulphurless fuel, such as charcoal, natural gas, or desulphurized artificial gas.

C. *Dephosphorization and loss of iron* usually accompany each other, though it is quite possible in the sponge-making varieties of B, C, D, and E to lose much iron without dephosphorizing. Dephosphorization and loss of iron should reach a maximum under the oxidizing conditions of E, if a slag-melting heat be reached, and a minimum in C.

§ 317. The Future of the Direct Process.—To sum up what has gone before: the direct process is chiefly adapted to preparing material for the open-hearth and crucible processes.

There seems little reason to expect that it can be applied to lean ores, unless they be very cheap, since it cannot remove their gangue except with fearful loss of iron.

[a] To produce 100 of iron would take say 170 of ore and 30 of charcoal by weight. Considering the greater irregularity of the lumps of charcoal and of ore than of the rectangular closely fitting pieces of iron, we may estimate that the pound of ore will occupy twice as much, and one of charcoal twenty-five times as much space as one of iron, so that we need 170 × 2 + 30 × 25 = 1,090 volumes of ore and charcoal where we would have but 100 of closely packed iron.

In case of rich ores, it holds out good hope of producing a ton of malleable iron with less fuel, but with greater outlay for labor, than is needed to make a ton of cast-iron in the blast-furnace.

It can remove phosphorus, but this implies heavy loss of iron. In any event the loss should be greater than in the blast-furnace.

The sponge-making processes are very heavily handicapped by their small output if the sponge be cooled before drawing, by the heavy loss of iron if it be not. The use of natural gas or of lime may indeed enormously increase the output: but the trouble of cooling the sponge before drawing still remains.

In the steel-melting-heat processes the fuel-consumption will probably be greater not only than in other direct processes, but even than in the blast-furnace. Moreover, the loss of iron is likely to be excessive.

The balling processes seem to hold out the most promise. Of the many processes which have been proposed and tried, only those of this class show any vitality, the American bloomary, the high bloomary (*e. g.* Husgafvel's), the Eames process. Whether the last will stand the test of prolonged use remains to be seen. This class has the advantage of getting rid of the gangue at once: of delivering hot balls ready for the open-hearth process: of dephosphorizing. On the other hand the loss of iron is considerable, the product somewhat carburetted and heterogeneous; but these last two objections are of little weight in preparing materials for the open-hearth process. If carried out in shafts, the sulphur of the fuel is absorbed by the iron, but the consumption of fuel should be small. If in open reverberatories, more fuel is consumed, but the iron does not take up the sulphur of the heating fuel.

These balling processes then should be best suited to places where ore is cheap, sulphurless fuel available at a price which does not put it out of competition with sulphurous blast-furnace fuel, and the open-hearth process at hand to consume the balls.

If direct processes offer such advantages, why, we are asked, have they failed so often, so almost universally? Knowing that the blast-furnace has defeated them in the past, how can we expect them to compete with it in the future?

First, their failure has not been so complete as many believe. Remember the steam-engine before Watt. Numberless foolish processes have failed, but even so crude and wasteful a process as the American bloomary has yielded a profit, directly or indirectly, within a few miles of elaborately equipped and apparently well-situated blast-furnaces which in the same period have failed. And, passing by the rather feeble existence of Gurlt's and of the Catalan process, we have the present increased activity of the high bloomary as modified by Husgafvel, even in face of a very great shrinkage in prices.

Next, we can see reasons why the direct process has failed in the past which apply with much less force to the future. The blast-furnace process was stumbled into, along the path of least resistance. It was developed with little comprehension of the principles on which it rests. At one end we have the modern blast-furnace: to manage this with highest efficiency demands skill, knowledge, talent. At the other we have the crudest forms of charcoal-hearths, and in these it is probably easier to make wrought- than cast-iron. But as we begin to elaborate the process and seek greater fuel-economy, greater output, and less loss of iron, it becomes easier to make cast- than wrought-iron: hence the line along which, thanks to existing ignorance, development began: and the tendency of development to follow its original lines need not be dwelt on.

As the desire to economize fuel and increase output led to lengthening the charcoal-hearth into the shaft-furnace, the difficulty of removing from beneath the overlying charge shapeless, unwieldy, pasty masses of wrought-iron and of forging them, and the ease of running molten cast-iron into easily handled pigs, led irresistibly to the development of the cast-iron-making rather than of the direct process. To-day the former has reached an extraordinary degree of efficiency: probably few human devices have so closely approached the highest perfection of which in their very nature they are capable. Fifty years ago nearly thrice as much fuel was often used as is to-day needed in our best blast-furnaces.

The direct process, on the other hand, while easy if wastefully conducted, becomes extremely difficult the moment we attempt high fuel-economy. We must guard against the absorption of sulphur and keep that of carbon within limits. If we make sponge we must guard against reoxidation: if we make balls in a furnace economical of fuel, to wit a shaft-furnace, we have the serious difficulty of forming, withdrawing and further handling them.

To do all this demands a high degree of metallurgical and engineering talent and knowledge, and just for lack of these, as I take it, direct processes have failed in the past. But to-day our knowledge is greater, the amount of trained talent available for solving difficult metallurgical problems incomparably greater than formerly, and both knowledge and the quantity of available talent are increasing rapidly.

Just as the open-hearth process failed in the hands of the greater man, Josiah Marshall Heath, who realized its intrinsic merits, but succeeded later under Martin, thanks to the better technical appliances and skill of his day: just as advancing civilization constantly sees the more difficult, when capable of being made more economical, win a place beside the easier, the triple-expansion compete successfully with the single-cylinder engine, the automatic cut-off with the plain slide-valve, the railway with the coach; so may we hope that, the obstacles in the way of the direct process understood and overthrown, its disadvantages minimized, it will win a place of real importance, under the special conditions which favor it, rich ores and cheap sulphurless or desulphurized fuel.

It is clearly fallacious to reason that the process will never succeed because the past usually ill-advised attempts have failed, have wasted much iron and more gold, have used more fuel than the blast-furnace and puddling combined; because the direct process in the infancy of its intelligent life was weaker than the blast-furnace in its perfection. They failed because they did not overcome obstacles, often unseen, not understood, serious, but not in their nature insuperable. They failed not because the direct process lacked capability but because it was difficult.

But a new and most promising feature is our natural gas If with the most reckless waste it competes easily with slack coal costing $0.90 per ton, it should compete easily with coke, which costs about $2.00 per ton even at Pittsburgh. It has enormous advantages in its freedom from sulphur (if, as reported, it be usually free from sulphur), and in its cheapness. A greater stimulus to the direct process could hardly be imagined. As we do not see how natural gas can be used to a great extent in the blast-furnace, we may expect its successful application to the direct process. It has, indeed, already given encouraging results in the Eames process: in shaft-furnaces the consumption of gas should be less and the loss of iron less, while the graphite or retarded coke of the Eames process could be replaced by natural gas, which would thus both heat and deoxidize.

If the wasteful American bloomary can exist where charcoal, labor and rich fine ores are cheap, some such improvement of it as Husgafvel's, which reduces the cost of fuel-consumption enormously, should flourish. With some quick way of cooling the sponge, some modification

TABLE 154.—GENERAL SCHEME OF THE DIRECT PROCESSES.

Class	Description.		Date, approximately.[a]			Fuel consumption.[b]				Labor.		Loss of iron.	
			Described or patented in A. D.	Used in A. D.	Abandoned or not.[e]	Per 100 of	For reducing.	For heating.	Total.	Per 2,000 lbs. of	Days	From ore to	Per 100 of iron in ore.
Ore reduced and heated by the same solid fuel: product balled. — *Charcoal-hearths*, balling processes.	Catalan and Corsican hearths, ore and fuel in separate columns					bars.			200 @ 36	bars.	19·7	bars.	27 @ 31%
	American bloomary, ore and fuel charged together				now in use.	blooms.			190 @ 32	blooms.	1·25 @ 1·8	blooms.	17 @ 25
Shaft-furnaces, balling processes.	Osmund furnace, a very low shaft				now in use.								33 @ 50
	German high bloomary (stückofen), a taller shaft					blooms.			280 @ 45	blooms.	12		
	Husgafvel's bloomary, still taller, hearth movable				now in use	"			105 @ 145	blooms.	4	blooms.	21 @ 23
	Nyhammar bloomary, spongy iron raked into charcoal hearth		1882	1882 ±		"			121			blooms.	8·15 ?
Ore reduced and heated by the same gas in a shaft-furnace or retort. — Sponge-mak'g processes.	*Gurlt's* type: carbonic oxide passed through ore, product spongy iron.	Gurlt	1856	1884		"			84 [h]			blooms.	10 ?
		Chenot direct-heating.			probably in use.	"			99 [h]				
		Ramdohr	1871		abandoned.								
	Cooper's, carbonic oxide passed through ore, resulting CO_2 reduced to CO by passing through fuel, etc.	Cooper	1873 ±		"								
		Westman	1888		projected.								
	Touranjin. Hot CO from hot-blast gas-producer passed through ore: residual CO burned to heat the blast		1882										
	Laureau. (Application for patent pending)		1889 ±		projected.								
Steel-melt'g heat.	*Bull*. Ore reduced and heated and product melted by combustion of hot water-gas in shaft-furnace		1883		abandoned.	cast iron.			700				
Ore reduced by solid fuel and heated by other than the reducing fuel. — Reduction in retorts, shaft-furnaces, etc. — Sponge-making processes.	*Lucas* Ore reduced in horizontal retorts with charcoal.	Lucas	1792		"								
		Conley ? [g]			now experiment'g								
	Chenot's type. Ore reduced by charcoal or coke in vertical retorts heated externally: sponge cooled before removal.	Chenot	1831		abandoned.	iron in ore	35 @ 48	96 @ 157	131 @ 205	iron in ore	3·3	blooms.	36 ±
		Blair	1872		abandoned.	ingots.	43 [c]	58 [c]	101 [c]	ingots.	1·8 [c]	ingots.	24
		Yates			"								
		Trosca			"								
	Blair's later: Ore reduced by charcoal in vert. retorts heated internally by hot carbonic oxide	Blair			"								
Balling-processes.	*Clay's* type. Ore reduced in retorts over puddling furnace: sponge dropped into puddler and balled.	Clay	1837		abandoned.								
		Renton	1851		"	blooms.	150	100 ±	250 ±				
		Wilson	1884										
		Rogers	1862		"								
	Schmidhammer. Ore reduced in shaft by charcoal, and heated directly by combustion of hot water-gas: balled in forehearth		1886		projected.								
	Du Puy Ore reduced in sheet-iron cases by charcoal: resulting sponge rolled out into bars		1878		abandoned.							blooms.	21·5
Steel-melting heat processes.	*Mushet*. Reduction and fusion with charcoal in crucible		1800		"								
	Siemens retort type. Ore reduced in vert. retorts within open-hearth furnaces; sponge melted by bath of cast-iron in the same furnace.	Siemens	1868										
		Ponsard	1868										
Reduction in open reverberatories. — Sponge-making process.	*Thoma*; ore uniformly mixed with coal, heated in an open reverberatory; sponge used for copper precipitation		1845		aband'n'd within a few years.	iron in ore	45	114	159			sponge.	appar'ntly 10%
Balling process.	*Harvey*. Ore reduced with charcoal on shelves above reverb., then balled in reverb.		1854 ±		abandoned.								
	Gerhardt. Ore bricked with tar, flux, and carbonaceous matter in a puddling furnace		1874										
	Eames. Reduction with graphite, and balling, in open reverberatory		1885-9		now in use.	balls.				balls.	1·17	ingots.	21%
	C. W. Siemens, reduction and balling in rotary puddler		1873	1881	abandoned.	blooms.	28 ? @ 138	126 @ 237	149 @ 375	blooms.	5·5	blooms.	12 @ 25
Steel-melting heat process.	*Leckie*. Ore bricked with coal, reduced in fore-hearth of open-hearth furnace, then melted on its hearth.		1869 ±		abandoned.								
	F. Siemens. Melted ore reduced by coal in open-hearth furnace		1887 ±		projected.								
	Eustis. Ore coked with coal, melted in shaft-furnaces		1880		abandoned.								

a *Dates*. No attempt has been made to trace the earliest and latest dates. I give simply those met in a superficial examination, without aim at historical methods.
b *Fuel*. In certain cases the consumption of charcoal is given in bushels: I have in these cases assumed a probable weight for the bushel: but this is only a guess.
c The quantity of fuel, etc., is used in sponge-making, per 100 parts of ingots obtained from the resulting sponge.
e "*Abandoned*" is not meant to imply that the projector has abandoned all hope, but that operations are suspended or practically so, according to such information as I have obtained.
f This process or its equivalent was in use till within a few years.
g The kind of retort used is not given.
h Fuel used in sponge-making, per 100 of blooms made in charcoal-hearth from the sponge.

of Gurlt's process should under the same conditions be applicable. Where rich ores are cheap and not charcoal but some non-blast-furnace mineral fuel is also cheap, this same process should be applicable, provided the producer-gas which it uses can be cheaply desulphurized.

The pressing problems for the direct process then seem to be

1, The application of natural gas in some shaft furnace like Husgafvel's.

2, Better means of the removing the balls than in Husgafvel's process.

3, Some quick cheap way of cooling sponge for sponge-making processes.

4, An automatic compressing apparatus for sponge, so simple that a single mechanic can compress enormous quantities rapidly.

5, Some cheap way of desulphurizing producer-gas.

Let not us who have seen Thomas solve the basic problem which had long baffled the wisest, say that this goal unreached is unattainable.

SOME DIRECT PROCESSES DESCRIBED.

Under most conditions, whether in making weld-metal to be used as such or in making material for the open-hearth or crucible process, iron relatively free from carbon is sought: and I assume that it is in the following descriptions. I have pointed out in considering the sponge-making and balling processes (§§ 315, A, B) how a carburetted product may be obtained.

§ 318. In the Catalan Process ore and charcoal are charged in separate columns in a low one-tuyered hearth, the column of charcoal lying between tuyere and ore, and the deoxidizing carbonic oxide generated in it passing through the ore column. The temperature is low at first, to avoid fusion before reduction, later reaching a welding heat, when the pasty iron is balled beneath the charcoal.

The hearth is built chiefly of heavy iron plates, with a tuyere inclining downwards from 30° to 40°. The following dimensions are given:

	Area.	Total depth.	Height to tuyeres.	Charge.
Pyrenees	20″ × 20″	16″	9″	3 @ 4 cwt.
Navarre	30″ × 24″	....	16″	5 @ 6 "
Biscay	40″ × 32″	24″ @ 27″	14″ @ 15″	7 @ 9 "

After cleaning and while still hot from the last charge, the hearth is filled to the tuyere level with charcoal. On this the ore in lumps, not more than two inches cube, is piled, together with charcoal, the charcoal against the tuyere-side, the ore against the other, as at *b*, Figure 131, a sheet of iron (later removed) separating them. The

Figure 131.—Catalan Hearth.

talus-face *b* being plastered over with fine moist charcoal, the blast is turned on gently and reduction sets in, the gases (chiefly carbonic oxide and nitrogen thanks to the thickness of the charcoal body) passing by preference through the open pile of lump ore, and escaping at its apex. As the charcoal burns away more is charged, and with it is added fine ore, moistened to prevent blowing away and sifting down. The fine ore sinks with the charcoal, apparently reaching the zone of fusion less completely deoxidized than the lump ore.

After two hours the lump ore column is gradually pushed downwards, and the temperature raised; as successive portions of the ore become sufficiently deoxidized they are pushed into the hotter region nearer the tuyere. By the time that a given portion is pushed into the hotter region much of its iron has reached the metallic state, though much still remains more or less oxidized. The temperature in this region is so high that the unreduced part of the ore melts and forms a slag with the gangue, and that the completely reduced part, growing pasty, welds readily into a bloom.

The whole of the lump-ore reduced and balled, the blast is stopped and the bloom pried out of the hearth and hammered. It is reheated in the upper part of the same hearth while a second charge is reducing.

The slags are essentially basic ferrous silicates. To avoid carburizing and phosphorizing the iron we should (1) have plenty of highly ferruginous slag, which devours phosphorus and carbon, and should hence add much fine ore with the charcoal and tap the slag but rarely: (2) hasten the operation and so shorten the carburizing and phosphorizing exposure: (3) use much blast, to weaken the reducing and carburizing tendencies: (4) incline the tuyere downwards towards the iron, that the blast's oxygen may be less fully converted into carbonic oxide before reaching iron and ore, and the reducing conditions thus weakened. These steps increase the necessarily great waste of iron, and, in spite of them the metal is liable to be carburized and steely: it is necessarily heterogeneous, but nearly free from phosphorus.

In the *Genoese* modification of the Catalan process, which aimed at fuel-economy, a flat-bedded reverberatory received the hearth's flame at one end, delivering it at the other through a horizontal grating, on which the raw ore was piled, into a vertical chamber leading to the chimney. Roasted and somewhat desulphurized here, the ore was next made friable by quenching in water; was crushed, spread on a charcoal layer on the reverberatory's hearth, heated by the flame again and partly reduced by the charcoal on which it lay; was here mixed with cast- or wrought-iron scrap, pushed into the charcoal hearth, and further reduced and balled.

Some economic data follow.

Table 155.—Catalan Hearth Practice.

	I.	II.	III.
	Percy, 1841.	1840 ±, Richard Percy.	1868, Mussy, Phillips.
Weight of bars per charge, lbs	368 ±	334	374
Length of charge	....	6 hours.	
Men per hearth per shift	....	6 *b*	
Labor, days per 2,000 pounds bars	....	19·7	
Charcoal, tons per 2,000 pounds bars	2·76	3·59	2·00
Loss from ore to bars, per 100 of iron in ore	27·2 *a*	30·9 *a*	28·3
Cost per 2,000 lbs. of bars			
Charcoal	$42.82	....	$31.99
Ore	10.69	....	7.76
Labor	10.25	....	8.13
Repairs	1.38	....	1.22
	$65.14	....	$49.10

I. Francois, Percy, Iron and Steel, p. 310, 1864.
II. Richard, idem, p. 298.
III. Mussy, Phillips and Bauerman, Elements of Metallurgy, p. 175, A. D. 1887.
a The ore is asssumed to contain 45% of iron.
b It is assumed that there were two heats per shift. There were altogether ten persons at the forge, but of these only six seem directly chargeable to bloom-making.

§ 319. THE AMERICAN BLOOMARY PROCESS,[a] resembling the Catalan process in its general features, differs from it in that the ore is charged wholly in a fine state and mixed with charcoal, instead of chiefly in lumps and in a separate column.

The furnace, Figure 132, costing (Egleston) $550 to $600, consists of a nearly rectangular box, of thick castings. It is from 20″ to 30″ wide, and from 27″ to 32″ long, its depth being from 15″ to 25″ above the tuyere and from 8″ to 15½″ below it. It has a single D-shaped tuyere, about 1″ × 1·75″, supplied with blast heated in overhead cast-iron pipes to from 550° to 800° F., and at 1·5 to 2·5 pounds pressure per square inch.

Operation.—The hearth being filled heapingly with burning charcoal, charcoal and coarsely pulverized, washed, and nearly pure ore are thrown on at short intervals, usually one to five, occasionally 12 to 25 minutes, together with slag from previous operations if the gangue be very scanty. The ore reduces in sinking, the usually silicious gangue forms with unreduced ore a basic ferruginous slag, which is tapped intermittently. The reduced iron gradually agglomerates to a pasty ball (loup), which, after nearly three hours, is pried through the charcoal towards the tuyere for greater heat, is then drawn,[b] hammered to a bloom, reheated usually in the bloomary itself, rarely in a chamber heated by its waste gases, and rehammered.

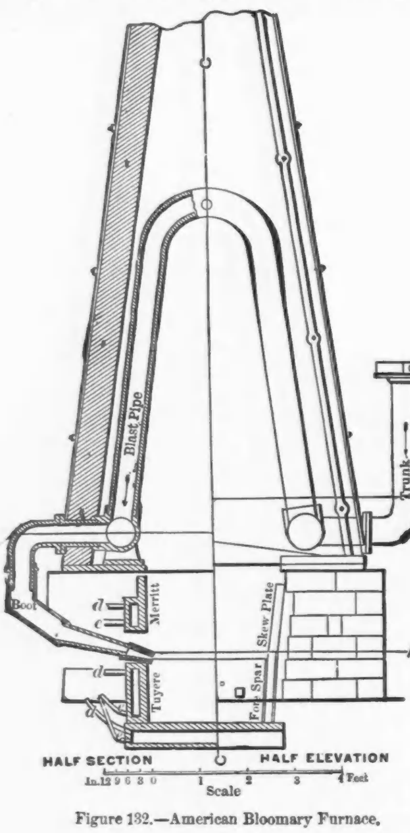


Figure 132.—American Bloomary Furnace.

The operation lasts about three hours, so that eight loups, usually of 300 to 400 pounds each, are produced per twenty-four hours, at an outlay of from 250 to 350 bushels of charcoal and 1·25 to 1·5 days' labor per 2,000 pounds of blooms, and with a yield of say 80% of the iron in the ore. Table 156 gives some numerical details.

[a] For an admirable description, see T. Sterry Hunt, Geol. Survey of Canada, Rept. Progress 1866-9, p. 274. Also T. Egleston, Trans. Am. Inst. Mining Eng., VIII., p. 515, 1880.

[b] A noted writer tells us that the bloom is dug up by the clock, but leaves us in the dark as to how the time keeping properties of this instrument are thereby affected.

TABLE 156.—AMERICAN BLOOMARY PRACTICE.

	Lake Champlain. 1889.	Lake Champlain, 1879.	Palmer.	New Russia.	Moisie. 1868.	E. Middlebury
	0.	I.	II.	III.	IV.	V.
Dimensions of hearth:						
Width	29″	24″ @ 30″	....	20″	30″	24½″
Length	31″	27″ @ 32″	....	32″	32″	29″
Height to tuyere	15½″	....	....	....	14″	12″
" above tuyere	25½″	....	....	....	....	
" total	41″	28″ @ 36″	....	24″	....	
Blast:						
Pressure, lbs per sq. in.	2 @ 2½	1⅞	....	1½ @ 1¾	⅞ @ 1¼	1¾ @ 2
Temperature, C.	....	315 @ 427	....	....	....	288 @ 315, est.
" F.	....	600 @ 800	....	....	....	550 @ 600, est.
Size of tuyere-nozzle (one only)	2″ × ¾″	1¾″ @ ½	....	....	1″ × 1⅞″	1″ × 1⅞″
Inclination of tuyere	12°	....	....	....	very slight.	
Ore, kind	Chateaugay conc'ntr'ted	magnetite	magnetite	magnetite	magnetic sands.	
" % iron	65	65	60	70 ±	55 ±	
Length of one heat	3 hours	3 hrs. aver.	....	....	3 hours.	
Labor:						
Men per hearth per shift	1	1	....	....	1½	
Length of one shift	12 hours	12 hours.	....	....	12 hours.	
Output per hearth:						
Weight of blooms per heat, pounds	400	300 @ 400	....	....	210	
Weight of blooms per 24 hours, pounds	3,200	2,600	....	2,400	1,680	
Slag:						
Composition, silica %	....	24·6 @ 26·4	....	....	8·7 @ 11	16 70
" iron-oxide %	....	48·6 @ 49·7	....	....	52 @ 67	62 06
" alumina	....	0·8 @ 1·6	....	....	....	17·33
" phos. acid	....	0·05 @ 0·03	....	....		
Outlay per 2,000 pounds blooms:						
Charcoal, bushels	310	255 @ 300	....	212 @ 255	396	230
" pounds *a*	5,425	4,640 @ 5,400	....	3,800 @ 4,550	6,240	4,100
Ore, tons	2	2 washed.	2 washed.	1·5 washed.		
Labor, days	1·25	1·5	....	....	1·8	
Loss from ore to blooms, per 100 of iron in ore	23·07	23	16·7	*b* < 7·9	48	

I. T. Egleston, Trans. Am. Inst. Mining Engineers, VIII., p. 515, 1880.
II. to V. T. Sterry Hunt, Rept. Geol. Survey Canada, 1866–9, pp. 274, et seq.
a It is assumed that a bushel of charcoal weighs 18 pounds.
b It is stated that 1·5 tons of nearly pure magnetite yield one ton of blooms. If the magnetite were absolutely pure this would imply a loss of only 7 89%; but as it never is, the loss implied is probably nearer 5%. This is intrinsically improbable: and the statement that 1·5 tons of ore yields one ton of blooms is probably intended to be only approximately true. No doubt in an occasional heat, in which a considerable quantity of rich slag from previous operations is added, such results may be reached.

Indications.—The condition of the operation is judged from the color and brightness of the flame, which should be blueish or reddish, and not brilliantly white; the appearance and consistency of the slag; and the hardness and shape of the loup, which should be moderately soft. If the loup is very soft so that a bar sinks deeply into it the hearth is too hot, and the proportion of ore must be increased: if the loup is hard the temperature is too low and the proportion of charcoal must be increased.

The ore is so charged that a rim of iron shall form around the outer edge of the upper face of the loup, and thus form a basin which remains filled with slag, and protects the loup's face at once from the blast and from carburization.

TABLE 157.—COMPOSITION OF AMERICAN BLOOMARY IRON.

	1	2	3	4	5	6	7	8
Sulphur	·008	trace.	trace.	·001	trace.	trace.	trace.	trace.
Phosphorus	015	·042	·034	·028	·023	.042	·011	·015
Silicium	·095	·280	·021	·512*	·025	·100	·013	·013
Manganese	·079	......	......	......	......	......	......	0
Carbon	·228	·170	·220	·180	·170	·165	·220	·10 @ ·30
Slag	......	......	·180	·014	·155	·075	·150	·25 @ ·50
Copper	......	......	......	......	......	......	......	......

1 to 7. Billets, Egleston, Op. Cit. 1 and 6, Saranac, Hasegawa. 2, 3, 4, Au Sable Forks, Britton. 5, Peru Iron Company, Wuth. 7, Chateaugay.
8. Bloom, A. E. Hunt, Trans. Am. Inst. Mining Engineers, XII., p. 313, 1884. Chateaugay.

The cost of making blooms in the Lake Champlain region is, I am credibly informed, about $45.00 per ton at a mill which, I understand, is closely connected with an iron-mining concern. The estimated cost, under such conditions, is in large part a matter of book-keeping, depending chiefly on the price at which the fine ore, which is to a certain extent a bye-product, is charged against

(TO BE CONTINUED.)

the smelting works. Charcoal blooms are quoted at $52.00 to $54.00 per ton in Philadelphia.

The output of the American bloomaries is decreasing rapidly, as the following table[a] indicates: but, as it more than doubled between 1876 and 1882, it would be rash to predict the early decease of the process confidently. Yet it certainly seems moribund.

Year.	Output of blooms and billets, net tons.
1874	36,450
1876	20,784
1882	48,354
1887	15,088
1888	14,088a

a J. M. Swank, private communication.

From the following table, compiled from the "Directories to the Iron and Steel Works of the United States" for 1884 and 1888, we see that some of the bloomaries now standing are extremely old, and that the building of bloomaries continued till 1883. Between 1870 and 1880 no less than sixteen establishments were built.

TABLE 157A.—HISTORY OF THE AMERICAN BLOOMARY ESTABLISHMENTS REPORTED IN 1884 AND 1887.

Years in which the bloomaries reported in 1883 and 1887 were built or rebuilt.			Of those built in the several periods of Column 1. the following numbers were			
Years.	No. built.	No. rebuilt.	Idle or abandoned before 1884.	Abandoned between 1883 and 1887.	Idle but apparently not abandoned in 1887.	Running in 1887.
1797–1819	2	....	....	1	....	1
1820–1829	3	....	2	....	....	1
1830–1839	6	1	1	4	....	2
1840–1859	7	1	....	3	....	5
1860–1869	6	1	....	1	2	4
1870–1879	16	6	....	11	5	6
1880	3	1	....	1	1	2
1881	2	....	....	1	1	
1882	0					
1883	1	2	....	....	....	3
1884–7	0	0				

Clearly the process is applicable only where rich fine ore, charcoal, and labor are cheap. Even under these conditions it could not compete with fuel-saving processes such as Husgafvel's.

§ 320. THE OSMUND FURNACE (blaseofen, bauernofen), is intermediate between the low and the high bloomaries. It appears to be about eight feet in height. Smelting calcined phosphoric bog-ores with charcoal, it yielded 1½ tons or less of good malleable wrought-iron weekly, with a loss of from 33 to 50% "in working up the bloom:[b] the enormous loss tallies with the production of good iron from phosphoric ores.

The osmund furnace is said to be used still to a very considerable extent in Finland, apparently solely by the peasants.[c]

§ 321. THE OLD HIGH BLOOMARY (STÜCKOFEN.)—Here the height, and with it the carburizing tendencies and the economy of fuel, were carried so far that there was a strong tendency to make cast- instead of malleable-iron: indeed, cast-iron was often made unintentionally in these furnaces. They differed but slightly from the blauofen in which cast-iron was habitually and intentionally made, and in which indeed by varying the strength of the carburizing conditions wrought- or cast-iron could be made at will.

Furnace.—The old Stückofen was a shaft-furnace from 10′ to 16′ high: round or rectangular in section: say 2′ 6″ wide at top and 1′ 6″ (at Eisenerz 4′ × 2′ 6″) at bottom, usually bellying out midway to say 4′ 2″: and had one tuyere say 14″ to 20″ above the bottom, and at the bottom a drawing-hole say 2′ wide, opened for removing the bloom, but closed at other times.

Operation.—The furnace was filled with charcoal, which was lighted from below: as soon as the fire reached the top the blast was turned on, and charcoal and burden (rich slags and ore) charged. The burden was at first light, gradually increasing to the normal—one volume to four of charcoal. Descending, its iron was deoxidized, and, reaching the bottom, agglomerated to a bloom. The slags ran out constantly through a notch in the stopping of the drawing-hole. As soon as the bloom was found by probing to be large enough, charging ceased, the furnace was blown down and the bloom loosened and drawn through the drawing-hole. The furnace was then cleaned out, repaired, its bottom brasqued, and charging began again.

To guard against carburization and the production of cast- instead of malleable iron, the carburizing tendencies were purposely restrained, *e. g.* by charging a large proportion of ore to charcoal.[d]

Some economic data follow.

TABLE 158.—STÜCKOFEN PRACTICE.

	Usual.	Eisenerz.	Old Porsaskoski.
Weight of blooms per charge, lbs.	448@672	1,500 ±, with 700 lbs. ± of cast-iron.	....
Length of charge	8 hrs. = 1 shift.	18 hrs.	....
Men per furnace per shift	3	......	....
Labor, days per 2,000 lbs. blooms	12±	......	....
Charcoal, tons per 2,000 lbs. blooms	4·5a	......	2·8
Ore, " " "	....	......	5·36

a At 10 lbs. per cubic foot, or say 15 lbs per bushel.

§ 322. HUSGAFVEL'S[e] HIGH BLOOMARY or continuous stückofen is a tall shaft-furnace, with double, air-cooled, wrought-iron walls, and a movable hearth.

These arrangements tend to diminish the quantity of fuel, ore and labor needed per ton of blooms, and increase the output per furnace: but this last is still very small, while the consumption of fuel is certainly moderate.

The Furnace, Figure 133.—The air-space between the double-walls serves for heating the blast, which by the spiral partitions B B is forced to travel circuitously. The lower five feet of the shaft are lined with fire-brick, the rest is naked within. The outer walls are lagged with four inches of fire-clay, to lessen heat-radiation.

A movable, air-cooled, cast-iron section is provided between shaft and hearth, as this part is relatively perishable, because its temperature is high, and because it is cut by the reduced iron which often adheres to it, and by the workmen's tools used in removing these accretions.

The movable hearth has four water-cooled tuyere-holes *s* on each of two opposite sides: four slag notches *t* at different levels: trunnions *b* for dumping: and a false bottom *u* that accretions may not form on the hearth

a Ann. Statistical Rept. Am. Iron and Steel Ass., p. 37, 1888.

b Percy, Iron and Steel, p. 320. The wording is obscure: I infer that this loss is from ore to hammered bloom.

c F. L. Garrison, Private Communication, April 10th, 1889.

d Percy (Iron and Steel, p. 330), from whose description the above as well as part of Table 158 is condensed, further says that one essential condition of obtaining malleable iron from the blauofen, (which was really a stückofen, the difference originally referring to the mode of working the furnace and the consequent product, not to construction), was to allow the slag free escape, so that it might not protect the bloom from the blast. As the slag was highly fining, containing say 51·7% of ferrous oxide, one might have anticipated that if present it would not only oppose carburization, by preventing charcoal from resting against the bloom, but would tend to decarburize the gradually arriving particles of iron.

e Cf. F. L. Garrison, Trans. Am. Inst. Min. Eng., XVI., p. 334, 1888: and Journ. U. S. Ass. Charcoal Iron Workers, III., p. 280, 1887. He refers to Husgafvel, Jernkont. Annal., 1887: Russian Mining Jl., 1887, II., pp. 398, 435. See also Eng. Mining Jl., XIV., p. 90, 1888: also Stahl und Eisen, IX., pp. 35, 121, 1889. The last has appeared since this article was written, and I have only been able to avail myself of part of its data.

proper. It rests on a lifting platform, which facilitates removal and adjustment.

From the fact that, in experimenting with slow charging and lightened burden in the Dobriansky furnace, whose internal capacity is 400 cubic feet, no cast-iron was made, it is inferred that the limits of size have not been reached, and furnaces of a capacity of 1,000 cubic feet are projected.

The Blast at a pressure of ½ to 1½ inches of mercury (3·9 to 11·8 oz. per sq. in.), is heated in passing downwards through the double walls of the shaft and of the movable section, to from 150 to 250° C. (302 to 482° F.), its temperature and to a slight extent that of the furnace being regulated by varying the proportion of blast admitted at the points f^1, f^2, f^3, f^4 and g. The tuyeres and their trunks i, counterweighted at l, m, n, o, are moved vertically to the appropriate tuyere-holes s, and have ball-joints p, permitting change of direction in all ways.

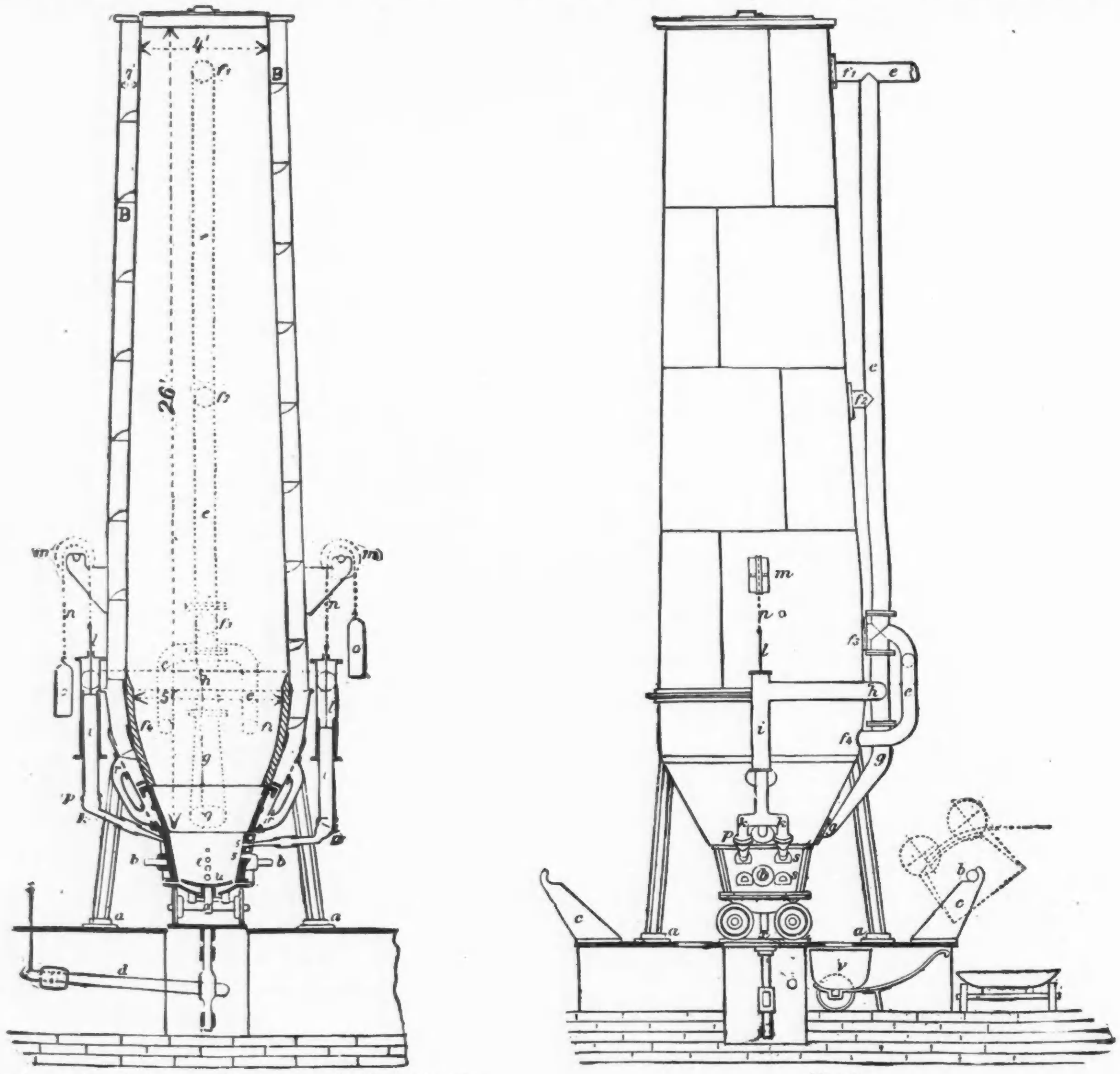


Figure 183.—Husgafvel's High Bloomary, at Dobriansky, 1886—Vertical Section. Elevation.

The Materials.—The ore and rich (*e. g.* puddling) slags are crushed to "quite a fine" size, apparently about ¼" to ½" cube.

The fuel is charcoal, divided into coarse and fine. Coke was used with apparent success, but for so short a while that the results are inconclusive.

The Operation is continuous, charcoal and ore being charged apparently in uniform horizontal layers: the fine charcoal is charged after the coarse, so as to close the interstices and hinder the fine ore from sifting down. The burden, descending gradually, reaches the hearth quite reduced, and probably considerably carburetted. The conditions in the hearth, contact with the ferruginous slag and exposure to the blast, appear to be decidedly decarburizing.

A fresh hearth being in place, the tuyeres are inserted in the lower tuyere-holes, and the blast turned on. The slag is apparently tapped at intervals, its level being kept somewhat above that of the top of the gradually forming bloom, so that the reduced iron, arriving little by little, sinks through a layer of molten decarburizing slag before reaching and coalescing with the iron already present. When the bloom has grown nearly to the level of the lower tuyere-holes, the tuyeres are raised to the upper holes, and the lower ones stopped. When it has reached the upper tuyere-holes the blast is stopped, the hearth lowered, and immediately replaced by a fresh one, the blast being interrupted for only about five minutes. The old hearth is now dumped, the false bottom being, if necessary, driven out by blows on the shaft x.

As false bars are not used, the charge sinks somewhat during changing hearths: to equalize this, the hearths are changed alternately to right and left, two dumping-rests, *c*, being provided. Before running a fresh hearth into place it is filled with charcoal.

Indications.—In normal work the tuyere is clear and bright; the throat-flame lively; the slag bright and fluid; the bloom hard and slippery. A rod thrust against it heats quickly, and particles of iron adhere to it.

With too fast driving or too heavy burden, *i. e.* with insufficient reduction, the bloom is uneven and porous, the slag is very ferruginous, ultra fluid, yellowish red (*i. e.* cool) while molten, solidifying abruptly, and sub-metallic and black when cold, a "scouring cinder;" the throat-flame is thin and feeble; the tuyeres dull.

With too slow driving or too light burden, *i. e.* too strong reduction and carburization, the slag becomes less ferruginous and hence less fluid, and the metallic product steely, or even cast-iron.

When the slag is too refractory, either from faulty fluxing or because excessive reduction robs it of its ferrous oxide, scaffolds form, and the throat-flame grows blue and hot.

Remedies.—The reducing conditions are strengthened by running more slowly (lowering the blast pressure); by lightening the burden; by raising the blast-temperature through admitting a larger part of the blast through the upper part of the inter-mural space, thus increasing the heating surface, and the average of travel and length of exposure of the blast.

They are weakened by the opposite steps.

Difficulties. The product is heterogeneous, thanks partly to the irregular descent and hence varying length of exposure to the reducing and carburizing conditions. It tends strongly to adhere to the walls, especially where these are of brick.

Products. The bloom, according to the following analyses, is liable to be extremely heterogeneous: *e. g.* lines 3, 5, 8, 11, 12. The proportion of silicon is in some cases astonishingly high, and indeed hardly credible. There is a variation of 0·57% between the different parts of Number 5.

TABLE 159.—COMPOSITION OF BLOOMS FROM HUSGAFVEL HIGH BLOOMARIES.

	Made from.		C.	Si.	Mn.	P.	S.
1.	Shingled bloom Magnetite	centre	·07	tr.			0·005
		side	·06	tr.			·03
2.	" " Ore	centre	·13	·22			·03
		side	·07	·32			·018
3.	" " Roll scale	centre	·07	·023			·015
		side	·32	·061			·015
4.	Wärtsilä "		·12@2·00			·29@·85	
5.	Shingled " fracture uneven	centre	·05	·04			·02
		side	·09	·61			·03
6.	Melted product from hot-working		1·5	·06			·02
7.	" " "		1·22				
8.	Hammered bloom, granular	centre	·06	·03			·03
		side	·19	·03			·02
9.	" " coarse granular	centre	·01				·04
		side	·01				·02
10.	" " " "	centre	·01	·06			·03
		side	·012	·02			·03
11.	Unhammered loup, hot-working	centre	·30	·05			·01
		side	·14	·40			·02
12.	Hammered bloom	centre	·01	·22			·08
		side	·01	·09			·02
13.	Unhammered loup, normal working	centre	·11	·45			·04
		side	·08	·52			·05

A. *Phosphorus.* The proportion of phosphorus eliminated of course increases with the loss of iron. When the loss of iron is small and the blooms highly carburetted, most of the phosphorus of the ore is found in the resulting metal: but when the loss is heavy and the bloom holds but little carbon, it may have only one-third of the phosphorus of the ore.

B. *Carbon.* The variation of 0·25% between the different part of bloom 3 is certainly very marked. The proportion of carbon in the bloom is said to be well under control; but it is probably only very roughly controllable.

The slag is said to contain about 52·46% of ferrous oxide, or 40·8% of metallic iron, when the blooms are but slightly carburetted; and about 9·91% of ferrous oxide, or 7·15 of metallic iron, when the reduction is strong, highly carburetted blooms resulting.

§ 323. ECONOMIC FEATURES.—Table 160 has been calculated from Husgafvel's data and from those collected by Mr. Garrison. I confess to doubts as to the value of certain numbers, chiefly because one cannot be

TABLE 160.—THE HUSGAFVEL FURNACE AND ITS WORK.

	I. Petrozavodsk, 1887.	II. Wärtsilä furnace, 1884.	III. Dobriansky furnace, fig. 133, 1886.	Dobriansky furnace, 1887.			
				IV.	V.	VI.	VII.
Dimensions—							
Total height	>30'		30' ±				
Diameter at throat			4'				
" " belly			5'				
Tuyeres, number		4	4				
Blast, pressure, oz. per sq. in.			0·5 @1·5	3·929@10·477	6·5 to 11·7	6·5 to 9·8	6·5 to 9·8
" temperature, °F		302° @ 482° +	302°@572°	405°	446°	437 to 446°	302 to 446°
" " C		150° @ 250	150 @300°	207°	230°	225 to 230°	150 to 230°
Materials and Labor—							
ORE, kind	Bog-ore.	Lake-ore and pudding slag.	Magnetites.	Raw magnetite.	Raw magnetite.	Roll scale.	Roll scale.
Percentage of iron		36% ±	estimate 55% ±	58%	58%		
Net tons per net ton blooms		1·64 ore (36% iron) 1·02 slag (49% iron) 2·66	2 tons ore 0·1 " slag 2·1 "	1·97	1·95	1·85	1·64
CHARCOAL, kind		Fir and pine, "Medium quality."	Fir "very inferior"	Pine.	Pine and birch.	Pine.	Pine.
Bushels per net ton blooms		157	159@250, average 190				
Lbs. per net ton blooms (13·4 lbs. per bushel?)		2,100 ?		2,899	2,899	2,326	2,222
" " 100 of blooms		105		945	145	116·3	111·1
Burnt lime, net tons per net ton blooms		0·01					
Limestone " " " " " "		0·12					
Cast-iron " " " " " " (for repairs)		0·01	0·017				
Labor, men per shift (12 hours)		3 +					
" days per 2,000 lbs. blooms			4·00				
PRODUCT net tons per 24 hours		1·52@3·00	2·46@3·08	2·96	8·28	2·94	[illegible]
Weight of each bloom, lbs.			670@795				
Composition, % carbon		·12@2·00	·06@·32				
" " phosphorus		·29@85					
" " silicon			tr. @·32				
Loss of iron, per 100 of iron in ore		21% *a*	23% *b*	21% *c*	21% *c*		
Slag, percentage of iron		7·15@40 8					

I., II. and **III.** From data collected by F. L. Garrison. **IV.** to **VII.** From Husgafvel, Stahl und Eisen, IX., p. 35, 1889.

a From the data given in this same column the loss appears to be 9%: but we cannot be sure that the data refer to the same conditions. Husgafvel states (Stahl und Eisen, 1889, p. 40) that the loss at Wärtsilä in 1885 was from 25·17 to 12%, according to whether soft wrought-iron or steely blooms were made: but that the blooms held in some cases as much as 15% of slag. If we assume that they held on an average 10% of slag, a loss of 12% from ore to bloom would, allowing for the slag contents of the blooms, rise to 21%.

b From the data about 86% of blooms appear to be recovered from 100 of iron in ore. Assuming that the blooms contain 90% of metallic iron, the loss would be 23%.

c Assuming that the blooms contain 90% of metallic iron.

sure that they refer to the same conditions. The loss of iron cannot be calculated with complete confidence, as we do not know how much iron the blooms (loups) contain. The numbers given are based on the assumption that they hold on an average 90% of iron. Husgafvel states that they sometimes contain 15% of slag. The results thus obtained tally with his further statement that the loss at the Konchozersky works at Olnetz is 20%, allowing for the slag in the loups, while in the old Finnish furnaces it was from 40 to 50%.

A Russian official table appears to show that the cost of Husgafvel blooms is the same as that of pig-iron under like conditions: but the data have a suspicious look. Thus the cost of pig-iron is only brought up to that of blooms by a charge of $2.65 per net ton for repairs. Labor costs but $0.36 per ton diem: if we assume that the cost of given repairs in Finland and in this country is proportional to that of labor, this implies repairs such as would cost here about $11.00 per ton of pig-iron, which is certainly surprisingly high.

It appears from this table that less than half as much flux, but 15% more fuel, 27% more ore and puddle slag, and 56% more labor are needed to make a ton of blooms than a ton of pig-iron. This difference in the quantity of flux must be referred chiefly to the heavy scorification of iron, which enables the bloom-maker to dispense with much of the limestone which the pig-iron-maker needs; but iron ore is a dearer flux than limestone.

On these data we might roughly put the cost of bloom-making as one-quarter greater than that of pig-iron making in a 42-foot charcoal-furnace.

The Husgafvel furnace undoubtedly gives much better economy of fuel than the American bloomary, and one would expect it to give better economy of labor. This it does not yet seem to do. As to the loss of iron, that must ever remain proportional to the degree of dephosphorization which takes place. To cut down the loss of iron we must increase the reducing tendency, and we thereby inevitably diminish dephosphorization.

In so high a furnace as the Husgafvel there should be greater liability to excessive reduction and hence imperfect dephosphorization than in the low American bloomary: and we may doubt, judging from the history of like processes, whether, even by charging an excessive proportion of ore to fuel and by rapid running, it would be possible to obtain constantly so pure a product from given ore in the former as in the latter. But direct experiment alone can answer this.

The use of coke would probably yield a highly carburetted and correspondingly impure product, indeed approaching cast-iron in composition, and rich in sulphur. We note that even with charcoal the Husgafvel furnace occasionally yields iron with 2% of carbon.

From reasoning similar to what has gone before we may infer that the cost of coke-blooms would be probably about from one quarter to one half greater than that of coke pig-iron.

In order to dephosphorize, the slag must be basic: a slag made basic by oxide of iron means heavy loss of iron. One might at first think that we could obtain a basic slag in this furnace by replacing iron-oxide with lime, and so dephosphorize without heavy loss of iron. But we must remember that to melt a basic lime slag demands a very high temperature, and such a temperature would not only imply greatly increased fuel consumption but much more strongly reducing conditions, more strongly reducing both because of the higher temperature and of the larger proportion of the reducing agent itself, charcoal. But these reducing conditions oppose the dephosphorizing action of the basic slag. In short, if we attempt to save iron we turn the furnace into a blast-furnace, and make, if not cast-iron, at least a very highly carburetted steel, containing much if not all of the phosphorus of the ore. Now charcoal blooms are marketable chiefly because of their freedom from phosphorus, and to a considerable extent on account of their relative freedom from carbon.

This ingenious direct process is certainly one of the most successful yet devised. When we consider how short a time has elapsed since these attempts to modernize the stückofen began, the progress thus far made is certainly most encouraging. The mode of dealing with the bloom is ingenious, but something much better still is needed. The output, too, is very small. One wonders whether it might not be greatly increased without increasing the tendency to carburize, or causing trouble as to the penetration of the blast, by making the furnace oblong instead of circular in plan, as in the Raschette furnace, and in the Orford copper furnaces. The Orford engineers increased the output of their furnaces enormously, with some economy in labor and fuel, by this simple expedient. In case of the Husgafvel furnace two or more hearths would have to be provided, for the bloom formed in a single long hearth would be unmanageable. Mr. Garrison informs me that Raschette furnaces are still extensively and successfully used in the Urals for making charcoal cast-iron.

§ 324. THE NYHAMMAR[a] CONTINUOUS HIGH BLOOMARY consists of a shaft 16′ high and 18″ wide, from the bottom of which covered flues lead to covered and closed charcoal-hearths. Actually there seems to have been but one hearth, but the design contemplates several attached to each shaft.

Ore and charcoal are charged in the chaft continuously, and through this the gases from the charcoal-hearths pass to heat the charge. The proportion of ore to charcoal charged in the shaft is regulated so that the temperature and reducing conditions in the shaft may be such as to deoxidize the ore and heat the resulting sponge strongly, but not to carburize or to soften it. The hot but not sticky spongy iron, together with the residual charcoal, is raked from the bottom of the shaft in o one of the charcoal-hearths, through one of the flues already described. In this hearth the spongy iron is heated to the welding point and balled, fresh lots of sponge apparently being raked in as fast as the iron, balling, sinks, till enough for a bloom has reached the hearth, when raking ceases or is diverted to another hearth. The melted slag is tapped from the hearth, the iron worked into a bloom, drawn and hammered.

When it is necessary to open a charcoal-hearth (*e. g.*, for drawing), the flue which leads from it to the shaft is closed with a damper, to prevent an inrush of air into the shaft, and the consequent reoxidation of the spongy iron.

The following results were, it is stated, obtained in five

[a] Särnströn, Iron, XIX., p. 467, 1882: Oest. Zeit., Aug. 12th, 1882.

apparently not successive shifts : I deduce these numbers from Särnströn's data.

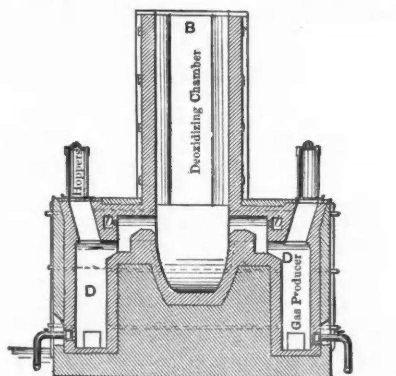
TABLE 161.—RESULTS OBTAINED IN THE NYHAMMAR BLOOMARY.

Percentage of iron in ore	60· % ±	
Blooms per 100 of iron in ore	91·85	
Loss of iron	8·15%	
	Bushels.	Pounds.[a]
Charcoal per 100 of iron in ore	8·8	132·
Charcoal per 100 of blooms	8·06	120 92
Blooms, pounds per furnace per shift		1085·
Phosphorus in ore	0·91%	
Phosphorus in blooms	0·08 @ 0·12%	
Proportion of initial phosphorus removed	93·% @ 95·%	

a Assumed at 15 lbs. per bushel of 2500 cub. inches, or 10·37 lbs. per cubic foot.

The loss of iron is certainly very small, especially in view of the dephosphorization which occurs : indeed Särnströn points out that it was probably greater than it appeared.

§ 325 A.—GURLT[a] deoxidized iron ore and carburized (?) the resulting sponge in the central shaft B of the furnace shown in Figure 134, by passing through it a stream of hot producer-gas from the producers D D. Here the producer gas both heats and deoxidizes the ore, which is unmixed with solid fuel. The hot spongy iron was drawn through a doorway at the bottom of the shaft, to be



GURLT'S FURNACE
Fig. 134.

balled, or if highly carburetted to be melted, in an open-hearth furnace or in a charcoal-hearth. Apparently fearing that the producer-gas would not be hot enough to heat the ore, he would burn part of it at the points *b b* by means of a carefully regulated air-supply. By prolonging the passage of the gas he would carburize the sponge.

This process was carried on in Spain in a few small furnaces from about 1865 at least till 1884. In 1884 some larger furnaces near Bilbao were idle.[b] The process was here called Tourangin's. The furnaces were built from his design and at first managed under his direction : and the air supply for partly burning the gas before it entered the ore column was omitted. Opinions may differ as to whether this constituted a new process: it seems to me clearly Gurlt's process.

At the Alonsotegui forges in Spain, we are told, hot producer-gas made from charcoal was passed through ore in a chamber of 105 cubic feet capacity, and holding about five tons of ore. The sponge was drawn while hot, and was immediately covered with cinders. It was drawn thrice daily, the total output corresponding to about 3·2 tons of ore, so that the ore remained in the reducing chamber nearly two days. 100 pounds of ore containing about 56% of iron lost 30 to 34% in weight in deoxidizing, and the resulting say 66% of sponge yielded about 50·5% of blooms in a charcoal hearth, with a further consumption of 25 pounds of charcoal : the loss of iron from

a British patent 1679, July 16, A. D. 1856 (Dec. 19, 1856; Jan. 16, 1857).

b L. G. Laureau, private communication, March 12th, 1889. The information was obtained by an agent sent to Spain by Mr. Laureau to examine the process.

ore to blooms was thus about 10% of the iron in the ore.[b] About 84 pounds of charcoal per 100 of blooms were used in deoxidizing, so that altogether about 134 parts of charcoal were used per 100 of blooms.

The process was tried at Ticonderoga, N. Y., in 1884, apparently with little intelligence. The reduction seems to have been complete, and neither reoxidation nor carbon deposition seems to have occurred to an important extent. Four analyses of the sponge gave from 0·52 to 2·17% of oxygen.[b]

B. *Ramdohr*[d] would shower iron ore through a Stetefeldt furnace filled with carbonic oxide.

§ 326. IN EDWARD COOPER'S PROCESS,[e] which was carried out experimentally about the year 1873, at Trenton, N. J., iron ore is heated and reduced by a current of hot carbonic oxide, or carbonic oxide and hydrogen. These gases are oxidized to carbonic acid and steam by the oxygen of the ore : they are then passed through a regenerator, in which they are highly heated, and thence through a bed of coal or other fuel in which they are again deoxidized to carbonic oxide and hydrogen. Still remaining in the same closed circuit, they are then used for reducing a fresh portion of ore, a part of the carbonic oxide and hydrogen, however, being diverted to heat the regenerator already mentioned.

To simplify matters let us suppose that only carbonic oxide is used, and follow the course of the gas. What is true of pure carbonic oxide would be true of a mixture of this gas with hydrogen, mutatis mutandis.

In passing through the ore column the carbonic oxide undergoes the reaction

$$(1),\ 3CO + Fe_2O_3 = 3CO_2 + 2Fe$$

in which $3 \times 12 \times 5{,}607 = 201{,}852$ calories are developed,
and $2 \times 56 \times 1{,}887 = 211{,}344$ " " consumed.

Net consumption of heat, 9,492 calories.

We now return the resulting gas to the producer, where the reaction

$$(2),\ 3CO_2 + 3C = 6CO$$

		Calories.
occurs, developing - - - - -	$3 \times 12 \times 2473 =$	89,028
and consuming - - - - - - -	$3 \times 12 \times 5607 =$	201,852
Net consumption in gas-producer - - - - -		112,824
Consumption in deoxidizing furnace - - - -		9,492
Total consumption of heat - - - - - - - -		122,346

We have now six equivalents of carbonic oxide, of which we may suppose that three are used to repeat reaction (1), three more being available for burning to carbonic acid in the regerator,

where they would generate -	$3 \times 12 \times 5{,}607 =$	201,852
as our total deficit was - - - - - - - - - - -		122,316
we now have an excess of - - - - - - - -		79,536

calories, or 65% of the theoretical heat-requirement as a surplus to make up for loss of heat by radiation, to use in heating the ore to the temperature of deoxidation, etc.

This, in Mr. Cooper's opinion, is not a sufficient surplus. Hence he introduces steam along with the carbonic acid into the regenerator, and thence into the gas-producer, thus making water-gas, and thus increasing the quantity of gas available for burning in the regenerator, but with-

c Extract from report under oath by P. Villaoz, manager of the Alonsotegui forges, October 31st, 1882.

d Berg und Hütt. Zeit., XXX., pp. 67-8, 1871.

e R. W. Raymond and E. Cooper, private communications, March 20th and May 8th, 1889.

out introducing nitrogen into the closed circuit of the reducing system. It may, indeed, be regarded as a mode of making water-gas, which is used while still hot from the gas-producer for deoxidizing iron-ore. The steam is introduced in the form of a jet, and incidentally aids the circulation of the gas through the system.

His apparatus was actually much more complex than that which I have sketched.[a]

solid fuel in the central chamber B, Figure 135 A, and through it passes a stream of carbonic oxide, generated in the gas producers DD′, which are shafts filled with charcoal or coke, hot air being blown in through the tuyeres a a. The waste gases (carbonic oxide and acid with nitrogen) escaping from the top of B are burned to heat the blast. The ore is heated wholly by the heat generated by the combustion of the fuel burned in the gas-producer:

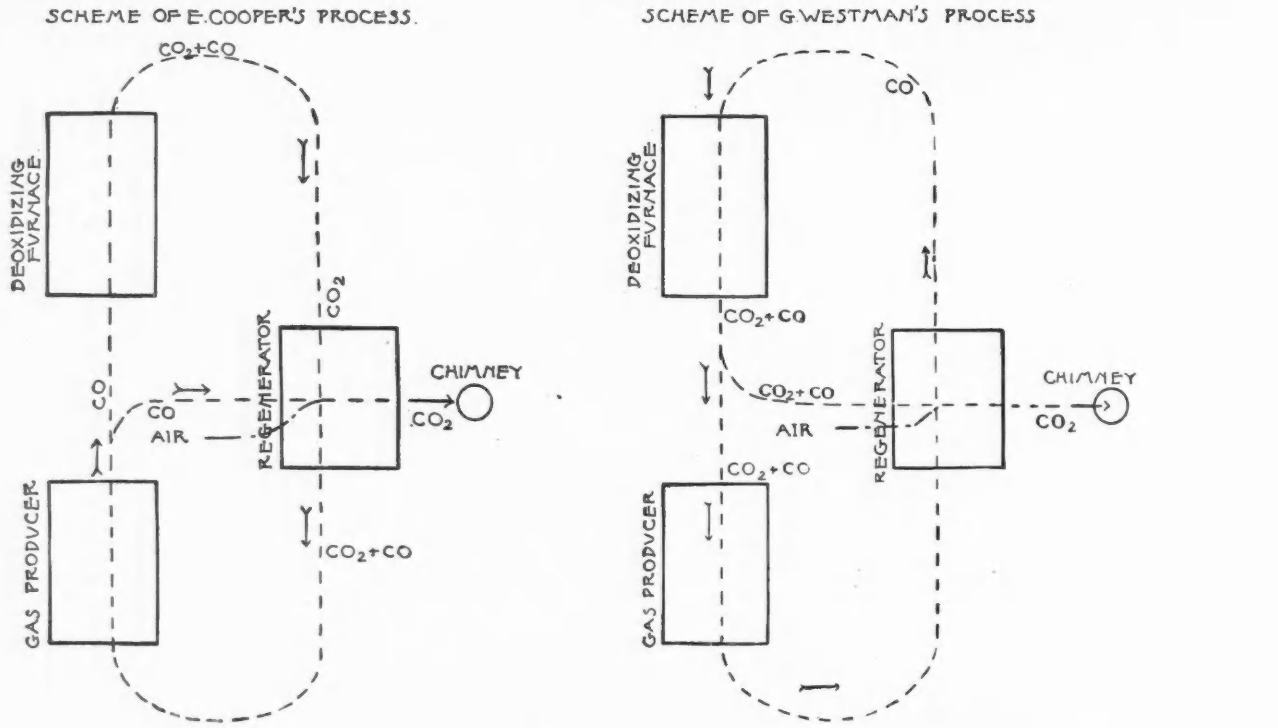


Figure 135.

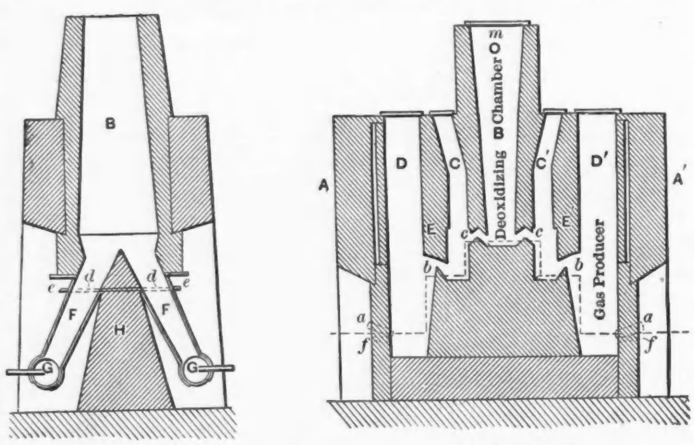
Westman's process[b] resemble's Cooper's, except that common producer-gas is used, and that, as indicated in Figure 135, the gas passes through the regenerator while on its way from the gas-producer to the deoxidizing furnace.

It is to be noted that by reaction (2), which is repeated indefinitely, we oxidize our carbon by oxygen derived from ore, not from the atmosphere, that is to say by oxygen unaccompanied by nitrogen. At each cycle we divert part of our carbonic oxide from the circuit to the combustion chambers of the regenerators and thence through the chimney to the outer air, and with this carbonic oxide the accompanying nitrogen. We are thus constantly eliminating nitrogen from the system, and it seems as if this might be taken advantage of to gradually remove the whole of this gas, so that we would eventually have a closed circuit of pure carbonic oxide and hydrogen, as in Cooper's process.

The course of the gases is sketched in Figure 135.

§ 327. IN TOURANGIN'S PROCESS[c] ore is charged without

part of this heat is communicated directly by the hot carbonic oxide, part by conduction through the partitions: while by heating the blast the energy in the waste gases is returned to the apparatus. In case coke is used the chambers CC′ are filled with charcoal and scrap iron, the latter serving to desulphurize the gas. The spongy iron is cooled in the water-jacketed legs F F before drawing.



Transverse Section. Longitudinal Section.
Figure 135A.—Tourangin's Furnace.

We here have a blast-furnace, with carburization prevented by separating fuel from burden, and sulphurization prevented by desulphurizing the products of the combustion of that fuel without cooling them; while compactness favors thorough utilization of heat. The project is simply beautiful: but maintenance of the apparatus may involve

[a] Mr. Cooper would pass the gas on its way from the deoxidizing furnace to the regenerator through a second gas-producer or bed of fuel: indeed, only a part of the gas issuing from the gas-producer shown in Figure 135 goes directly to the deoxidizing furnace, part joining the gas which issues from the deoxidizing furnace, and with it entering the second gas-producer, and passing thence to the regenerator again. Further, a kiln for preheating the ore is projected. Mr. Cooper thinks the continuous passage of the current in a single direction without reversals important.

[b] G. Westman, U. S. patent 383,201, May 1st, 1888.

[c] U. S. Patent 268,840, Dec. 12th, 1882. Also "A Treatise on the Reduction of Iron Ore," by E. Tourangin, 1881. The reader is cautioned to scrutinize the heat calculations and thermal data.

very grave difficulties. If the apparatus be so compact and so well lagged that but little heat radiates, and if the blast be preheated in an efficient apparatus, a very high temperature should be developed in the gas-producer. Compared with the blast-furnace the gas-producer would be cooler in that its fuel is not greatly preheated before reaching the zone of combustion, but hotter in that it is not cooled by the constant arrival of fresh lots of burden to be heated and melted. Neglecting the losses by radiation, and supposing the blast to be cold, the gas should reach the partitions EE at the temperature theoretically due to the combustion of carbon to carbonic oxide, or about 1,500° C. (2,700° F.), the heat radiated away to the surrounding fuel being returned to the region of combustion when that fuel in turn burns. Add to this the heat brought in by the blast, and the gas at EE might reach 2,000° C. (3,600 F.). If, on the other hand, the temperature here be kept down by permitting loss of heat by radiation, by water-jacketing, etc., we diminish the heating-efficiency of the apparatus, and its chance of successful competition with the blast furnace.

§ 328. LAUREAU'S PROCESS aims to deoxidize iron-ore with natural gas, and to prevent the deposition of carbon which occurs when this fuel is passed directly through hot ore. An application for a United States patent is now pending. If the patent issues soon enough I will describe the process in an appendix.

§ 329. BULL'S SO-CALLED DIRECT PROCESS[a] was hardly a direct process at all, but rather an ill-advised attempt to replace the whole of the solid fuel of the blast-furnace with superheated water-gas. Bull indeed expected to make steel in the furnace: but these expectations do not deserve our notice. I may, however, point out that in the blast-furnace we are able to reach a temperature well above the melting point of cast- and even of wrought-iron, while preserving a reducing atmosphere, by the combustion of highly preheated solid carbon to carbonic oxide: that if we start with hydrogen and carbonic oxide, these gases can hardly be introduced into the blast-furnace while at a temperature above the melting point of cast-iron by any means of which we now know. To raise their temperature above that of wrought-iron or of the slag which accompanies cast-iron, they must burn, and in burning they must generate either carbonic acid or aqueous vapor or both, and each oxidizes metallic iron energetically: so that the use of unoxidized carbon seems a necessity if we are to obtain our iron and slag in a molten state without great loss of iron.

The results obtained with the process seem to bear out these views. In a fourteen-day run at the John Cockerill works at Seraing, in an iron blast-furnace 21 feet high and 6 feet in diameter at the boshes, which appears to have used the astonishing quantity of nearly seven tons of coke per ton of white pig-iron produced, or seven times as much as in our best practice, part of the coke was replaced by water-gas. Although the quantity of coke charged in the blast-furnace along with the ore was still enormous, running from a little above one up to ten tons of coke per ton of iron, and although the total quantity of coke used in producer and blast-furnace together was still more than four tons per ton of iron, yet the partial substitution of water-gas seems to have chilled the furnace. The silicon fell from 2·3 to 0·15%, the carbon from 2·27 to 1·45%, while the sulphur and phosphorus ran from 1·6 to 0·33% and from 1·75 to 1·10 respectively. The ore seems to have held about 25% of iron.

The results obtained before using Bull's process were astonishingly bad, even for an experimental furnace. But how the promotors had the rashness to lay before investors the damning results which the Bull process here yielded: how journals of high standing could, as they did, treat them with respect, and discuss them as if they were of real technical and economic importance, passes all understanding. Verily, iron-making is the home of the charlatan.[b]

§ 330. S. LUCAS[c] in 1792 would deoxidize iron ore in horizontal retorts (the pots of a cementation furnace), and, apparently after allowing the sponge to cool within the retorts, melt it in crucibles.

Substantially similar are the processes of Hawkins[d] and Newton.[e]

§ 331. IN THE CONLEY PROCESS[f] the ore is crushed to pass a screen of about twenty meshes to the linear inch, and is then apparently dressed to remove gangue: then, mixed "with what is chemically required to free" the sulphur, phosphorus, "etc.," and enough charcoal to remove the desired proportion of the oxygen, it is gently heated and continually stirred in peculiarly constructed retorts. The partially deoxidized ore is next run into air-tight vessels and there cooled: is bricked with enough melted pitch "or other carbon" to coke and to remove the remaining oxygen but not to melt on subsequent heating, and is melted in a furnace or crucible. All conditions being rigidly fixed, complete control over the product is claimed.

Few experienced metallurgists will entertain the claim seriously. The conditions are evidently not under control. Important variations in the composition and physical condition of the ore, in the temperature of the reducing retort, in the degree of reoxidation when the partly reduced ore runs from the retort to the cooling vessel, in the temperature and in the strength of the oxidizing conditions when the bricks are remelted, will arise and will destroy the expected completeness of control. But closer control is not to-day a pressing need in our Bessemer and open-hearth practice. In the crucible process it is indeed desirable, but here the variations which arise are due chiefly to variations, not in the composition of the material charged, but in the temperature and strength of the oxidizing conditions in the crucible and in the behavior of the crucible itself; and, clearly, these variations would not be lessened by the Conley process.

Beyond this one sees no reason to expect merit in the process, unless it be in the peculiarity of the retorts and in the nature of "what is chemically required to free" the phosphorus and sulphur. What these are is beyond our present ken.

§ 332. IN CHENOT'S PROCESS[g] iron ore was deoxidized

[a] See Iron, XXI., p. 89, 1883: Ledebur, Handbuch der Eisenhüttenkunde, p. 838, 1884: Stahl und Eisen, VI., p. 578, 1886.

[b] The published account of the results is so astonishingly bad that one wonders whether there is not some clerical error, misprint, or obscurity.

[c] British patents, April 18, 1792, No. 1869.

[d] July 4, 1836, No. 7142.

[e] April 8, 1856, No. 851.

[f] Iron age, XLI., p. 722, 1888.

[g] British patent 1590, A. D., 1856. My information is taken chiefly from Percy, Iron and Steel, 1864: Grateau, Rev. Univ., VI., pp. 1-62, 189: 5Bell, Manuf. Iron and St., p. 84 1884, and Hunt, Rept. Geolog. Survey, Canada, 1866-9, p. 288. Bell reports that the process was used in 1872 at only one establishment in the world.

by heating with charcoal in vertical retorts, whose upper part was of fire-brick and externally heated, the lower part being of sheet-iron and water-jacketed, to cool the sponge before drawing, and thus prevent reoxidation. The operation was continuous. Chenot is said to have built a large furnace for the direct process in 1831.

In his direct-heating method hot carbonic oxide was passed directly from a gas-producer through the column of ore, as in Gurlt's process.

TABLE 162.—CHENOT'S PROCESS.

	Indirect heating.			Direct Heating
	Per 100 pounds of iron in 55% ore, at Hautmont.	Per 100 of iron in 60·6% ore, at Baracaldo.	Per 100 of merchantable bar-iron, at Baracaldo.	Per 100 of merchantable bar-iron, at Laramede (leaner ore).
Ore as mined	....	....	300	3·75
Ore freed from fines	....	....	256	319
Products: Iron sponge	....	88	160	220
Products: Blooms	....	63·54	115	110
Products: Bar-iron	....	55·25	100	100
Labor, days	0·165	....	....	....
Charcoal for reducing	48	35	64	99
Coal for heating reducing-furnace	157	96	175	0
Charcoal for charcoal-hearth	....	....	86	88
Coal for last heating	....	....	100	100
Total fuel	....	....	325	287

Chenot received a gold medal at the Paris exhibition of 1855, but apparently on questionable grounds.

A. The indirect-heating process.

I. *The Furnace* contained one or two vertical rectangular retorts of the following dimensions,

	Height.	Width.	Length.	Locality.	Authority.
1.	28′ 0·65″	1′ 7·69″	6′ 6·74″	Hautmont.	Grateau, Percy, Iron and Steel, p. 338.
2.	....	1′ 7·69″	4′ 11·06″	"	" " " p. 339.
3.	33′ ±	1′ 4″	4′ 9″	Spain, 1872-	Bell, Manf. Iron and Steel, p. 34.

The upper parts were of fire-brick, and were heated by means of external flues. Below and forming a continuation of the fire-brick part of the retort were rectangular, vertical, water-cooled, sheet-iron "refroidissoirs," or coolers, which were, in the first of the above cases, 14′ 9·17″ long. The bottom of a cooler was temporarily closed with removable grate-bars 0·79″ apart. To draw a charge a wagon standing on a lift beneath the cooler was raised to the grate-bars; these were drawn, the wagon descended, and the sponge dropped into it, the grate-bars probably being replaced as soon as the wagon was full.

II. *The Process*.—Lump ore was broken to about 1·8-cubic-inch pieces: fine ore, sometimes mixed with reducing matter, was agglutinated by compression. The ore, now mixed with say 60 pounds of charcoal per 100 of iron present, was charged in the retorts and there deoxidized. The daily withdrawal of part of the spongy iron from the bottom of the cooler caused the charge to descend, so that it remained three days in the hot part of the retort, and three more in the cooler.

The sponge was worked into blooms in a charcoal hearth, or melted in crucibles. In the latter case it was first compressed into little cylinders occupying about one-third of its original bulk, together with deoxidizing and carburizing matter, such as charcoal, wood-tar, resin, or fatty matter, and these were melted in common crucibles as in the crucible process. But as the sponge cylinders were bulky and the weight of a charge consequently small (40 to 55 pounds), the cost of this fusion per pound of ingots was excessive.

While it was thought possible to reduce the iron completely, this took much time, and it was found better to reduce it partially, and to select by hand the imperfectly deoxidized pieces for further treatment.

III. *The Loss*.—At Baracaldo, 100 of iron in a 60·6% ore yielded 63·54 of blooms, the loss being 36·46%, and 55·25 of bar-iron, the loss being 44·75%.

IV. *Fuel*.—For reducing 100 of iron from the ore about 48 pounds of charcoal were used at Hautmont and about 35 pounds at Baracaldo.

For heating the retorts 157 and 96 pounds of coal were used at these two establishments respectively, per 100 pounds of iron in the ore.

V. *The Labor* in producing sponge was about 3·7 days per 2 240 pounds of iron in the ore, or ·165 per 100 pounds.

Bell[a] estimates that the loss of iron is 3·5 times and the cost for fuel 2 3 times as great in producing bar-iron by Chenot's process as in making rolled steel by the blast-furnace and Bessemer processes. But it is more to the point to compare the cost of 100 units of iron available for the open-hearth process in sponge and in scrap-iron.

B. *In the direct-heating method* the heating was done wholly by the hot reducing gas, and the total fuel-consumption thereby greatly lessened: but as the reducing gas was made wholly from charcoal, somewhat more of this fuel was needed than in the indirect-heating method, in which the charcoal had merely to deoxidize: so that in the direct-heating method a given weight of coal is replaced by a much smaller one of charcoal. It would thus depend on the relative prices of these fuels whether this would effect a saving. In the cases here given one part by weight of charcoal appears to replace five of coal, which, considering that a leaner ore was used in the direct- than in the indirect-heating method, would indicate a decided advantage for the direct-heating method: but we cannot be sure that other conditions were alike in these two cases.

§ 333 A. BLAIR'S PROCESS.[b]—As the success of the open-hearth process promised a demand for iron sponge, Blair made strenuous efforts from about 1871 to 1878 to bring Chenot's process to a commercial success, introduced important improvements in heating the ore, and hastened the reduction by the addition of lime. The process has been abandoned.

I. *The early furnace*, Figure 136, like Chenot's in its general features, had three vertical retorts completely filled, above with charcoal and ore, below with spongy iron. The upper parts were made of tongued and grooved fire-bricks, and heated externally by gas introduced through the pipes OO; their lower parts or coolers were of sheet-iron water-jacketed (K). At the top was a cast-iron thimble C heated internally by gas introduced through a central pipe, and by the carbonic oxide generated by the oxidation of the carbon of the charcoal by the oxygen of the ore. At the lower end was an external sleeve LL, usually luted, but raised at intervals to allow a little of the sponge to slide out.

II. *The Process*.—The ore, in lumps two inches thick or less, mixed with 33 to 44 parts of charcoal per 100 of iron, was charged in the four-inch annulus between the thimble and the sides of the retort: here lying in a thin sheet, it was quickly raised to redness by the heat transmitted through the walls of the thimble and those of the retort. Thus one of the great difficulties,—heating a thick

a Prin. Manuf. Iron and Steel, p. 34, 1884.

b U. S. patent 126,922, May 21st, 1872: Trans. Am. Inst. Mining Engineers, II., p. 175, 1874: Journ. Iron and Steel Inst., 1878, I., p. 47, 1875, I., p. 177: Eng. Mining Jl., XVII., June 6th, 1874. Bell, Princ. Manuf. Iron and Steel, p. 34, 1884.

(TO BE CONTINUED.)

body of ore to the middle, was met simply: but some still more economical plan seems needed, such as preheating the ore by direct contact with fuel in a kiln, whence it could be drawn directly to the reducing retort while still red-hot.

As sponge was drawn from the bottom, the whole contents of the shaft sank, the now hot ore from the preheating annulus into the body of the retort, the sponge at the bottom of the retort into the cooler. The height and compactness of the column was thought to prevent air from entering beneath when the sleeve L was raised.

A retort 4′ 6″ in diameter and 40′ to 50′ high turned out about two tons of sponge per 24 hours. This would imply that the ore remained

in the preheating annulus about	0·5	days.
" brick retort	7	"
" cooler	4	"
	11·5	days.

The cost of a Blair sponge-making plant with a daily capacity of 60 tons of sponge per 24 hours was estimated by Holley at $75,000.

III. *The later Furnace.*—Blair discovered that the addition of say 5% of lime to the ore greatly hastened deoxidation—the alkaline earth it has been conjectured favoring the formation of cyanogen. It was now found that the thimble arrangement could not preheat the ore as rapidly as it could be deoxidized in the retort proper: to hasten heating, the single-retort furnace shown in Figure 137 was designed. In this the ore was mixed with charcoal as before, but was heated wholly by a stream of hot carbonic oxide and nitrogen from a coke-burning gas-producer C. The gas passed up around the retort D, entering at the point E where, by narrowing the retort, an annular ring was left, permitting the gas to enter the ore-column on all sides. The charcoal was relied on for the deoxidation, though doubtless the carbonic oxide took up more or less oxygen in passing through the ore. The sponge was cooled as before in a cooler, F.

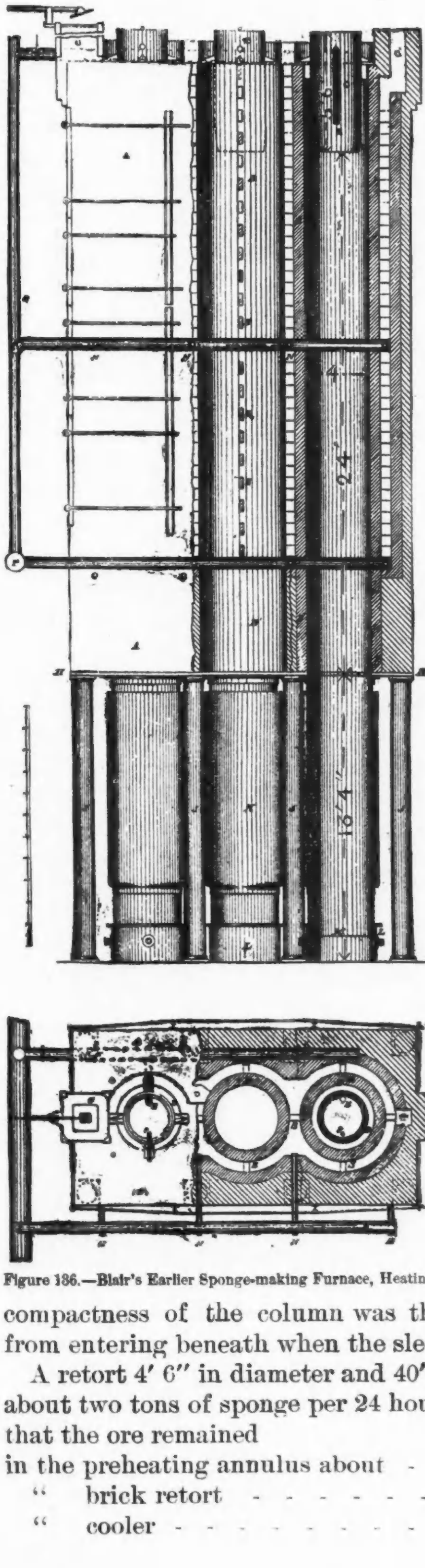


Figure 136.—Blair's Earlier Sponge-making Furnace, Heating by Transmission.

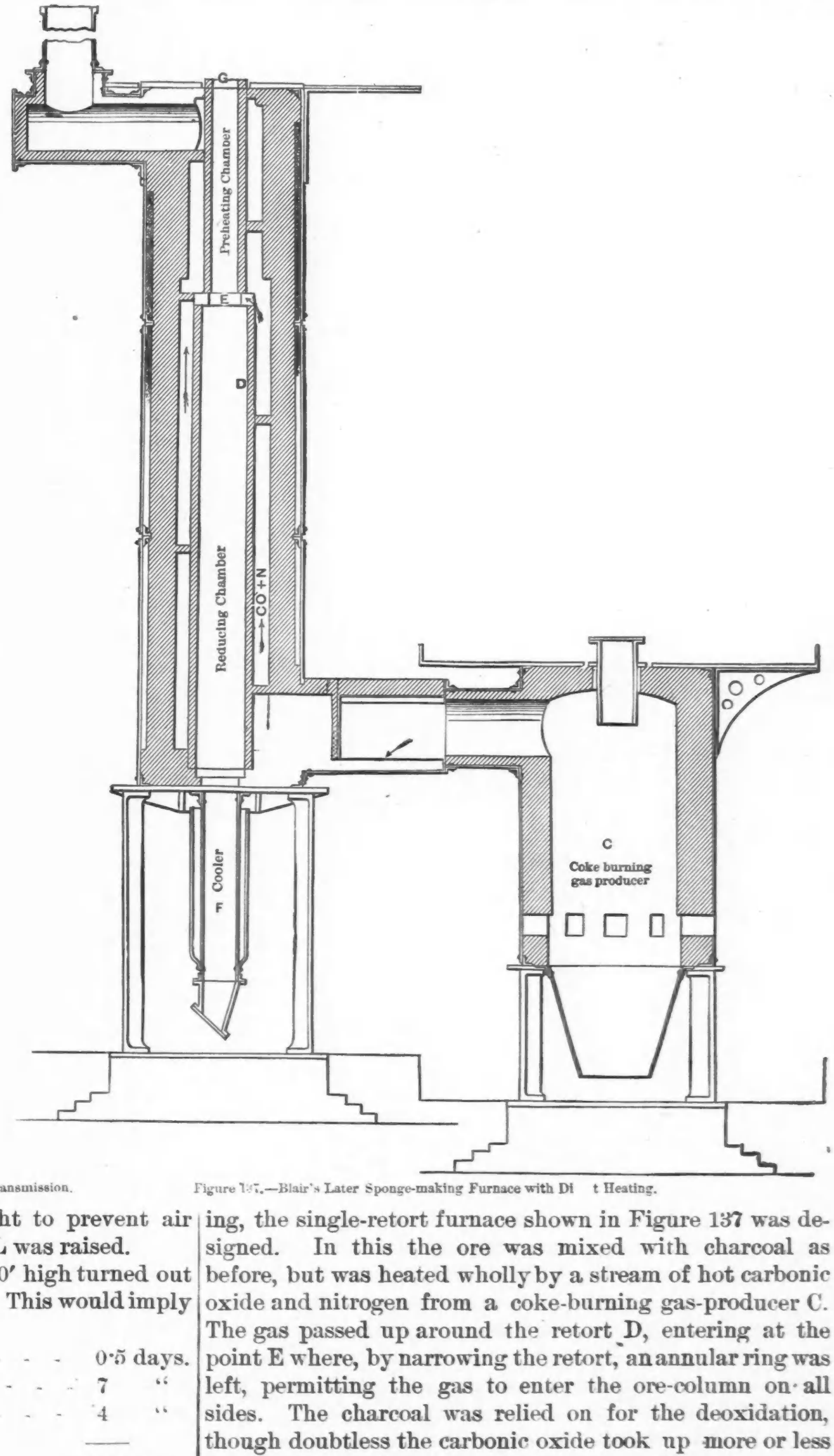


Figure 137.—Blair's Later Sponge-making Furnace with Di t Heating.

Just how much the presence of lime hastened operations cannot be readily determined. Ireland stated that in such a retort 16′ high, its inside diameter being 4′ above and 6′ 6″ below, and the total height of the structure 36′, about 200 tons of ore could be deoxidized per week, which implies that about a day was occupied in deoxidizing and another in cooling, so that the presence of lime hastens deoxidation sevenfold. But Mr. Morrison Foster informs me that, "while the use of lime was undoubtedly an improvement, yet operations were not carried far enough in a practical way to justify the establishment of a basis for working."[a] I am confident that Mr. Ireland is mistaken. To increase the cooling surface he would have several narrow coolers instead of a single wide one, beneath the brick part of the retort.

Clearly most if not all the sulphur of the coke must in this arrangement be absorbed by the iron sponge: but it would seem possible to intercept it by placing between the gas-producer and the retort a thin column of some absorbent, such as lime, or iron sponge itself, through which the producer-gas would pass.

In case the producer-gas heated the ore at the point E too highly, it was cooled by diluting it with the cool gas escaping from the top of the retort at G: clearly this escaping gas, owing to the presence of the charcoal in the ore column, would be chiefly carbonic oxide and nitrogen; or, in other words, the producer-gas would be little altered in composition in passing through this column.

IV. *The product* was cold spongy iron, preserving roughly the shape and size of the original lumps of ore, and apparently unimpregnated by carbon. The temperature in the hot part of the retort was probably rather too high to favor considerable carbon-impregnation, which, as we have seen (p. 120), almost ceases when the temperature rises to bright redness: but in cooling the spongy iron must pass very slowly through the range at which carbon-impregnation occurs rapidly, and it must still be surrounded by an atmosphere of carbonic oxide. Yet, though I conducted the process for some time, I was never able to assure myself that the sponge contained carbon left by impregnation.

The deoxidation could be made very thorough: according to Blair 95 to 98% of the iron was deoxidized.

[a] Private communication, March 22d, 1889.

V. *Further Treatment.*—The sponge when drawn from the reducing furnace was quite cool so that it did not reoxidize. It was squeezed under a pressure of 30,000 pounds per square inch into cylindrical blooms 6″ in diameter and from 12″ to 18″ long. These could be either thrown direct into the bath in the open-hearth furnace, or preheated in an auxiliary furnace. In later practice only the fine sponge was compressed, the lumps being shovelled into the open-hearth bath either without previous preparation, or after balling in a preheating gas-furnace.

As rich ores containing about 63·6% of iron and hence about 9% of gangue were used, the quantity of gangue to be melted in the open-hearth furnace was not excessive, its heat-capacity being probably about one-quarter of that of the iron of the sponge. The consumption of fuel in melting was indeed very moderate, only about 400 pounds to the ton of steel I am informed by Mr. M. Foster.

VI. *Carburization.*—Believing sponge cheaper than cast-iron, Blair would lessen the proportion of cast-iron to sponge used in the open-hearth process by carburizing part of the sponge, either by inclosing charcoal or tar in the blooms, perhaps together with some accelerating (*e. g.* cyanogen-yielding) matter: or by passing through the reducing retort gaseous hydrocarbons, which he says would carburize the sponge.

In actual practice Blair used tar-plugs, *i. e.* cylinders of sponge compressed with 8% of their weight of coal-tar, for part and sometimes for a large part of the cast-iron of the open-hearth charge. In one case the proportion for cast-iron was only 14·05% for the average of a week's work, and in two heats it was only 10% of the whole charge.

The loss chargeable to the sponge-making process is not easily arrived at. As Table 162A shows, 100 parts of iron in the charge yielded about 91% of ingots and scrap in eleven charges selected at random by Bell, and about 85% of ingots and scrap in 428 consecutive heats. If, however, we follow the usual course and reckon the loss on the gross weight of cast-iron and scrap charged without deduction for non-ferrous substances which they contain, and on the iron actually in the sponge, the loss rises in these two cases to 14·62 and 19·90% respectively.

In the third schedule Bell finds the loss 15·83% reckoned in the former way: if reckoned in the latter way it would rise to 19·41%. Without disputing Mr. Bell's data

TABLE 162A.—LOSS IN THE OPEN-HEARTH STEEL PROCESS, USING IRON SPONGE.

	Allowing for impurities in pig-iron and scrap.									Reckoned on gross weight of pig and scrap, but on actual iron-content of sponge.								
	11 heats selected by Bell. I.			428 consecutive heats, II.			Data given by Bell. III.			11 heats selected by Bell. I.			428 consecutive heats. II.			Data given by Bell. III.		
	Gross weight.	% Fe.	Weight Fe.	Gross weight.	% Fe.	Weight Fe.	Gross Weight	% Fe.	Weight Fe.	Gross Weight.	% Fe taken as	Weight Fe taken as	Gross Weight.	% Fe taken as	Weight Fe taken as.	Gross Weight.	% Fe taken as	Weight Fe taken as
Pig-iron	23,816	94	22,387	1,000,632	94	940,594	860	94	338	23,816	100	23,816	1,000,632	100	1,000,632	860	100	860
Sponge	13,255a; 10 500b; 8,116	85	26,959			1,137,090	470	90	423	13,255a; 10,500b; 8,116c	85	26,959			1,137,090	470	90	423
Scrap-steel from previous meltings	14,161	90	12,745	843,442	90	759,098	60	90	54	14,161	100	14,161	843,442	100	843,442	60	100	60
Spiegeleisen	7,531	80	6,025	213,358	80	170,686	110	80	88	7,531	100	7,531	213,358	100	213,358	110	100	110
Ferromanganese				15,551	20	3,110							15 551	100	15,551			
Total			68,116			3,010,578			903			72,467			3,210,073			953
Total steel made			61,870			2,571,353	768	99	760			61,870			2,571,353			768
Loss			6,246			439,225			143			10,597			638,720			185
Loss %			9·17			14·59			15·83			14·62			19·90			19·41

a Tar plugs, *i. e.*, cylinders of sponge compressed with 8% of their weight of tar.
b Hot sponge.
c Cold sponge.
In case of the sponge, the loss here given is of course the total loss from ore to ingots.
I. "Mr. I. Lowthian Bell and the Blair Direct Process," Pittsburgh, 1875. Mr. Bell made the loss 20·01%, apparently through omitting to allow for the impurities in the sponge, which he took as 100% iron.
II. M. Foster, Vice-President of the Blair Iron and Steel Company. Private Communication, March 22d, 1889. 428 heats, between August, 1874, and Oct., 1875.
III. Bell, Principles of the Manufacture of Iron and Steel, p. 36, 1884.

I am at a loss to find what they refer to. The weight of steel scrap is but one-sixth that of the pig-iron charged, while a very different ratio exists in the data previously discussed by him and in those given me by Mr. Foster.

In formerly discussing this process Mr. Bell arrived at the loss by adding to that actually arising in the open-hearth melting *the loss previously experienced on the steel scrap charged.* While doubtless quite proper for the special conditions which he had in mind, this is wholly misleading in determining the loss between ore and ingots by the sponge-making and open-hearth processes combined. Scrap steel charged represents runners, gates, fountains, crop-ends, sloppings, skulls from previous meltings, scrap purchased in the market, and what not. The first group simply represents unmerchantable castings. The proportion of the castings which is merchantable should, with equally skillful founding, be the same whether the molten metal be made from sponge or old rails or pocket-knives. It is dependent not on the source of the materials charged in the open-hearth process, but on the mode of casting the products of that process and the skill of the workmen in casting.

In comparing the direct and indirect methods of steel-making it should be neglected quite as we neglect the loss in mining or in ore-dressing, as foreign to the subject. Whether he has included it in the data of Schedule III. I know not.

The proper way to arrive at the loss appears to be to deduct from the total loss that properly chargeable to the cast-iron and scrap used in the process, and to charge the rest against the sponge. But it is not easy to decide how much is chargeable to cast-iron and scrap, for this depends greatly on the skill with which the open-hearth furnace is managed, and, as I know well, this particular open-hearth furnace (Franks) was not well managed.

The loss in what I believe to be the first 37 heats made in this country (in 1870) by the open-hearth process, in regular working, was 16·63%.[a]

Blair claimed that the loss in using scrap, blooms and cast-iron was 18·37% in American practice at the time when the result obtained in Table 162A were obtained. M. Foster claimed that the loss by the pig and ore process was then 18·4%. According to notes which I obtained from Mr. Holley the loss at Landore by the pig and ore process was about 22% in 1874. The loss is much less at present. Bell took it at 6% for comparison with Blair's work: but I am sure that a loss of 6% represents much better open-hearth practice than Blair's, and that this number is not fair. Holley reported that the loss in the Pernot open-hearth practice was 5·94% in 1876 and 4·3% in 1878: and that the loss at Terre Noire and Creusot was 5 and 6% respectively in 1878.

The loss is usually heavier on the gross weight of cast- than on that of scrap-iron, owing to the much smaller proportion of iron initially present in the former material. From personal knowledge of the operations at Glenwood I do not believe that the loss on the cast-iron was less than 15% of its g oss weight. If we adopt this number and assume that the scrap (which in this case appears to have been especially impure, having by Bell's estimate only 90% of iron) also lost 15%, then the data given by Bell in Schedule III. of Table 162 A imply that the sponge lost 24%. Thus:

360 of cast-iron at 85% yielded	306
60 of scrap-iron at 85%	51
110 of spiegeleisen at 75%	82·5
Total	439·5
Balance of yield to be credited to sponge	320·5
Total yield	760
Sponge contained	423
Loss on sponge = 24·23%	102·5
Yield of sponge as above	320·5

TABLE 163.—BLAIR'S PROCESS.

	Indirect heating per 100 lbs. of iron in ore.		
	Blair. I.	Bell. II.	Foster. III.
Per centage of iron in ore	50	66	63
Ore used	200 lbs	....	160 lbs.
Charcoal for reducing, lbs	33	44	33 ±
Coal or coke for heating the retorts	33	150	44 ±
Labor, days	0·1±	....	1·4
Cost of compression	\$0.12 ±		
Output of sponge per retort per week, tons	....	14	12 ±

I. Blair, Trans. Am. Inst. Min. Eng., II., p. 175. 1874. These are expected results.
II. Bell, Princ. Man. Iron and Steel, p 34, 1884.
III. Report of the Blair Iron and Steel Company, January 1st, 1875. The data are given as the actual working resuts obtained at Glenwood, near Pittsburgh.

Comparing these numbers with those in Table 162, we see that Blair lessened the consumption of fuel for heating greatly, but not for deoxidizing. As regards loss no safe comparison can be made: for while Blair's loss from ore to ingot was much less than Chenot's, we cannot tell how much of the difference was due to better deoxidation, and how much to the smaller opportunity for reoxidation in melting in the open-hearth, in which Blair's sponge was treated, than in the charcoal-hearth in which Chenot's was balled.

The consumption of fuel and the cost of installation per unit of product were not immoderate. I have attributed the failure of the process less to its being inapplicable to existing conditions than to injudicious management, in carrying out avoidable experiments (as if the unavoidable ones were not burdensome enough), and to certain misfortunes for which the management seemed in no way to blame.

B. *Yates' process*[b] appears to be identical with Chenot's indirect-heating process.

C. *In Trosca's process*[c] ore was reduced by contact with carbonaceous matter in externally-heated vertical retorts: the resulting sponge was removed in an air-tight buggy.

D. *In Clay's*[d] *original process* walnut-sized lumps of ore were deoxidized by heating to bright redness in clay retorts, etc., with one-fifth of their weight of carbonaceous matter: the resulting sponge was immediately balled in a puddling furnace, with or without some 5% of coke, hammered, and rolled into merchant iron. The process failed, chiefly because the reduction was very slow, and because the iron was often very redshort. We may surmise that the gangue of the ore was often imperfectly

[a] From notes which I took in 1870, when attached as a student to the open-hearth plant of the Bay State Iron Company, during this early practice.

[b] Percy, Iron and Steel, p. 345, 1864.

[c] Berg. und Hütt. Zeit., XXV., p. 398, 1866.

[d] This description is condensed from Percy, Iron and Steel, p. 330. Clay's British patent was 7,518, Dec. 19th, 1837. Percy's description indicates that the sponge was taken hot to the puddling furnace: according to Kerl it was cooled before the transfer. (Grundriss der Eisenhüttenkunde, p. 266.)

fluxed, so that it formed a slag which was difficultly fusible, hence was expelled with difficulty, and, present in excess, made the iron redshort or rather slag-short. Heavy waste of iron doubtless weighed against the process.

E. *In Renton's process*[a] ore was deoxidized by heating in contact with coal in a vertical retort, at the end of a puddling furnace, by whose waste gases the ore was heated, and in which the spongy iron was balled prior to shingling. To make a ton of blooms required,

2·5 tons of ore at $4 - - - - - - - - - -	$10.00
About 2·5 tons of coal - - - - - - - - - -	10.13
Welding, working, $5, shingling, $1.50, labor, $3	9.50
	$29.63

F. *In Wilson's*[b] process coarsely pulverized ore with 20% of charcoal- or coke-dust is heated to 800°@1,000° F. (427°@538° C.) for twenty-four hours in vertical retorts (C, Figure 138) at the end of a puddling furnace, by

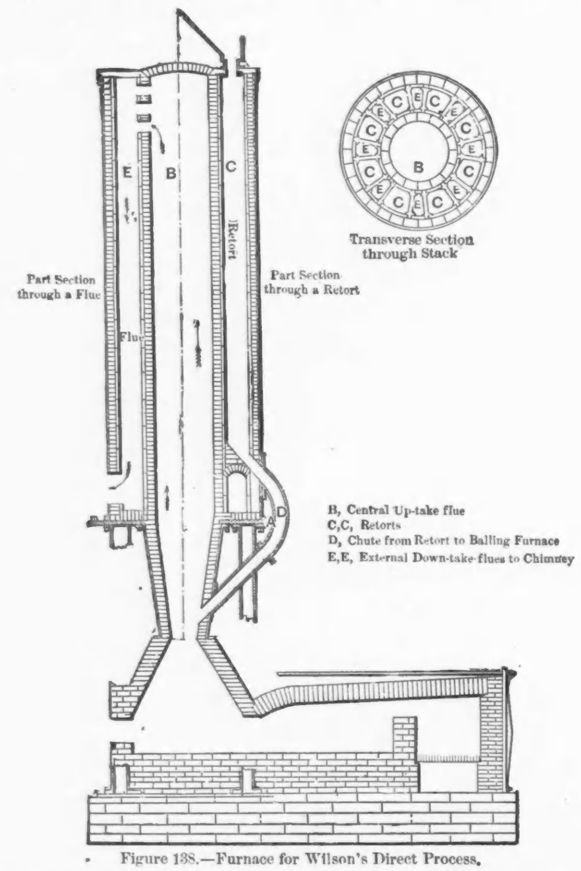


Figure 138.—Furnace for Wilson's Direct Process.

whose waste heat they are heated externally. The partially deoxidized ore is then dropped into a second hearth of the puddling furnace, and after twenty minutes more is pushed into the hearth proper, where it is balled.

G. *Rogers*[c] would heat ore with coal in a rotating retort above a puddling furnace, into which he would drop the resulting sponge.

§ 334. SCHMIDHAMMER,[d] apparently following out the idea of the Nyhammar furnace, §324, proposes the continuous stückofen shown in Figure 140. The shaft is charged continuously with ore and enough charcoal for deoxidation: the ore is deoxidized during its descent: the temperature is raised to the welding point by hot blast and hot water-gas blown through the tuyeres: the spongy iron is balled through working openings, and the balls are drawn from the fore-hearth A on lifting the door B.

The distinctive features are substitution of hot gas and air for part of the more costly charcoal; the fore-hearth A, and the door B, which permit forming and drawing the balls without allowing the superincumbent charge to slide down as in Husgafvel's furnace.

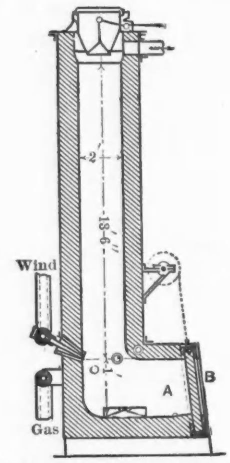


Figure 140.—Schmidhammer's Continuous High Bloomary (Stückofen).

§ 335. THE DU PUY PROCESS[e] uses a thin sheet-iron instead of a clay retort. The sheet-iron conducts heat to the charge much more readily than fire-clay, but of course lasts but a single heat. It welds to the spongy iron and is hammered, rolled, or melted with it as the case may be.

About 116 pounds of ground iron ore, mixed with carbonaceous matter for reduction and with suitable fluxes to scorify the gangue, is inclosed in annular sheet-iron (No. 26 gauge =0·018" thick) canisters about 13" high, 15" in diameter outside, 6" in diameter inside, and weighing 6 pounds. The charged canisters are heated to bright whiteness (a welding heat) for from 5½ to 10 hours on the coke-covered hearth of a common open reverberatory furnace. The reduced metal, still in its canister, may, according to Du Puy, be converted into muck-bar by hammering or squeezing and rolling, then cut up and treated by the crucible process; may be charged at once in the open-hearth process with or without (?) cast-iron: or may be melted down with cast-iron in the furnace in which it has been reduced.

In a table of results given, from 71 to 86 or on an average 78·5 pounds of muck-bar or blooms were recovered per 100 pounds of iron contained in the ore: so that a 116-pound charge of 67% ore would yield 61 pounds of blooms: or, deducting the six pounds of canister, 56 pounds. Thus for every 100 pounds of blooms we have to sacrifice 10 pounds of thin sheet-iron on which has been put the expense not only of rolling down to No. 26 gauge, but of working into canisters. The cost of the canisters alone, judging from Mr. Du Puy's data, should have been at least $7 @ $8.50 per ton of muck-bar.

If charcoal were used the cost for reducing fuel would be considerable: if either anthracite or coke the sulphur of the fuel would contaminate the iron.

The phosphorus of the ore of course remained within

[a] Condensed from Percy, Iron and Steel, p. 334. The process was patented in 1851 in this country.

[b] W. P. Ward, Trans. Am. Inst. Mining Engineers, XII., p. 522, 1884.

[c] Berg und Hütt. Zeit., 1862, p. 341.

[d] Stahl und Eisen, VI., p. 465, 1886.

[e] Metallurg. Rev., I, p. 486, 1878. Journ. Frank. Inst., CIV, p. 377, 1877; CVI., p. 404, 1878; July, 1881.

the canister. If the mass were rolled to muck-bar and if the slag were sufficiently basic, owing to scorification and loss of iron, some of the phosphorus would be eliminated as the slag was squeezed out in rolling or hammering. But this rolling or hammering involved expense and further waste If the canisters were charged direct into an acid open-hearth furnace, the phosphorus of the ore would enter the iron. Metcalf gives the following composition of extremely redshort wrought-iron made by this process.[a]

Silicon.	Sulphur.	Phosphorus.	Oxide or cinder.
·460	·027	·010	·796

Later, dispensing with canisters, Du Puy moulded ground iron ore with charcoal, clay and lime into pipes, 18″ × 8″, which he heated and balled in open reverberatories, with prohibitory loss of iron, 40 to 50%.

§ 337. MUSHET[b] would deoxidize iron ore with carbonaceous matter in crucibles, and immediately melt the deoxidized iron. His process has already been discussed, (§ 315, C. II).

§ 338 A. SIEMENS, in one of his early direct processes, would suspend two cast-iron retorts or hoppers AA, with fire-clay ends, above the laboratory of an open-hearth steel-melting furnace, Figure 141.

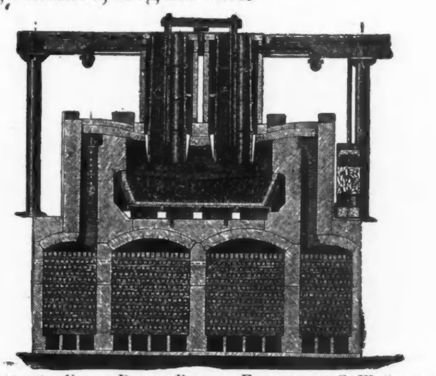


FIG. 141.—AN EARLY DIRECT-PROCESS FURNACE OF C. W. SIEMENS.

Around each hopper is a space heated by a regulated supply of flame from the open-hearth furnace: within it a wrought-iron pipe supplying producer-gas for deoxidizing the ore.

About 28 pounds of charcoal is charged through each hopper, and on this sufficient ore to fill the hopper completely. Producer-gas is then injected through the pipes in the center of the hoppers, and deoxidizes the ore which has meanwhile been raised to redness by the heat conducted through the walls of the hoppers. About half a ton of pig-iron is charged on the open-hearth: melting, it dissolves the lower end of the columns of more or less completely deoxidized iron, with a rapidity which is only limited by the time needed to deoxidize the ore in the hopper. Sufficient sponge having been thus melted off in three or four hours, charging ceases, the remaining ore in the hoppers sinks, a clay-coated cast-iron cover suspended by strong wire descending with the ore-column, so that the flame may not enter the empty hoppers. On this cover is placed the charcoal and ore of the subsequent charge, eventually lowered by cutting the wire. The charge already melted is brought to the right degree of carburization, and, after an addition of spiegeleisen, is tapped.

To-day we wonder that a man of Siemens' genius and judgment could have seriously entertained so crude a project even twenty-one years ago. To maintain these hoppers, exposed thus in an open-hearth furnace; to heat these thick bodies of ore through and to deoxidize them at their necessary low temperature in any reasonable time; to keep this open-hearth furnace waiting while the charge of ore was deoxidizing;—well, well! To-day's folly is wiser than yesterday's wisdom.

B. *Ponsard*[d] in like manner would place several fire-clay retorts 8″ in diameter and 40″ high in a reverberatory gas-furnace, their mouths being fitted into openings in the roof, their lower parts open or perforated and resting on the hearth, which had gutters leading to a central sump. In the retorts is charged ore with flux and about 12% (!) of carbon for deoxidation and carburization. The reduced iron, melting, runs through the holes in the bottoms of the retorts and collects in the sump.

Ponsard claimed that for producing one ton of cast-iron in this apparatus one ton of coal sufficed for deoxidation, carburization, and melting. This process is open to the same fatal objections as Siemen's. Indeed they seem identical. Which was the prior invention I know not.

§ 339 A. FOR PRECIPITATING COPPER[e] from its solutions spongy iron was used as early as 1837, and has been used in later years. I am informed that its use is now abandoned. Three tons of "purple ore" (the residue from leaching copper from roasted cupreous pyrites), with 18 cwt. of coal which has passed a screen of eight meshes to the linear inch, is heated to bright redness in a 6″ layer on the 22′ × 8′ hearth of an open reverberatory furnace with tightly fitting doors and a very, say 4′ 8″, deep fire-box (to yield a so-called reducing flame), for from 9 to 24 hours, during which the ore is turned twice or thrice. The spongy iron is then drawn through holes in the hearth into tightly closed, wheeled sheet-iron boxes of 12 cubic feet capacity, where it cools for two days. For heating, 15 cwt. of coal are needed per ton of ore, or altogether say 159 pounds of coal per 100 of iron in ore. The composition of the copper precipitated by this sponge is given as 67·5% copper, 5·15% ferric oxide. If this is the usual composition, it would indicate that the spongy iron was surprisingly well deoxidized, probably 90% of its iron being in the metallic state.

B. *Harvey* heated coarsely powdered ore with charcoal on inclined steatite shelves connected with a balling furnace, and heated by a passing flame. The deoxidized ore was transferred to the hearth of the balling furnace and balled. The process failed.

C. *Gerhardt* bricked ore, flux and carbonaceous deoxidizing matter with tar, heated these bricks in a puddling furnace, and there balled the resulting iron, using 330 pounds of coal per 100 of finished iron.[f]

§ 340. IN THE EAMES[g] or Carbon Iron Company's process iron ore is deoxidized on the carbonaceous hearth of an open reverberatory furnace, by means of graphitic anthracite or "retarded coke,"[h] with which it is mixed.

[a] Trans. Eng. Soc., W. Penn, p. 218, Mch. 16th, 1883.
[b] British patent, Nov. 13, 1800, No. 2,447.
[c] Lecture before Fellows' Chem. Soc., May 7th, 1868.

[d] British Patent 2,334, July 24, 1868; T. S. Hunt, Geolog. Survey Canada, 1866–69, p. 292; Comptes Rendus, LXIX, p. 177, July 19th, 1868. Berg und Hütt Zeit, XXVIII., p. 415, 1869. The numbers here given are Ponsard's.
[e] Lunge, Sulphuric Acid and Alkali, I., pp. 615–21, 1879, gives drawings of the apparatus and details of the treatment.
[f] Berg und Hütt. Zeit., XXXIII., p. 183, 1874.
[g] Trans. Am. Inst. Min. Eng., XVI., p. 708, 1888. Iron Age, XLI., p. 349, 1888. A. E. Hunt, private communication. U. S. patents 318,551 to 318,554, 318,605 to 318,607, 318,609, May 26th, 1885: 396,992, Jan. 29, 1889.
[h] "Retarded coke" is coke mixed with milk of lime, so that it offers very little surface for oxidation.

These reducing agents, in that they themselves become oxidized only very slowly, indeed reduce the iron less rapidly than charcoal or common coke; but after reduction is effected they resist oxidation and so persist and remain to protect the reduced iron from reoxidation: and as the difficulty in direct processes is not so much in the reduction as in preventing reoxidation, the idea is reasonable. Indeed, I think it likely that the substitution of graphite for charcoal has diminished the loss of iron.[a]

I. *The furnace* now used is an open reverberatory measuring about 18″ from roof to hearth, and fired with natural gas at both ends, the products of combustion escaping through a flue in the middle of the roof. The hearth is about six feet wide and fifteen feet long, and has a layer of graphite from four to six inches thick on its upper surface. Eames recommends a graphite-iron bottom prepared as follows:[b]

Lumps about one foot thick of the graphitic anthracite of Cranston, R. I., are set in a single layer on the hearth; the interstices are filled with ground iron ore; the whole is covered with a layer (2″ to 4″ thick in the middle, 3″ to 6″ at the side) of wheat-grain sized anthracite: this is dried by gentle heating; on it is placed a half-inch or inch-thick layer of ground iron ore; the temperature is gradually raised during from three to five hours to 1,371° C. (2,500° F. bright whiteness) to deoxidize the ore and later to soften the mass. The hearth is then rammed solid witha heavy dolly. The iron ore, or the iron reduced from it by the surrounding carbon, is said to strengthen the hearth greatly. A graphite-clay hearth is said to be readily indented, a pure graphitic-anthracite hearth to flake and get mixed with the sponge-balls.

II. *Reduction.*—2,240 pounds of dry rich ore (say 62% of metallic iron) and 550 pounds of graphitic anthracite containing 78% of carbon, are ground to pass a screen of sixteen meshes to the linear inch, mixed with enough water to render the mass slightly plastic, and spread in a four-inch layer on this hearth. The carbon is not quite enough to deoxidize the whole of the iron by the reaction

$$Fe_2O_3 + 3\ C = 2Fe + 3\ CO,$$

so that some of it appears to be oxidized to carbonic acid by the ore. The doors are closed and luted, and the furnace is now heated with a so-called reducing flame.

20 m.: The charge has shrunk to a thickness of 2″; temperature incipient redness, say 538° C., 1,000° F.

1 hr.: the charge has shrunk to 1·3″: beads of iron are seen on its surface.

1 hr. 30 m.: the charge has shrunk to 1″: begin working into balls say 20″ in diameter, and weighing from 85 to 185 pounds each. Temperature not above moderate redness, 816° C., 1,500° F.

If the balls are for the open-hearth, balling takes but 30 to 40 minutes; if for rolling, an hour, as in this case they must be brought to a welding heat. Thus the last ball is drawn at 2 h. 40 m. and 3 h. in charges for the open-hearth and for rolling respectively. Repairs, fettling and charging take 20 minutes more, so that the total length of the operation, when balls for the open-hearth furnace are made, is three hours, and six 1,600-pound heats are made per reducing furnace per 24 hours.

III. *Further Treatment*—The sponge balls, like those produced in other processes, may be hammered or squeezed and rolled to muck-bar for use in the open-hearth or the crucible process; or they may be charged while still white-hot into a bath of molten cast-iron in the open-hearth furnace.

IV. *Loss.*—From Hunt's data I calculate the loss in one reducing heat as follows:

	Iron, pounds.	
Ore charged in reducing furnace, 2,973 pounds, at 62% = - - - - - -	1,818	at 9:10 A. M.
2,010 pounds of sponge-balls resulting were charged in the open-hearth furnace at 10:45 to 11:45 A. M.		
The open-hearth charge further contained		
Of pig-iron - - - - - - - -	870	at 9:30 A. M.
Of ferromanganese of 70% manganese	24	at 1:10 P. M.
	2,712	
Ingots produced 2,150, scrap 191 - -	2,341	at 1:20 P. M.
Loss - - - - - - - - -	371	
11%[c] of loss is chargeable to pig and ferromanganese - - - - - - -	98	
Loss chargeable to sponge process, from ore to ingot - - - - - - - -	273 pounds,	

which is 15% of the iron contained in the ore. This way of calculating the loss, I think, gives us the most valuable results, since what we seek to know is, "Assuming that the pig and ferromanganese lose the same amount when melted with sponge balls as when melted with scrap, how does the loss on the sponge-balls themselves compare with the loss on scrap?"

The loss reckoned on ore, pig and ferromanganese is 13·7% here, but in regular working the loss seems to be rather higher than this. With two 15-ton open-hearth furnaces using about 50 parts of pig-iron, 10 of scrap (both taken at their gross weight and without reduction for non-ferrous matter which they contain), and 40 parts of iron contained in sponge-balls, or altogether 100 parts reckoned in this way, 87 parts of ingots and scrap result, implying a loss of 13%.[d] If, now, we assume that the pig-iron and scrap lose 8% by weight or $60 \times \frac{8}{100} = 4{\cdot}8$ parts, we have to charge against the 40 parts of iron in sponge a loss of $13 - 4{\cdot}8 = 8{\cdot}4$ parts of iron, or $\frac{8{\cdot}4 \times 100}{40} = 21\%$ of the iron in the sponge. That is to say, in the sponge-making and open-hearths processes combined the loss from ore to ingots is 21%. This is decidedly more than in the combined blast-furnace and open-hearth processes, in which the total loss probably does not exceed 10 per cent.

In making muck-bar the loss is still greater, as at the higher welding heat to which the balls must be raised oxidation is very rapid. Hunt reports that in one week three reducing furnaces made collectively 50 heats:

Receiving altogether of ore	112,000	pounds
This contained of iron	69,440	"
There was produced of muck-bar	44,810	"
Implying a loss of 35·%a	24,630	"

a The original contains an error, giving the loss as 29.71%.

a This substitution seems to about balance the excess of the oxidizing tendencies of Eames' open reverberatory over those of the charcoal-hearth and shaft-furnace, for the loss of iron is about the same as in the American bloomary and in Husgafvel's furnace. (Cf. Table 154, p. 268.) Eames' loss, 21%, is, indeed, from ore to ingots, that of these other processes only from ore to blooms, in remelting which a further loss would result. But these blooms have been made at a high welding heat, and hence with greater loss than if, as in Eames' process, the heat merely sufficed for making loose balls for the open-hearth furnace. If graphite has real advantages, a shaft-furnace like Schmidhammer's seems better for using it than an open reverberatory.

b U. S. Patent 396,992, Jan. 29, 1889.

c The loss on pig and scrap charges in this same furnace is 11%.

d A. E. Hunt, private communications, April 9th and 22d, 1889.

He further gives the loss as follows:

100 of iron in ore yields of blooms 6″ × 6″ × 20″	80·6	loss = 19·4%
of billets 4″ × 4″ × 24″	72·54	" = 27·46%
of muck-bar 3½″ × ⅝″	68·51	" = 31·49%
100 of muck-bar contains	0·015 of phosphorus.	
Ore for making 100 of muck-bar contains	0·148 " "	
100 of ore contains	0·063 " "	

In a heat described to me by a very trustworthy witness, of 100 parts of iron in the ore charged in the reducing furnace, 15·6 were removed in the slag of the same furnace, (this slag contained 57% of iron), and 19·7 more existed in the sponge-balls as oxide, so that only 61·7 of metallic iron in sponge-balls was recovered from 100 of iron in ore, a loss of 35·3%. The sponge-balls contained about 62·61% of iron as metal and 19·7% as oxide: but these numbers are only rough approximations, owing to the heterogeneousness of the sponge-balls. Had these balls been for the open-hearth furnace, part of this iron-oxide would have been deoxidized by the carbon and silicon of the bath.

TABLE 163B.—EAMES OR CARBON IRON COMPANY'S PROCESS.

Dimensions of reducing furnace.	
Length of hearth	15′
Width of hearth	6′
Height from hearth to roof	18″
Length of campaign without serious repairs	One year.
Charge for one heat.	
Ore, kind	Minnesota Y
" percentage of iron	65
" weight	2,240 lbs.
" percentage of phosphorus	0·04
Length of one heat	3 hours
Number of heats per 24 hours	6
Men employed per furnace per shift	2
Shifts per 24 hours	2
Output per furnace per heat.	
Pounds of balls per heat	1,600
" " per 24 hours	12,800
Outlay in reducing-furnace for 2,000 pounds of iron recovered as ingots in subsequent open-hearth melting.	
Ore, pounds	3,896
Labor, days	1·17
Loss from ore to ingots	21%
Composition of sponge balls.	
Iron	90%
Coke or graphite	6
Carbon combined with iron	0·15
Gangue	3·80
Sulphur and phosphorus	0·05

These data are communicated by Mr. A. E. Hunt, of the Carbon Iron Company.

V. *Dephosphorization.*—Open-hearth steel made from these sponge-balls contains nearly the whole of the phosphorus of the ore: but muck-bar made from them is nearly free from phosphorus, having according to Hunt less than 0·015% of phosphorus from an ore holding 0·063%. The muck-bar, were there no dephosphorization, would contain 0·148% of phosphorus, so that 0·133 of phosphorus is removed per 100 of iron recovered, or 0·09 per 100 of iron in ore.

The difference between the dephosphorization in ingot and in muck-bar-making is clearly due to the general principle that in the direct process the dephosphorization and loss of iron usually go hand in hand. Balls for the open-hearth are made at a low temperature, with a flame but slightly oxidizing, and with rapid balling: little iron is oxidized, the mechanically inclosed slag is chiefly an earthy silicate, difficultly fusible, pasty, and hence but little of it runs out from the balls: most of it goes with the balls to the open-hearth furnace, whose siliceous walls give rise to an acid slag, and the phosphorus of the slag within the balls is reduced by the carbon of the bath as fusion proceeds.

In making muck-bar, however, the higher temperature and the more oxidizing flame which it entails in the reducing furnace, as well as the longer heating, oxidize much iron: the slag becomes basic and hence dephosphorizing, ferruginous and hence fusible: it melts and runs away from the balls both in the reducing furnace, in shingling and in rolling, and in running away removes the phosphorus. The slag from the blooms contains, according to Hunt:

Iron	from 30 to 50 %
Silica	" 24 to 30 %
Phosphorus	" 0·1 to 0·15%

and is thus probably between a singulo- and a subsilicate in composition. This composition tallies fairly with the actual loss of iron and removal of phosphorus: thus, if iron and phosphorus are removed in the ratio 50 to 0·15, the removal of 0·09 of phosphorus per 100 of iron in the ore, which as we have seen occurs, implies a loss of 30% of the iron of the ore, which is very close to the actual loss of 31·49%.

§ 341. A. IN THE LATE SIEMENS DIRECT[a] or "precipitation" process fine ore was reduced by coal, with which it was mixed and heated in a rotating furnace like a Danks puddler, the coal precipitating metallic iron from the molten ore. The resulting metal was balled as in puddling, squeezed to expel slag, and either used as material for the open-hearth process or worked into merchantable wrought-iron.[b] Some details are condensed in Table 165.

I. *The plant* for furnaces, crusher, hammer, etc., was estimated by Holley to cost $40,000 per 125 tons weekly capacity.

II. *The furnace*, Figure 144, differed from the common rotary puddler chiefly in being gas-fired and regenerative, the gas from the producer *d*, passing through a flue *g*, enclosed between the regenerators *b b*, direct to the rotator *a*, the air alone being preheated. The entrance for gas (*b*), and air (*c*) and the exit for products of combustion were at the same end of the rotator, leaving the other end free for charging and working. The ports were small, so that the velocity of the entering gas and air should suffice to throw the flame well towards the working end.

The three-inch brick lining (which lasted months) was glazed by heating with roll-scale, and fettled (say 2½ to 6 inches deep) with iron ore and a little coal, which reduces the ore slightly to a very refractory state. The ends exposed to the basic slags were sometimes lined with bauxite; thorough lining occupied from 24 to 48 hours, fettling three to four hours. To make the charge roll rather than slide the lining was roughened, *e.g.*, by ridges of fettling holding a water pipe, which cooled and maintained them; or by ridges of ore-lumps placed, after drawing the charge, in the still liquid slag, which was then chilled with water.

III. *The operation* was divisible into there periods (1) heating and partial reduction; (2), complete reduction and balling. In the first the temperature was relatively low to avoid fusion before reduction, and the rotation slow. In the second the temperature gradually became high enough

a Tunner, Metallurg. Rev., I. p., 573, 1878, Holley, Trans. Am. Inst. Min. Eng., VIII., p. 321, 1880; Maynard, Idem, X., p. 274, 1881; Siemens, Jour. Iron and Steel Inst., 1873, I., p. 37; 1877, II., p. 345.

b Mr. J. Head informs me that the process was practically abandoned during the life of Sir William Siemens. The deoxidation was successful, but the reoxidation fatal. Private communication, Nov. 7th, 1888.

c In 1877 Halley reported that "a charge" "has been made in two hours twenty minutes. The time of the shortest operation I witnessed was 2¾ hours. At Newton, two years ago, the time was 4 to 4½ hours."

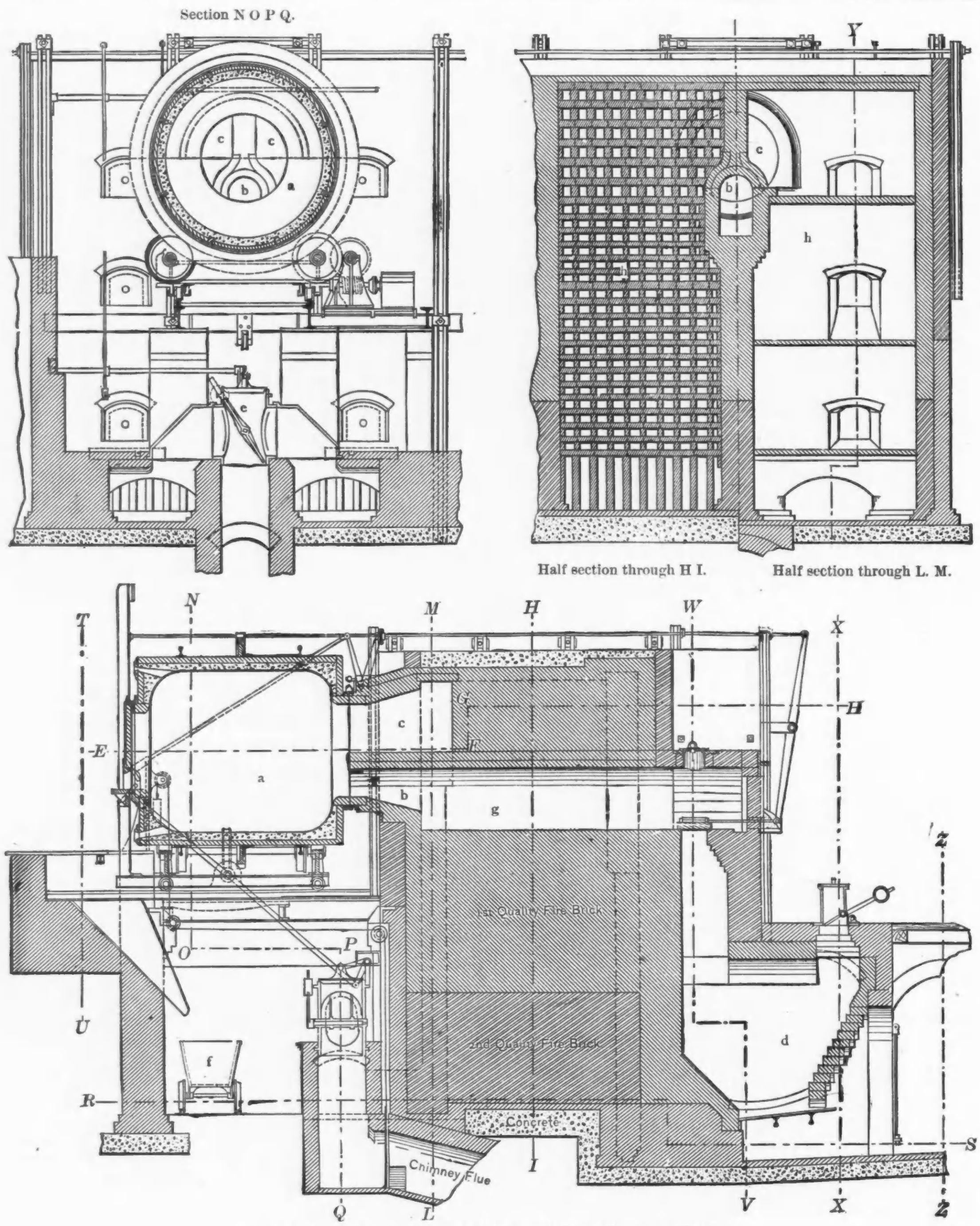


Figure 144.—Rotary Gas Furnace for Siemen's Direct Process. (Holley.)

a Rotator in which deoxidation occurs. *b* Gas-port. *c* Entrance-port for air and exit-port for products of combustion. *d* Gas-producer. *e* Reversing valve. *f* Slag buggy. *g* Gas-flue. *h* Regenerator.

for balling, and the rotation faster. In both the atmosphere was necessarily strongly oxidizing to iron and its low oxides.

Pea-sized ore, basic-slag-yielding flux (actually limestone) and small coal were heated in the slowly revolving rotator with a pretty full air-supply. After 2.5 hours, reduction being well advanced, the temperature and rate of rotation were raised, the slag began to form, accumulating till, after another hour, it was tapped. After four hours, reductionbeing completed, the temperature was again raised and the rotation accelerated, then temporarily arrested to permit balling by hand, and later to draw the balls successively. This done, the furnace was charged afresh. The balls contained about 70% of metalic iron, the blooms made from them it is said 99.7 per cent.

I deduce the following from Tunner:

TABLE 164.—DIARY OF SIEMENS DIRECT PROCESS: TOWCESTER.

HOURS.	MINUTES.	
0	0	Charge introduced: furnace stationary.
0	5	Rotate at 12 to 15 revs. per. min. (?)a Full air supply to heat quickly.
2	0	Heat bright red. Charge still dry. Much coal yet unconsumed. Ore hard, magnetic, partly metallic.
2	30	The charge partly pasty. Heat raised. Some slag appears.
3	0	Heat raised more. More liquid slag appears.
3	30	The pasty mass begins balling. More slag forms. Rotate quicker. Tap slag, for first time, completely.
3	45	Tap again. Less slag.
4	0	Heat raised to whiteness. Rotate quicker, stopping momentarily to ball.
4	8	First ball drawn. Shape and draw remaining balls.
4	30	All drawn. Charge anew.

a This implies a circumferential speed of 320 to 400 feet per minute, or of a mile in 13 minutes. Maynard reports that the speed of the Tyrone 11-foot rotators was one revolution in 15 to 18 minutes, or a circumferential velocity of about 2 feet per minute.

The most important variation in the process seems to have been in its length. In 1873, Siemens reported that

(TO BE CONTINUED.)

(CONTINUED FROM SUPPLEMENT PAGE 286.)

"the time occupied in working one charge rarely exceeds two hours." In 1880, Holley reported that the output at Tyrone had been increasing gradually, having now reached about five heats a day.[c] In 1881 Maynard reported that a charge occupied nine hours. Thus, although there was clearly an endeavor to shorten the operation, it seems to have lengthened greatly, and unavoidably.

The statements on page 59 imply that the silica should be near the lower of the above limits, 24%, to permit thorough dephosphorization.

Condition of the Process.—The Carbon Iron Company has eight reducing furnaces, which are running double turn all the time, and two 15-ton open-hearth furnaces running steadily, with a charge of about 50% of cast-iron, 10% of scrap and 40% of sponge-balls. A considerable part of the spongy iron is rolled into muck-bar, not for use as wrought-iron, but as a material for the crucible and open-hearth processes. The process has clearly passed to the commercial stage, and, with the cheap fuel of Pittsburgh and under the very skillful superintendence which it is so fortunate as to have, apparently to the profitable stage.

The success of the process in Pittsburgh, where the Blair, the DuPuy and the Siemens processes have failed, would be chiefly attributable to the supply of a very cheap heating fuel, natural gas; but still I think in some part to the use of special reducing agents, which lessen the loss of iron. The loss from ore to ingots is probably less than that in the DuPuy and Siemens processes from ore to blooms: while over the Blair process the Eames has the advantage of utilizing the sensible heat of the sponge when the balls are plunged into the open-hearth bath.

The loss of iron was actually heavy, probably at least 20%. As the material was melted and subsequently balled in the necessarily strongly oxidizing atmosphere of the rotator, this was probably absolutely unavoidable. The rich slags given in columns I and II of Table 165 tally well with this loss. The data in column VIII indeed indicate a very slight loss, for no less than 60.5 pounds of blooms were recovered from 100 of ore and scale. But this loss does not tally with the extremely small quantity of fuel used for reducing, only 23 parts per 100 of blooms, and I think that there must be some error. The heavy loss of iron of course permits dephosphorization; note the large proportion of phosphoric acid in the slags of Table 165.

The loss here given is from ore to blooms: that from ore to ingots would probably be at least 30%.

The fuel-consumption was heavy, and probably unavoidably, as the heating was indirect, and as the strongly oxidizing atmosphere of the reducing furnace both directly oxidized the reducing fuel and continually reoxidized the iron, to re-deoxidize which demanded a further excess of reducing fuel. It should hardly be possible to bring the fuel-consumption much below 200 pounds per 100 of blooms.

TABLE 165. DETAILS OF THE SIEMENS DIRECT PROCESS.

Number	I.	II.	III.	IV.	V.	VI.	VII.
Place	Towcester.	Towcester.	Towcester.	Towcester.	Tyrone.	Pittsburgh.	Landore.
Date	1876	1877	1877	1887	1879	1881	1881
Authority	Tunner.	Siemens.	Siemens.	Siemens.	Holley.	Maynard.	Holley.
ROTATOR.							
Diameter, outside	8′ 6″				11′	11′ 4″	
Length	9′ 6″	9′			11′	12′	
Thickness of br'k lining	3″					4¼″	
Thickness of fettling	5″ @ 6″					2′	
Circum. veloc., ft. per min., initial	320′ @ 400′						
Revs. per min., initial	12 @ 15					.56 @ .67	
CHARGE.							
Ore, % Fe	44·29 d	40 ±			50		
Lbs. per charge, ore	1,960	3,360	578	500	4,000	5,023	2,240
mill-scale	504 o		1,008	1,003	800		1,344
slag		168 m	784 n	784 n			
Total iron-bearing matter, lbs	2,464	3,528	2,370	2,287	4,800	5,023	3,584
Total iron in charge, lbs	868 a		1,312 h	1,274 h			2,156
Limestone	280	168	112	95	250	271	
Reducing coal	896	1,008	728	728	600 @ 700	1,382	504
Producer coal						6,103	2,734
Per 2,240 pounds of blooms. Ore, pounds	6,744	6,744	1,051	1,006	5,430	436	2,813
Other iron-bearing matter, pounds	1,734	3[illegible]9	3,258	3,596	1,086		1,388
Total iron-bearing matter, pounds	8,478	7,083	4,309	4,682	6,516		3,701
Limestone, pounds	963	539	204	191	339	235	
Coal, reducing, pounds	3,083	2,032	1,324	1,465	882	1,200	521
Coal for producers, pounds	4,592 f	4,480 e			3,800	5,302	2,824
Coal, total pounds	7,675	6,512			4,682	6,502	3,345
Labor, days					5·5		
Labor, $	10.00	3,63			10.00	9.24 l	
Repairs, etc., $						2.00	
Total cost, $		16.45	(?)		25.00	(?)	
No. charges per 24 hours	5 (?)	5 ?	5·3 ?	7 ?	3·5 ±	2·6 ±	5·2
Length of charge	4 hr. 30 m.	4 hr. 21 m.	4 hr. 8 m.	3 hr. 12 m.	7 hr. ±	9 hr. +	4 hr. 30 m. ±
PRODUCT.	a. / b. / c.	a. / b.					
Slag, composition % Fe Ox	47 / 56 / 46	47 / 56					
% P_2O_5	5·2 / 3·5 / 1·9	5 2 / 3·5					
% S	1 0 / 0·4 / 0·3	28 / 19					
% SiO_2	28·1 / 18·8 / 12·5						
Blooms, composition % Fe	99·71	98·3 @ 99 9				87 ±	
% C	0.12	tr. @ 0·23					
% P	·074	.02 @ .128					
% S	·027	tr. @ 0·27					
Weight per charge, lbs. blooms	651	1,111	1,232	1,113	1,600 @ 1,700	2,579	2,168
Total output per 24 hours per furnace, lbs	3,225 ?	5,555	6,530	7,791 ?	5,600 ± @ 5,950 ±	6,075 ±	11,290
Loss % of iron	25% d	19 3 i	6·07 ! hj	12·6 h	15 @ 20 d	20·15	p.

I. Tunner, Metallurg. Rev., I., p. 573, 1878.
II. Siemens, 18 charges at Towcester, Jour. Iron and St. Inst., 1877, 11., p. 352.
III. Idem, p. 357: Average of 27 charges.
IV. Idem, p. 358: Average of 40 charges.
V. Holley, Trans. Am. Inst. Mining Eng., VIII., p. 321, 1880.
VI. G. W. Maynard, Idem, X., p. 274, 1881.
VII. Data quoted from Holley by Maynard, Loc. Cit.

a First tapping.
b Second tapping
c Reheating.
d Excluding mill scale used
e Producer coal only.
f Producer and steam coal.
g Special charges only: does not nclude rolling the hammered blooms.
h Including scale, etc.
i Apparently including scale, etc.
j This number is incredible.
k The actual loss of iron, assuming that the blooms contained 87% of iron. It is stated that they contained 10 @ 15% of cinder.
l $9.24 per ton of blooms of 87% of iron: $10.62 per 100 of iron in the blooms. The latter seems more nearly comparable with other numbers in the same line, as in the other columns blooms apparently of 98 to 99·9% of iron are referred to. The sum, $10.62 appears to include labor for heating, for shipping, and for receiving.
m Tap-cinder.
n Undescribed cinder.
o Reheating-furnace slag.
p If, as the context suggests, the ore contained about 58% of iron and the scale about 72, the weight of blooms would exceed that of iron charged, so that the loss would be represented by the slag inclosed in the blooms.

In addition to the compositions given in Table 165 we have the following from Metcalf, of very redshort wrought-iron made by this process[j]:

Carbon,	Silicon,	Manganese,	Phosphorus,	Sulphur,	Copper,	Dissolved Oxide.
.033	.038	0	tr.	.046	.030	.30

B. *The Cascade Furnace.*—Instead of a rotator Siemens at one time used a "Cascade" furnace, Figure 145. A lake

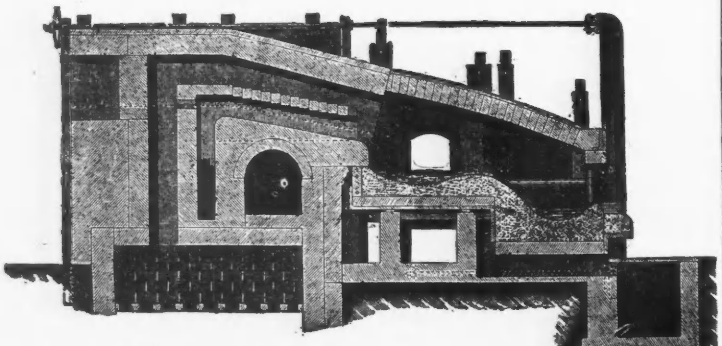


Fig. 145.
SIEMENS CASCADE FURNACE.

of fused ore was formed on the upper hearth, and, by piercing the intervening bank of unmelted ore, was run at intervals upon the lower hearth, upon which me nwhile a layer of equal parts of powdered anthracite or coke and ore had been spread. On stirring, the mass foamed and became pasty; in from 40 to 50 minutes the iron, precipitated by the carbon, was balled, to be melted in the open-hearth furnace or squeezed. In Siemens' published results the loss was less than 7%; but as the slag rarely held less than 15 and sometimes as much as 40% of iron, I doubt whether such results could be obtained regularly. Indeed, Siemens abandoned this method because of liability to heavy loss of iron, and because "a certain degree of manual skill and labor" was needed.[c] Truly, it is hard to understand on what kind of information Siemens and others based their statements concerning both this and the rotator process.

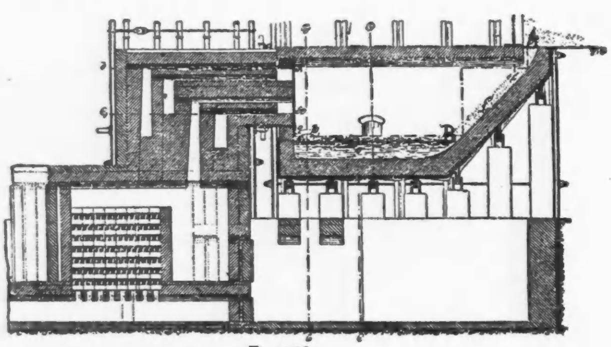


Fig. 146.
FURNACE FOR F. SIEMENS CONTINUOUS DIRECT-PROCESS.

§ 342. Leckie[1] would brick ore with coal or peat, heat the bricks in chambers adjoining an open-hearth steel melting furnace, and when deoxidation has progressed well, push them into the bath of molten cast-iron on the open-hearth. The objections stated in § 315, C, I, apply here.

§ 343. In F. Siemens'[g] direct process ore, coal and fluxes are charged continuously through a slit at the end of a regenerative gas-furnace, Figure 146, which is rectangular in plan, with the entrance and exit ports at the same end, the opposite end AB being strongly inclined. The heat is so high that the ore melts immediately on entering the furnace, and so coats over and protects the coal from the action of the flame of the furnace. The melting ore trickles down the incline A B, its iron being reduced by the coal, partly during its descent, partly after reaching the bath at the bottom of the incline. Basic additions are made to the molten slag, to permit dephosphorization and the reduction of the iron. The slag runs out continuously, the metal is tapped from time to time.

For reasons given in § 315, C, I, the plan is less promising than striking.

§ 344, A. Eustis[g] would coke fine ore with coking bituminous coal, and melt the coked lumps in a cupola furnace, thinking that the phosphorus would escape deoxidation both in the coking and the fusion.

It would be necessary to have a great quantity of carbon present. If the product were not itself carburized, it would be so extremely infusible that an enormous quantity of fuel would have to be present in order to melt it, and this quantity of fuel would probably make the deoxidizing conditions so strong that the phosphorus would enter the iron. If, on the other hand, the product were carburized, and therefore fusible, enough carbon would have to be present to prevent its decarburization by any small quantity of reoxidized spongy metal, and to keep the slag quite free from iron-oxide, as this of course would react rapidly on the carburetted bath and remove its carbon. But in this case the slag, being free from iron-oxide, would not hold phosphorus unless made basic with lime or magnesia, and to melt a lime or magnesia slag would require so high a temperature, and hence so much fuel (the reducing agent), that here too the phosphorus would be deoxidized.

In short we have the difficult if not impossible task of dephosphorizing under the necessarily strongly deoxidizing conditions of shaft-furnace smelting.

For the rest, if cast-iron is to be made, the process is more costly than the blast-furnace; if ingot metal, the problem of melting it in a shaft-furnace is no easy one. To melt it in the open-hearth we have to preheat gas and air tremendously; to melt it in a shaft furnace would, I fear, need very hot blast and an abundance of highly preheated fuel; in short the conditions of the blast-furnace exaggerated, for the temperature must be much higher than that reached in cast-iron making.

B. Ireland.—The same objections apply to Ireland's plan of melting sponge in a cupola furnace.[n]

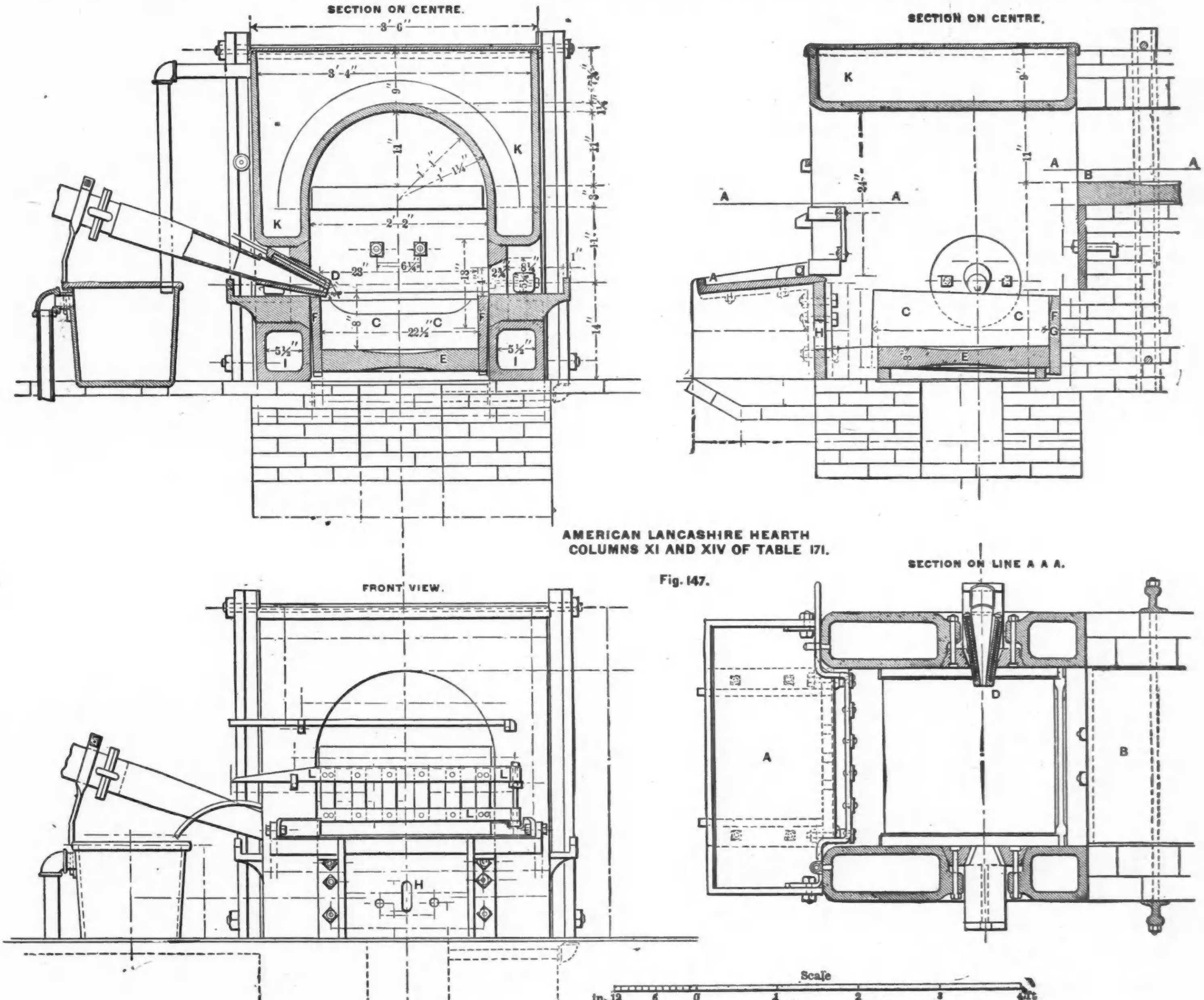
j Trans. Eng. Soc. W. Penn., March 16, 1883, p. 217.
c Journ. Iron and Steel Inst. 1873, I, pp. 43, 51.
l T. S. Hunt, Rept. Geolog. Survey Canada, 1866-9, p. 295.
g Trans. Am. Inst. Min. Eng., IX., p. 274, 1881.
n Jour. Iron and Steel Inst., 1878, I., p. 52.
g Wagner's Jahresbericht, xxxiii., p. 305, 1887.

CHAPTER XVI.

Charcoal-Hearth Processes.

When steel is made from cast-iron, this material may be used without preparatory treatment, as in the Bessemer process, or it may undergo some preparatory process. The chief and normal use of some of these preparatory processes, such as pig-washing and mechanical puddling, is to prepare material for steel-making; that of others, *e. g.*, hand-puddling, charcoal-hearth refining, etc., is to make wrought-iron to be used as such, and their use as preparatory to steel-making is only subsidiary.

§ 346. In General.—*Charcoal-hearths* for refining cast-iron are, roughly like the Catalan and bloomary hearths for reducing iron from the ore, low, rectangular chambers, Figure 149, sometimes roofed, Figures 147, 148, and with one or more tuyeres. The chief difference is that in refining cast-iron much more strongly oxidizing conditions are brought about, chiefly (1) by melting the metal down in drops before the tuyere, repeatedly if need be, so that it passes in a state of minute subdivision and with great surface exposure through a part of the hearth where the atmospheric oxygen is in excess; and (2) by the action of the basic ferruginous slag with which the metal is mixed during the earlier stages, and with which it is covered during the later stages, to ward off the strongly carburizing tendency of the charcoal.



AMERICAN LANCASHIRE HEARTH
COLUMNS XI AND XIV OF TABLE 171.
Fig. 147.

Material.—As this process is a very expensive one, and hence only used for making iron of excellent quality, and as the quality of the product depends to a considerable extent on that of the material, *i. e.*, on its freedom from phosphorus and sulphur, so only pure cast-iron is used, and preferably charcoal cast-iron. As the length and cost of the operation increase with the proportion of carbon, and still more with that of silicon in the metal, so close gray or preferably mottled or white cast-iron is habitually

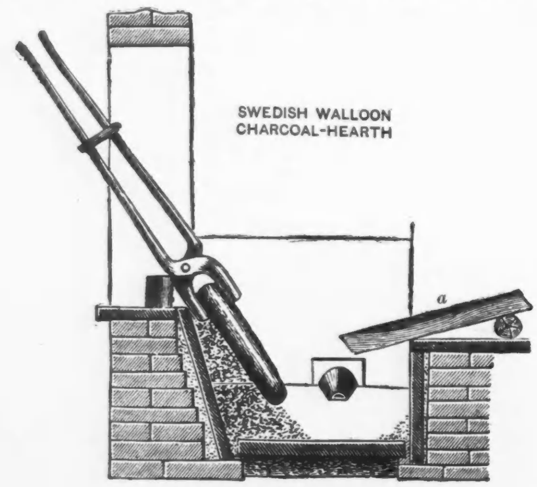


Fig. 149.

used; and, in case open gray iron is used, it is well to remove part of its silicon by a partial refining in a preliminary process.

Silicon not only greatly retards the operation by being oxidized in preference to carbon, but more especially because the silica formed by its oxidation makes the slag less basic, and so less strongly decarburizing; and the removal of phosphorus and carbon occurs in large part through the action of the basic slag. Not only does a less basic slag remove phosphorus and carbon less rapidly, but it devours iron-oxide the more readily, and thus increases the loss of iron. Indeed, we must make up our minds to a loss of over two parts by weight of iron for every part of silica, or of about one part by weight of iron for each part of silicon that enters the slag. Moreover, a very considerable outlay of labor and time is needed to work the iron-oxide into the slag.

The pigs are in many cases cast in cast-iron moulds ("chills"); if cast in sand, much of this would adhere to them and silica would thus be introduced.

The presence of manganese in the cast-iron is thought undesirable, not only because it is oxidized in part in preference to the carbon and silicon, and because the manganese slags are less strongly fining than the iron slags—thanks to the higher affinity of manganese than of iron for oxygen, and to the fact that manganese does not slide up and down in its degree of oxidation as iron does, carrying oxygen from atmosphere to metal—but also for another important reason. The manganese slags are unduly fluid, and do not adhere to the sides and upper part of the lump of iron and exert their fining influence over its whole surface like the relatively pasty iron slags, but run down and collect beneath, leaving the iron in contact with the charcoal, from which it rapidly takes up carbon.

For fuel charcoal is used, not only because free from sulphur, but because it has less ash than solid mineral fuels, and so introduces less silica into the slag. To remove sand, pebbles, etc., serious sources of silica, the charcoal shortly before use is washed in large tanks which stand hard by the charcoal-hearths themselves.

The hearths are usually of naked, unlined cast-iron plates, at least in part water-cooled. Brick-work or other clayey lining is to be avoided, because its silica would enter the slag.

§ 347. Product—the Reasons for the Existence of the Process.

From given cast-iron the charcoal-hearth process yields better wrought-iron than puddling, perhaps in part because the charcoal lacks the sulphur which the mineral fuel of the puddling furnace contains, and of which a little

Table 167.—Composition and Properties of Charcoal-Hearth Iron.

No.		C.	Si.	Mn.	P.	S.	Tensile strength, lbs. per sq. in.	Elastic limit, lbs. per sq. in.	Elongation. Per cent.	Elongation. Measured on	Reduction of area, per cent.
1	Åryd, Småland, Sweden (Rolled)	0.07	....	....	....	....	65,669	37,397	14.1	....	49.
2	" " " "	0.18	....	....	0.264	....	.....	40,485	....	....	18.
3	Hallstahammer, Westmanland, Sweden (Rolled)	0.07	....	....	....	....	50,916	27,104	16.7	....	56.
4	Lesjoforss, Wermland, Sweden (Rolled)	0.07	....	....	0.022	....	45,014	24,360	22.0	....	77.
5	Hallstahammer	0.07	....	....	....	....	47,553	.....	....	....	74.
6	Lesjoforss	0.08	....	....	....	....	44,603	.....	19.0	...	68.
7	"	0.07 ±	....	....	....	....	44,877	.....	29.0	....	65.
8	"	0.06	....	....	....	....	51,053	.....	....	....	65.
9	"	0.07	....	....	....	....	56,199	.....	17.2	5.2″	59.
10		0.087	0.115	....	0.034	0.220					
11	From Dannemora Ore	0.054	0.028	tr.	tr.	0.055					
12		0.087	0.056	...	0.005	0.632					
13	Swedish a	.040	nil.	nil.	0 005	nil.					
14	" a	.200	.100	.050	.100	.025					
15	"	.01	.005	.005	.016	.002					
16	"	.18	.005	.02	.04	.002					
17	"	.06	.016	.01	.03	.01					
18	"	.11	.021	.07	.05	.02					
19	"	.06	.02	.005	.02	nil.					
20	"	.05	.02	nil.	.04	.009					
21	"	.06	.023	.008	.017	nil.					
22	"	.05	.02	nil.	.02	.01					
23	American	.06	.10	tr.	.05	.09					
24	"	.03	.25	.008	.01	.01					
25	"	.06	.21	.009	.01	.02					
26	"	.12	.19	.01	.01	.008					

(a) Made from cast-iron, containing carbon, 4.00 to 4.50 %, silicon, 0.20 to 0.50 %, manganese, trace to 1.80 %, phosphorus, 0.01 to 0.15 %, sulphur, 0.01 to 0.03 %.

1 to **9**, Styffe, Iron and Steel, pp. 132, 136, 140, 1869.
10 to **12**, Percy, Iron and Steel, p. 736, 1864.
13 and **14**, Bell, Princ. Manuf. Iron and Steel, p. 345, 1884.
15 to **26**, G. H. Billings, Private Communication, April 7, 1889.

may enter the metal, but chiefly for the following reason. In both processes we can decarburize the pasty metal throughout its mass only by stirring it vigorously, exposing fresh surfaces to the action of the atmosphere and of the strongly decarburizing basic slag, and this stirring intentionally mixes slag with metal to effect decarburization. We thus get a ball of stiff, pasty wrought-iron mixed with much slag. In some of the charcoal-hearth processes we get rid of most of this slag by remelting this ball; holding it aloft we allow its metal to fall drop by drop, and collect it in a new ball, which we carefully avoid touching, and which is thus relatively free from slag. In the puddling process we cannot do this, and must content ourselves with squeezing out as much of the slag as we can in hammering or rolling.

Charcoal-hearth iron, then, is in a manner intermediate between common wrought-iron and ingot-iron in that it is remelted and cast while molten into a malleable mass; but instead of being cast into a slagless-mould as in true ingot-metal-making processes, it is poured upon a bath of slag of which a very little inevitably becomes mixed with the metal.

But while it is clear why charcoal-hearth iron is tougher than puddled iron, it is not so easy to see why it is tougher than ingot-iron, unless we hold that the small quantity of slag in charcoal-hearth iron promotes toughness while the larger quantity in puddled iron opposes toughness. The conditions under which the charcoal-hearth iron is melted and, as it were, cast within the hearth, are very different from those which attend the casting of ingot-iron. Charcoal-hearth iron is raised but slightly above its melting point, and for a few moments only; is cast drop by drop through an atmosphere rich in carbonic oxide and carbonic acid into a white-hot bath of slag, falling in all but a few inches: ingot-iron is held for a very considerable length of time far above its melting point, is cast in a thick stream, through a cold atmosphere of oxygen and nitrogen, usually into a cold cast-iron mould, often falling several feet. In the charcoal-hearth drop of metal follows drop in such a way that neither pipe nor blowhole nor microscopic cavity seems to form; ingot-metal is so cast that pipes or blowholes or microscopic cavities or all three arise. Charcoal-hearth iron is purposely kept as free as possible from slag, ingot-metal is purposely kept practically absolutely free from slag.

I will not attempt to say to which, if to any, of these differences the apparently very considerable difference between the properties of ingot-iron and of those of charcoal-hearth iron is due, nor even that it is due to any of these rather than to other and unnoticed differences. I will not even insist that there is a real difference in quality. We know that the properties of tough-pitch copper are influenced very greatly and obscurely by the conditions preceding and attending casting.

The apparent superiority of charcoal-hearth to ingot-iron can hardly be attributed to greater freedom from carbon, silicon, phosphorus, etc., if we may judge by the analyses in Table 167.

Uncertain whether the conditions of the charcoal-hearth give better quality than we can obtain in ingot-metal, we may not, like so many superficial observers, predict the early disappearance of the process.

Here is a case which exemplifies the curious and anomalous facts, or at least beliefs, touching the properties of charcoal-hearth and ingot-iron. For making screws charcoal-hearth iron is used because, so it is said, ingot iron is not tough enough to endure the upsetting which arises in forming the head of the screw. But the charcoal-hearth iron used is purposely rather brittle, is intentionally made from rather phosphoric cast-iron, so that the shaving formed in cutting the thread may break off short, and not interfere with the cutting tool. Now we are told that charcoal-iron endures upsetting better than ingot-iron, and at the same time its shavings break off more aptly; in brief, it is tougher in the head but shorter in the thread! Some of these paradoxical beliefs turn out on investigation to be mere superstitions, others to be true, due now to simple now to obscure conditions. How it is with this one I know not.

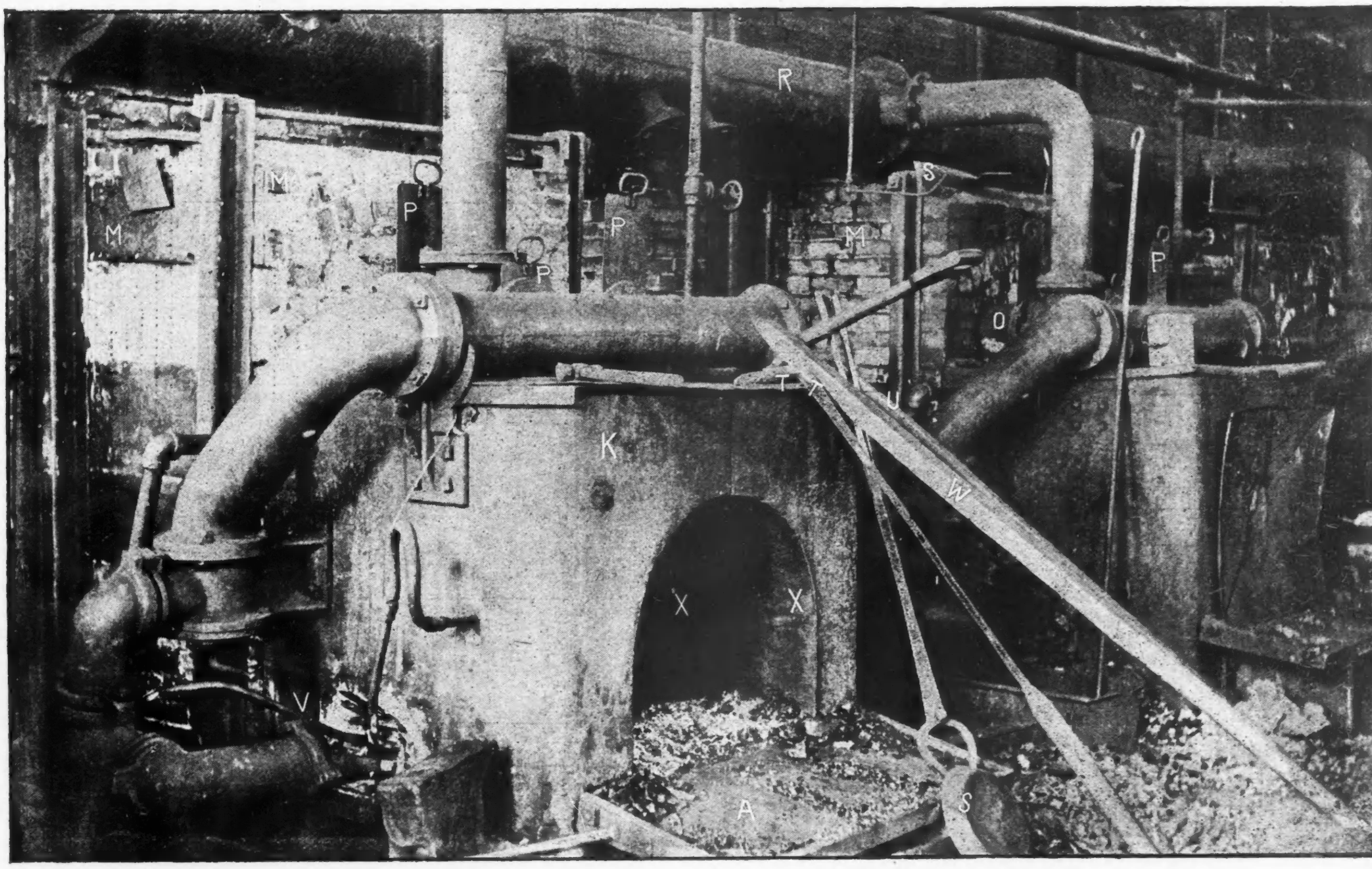


Fig. 148. American-Swedish-Lancashire Hearth.

It is doubtful whether the charcoal-hearth removes phosphorus as thoroughly as the puddling process, for its atmosphere seems much less powerfully oxidizing. This appears to more than outweigh the usually greater basicity of its slag, and the more thorough removal of the slag from which, as long as it is present, the iron may reabsorb phosphorus at high temperatures, as in reheating.

Thanks to the excellence of its product charcoal-hearth refining seems to hold its own pretty well, at least if we include the balling of scrap wrought-iron in charcoal-hearths. The output of charcoal blooms from cast-iron and scrap together in this country was greater in 1887 than in any of the years from 1874 to 1878; the output of the Swedish charcoal-hearths increased by about 60 per cent.

between 1860 and 1880. In South Wales the charcoal-hearth has been used very extensively for making iron for tin plates, but there mild steel is now driving it out of the field.

In the Austrian Alps and in Russia it is still used extensively, I understand. The following table gives data concerning the extent to which it is used:

TABLE 168.—PRODUCTION OF BLOOMS BY REFINING CAST-IRON IN CHARCOAL-HEARTHS.

Year.	United States. (Blooms from Cast-iron and Scrap.)		Sweden.	
	Number of Hearths.	Output. Net Tons.	Number of Hearths.	Output. Net Tons.
1860			1,260b	124,223
1874		25,220		
1877		23,073		
1880		33,937	729b	198,915
1882		42,939		
1884	53a	27,216		
1885		21,813		
1887		28,218		
1888		25,787		

a This does not include charcoal-hearths which make blooms for use in the plate, sheet and wire-making mills with which they are connected.
b Hearths and furnaces.
United States, from Ann. Statistical Rept. Am. Iron and Steel Ass., 1888, p. 37, and J. M. Swank, private communication.
Sweden, from Ehrenwerth, Das Eisenhüttenwesen Schwedens, p. 99, 1885, from Åkerman.

Table 169 shows that some of the American charcoal-hearth establisments existing and even running at present are extremely old, and that the development of the industry, as judged from the number of establishments built, was most rapid between 1870 and 1880.

TABLE 169.—AGE OF THE CHARCOAL-HEARTHS EXISTING NOW OR LATELY IN THE UNITED STATES.z

Years.	No. Built.	No. Rebuilt.	Of those built in the several periods of Column 1, the following numbers were		
			Abandoned apparently between 1883 and 1888.	Idle in 1887, but apparently not abandoned.	Running in 1887.
1755–1799	6		4		2
1800–1819	6		2	1	2
1820–1829	4		3		1
1830–1839	6		2		4
1840–1849	6		3	1	2
1850–1859	0	0			
1860–1869	7	2		3	6
1870–1879	10	2	4(?)		8
1880	1			1	
1883	1				1
1884	1	1	1		1
1885	1				1
1887	1				1
1888	0	0			

z One may not safely infer that the original hearths still exist in these establishments; they may have been built, rebuilt or replaced, but at least the original establishments exist.

Bell estimates the cost of making 2,240 pounds of charcoal-hearth bar iron in Sweden as follows:

TABLE 170.—COST OF MAKING CHARCOAL-HEARTH IRON IN SWEEDEN. *Bell.* b

2,912 pounds	Cast-iron @ $14.52 per 2,240 lbs.	$18 82
3,080 "	Charcoal @ $4.84 " " "	6 68
	Labor	5 57
	Total	$31 07

b Prine, Manuf. Iron and Steel, p. 347, 1884.

The data in Table 171 indicate that the cost of the manufacture of blooms, assuming Bell's prices, is much less, to wit:

2,575 pounds of	Cast-iron @ $14.52 per ton	$16 69
1,120 "	Charcoal @ $4.84 " "	2 42
	Labor, 2 days @ $1.25 d	2 50
		$21 61

d Bell does not give the rate of wages.

As the data in Table 171 show, important economies have been reached since the time of Percy's description of the process. Thus we see that the output of the

TABLE 171.—CHARCOAL-HEARTH REFINING.

	Single-smelting.	Double-smelting process.										Triple-smelting Process.		Scrap-balling process, United States.
		Swedish Wallon.			Swedish Lancashire hearth.							German.	Franche-Comté.	
					In Sweden.						United States.			
	I. Siegen, before 1875.	II. Sweden, before 1864.	III. Sweden, Dannemora, about 1873.	IV. Sweden, Dannemora about 1884.	V. Before 1864.	VI. Before 1875.	VII. Nyby, 1884.±	VIII. Ramnäs, 1884.	IX. Domnarfvet 1882.	X. Bell, before 1884.	XI. 1889.	XII. Before 1875.	XIII. Before 1875.	XIV. 1889.
DIMENSIONS OF HEARTH— Width and length	24″ × 30″	22″ @ 24″ × 32″ @ 35″		20¼″ × 17¾″			24¼″ × 22″	26⅜ × 21¼″	25¼ × 21½″		25¼″ × 22⅛″		22⅝″ × 20⅝″	25¼″ × 22⅛″
Height to tuyere									7½″		8″		9¼″	8″
" above tuyere								7¾″						
" total "	30″						7¼″							
BLAST— Pressure, ounces per sq. inch				13.6	19.5	24.7	16.9–20.4	17.9–19.1	19.1				14.2 to 16.1	
Temperature C / F		cold.		cold.	100°C 212°F	100°@200°C 212°@392°F	150°C 302°F	80° @ 100°C 176° @ 212°F	50° @ 90°C 122°@194°F	100°C 212°F	85° @ 100°C 185° @ 212°F		112° @ 125° 233.6° @ 257°F	85° @ 100°C 185°@212°F
Size of tuyere, nozzle		1.4×1.8″		.8″×1.45″		5 sq. in.	.9″×0.7″	0.7″×.91″	0.7″×0.9″		¾″		1″×1.5″	¾″
Inclination of tuyere				20°			5° @ 6°	30	12°					
Number of tuyere	1					2	2		2					
Grade of pig-iron		White or mottled.	white or mottled.	white.		mottled.		half white, half mottled to gray			½% Si. mottled.	gray.		
Length of one heat		25′ @ 30′			1hr.15′ @ 1hr.30′		1 hr.	1 hr. 25′			1 hr. 15′	4 @ 6 hrs.	2 hours 25′	37′
LABOR— Men per hearth per shift		3					2	2	2	2 @ 3	2			2
Length of one shift		8 hours.					8 hrs.							
Number of heats per 24 hours		40 a c			14 c		14±	20	21		14	4	9	28
OUTPUT PER HEARTH— Weight of blooms per heat, pounds		56 a c		93 @ 84	173.5 c	130 @ 246	226	261	231		244	186	159	285
Weight of blooms per 24 hrs., pounds	4409.2	2240 a c	3123–4666 a	3895 a	2464 c	2500 to 4700	3169	5291	4903	2613 to 5600	3410	894	1582	7988
OUTLAY PER 2,000 BLOOMS, POUNDS— Bushels charcoal	109.5 b	551 a	366 @ 561 a b	387 a b	157	b102 @ 146	59 b	soft 86 b	83 b	114 d		106 a b	133.5	37
Charcoal, pounds	1204.5 b	6000 a	4026 @ 6171 a b	4253 a b	1800	b1120 @ 1606	645 b	947 b	913 b	1250		1168 a b	1468.5	405
Cast-iron, pounds	2667	2500 a		2639 a	2305	2299	2299	2300	2293	2299	2299	2722	2548	2324
Labor, days		5.4 c a					2.5	1.5	1.6	1.5 to 1.7	2.3			1
LOSS— From cast-iron to blooms, per 100 of cast-iron	25%	20% a		24.2% e	13.25%	13%	13%	13.04%	12.77%	13%	13%	25 @ 28%	20 @ 23%	13.55%

a This is the consumption per 2,000 lbs. of bars, not blooms.
b It is assumed that a bushel of 2,500 cubic in. weighs 11 lbs.: then 1 $\overline{m}^3$ = 24 bushels. The original gives the measure of charcoal, but not the weight.
c There seems to be a slight discrepancy between the output, the charge, and the loss.
d The same assumption as in b: the weight of charcoal is given, but not the measure.
e This is the loss from cast-iron to bars, not blooms.

I., Kerl, Grundiss der Eisenhüttenkunde, p. 340, 1875.
II., Percy, Iron rand Steel, p. 599, 1864.
III., Kerl, op. cit., p. 338.
IV., Ehrenwerth, das Eisenhüttenwesen Schwedens, p. 32, 1885.
V., Percy, op. cit., p. 591.
VI., Kerl, op. cit., p. 338.
VII., VIII. and IX., Ehrenwerth, op. cit., pp. 27, 68, 45.
X., Bell, Princ. Manuf. Iron and Steel, p. 346, 1884.
XI., From the author's Notes.
XII. XIII., Kerl, op. cit., pp. 334, 336.
XIV., From the author's Notes.

Lancashire hearths per 24 hours has doubled, while the consumption of fuel per ton of blooms is but half as great as formerly. The loss of iron remains the same as of old.

§ 348. CLASSIFICATION.—The charcoal-hearth processes are classified according to the number of times that the metal is melted down before the tuyere into the single-, the double- and the triple-smelting classes (Einmalschmelzerei, Zweimalschmelzerei, and Dreimalschmelzerei or German or breaking up [Aufbrechschmiede] class).

The number of smeltings needed depends chiefly on the proportion of carbon, silicon and manganese to be removed, and also, but to a smaller extent, on the desired thoroughness of decarburization, etc. Hence the single smelting is chiefly applicable to white cast-iron and to iron already partly refined: the double smelting to mottled iron, or to white or previously partly refined iron when an extremely pure product is sought: the triple smelting to mottled or to gray iron.

The processes are also divided into the Walloon and non-Walloon classes. The ground of this distinction seems to be a little in dispute. Tunner classes as Walloon all those processes in which the bloom is reheated in a separate hearth, an arrangement which leads to a smaller consumption of charcoal, as mineral fuel, sawdust, etc., may be used for reheating. But this is not true of the Swedish Walloon process. Kerl appears to class all double-smelting processes as Walloon.

Tunner recognizes no less than fourteen kinds of wrought-iron making types of charcoal-hearth refining processes, and five more steel-making: but we need concern ourselves only with those given in Table 171, which are,

- Single smelting.
- Double Smelting.
  - Swedish Walloon.
  - English Walloon.
    - Lancashire.
    - South Wales.
- Triple smelting, *e. g.* Franche-Comté

Of these the Swedish Walloon (called in Sweden, plain "Walloon") is used in Sweden solely and exclusively for making bars from Dannemora cast-iron which are to be converted into blister steel. Changes in the procedure have long been and I believe are still prohibited by contract with the English consignees, lest the quality of the product be injured. However faithfully the spirit of this contract may be kept, the data in columns II. to IV. of Table 171 indicate that its letter has been violated, for the output per hearth per 24 hours has increased greatly, while the consumption of fuel has fallen off, since Percy's great work was written.

This process is more expensive than the Lancashire, using, say, four times as much charcoal and much more labor. One would naturally suppose that the excellence of the Dannemora iron was due rather to the excellence of the ore, notably its remarkable freedom from phosphorus, and to the thorough roasting which it undergoes, than to the use of the Swedish Walloon instead of the Lancashire process. The vastly greater fuel-consumption of the former should indeed be detrimental as opposing the removal of phosphorus, of which a little is reported even in the Dannemora iron (see Table 167). Moreover, the Swedish Walloon iron is probably much less homogeneous than the Lancashire-hearth iron.

Nearly if not quite all the charcoal-hearth iron made in Sweden, other than Dannemora iron for cementation, is made by the Lancashire process, and much Dannemora iron not intended for cementation is thus made. This process is also used extensively in this country. Whether it has ever been used in Lancashire I know not. It was brought to Sweden by Welsh workmen, and to this country by Swedes. The South Wales process was used extensively, and actually in South Wales, notably for making plates for tinning. But it has been driven out of that district to a great extent, if not altogether, by the Bessemer and open-hearth processes.

§ 349. EXAMPLE OF THE SINGLE-SMELTING PROCESS.—The white-iron pigs, much as shown at the right of Figure 149, are gradually pushed forward towards the tuyere as their hotter ends melt away, and the iron is almost completely decarburized as it trickles past the tuyere. It collects as a ball on the oxide-bottom. Imperfectly refined parts are broken off and melted again: the ball is drawn and hammered: the billets from the preceding charge are heated in the same fire.

§ 350. IN THE LANCASHIRE-HEARTH PROCESS[a] three periods are distinguished

1, the preheated cast-iron is melted down before the tuyeres (say 15 minutes);

2, the pasty mass which the collecting drops form is constantly broken up by prying from beneath, and the slag is thereby mixed with it (20 to 30 minutes);

3, the almost decarburized mass is raised above the charcoal and gradually melted down, collecting beneath in a ball which is drawn and hammered (25 to 30 minutes).

The hearth is wholly lined with naked, unprotected, cast-iron plates, the bottom and preferably the sides being water-jacketed. In American practice a bottom-plate lasts about four weeks, and the others about twice as long.

In some American Swedish Lancashire-hearths, Figures 147, 148, whose work is given in column XI. of Table 171, the whole of the roof and sides are formed by one or two heavy castings, K K, Figure 148, which are full to the top with water. Figure 148, which is from a photograph of the hearths represented in Figure 147, further shows the tools used, and the actual form of double-elbowed blast-pipe, which enables us to withdraw the tuyere readily. The products of combustion pass first into the fire-brick ells M M, in which they heat the blast, whose entrance is effected through the pipe O, and regulated by the dampers P. By shifting these dampers we can send the blast through the blast-heating pipes, or directly to the tuyeres without preheating, or in readily variable proportion through both paths simultaneously. From these ells the products of combustion pass beneath the boilers, which stand behind and beneath the blast-main R. The lattice L, designed to hold in the charcoal and to protect the workmen in some measure, was not in use at the time of my visit.

The charcoal is added and nearly all the work is done through the wide-open doorway X X, through which an enormous excess of air rushes, greatly lessening the heating power of the products of combustion.

A Fore- or working-plate.
B Shelf for preheating cast-iron.
C Hearth proper.
D Water-tuyere.
E Water-cooled cast-iron bottom-plate.
FF Cast-iron side-plates.
G Cast-iron rear-plate.
H Tap-hole for slag.
I Cast-iron water-cooled boshes.

a According to Percy this is a misnomer, as the process was imported into Sweden from South Wales in 1829. (Iron and Steel, p. 598, A.D. 1884.)

K Cast-iron water-cooled roof and sides.
L Lattice-door.
M Hot-blast stove.
O Blast-pipe leading to hot-blast stove.
P Dampers regulating the admission of air to the hot-blast stove.
R Blast-main.
S Pan for wetting the charcoal.
T Hook.
U Light bar for working the charge.
V Opening for detaching iron from the rear-plate.
W Heavy bar for prying up the ball.
X Working doorway.

Description of Process.—I will now describe the practice which I have seen in this country; it corresponds closely to the Swedish.

Preparatory.—275 pounds of pig-iron in lumps up to one foot long are preheated on the shelf B, while the preceding charge is working. The ball being drawn, the hearth is cleaned, and the quantity of slag present ascertained. If there is not enough to cover the bottom-plate E thoroughly, slag is added. It is essential that there should be enough for this purpose, lest the molten iron should strike and attach itself to this plate.

1st Period.—The hearth is next filled to about one foot above the tuyeres with charcoal, and on this the now red-hot pigs are drawn from the shelf B. The blast is turned on; the pigs are covered with charcoal. During the whole operation charcoal is added every few minutes, and on it is thrown water by the pan S, partly that the workman may work at the hearth without excessive discomfort, partly that the charcoal and carbonic oxide may not burn uselessly at the top of the fire, and that the carbonic oxide may be preserved to burn beyond, in the flue under the boiler. The melting pigs tend to sink down as the charcoal beneath them burns away; they must therefore be lifted a little every few minutes, so that the drops which trickle from them may pass through the oxidizing core of the region of combustion. But for this they would soon sink down to the bottom of the hearth, and the fusion would lose its oxidizing character, which is due wholly to the passage of the molten metal, drop by drop, through the most strongly oxidizing part of the hearth.

As the mass, now considerably decarburized, collects at the bottom of the hearth, it is so far cooled by the neighborhood of the water-cooled bottom-plate that it becomes decidedly pasty; thus any given particle of metal is only fluid during the brief period when it is dropping from the still unmelted portion above to join the previously melted but now partly resolidified mass beneath.

If too much slag be present, the gradual accumulation of metal on the bottom raises the slag-level so high that the entrance of the blast is impeded; this may be recognized by a peculiar fluttering noise which the blast makes. In this case the excess of slag must be tapped out through H; but as it is not easy to judge just how much is excess, the whole of the molten part of the slag may be tapped out, and enough slag returned to cover the bottom fully when the second fusion occurs.

Up to this point one man only works at the hearth, but two are at work during the whole of the second period.

2d Period.—When the whole charge seems to have melted down and collected thus at the bottom of the hearth, the workman feels about in the charcoal with the hook T, to find any still unmelted lumps. He now begins lifting up the pasty lump with the light bar U, running its point along the face of the bottom-plate so that no scattered pieces may escape him, and from now on throughout the second period this lifting is continued with but brief interruptions; indeed, during part of the time both workmen are prying simultaneously, one at each side of the hearth. Running the point of his bar beneath the mass the workman bears down, using the inner edge of the fore-plate *A* as a fulcrum, and raises the mass by from three to five inches from the bottom-plate. Into the space thus left falls some charcoal, runs some molten slag, and pierces the blast. As the workman moves his bar from this point to another, the pasty mass gradually sinks back again, and must soon again be raised.

In prying the mass up the workman's bar cuts deeply into it, carrying some of the slag which had collected beneath the metallic lump; thus slag, cooled to pastiness by the bottom-plate, and pasty metal are intimately mixed, and thus the fining action of slag on metal is promoted. The iron-oxide of the slag gives up oxygen to the carbon, silicon and phosphorus of the metal, and when the blast again penetrates again absorbs oxygen from the atmosphere, to be again given up. The pasty mass is not only indented from beneath by this prying, but broken up here and there. It is reunited not only by the same prying from beneath, but also as the workman pries the metallic lumps horizontally from around the tuyeres towards the centre of the hearth, for pains must be taken at all times that the tuyeres are clear and that the blast issues freely. At first the metal, soft and barely pasty, is lifted readily; as fining progresses it becomes stiffer and stiffer, and soon a powerful pressure is needed to raise it.

Towards the end of this period the carbonic oxide comes off so rapidly that the fine charcoal lying above the metal seems to boil, so energetically is it stirred by the escaping gas.

The indications of progress are chiefly the consistency of the metal just noted, and the color and consistency of the slag. At first the coating of slag seen on the bar as it is drawn from the fire is sluggish and reddish, sluggish because silicious and relatively cool; reddish because relatively cool and apparently because sluggish, the outer air-cooled layer remaining outside and concealing the hotter interior. Later it grows ever thinner and whiter; thinner because more basic (with decreasing proportion of carbon and silicon in the metal, iron oxidizes more readily and is less readily deoxidized), and because hotter (the oxidation of carbon, silicon and iron as well as of the charcoal ever raising the temperature); whiter because hotter and probably because thinner, moving quickly with shifting positions of the bar, so that the hotter interior comes readily to the surface.

When the metal appears from these indications to have "come to nature," *i.e.*, to be almost wholly decarburized, the third period begins.

3d Period.—The lump is now broken into several pieces, which are lifted above the tuyere, much of the metal indeed reposing on top of the charcoal. A bar U, is introduced through the opening V, behind one of the tuyeres, to break off any lumps adhering to the back of the hearth. This is the first time that the metal has been visible since charging, having meanwhile been covered with charcoal. From this point till the ball is to be pried out of the hearth, only one man is at work.

This period is essentially a remelting, and the work is similar to that in the first period. As fast as the lumps which are to be melted sink down owing to the burning away of the charcoal beneath, they must be pried up so as to keep them well above the mass which is collecting at the bottom as fusion proceeds (call this the lower mass), and so that the metal in melting may as before drop through the current of air thrown in by the tuyeres. The workman is very careful not to touch the lower mass with his bar, lest he force slag into it, and so defeat the chief object of this period, the elimination of the slag.

During the first part of this second fusion the lower mass is so small that the molten slag protects it from the carburizing action of the charcoal; but by the time that say two-thirds of the metal has reached it, it has outgrown the covering capacity of the slag, and more slag must be added. That actually added is hammer-slag from hammering the charcoal-hearth blooms. It is thrown on the shoulders of the lower mass, and, thanks to its high state of oxidation (which the blast maintains), it is so pasty that it does not all run down, but a layer of it remains and covers the shoulders of the lower mass, and wards off the carburizing action of the charcoal.

During all this time, be it remembered, the workman is occasionally prying up the upper mass, to keep it out of contact with the lower.

The upper mass being nearly all melted, the scattered lumps are raked together and welded to the lower mass with light taps of the hook T. The blast is slackened, and the glowing bloom is pried out from the hearth by both workmen, who bear down on the heavy bar W. Nearly the whole of the slag comes out with the ball, in a layer whose lower side is nearly smooth, showing the shape of the bottom-plate, but whose thickness is naturally very irregular, being on an average perhaps three inches. The slag does not adhere so strongly but that it could be pried off in large lumps; this is not done, however. All of the slag falls off when the ball is hammered. In hammering, all imperfectly refined parts are cut off, and returned to the hearth.

The hammered ball is reheated in another furnace; we need not follow it further.

Here is the diary of an operation which I saw in March, 1889:

DIARY OF A LANCASHIRE HEARTH REFINING.

Preceding ball drawn	11h. 57m.
Hearth cleaned till	11h. 58m.
1st Period. Redhot pigs drawn from the flue from	11h. 58m. till 12h. 00m.
Blast turned on: pigs covered with charcoal; pigs lifted occasionally; charcoal added and water thrown on.	
2d Period. All melted at	12h. 14m.
Both men pry lump almost constantly; charcoal added frequently; water thrown on occasionally.	
Metal has come to nature	12h. 33m.
3d Period. The lump is broken up and lifted above the tuyeres, protruding far above the charcoal	12h. 37m.
Begins melting again	13h. 44m.
Bar introduced by one workman horizontally, to keep upper mass up; charcoal charged occasionally; water added; hammer-slag charged.	
Small pieces raked together	12h. 59m.
Loose pieces balled to main mass	1h. 00m.
Blast stopped	1h. 01m.
Ball pried up and drawn	1h. 01m. to 1h. 02m.
Begin hammering	1h. 03m.
End hammering	1h. 05m.

§ 351. In the South Wales process the cast-iron is first melted down in a coke refinery or run-out fire, and there part of its silicon and carbon are removed by the action of the blast. It is then tapped out into a pair of charcoal-hearths, the relatively acid slag being held back, and any which runs into the charcoal-hearth being carefully removed. The partly solidified metal is broken up and piled near the tuyere. After melting down it is repeatedly raised slightly from the bottom, apparently as in the Lancashire process. The slag is tapped off from time to time. As soon as the metal has "come to nature," *i.e.*, is thoroughly decarburized, it is withdrawn and hammered.

This process thus lacks the descorifying final melting of the Lancashire process.

I have met no late description of the South Wales process. Greenwood, indeed, states that the charge in the coke refinery is from 5 to 6 cwts. of cast-iron, and that a charge lasts a little over an hour.[q] These agree with Percy's statements made in 1864; whether they are simple copies, or whether the process has remained stationary, I know not.

§ 352. In the Swedish-Walloon process one or two very long pigs of white or mottled cast-iron (*a*, Figure 149), are melted down drop by drop, being pushed forward as fast as their ends melt off, till enough to yield a bloom of from say 84 to 93 pounds has been melted. This may take some twenty minutes, during which the pasty metal gradually reaching the bottom of the hearth, is worked constantly. The pasty mass is now broken up, raised above the tuyere, and melted a second time, apparently much as in the Lancashire method. During this time the bloom from the preceding charge is heated in this same hearth, held steeply inclined as shown in Figure 149.

This process differs chiefly from the Lancashire process in that the bloom is reheated in the hearth in which it is made, in that the charge is very small, and that the cast-iron, instead of being introduced all at once, is gradually pushed forward. From this last it happens that the interval between the melting of the first and that of the last part of a given charge bears a much greater proportion to the total length of the heat in the Swedish-Walloon than in the Lancashire process. Indeed, from printed and oral descriptions of the former process, I infer that the pasty mass is broken up for remelting immediately after the last of the cast-iron has melted. Hence the first-melted part of the metal is much further decarburized when the remelting begins than the last-melted part; as I am informed that the heterogeneousness thus introduced survives the remelting to a very considerable extent, *i.e.*, that the product is decidedly heterogeneous.

§ 353. In the Franche-Comté Process—the pigs of gray cast-iron are melted down as in the Swedish-Walloon process, Figure 149, *i. e.*, are gradually pushed forward as their ends melt off. This continues for about 90 minutes or less, during which the bloom from the preceding charge, having been cut in two, is reheated in the same hearth and forged, three heatings and forgings being needed for each half bloom. The pasty mass which has meanwhile accumulated on the hearth bottom, is now lifted above the tuyeres and gradually melted down, falling drop by drop past the tuyere. This occupies some 20 to 25 minutes more. Those parts of the mass resulting from this second fusion, which are still imperfectly decarburized, must be raised up and melted down a third time.

q Steel and Iron, p. 229, 1884.

The hearth is usually covered, and the sensible heat of the products of combustion is utilized somewhat as in the Lancashire hearth.

The distinctive features of this process, then, are that the bloom from the preceding heat is reheated in the refining hearth; that gray cast-iron is used; that the pigs are pushed forward in melting instead of being charged all at once; that the metal or part of it is melted thrice; that the hearth is covered, and its waste heat utilized.

§ 354. MELTING SCRAP-IRON IN THE LANCASHIRE HEARTH (Cf. Table 171, Col. XIV.).—Owing to the relative prices of scrap malleable iron (steel and wrought iron) and of pure cast-iron, most of the American-Lancashire hearths now treat the former material exclusively.

The process is practically the third period of the cast-iron refining process already described. The ball from the previous operation being drawn, the hearth is cleaned and partly filled with charcoal, and cold malleable-iron scrap is thrown on it. If, as often happens, much light scrap is used, such as sheet-iron clippings, broken wire from wire-drawing establishments, etc., this is charged first, and after a few minutes whatever heavy scrap is at hand. The charge is covered with charcoal as before and melted down, the chief work being to raise the upper mass (the still unmelted part) occasionally, so that the blast may enter between it and the lower mass (*i. e.*, the metal which has melted, dropped, and accumulated on the bottom), and care is taken not to touch the lower mass with the tools, lest slag become mixed with it. As soon as all the material has reached the lower mass, this is pried out and hammered, quite as in the case of cast-iron.

In the last six months of 1888 the loss from scrap to cropped billets at an American mill was 22.75%, of which the croppings formed 0.66%, and 9.20% occurred in the two reheatings and hammerings which followed the hammering of the ball, so that the loss from scrap to hammered bloom was 12.89%. As most of the scrap was thin, with much surface, this loss is certainly small. Column XIV., Table 171, represents practice at this mill.

As the scrap is nearly free from silicon and silica, the slags are more basic than in treating cast-iron. There is thus a considerable fining, and I am informed that about 10 to 15% of the phosphorus present is removed, that the sulphur, even if initially as high as 0.10%, falls to a mere trace, and that the carbon, even if initially as high as 0.40%, usually falls to about 0.03%.

The operation is of course much more rapid than fining cast-iron, and fourteen heats are made per shift instead of seven, by two workmen.

The cast-iron plates which line the hearth last much longer, three or four times as long, as when cast-iron is treated. The difference is probably due to the fact that in the latter case the product of the first fusion, being much more fusible, and hence remaining fluid longer, penetrates to the lining-plates to a greater extent. Further, the energetic prying and scraping along the bottom during the second period of the treatment of cast-iron probably tend to wear the bottom plate out.

As the plates are less attacked, and as the addition of a little silica to the very basic slags formed in treating scrap-iron is less to be dreaded than in treating cast-iron, so the rear lining-plate is usually omitted, the brick-work of the rear wall being exposed to the heat.

§ 355. STEEL.—It is much harder to make weld-steel than wrought-iron in the charcoal-hearth, for, instead of carrying decarburization as far as it can go, we have to interrupt it at a given point, and there is little to indicate when this point is reached. Here, as in making puddled steel, the decarburization must proceed slowly in order that we may interrupt it with more certainty. Further, in limiting the final action which removes the carbon, we also limit the removal of phosphorus; hence, and because phosphorus is more hurtful to weld-steel than to wrought-iron, especially pure cast-iron should be used for making charcoal-hearth steel.

In order to retard the decarburization we use, when making weld-steel, an abundance of a liquid and less strongly fining slag than when wrought-iron is aimed at, less strongly fining through carrying less iron-oxide, and instead carrying more silica or more manganese. The slag is made manganiferous either through the direct addition of oxide or silicate of manganese, or by using manganiferous cast-iron. Manganese silicate is less strongly fining than iron-silicate for reasons already given.

CHAPTER XVIII.

APPARATUS FOR THE BESSEMER PROCESS.[s]

§ 371. THE ARRANGEMENT OF BESSEMER PLANTS.—According to their size these may be divided arbitrarily into the great and the small plants, or into the "big" and the "baby Bessemer."

The arrangement of large plants is a matter of the greatest importance, in view of the usually enormous quantity of material to be handled, and of the necessity of handling it not only cheaply but very rapidly: and it should therefore be studied carefully. The arrangement of small plants is much less important, and only deserves passing notice.

To fix our ideas, let us note the arrangement of the Joliet plant, Figure 163, and the path followed by the materials. We have to melt the cast-iron which is to be Bessemerized or "blown:" to blow it, removing its carbon and silicon: to re-carburize it in order to remove the iron-oxide taken up in blowing, and usually also in order to give it the desired proportion of carbon: to cast it in the form of ingots: and finally to remove these ingots. We will here follow the metal no farther.

The melting occurs in the cupola furnace I. Thence the cast-iron is tapped through the runner R into the *iron-ladle*[t] F, and from this a weighed quantity (say ten tons) of it is poured through the short runner below and

s This chapter treats of certain apparatus for the Acid Bessemer process. The Hydraulic apparatus and the Cupolas, as well as the modifications of the apparatus which the Basic process calls for, will be treated in the second volume of this work.

t This ladle is called the iron-ladle to distinguish it from the casting-ladle L.

to the left of F, into one of the already highly heated converters or *vessels* Co, which for that purpose is turned about the axis of the trunnion *t* by means of the rack G, so that its length lies horizontally, and that its nose comes under this short runner.

The vessel being thus charged with cast-iron, the blast is let on through the tuyeres Q, Figures 202 and 204, and the vessel is turned upright, so that the blast is forced through the bath of molton cast-iron, throwing it into violent ebullition, and removing its carbon and silicon rapidly. The escaping gases pass through the chimney or "hood" T.

As soon as the appearance of the flame issuing from the converter's nose indicates that decarburization is complete, the vessel is again rotated about the trunnion-axis, but this time in the opposite direction, so that its nose is brought close to the runner *d*, and the blast is now stopped. Through this runner the spiegeleisen used for recarburizing is now run into the vessel, having meanwhile been melted in the one of the cupolas S, and collected in the spiegel-ladle K.

A violent reaction occurs between the spiegeleisen and the decarburized and oxygenated metal in the vessel, which is now turned so as to pour the molten steel within it into the casting-ladle L, which rides on the jib of the casting crane C. This crane now swings the casting-ladle successively over the cast-iron ingot-moulds N, standing in the casting-pit P, the steel being poured into the moulds through the nozzle in the bottom of the ladle by raising an internal stopper lifted by the stopper-rod shown.

The ingot-moulds are next lifted from the partly solidified ingots by the ingot-cranes *c*, and, by means of tongs or "dogs" hanging from these same cranes, the ingots themselves are now lifted, placed on cars and carried while still molten within to the heating furnaces in the rolling department. The removal of the moulds is termed "stripping."

But meanwhile, after discharging its steel into the casting-ladle, the vessel has been inverted to pour out its slag, inspected rapidly to see what repairs are needed, and turned back into position for receiving another charge of cast-iron, or as it is called another "heat." The oxide of iron formed by the excess of blast in immediate contact with the ends of the tuyeres gradually scorifies and corrodes these, and heat by heat the tuyeres grow shorter and the bottom thinner, so that after from 15 to 30 heats it becomes necessary to remove the bottom and replace it with a fresh one, *i. e.* to "change bottoms."

In case "*direct-metal*"[s] is used, it is brought from the blast-furnace by a ladle like F, and running on the same track, and is poured through the same runner into the vessel.

The vessels must stand at such a height that their steel pours readily into the casting-ladle, and that the débris which they drop when inverted can be readily removed: the casting-crane so that it may receive the steel from the vessels and deliver it to the moulds: the moulds so that they are readily placed, and that they and the ingots cast within them are readily removed: the cupolas so that the molten metal is readily transferred from them to the vessels, and that their débris is readily removed by rail.

There are many modifications of the arrangement I have sketched; *e. g.* in the position of the cupolas and the arrangement of the runners, both cast-iron and spiegeleisen being in some mills introduced through the runner *d*: in the number of vessels, of which there are usually two, yet sometimes three or even four, while in small plants there is occasionally but one: in the number of casting-cranes, usually one, sometimes two, rarely three: in the shape of the casting-pit, which is very deep in old British mills, shallow in most modern mills, and occasionally wholly dispensed with, the moulds standing on the general level: in the number and arrangement of the ingot-cranes, etc., etc. Again, while in most mills the ingots are stripped in the casting-pit, in some they are removed with their moulds to another place before stripping. The value and object of these modifications we will consider later.

§ 372. Classification of Operations.—The operations above outlined may be divided into four groups:

1. Melting and transferring the molten metal to the converter.
2. Blowing.
3. The pit-work,[s] casting, stripping and removing the ingots.
4. Repairs, especially those to bottoms, ladles and moulds.

The following movements of materials are to be made, and for them tracks, runners, cranes, hoists, etc., are to be provided.

A. Taking cast-iron, coke and spiegeleisen to the cupolas.

B. Removing cupola-slag and "dump."

C. Conducting the molten cast-iron and spiegeleisen to the vessels.

D. Carrying the molten steel to the moulds.

E. Removing the ingots for rolling, hammering, etc.

F. Removing the moulds that they may cool, and returning them.

G. Bringing and removing ladles.

H. Bringing and removing vessel-bottoms.

I. Bringing and removing vessel- and pit-slag and scrap.

In addition to the above, which are of the nature of transportations, the following motions must be provided for:

J. Rotating the vessels.

K. Lifting the ingots from the pit.[s]

L. Setting the moulds and lifting them from the pit.

In designing a plant for small output it is usually very important that the cost of installation be kept very low, as the interest charges fall heavily on the small tonnage, and as powerful and hence costly machinery can be occupied but a fraction of the time, *i. e.*, to poor advantage. Thus a small and hence compact plant is sought; the converting building itself is small; cupolas, vessels, pit and perhaps heating furnace stand close to each other; some of the above movements are suppressed or combined, and several of them are effected by the same machine.

s "*Direct metal*" is cast-iron brought while still molten direct from the blast furnace and poured into the converter. In distinction from it, cast-iron which has been cast into pigs at the blast furnace and remelted in cupolas before run into the Bessemer vessels is known as "*cupola-metal*."

s Though in certain mills there is no true pit, it is still more convenient to speak of those classes of work which in most works occur in the pit, as "pit-work."

But when a large output is aimed at, *e. g.*, when rail-ingots are to made, and where operations are necessarily hurried, it is best to separate the places where the above four groups of operations are to be carried out, so that the workmen engaged in each group may not hinder those of another, and, sufficiently oppressed in hot weather with the heat necessary to their own group, may not have their working power further diminished by the heat from the other groups. Clearly this is more important in case of a large than in that of a small output, since in the former case more workmen are employed in each group, their operations and motions are quicker, and more in need of free working-space, and the evolution of heat, (whether from running streams of molten metal or the presence of hot ingots) is more constant, and its effects consequently more intense and far more trying than in the latter. Moreover, as in the case of large output there are more men in each group, so it is expedient to put in charge of each group a workman of exceptional powers of direction, and it is less important to have all the groups immediately under the eye of a single foreman. In case of large output the superintendent delegates his authority to a number of bosses (the head vessel-man, the head pit-man, etc.), and holds each of them responsible for results. In case of a small output bosses of such responsibility cannot be employed, for their wages would form too serious a charge per ton of the small product; hence, great compactness is further desirable here, in order that the superintendent, or rather in this case foreman, may be within sight and earshot of all.

Again, if we thus scatter the different groups we must have locomotives or other costly means of transporting the material from point to point; their absolute cost is relatively little larger in case of large than in that of small output, and thus forms a relatively light charge per ton of the greater product.

These considerations, of course, apply with more or less force to industries in general; but to iron manufacture with especial force, for here undue condensation not only impedes the many and rapid movements of heavy and often difficultly handled and white-hot objects, but leads to oppressive heat, which lowers the workman's efficiency, to say nothing of increasing his sufferings. Here mercy pays.

But though it is thus desirable to separate the four groups, it is best that the operations of each group be carried on in a small space, so that the men of each may have but short excursions to make, may communicate and co-operate quickly with each other, and that they and the objects in their charge may ever be well within sight and speaking distance of their boss.

§ 373. THE POSITION OF THE CUPOLAS must, as already stated, be such that the molten cast-iron can be conveyed readily from them to the vessels, and that their own débris can be readily removed.

A. *Their débris* is not only very considerable, but a very large quantity is thrown out suddenly when they dump. In order that they may dump (and dumping is by far the easiest way of removing their contents at the end of their campaign), and that the débris dumped may be readily removed, they should stand well above the ground level, not less than 8 or 9 feet; in close proximity to a broad-gauge track; and either apart from the converting-room proper, or along one of its sides, so that their débris may be delivered into an open space as free as practicable from walls and pillars, as these interfere with breaking it up, or, indeed, quarrying it as must sometimes be done.

In the older Bessemer plants, *e. g.*, Joliet (Figure 163), a chute U, beneath the cupolas, throws their débris completely out of doors. In most of the later plants the cupolas stand hardly high enough for this, but they are either removed from the converting-room (Bethlehem, Harrisburg); or their débris is carried from beneath them by a similar but shorter chute, and falls into a space encumbered only with short and smooth division walls; or both these plans are combined.

B. *Transferring the molten cast-iron.* In order that the cast-iron might run by gravity to the vessels, the cupolas in the older Holley plants stood close to and higher than the vessels, nearer even than in the Joliet type, figure 163. The cast-iron was tapped from the cupolas into stationary tipping ladles, resting on scales, and close to the cupolas; by tipping these ladles a given weight of cast-iron was run through long, loam-lined runners to the vessels. The runners in this and similar mills have a fall of about one in four or one in five. They are forked at the lower ends so as to deliver into either of two vessels, and pivoted so as to be pushed well into the vessel's mouth when delivering iron, and again withdrawn before the vessel is turned up (Figures 171 and 173).

But here a very serious difficulty arose. The cupola tappers, much of whose time was necessarily spent on the side of the cupolas nearest the vessels, were completely hemmed in by heat. In front of them were the hot cupolas, from whose shells much heat radiated; by their feet were large ladles full of molten cast-iron; while behind them rushed in a torrent of hot air, heated by the ingots in the pit and by the flame of the vessels. Their position was indeed intolerable. They stood, as it were, in a chimney conducting the hot air up from the pit and from around the vessels to the top of the cupola building. I have often known men to be overcome with the heat here, faintings, severe hemorrhage at the nose, etc.

When, as at Harrisburg, Figure 171, they sought to remedy this by setting the cupolas farther back from the vessels, inordinately long runners leading from cupola to vessel resulted, in which much cast-iron solidified, and much runner scrap resulted, which had to be remelted. Further, the additional height to which it was necessary to raise the cupolas in order to give the runners sufficient fall, the additional cost of the cupola building, which had to sustain a heavy load aloft, and the additional distance through which 1,000 tons of material had to be hoisted daily, were no trifle.

Hence many builders of plants have abandoned the plan of placing the cupolas so that the molten cast-iron can run from iron-ladles standing hard by them through runners directly to the vessels, and instead have placed the cupolas in a position convenient for receiving pig-iron and coke, and for discharging their debris; and they have provided traveling iron-ladles, carried by a locomotive from the cupolas to the vessels. Here, then, it is found expedient to separate the operations of one of our four groups from those of the others.

There are three common ways of carrying the iron-ladle from the cupolas to the vessels,

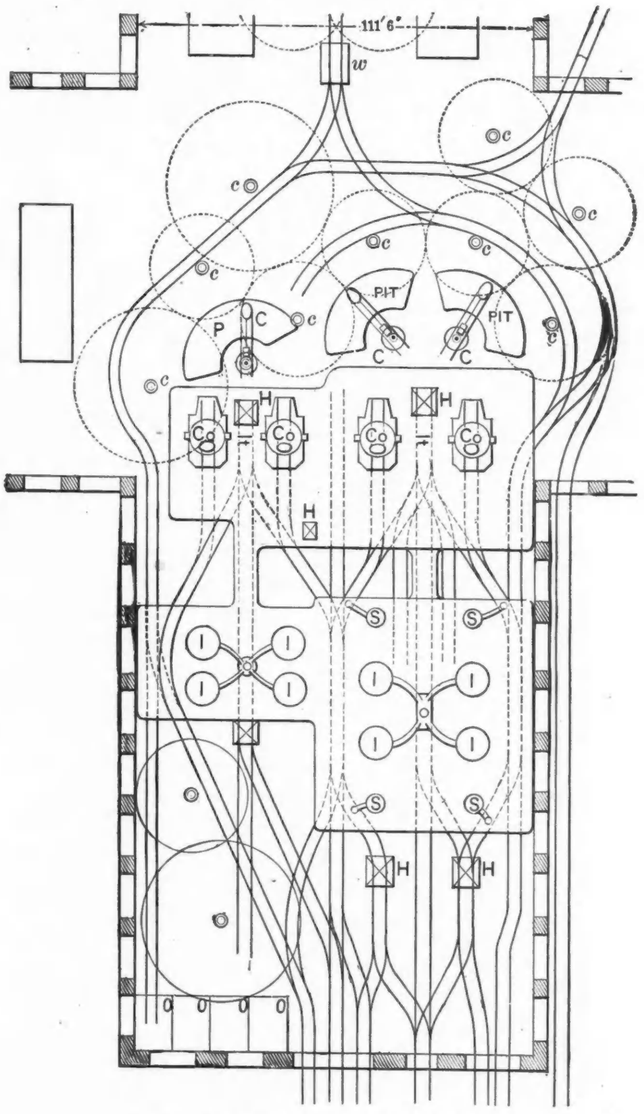


Fig. 164. Plan of Bethlehem four-ton plant.

C Casting-Cranes. c Ingot-Cranes. Co Converter. H Hoists. I Cupola for Cast-Iron. It Track for Cast-Iron. O Ovens for Bottoms. P Casting-Pit. S Spiegel Cupolas. W Scales.

1st. It may run on a track on the general level, (Figures 164, 209,) be raised to the level of the vessels by a hoist (or on the jib of a crane as at Rhymney and Eston) standing between or beside them, and there be tipped by gearing attached to its trunnions.

2d. It may run on an elevated track at about the level of the vessels' trunnions (figures 165, 168, 169); from this track it pours the metal into the vessel, being tipped by gearing attached to its trunnions. If the vessels stand side by side this track may run either before or behind them; if opposite each other, as in the British plan, the track should run between them, as at West Cumberland.

3d. It may be carried by a crane to the vessel's mouth, and, while suspended aloft by its own trunnions, be tipped so as to empty its molten iron into the vessel by lifting its bottom with a chain (Figure 167).

In the first and third of these arrangements the cupolas need only be raised so high that their debris can be easily removed from beneath them; in the second the cupola-bottoms should be some 7 feet above the vessel floor, while in the old arrangement, in which the cast-iron ran through gutters to the vessels, the cupola-bottoms stood some 17 feet above the vessel-floor.

Of these three plans the third (carrying the ladle by a crane) is decidedly the cheapest as regards cost of installation, but is much less convenient than the others. In pouring from the ladle into the vessel four men and boys are required, one man tipping the ladle, a second racking it in towards the mast of the crane to compensate for the horizontal travel of its lip as it tips, a stage-boy regulating the height of the ladle, and another the position of the vessel. With the second arrangement (a ladle running on an elevated track) only two men are needed, the locomotive engineer and a man to tip the ladle. The first (a ladle running on a surface track) needs but slightly more labour than the second, to wit, a stage-boy to work the hoist which raises the ladle to the vessel's mouth. I think that few good judges would recommend the third arrangement for works designed for large output.

As between the first and second plans, the first may effect a slight saving in first cost, the cost of a single hoist being less than that of elevating the track, and the lower position of the cupolas effecting a slight saving. As regards lifting the metal both the first and third arrangements are at a slight disadvantage, for their two lifts, first from the general level to the cupola-charging platform, and second from the general level to the vessel, are collectively rather more, say four to six feet more, than the single lift of the second plan, allowing for the necessarily higher position of the cupolas in the second arrangement than in the others.

But the chief objection to the first arrangement is that the surface track occupies space which is, if not more needed for other purposes, at least more likely to be encumbered or obstructed than that accupied by the elevated track of the second arrangement. This may be a rather serious thing. For every heat four trips must be made, carrying the iron-ladle to the vessels and back, and spiegel-ladle back and forth. If we are blowing a heat every eight minutes, this implies a trip along these tracks every two minutes on an average. Moreover, if successive heats are to be made in vessels served by the same track and hoist, the vessel which is preparing to blow must receive its cast-iron some little time before the blow in its neighbor ceases, in order that the track and hoist may be free to bring the spiegel-ladle to the blowing vessel the instant that its blow finishes. In the Bethlehem works, with their very talented management and with their four vessels, this arrangement indeed works smoothly; but with a two, and, perhaps, even with a three-vessel plant, one might anticipate considerable delay, owing to obstructions to the track, or to interference between the movements of the spiegel and the iron-ladle.

The length of time during which the vessel is delayed in receiving the charge of molten iron is practically the same for all these plans, as the numbers in Table 188 indicate. If anything, the crane-method here gives the best results when we consider that it takes longer per ton to pour a small than a large weight of metal. And, lest it be thought that, though the crane-method pours the metal rapidly, it wastes time by swinging the metal slowly from the cupola to the vessel, I will add that in one case I saw the stream of molten iron begin running into the vessel 45 seconds after beginning to raise the ladle which held it from the scales below the cupola.

TABLE 188.—TIME OCCUPIED IN POURING MOLTEN CAST-IRON INTO VESSELS BY DIFFERENT METHODS.

Mode of Transporting the Cast-iron.	By Runners.			By Surface Track.	By Crane.	
Weight of Charge, Tons...	10	6	7½	7½	5	4
Number of Observations...	3	1	7	5	5	2
Time Occupied. Max.....	2′ 5″	....	2′	2′	1′ 5″	50″
Time Occupied. Min......	1′ 40″	....	1′	1′ 15″	55″	45″
Time Occupied. Avge.....	1′ 55″	1′ 20″	1′ 38″	1′ 42″	57″	47″
Seconds per Ton, Avge.....	11′ 5″	13″	13″	13″	11″	12″

If direct-metal, *i.e.* molten cast-iron brought direct from the blast-furnace, be used, it is necessary to combine the direct-metal arrangement with one for cupola-melted cast-iron. For not only is it important to remelt in cupolas during the week the cast-iron made by the blast-furnaces on Sunday, when the steel works are closed, but to be able to substitute cupola-metal for direct-metal in case the supply of the latter should fail, or in case its composition should suddenly become unsuited to the Bessemer process, through some temporary derangement of the blast-furnace or otherwise. For simplicity it is desirable that direct-metal and cupola-metal should be carried to the vessels through the same channels, be weighed on the same scales, etc.

§ 374. WEIGHING THE MOLTEN CAST-IRON FOR THE VESSEL CHARGE.—The iron-ladle usually stands on scales, and an exact charge is weighed into it, the stream of molten metal being interrupted at the right moment by "Botting up[s]" the cupola. But it may in some cases be more convenient to tap a larger quantity into this ladle, and then weigh out from the ladle an exact vessel-charge. When the cast-iron is conveyed by a crane, the weighing may be effected by a hydraulic weighing-machine on the trolley running on the crane-jib. This machine is a hydraulic cylinder with a pressure gauge, and the ladle is simply suspended from its plunger.

This last plan admits of many modifications. For instance, the weighing cylinder may also be a lifting cylinder for raising or lowering the ladle; when a weight is to be taken the admission and escape of water are checked, when the pressure-gauge will indicate the weight of cast-iron plus tare, *i.e.* ladle, plunger and suspending pieces. Or the pressure-gauge may be attached to the main lifting-cylinder of the crane itself. In any case the gauge should be so set that it points to zero when the water or other fluid is supporting only the weight of the tare.

§ 375. ARRANGEMENT OF VESSELS, PIT AND CONVERTING-HOUSE CRANES.—Here we have quite a different problem, to arrange matters so the several operations shall not interfere with each other, shall not hold each other back. At the same time the manœuvres and supervision must be easy, and the cost of installation must be within bounds. In approaching such a problem we must, of course, have some starting point, and probably as good a one as any is to assume a given weight of vessel-charge and given boiler and blowing engine power, so that a heat (of, say, ten tons) can be blown in given time (say eight minutes); then we must seek to arrange matters so that we shall be able to blow a heat every eight minutes, one vessel turning up to begin blowing its heat the moment that the preceding heat is finished in another, and that the vessel in which it is blowing turns down. In at least one American three-vessel plant the blowing engine often runs continuously for several hours, blowing being absolutely continuous.

After the metal is blown it is recarburized, is poured into the casting-ladle, is teemed thence into the moulds, is removed to other departments. Now, in the mill which we are designing, as soon as a heat is blown in one vessel and before it is recarburized a second is to begin blowing in another vessel; and the first vessel (or a third in case there are three) must be ready so that a third heat may begin blowing as soon as the second is blown. In like manner the casting-ladle must deliver its steel, undergo its repairs and be back ready to receive the second heat as soon as the second heat is ready to be poured into it. So, too, a second set of moulds must be ready to receive the second heat, as soon as the casting-ladle has received this second heat and swung around to where the moulds stand, and so on.

I need not here combat the belief of many European metallurgists that such extremely rapid work is prejudicial to the quality of the product. This depends chiefly on the proportion of phosphorus and sulphur in the metal, which is of course wholly independent of the rapidity of working, and further on the temperature of blowing and of casting, on care in casting, etc. Now the rapid working which has led to such enormous outputs from American mills is not due to rapid *blowing*, but to avoiding delays between blows; and it is hard to see how this is to injure the metal, unless by inducing slovenly casting. Needless to say, the arrangements for teeming must be so ample, especially when high quality is sought, that this important operation may be performed carefully. I think, however, that even in some of our quickest working mills, the ingots are as well cast, as free from blowholes and as sound as those made in the most leisurely European practice.

As regards uniformity of composition, our rapid work leaves nothing to be desired. (Cf. § 365.) On the other hand, rapid working not only lessens the interest and general charges per unit of product, but, by preventing the vessels from cooling between heats, enables us to use less coke in the cupolas, and cast-iron which has less silicon and is hence cheaper, than in case of slower working.

§ 376. NUMBER OF VESSELS, ETC., NEEDED—DISCUSSION.—From this point to § 378 follows a quasi mathematical discussion of the number of vessels, cranes, etc., needed to permit continuous blowing.

The several operations which have to keep time with the blowing are, the work in and on the vessel between blows; the work done by and on the casting-ladle; and the work in stripping and removing the ingots and replacing the moulds, or the pit-work. But for the pit-work enough time must be allowed not only for this work of the ingot-cranes, but also to permit the ingots to solidify and become firm enough to bear handling.

s To "bot up" is to stop the tap-hope of a cupola or other melting furnace, *e.g.* with a ball of clay on the end of a pole or "bot-stick."

Thus the lengths of time which we now have to consider and to adjust are :

1. The length of the blow, blowing-time .... B. T.
2. Time for the vessel-work, vessel-time .... V. T.
3. Time for the casting-ladle work, ladle-time .... L. T.
4. Time to teem, cool and strip the ingots of a heat, and to replace the moulds for a new heat, mould-time .... M. T.
5. Time for the manoeuvres of the ingot-cranes, ingot-crane-time .... C. T.

With this discussion in view I have made more than 500 observations of the time occupied by the several operations connected with the production of ingots by this process.

Some results condensed from these will now be presented:

1. BT consists of the time actually occupied in blowing, plus the half minute occupied in turning the vessel up and down. The time occupied by the blow proper depends on the proportion of carbon and silicon in the metal, the weight of the charge, the number and size of the tuyere-holes and the pressure of the blast; and this last in turn on the capacity of the blowing engine. As the engine-power and the aggregate area of the tuyere-holes are usually roughly proportioned to the weight of the charge, the chief factor in determining the length of the blow is usually the proportion of silicon in the cast-iron.

Actually, Forsyth has made seven 10-ton heats in an hour and 73 in twelve hours at the Union works, or at the rate of 8.6 and 9.86 minutes per heat respectively.

At Homestead 61 five-ton heats have been made in eight hours, or at the rate of 7.87 minutes per heat[a]: and at Scranton 78 heats of 6.6 tons each have been blown in a single twelve-hour shift. As lately as 1883 Forsyth put the limit of the possible production of the South Chicago pit at one heat per twelve minutes.

Of course the output in certain single hours is likely to be much greater than the average of the day's work. It is not sufficient that the casting appliances can on an average receive and take care of the average of the vessel's output; they should be designed to receive it as it is delivered, even during the hours when its delivery is most rapid. Considering the advances made since 1883, we discount the future but little in taking BT as eight minutes, *i. e.*, in arranging our plant so that it can receive and handle a heat every eight minutes.

The little Swedish vessels, indeed, go far beyond the limit of eight minutes per heat, and, by using a very large tuyere-area per ton of charge, often blow a heat in five minutes; but it seems doubtful whether a proportionally large tuyere-area would be desirable for our great ten ton vessels.

2. VT, the time occupied by the vessel's work between heats, consists in the time occupied in recarburizing, in pouring the steel into the casting ladle, in emptying slag, in examining, and, if need be, replacing tuyeres and performing like minor repairs, and in introducing the new charge of cast-iron into the vessel. If we except time occupied in extraordinary repairs, such as changing bottoms, patching the lining, etc., VT is usually short enough. If there is any delay here, it is through charging large quantities of cold scrap steel by hand;[m] this may be avoided by charging the scrap steel through a chute during the blow.

[a] Eng. and Mining Jl., XLIII., p. 253, 1887.

[m] *E. g.*, to lower the temperature of the blow. This may, however, be done by blowing steam into the vessel along with the blast.

From many observations I believe that it is not necessary that the different parts of VT should occupy more time than is indicated in the first of the following sets of numbers; I have actually known them to occupy only the intervals given in the second column.

TABLE 189.—DETAILS OF VT.

	Time probably needed.	Minimum observed time.
Recarburizing	25″	15″
Pouring into casting ladle	45″	40″
Emptying slag and turning back into receiving position	25″	22″
Receiving cast-iron and examining tuyeres	1′ 50″	1′ 40″
Total	3′ 25″	2′ 57″

I have never known the whole of VT to take so little time as this, simply because there is usually no reason for haste, as VT is readily made so much shorter than BT. There is usually more or less waiting, except when changing bottoms: then indeed matters are hurried. In one case, watch in hand, I noted that 14′ 30″ elapsed between the time of pouring the steel of one heat into the casting-ladle and that of running in the charge of cast-iron for the next charge, and during this time a bottom was changed. Adding 25″ for recarburizing, 45″ for pouring into the casting-ladle and 1′ 50″ for receiving the cast-iron for the following charge, VT would in this case be 17′ 30″. This was at the Homestead works, where the facilities for changing bottoms are not remarkably good. At the Union works VT, including changing bottoms, has been as short as 17′, and 63 heats have been blown in 12 hours, using but one vessel and changing 3 bottoms!

3. LT usually consists of the time occupied by a single casting-crane in receiving the molten steel from the vessel, in swinging to the moulds, in teeming, in changing or repairing ladles and setting stoppers, and in swinging back to the vessel to receive a new charge of steel. In plants like Forsyth's, however, the time occupied in pouring from the vessel to the ladle is not part of LT, for here the casting-ladle is not put upon the casting-crane until it has received the charge of molten steel.

The details of LT should be about as follows in rapid work:

TABLE 190.—DETAILS OF TIME OCCUPIED BY THE OPERATIONS OF THE CASTING-CRANE, FOR 10-TON HEATS, L T.

	Vessel pours directly to casting-crane.	Vessel does not pour directly to casting-crane.	Minimum time observed.
Receiving the molten steel	45″	....	40″
Swinging to the moulds	28″	30″	25″
Teeming 10 tons in 8 ingots	5′ 30″	5′ 30″	5′ 15″
Changing or repairing ladles ...	1′ 0″	1′ 0″	50″
Swinging back to the vessel	13″	13″	11″
Total	7′ 56″	7′ 13″	7′ 11″

As LT consists chiefly of the teeming proper, its length should increase almost proportionally with the weight of the charge. For given total weight it will increase markedly with the number of ingots per charge; for a given weight of steel is more rapidly teemed into a few large than into many small ingots, as the last part of the steel poured into each mould must be added cautiously, in order that the ingot may have exactly the desired weight, and as time is lost in passing from mould to mould. But if the ingots are cast in groups, as in bottom- and other forms of multiple casting, LT increases relatively little with the number of ingots. The teeming is slower and hence LT is longer in case of very low-carbon steel than in that of rail-steel.

4. MT, or the interval from the time when we begin teeming into a set of moulds to the time when we can again teem into a set standing in the same place in the casting pit, consists (1) of the time needed for teeming the whole heat: plus (2) the time during which the last-teemed ingot must stand in its mould before we can strip it without danger of its bleeding, *or* the time needed for the ingot to contract and for the mould to expand so much that they separate readily: plus (3) the time needed for stripping the last teemed ingot, plus the time needed for lifting the last four ingots from the pit and placing them on cars (for it is more convenient to strip at least four ingots consecutively and then to lift them than to strip and lift one at a time): plus (4) the time needed for replacing the last four moulds, for it is hardly practicable to begin teeming into a set of moulds till the whole set is in place. We here assume that there are ingot-cranes enough to care for these moulds and their ingots.

The details of MT should be about as follows in rapid work:

TABLE 191.—DETAILS OF TIME OCCUPIED IN TEEMING AND REPLACING MOULDS, MT, FOR 10-TON HEATS OF RAIL-STEEL.

	Time probably needed.	Minimum time observed.
Teeming 10 tons in 8 ingots	5′ 30″	5′ 15″
Last ingot must stay in mould	10′ 20″	9′ 49″
Stripping last ingot	27″	23″
Lifting last four ingots	1′ 50″	1′ 40″
Replacing last four moulds	1′ 40″	1′ 30″
Total	19′ 47″	18′ 37″

Of these the only one as to which I feel in doubt is the most important, to wit, the time the ingot must remain in the mould before stripping. I have known ingots stripped successfully 9′ 49″ after teeming, but I have seen bleeding occur when a rail-ingot, cast at normal temperature, was stripped 9′ 50″ after teeming. On the other hand it is stated that at Darlington (Britain) half the 11-inch ingots of a rail-steel heat are stripped, removed and placed in the soaking-pit by the time that the last ingot is teeming, and that, in case of wire-steel, each ingot stays in its mould but 8 minutes. How this early stripping is made possible I know not, but it seems to imply some such expedient as the use of very cold and thick-walled moulds which, as pointed out in § 225, p. 151, is objectionable. Perhaps in addition the moulds may taper more strongly than ours. As MT consists chiefly of the time occupied by the ingots in solidifying, and as thin ingots solidify much more quickly than thick ones, so its length depends chiefly on the thickness of the ingots, and to a smaller extent on their individual weight. Further, as the teeming time forms a considerable part of it, MT must increase with the weight and the number of ingots per charge. So, too, MT seems to be somewhat longer with low than with high-carbon steel, as the former must be teemed slowly on account of its tendency to rise, and at a much higher temperature than is necessary for the latter; and this does not seem to be fully offset by the counter consideration that the former solidifies at a higher temperature than the latter, and hence quicker. The explanation appears to be that, with low-carbon steel, the difference between the temperature of fluidity sufficient for teeming and that of solidity sufficient for stripping and handling, is greater than with high-carbon steel.

5. CT consists of the time occupied by a single ingot-crane in lifting the moulds from the ingots, and placing them either on cars or in a cooling-space within the converting-room; in lifting the ingots and placing them on cars for removal, and in placing the moulds for another heat.

TABLE 192.—DETAILS OF TIME OCCUPIED BY THE OPERATIONS OF THE INGOT-CRANES, CT.

	Time Probably Needed.	Minimum Time Observed.
Lifting and removing 8 moulds	3′ 30″	3′ 0″
Lifting 8 ingots and placing on cars	3′ 30″	3′ 20″
Setting 8 moulds	3′ 10″	3′ 0″
Or at the rate of about 1¼ minutes per ingot.	10′ 10″	9′ 20″

CT clearly depends almost wholly on the number of ingots per charge, and only through this on the weight of the charge, save that heavy ingots cannot be raised and swung quite so quickly as light ones.

Table 193 condenses part of the foregoing.

TABLE 193.—TIME NEEDED FOR THE DETAILS OPERATIONS IN A 10-TON BESSEMER CONVERTING HOUSE, CASTING 8 INGOTS PER HEAT; CONDENSED.

	Probable time in rapid work.		Minimum time observed.	Time depends chiefly on
	Holley and like plants.	Forsyth and like plants.		
Turning the vessel up and down	30″	....	19″	
Blowing	7′ 30″	....	....	
Recarburizing	25″	....	15″	
Pouring into casting ladle	45″	....	40″	
Emptying slag and turning back to position	25″	....	22″	
Receiving cast-iron and examining tuyeres	1′ 50″	....	1′ 40″	
Swinging casting-ladle to moulds	28″	30″	25″	
Teeming 10 tons in 8 ingots	5′ 30″	5′ 30″	5′ 15″	
Changing or repairing ladles	1′ 0″	1′ 0″	50″	
Swinging back to the vessel	13″	13″	11″	
Each ingot must stay in the mould	10′ 20″	....	9′ 49″	
Stripping 8 ingots and setting their moulds on cars	3′ 30″	....	3′ 0″	
Lifting 8 ingots and setting on cars	3′ 30″	....	3′ 20″	
Replacing eight moulds	3′ 10″	....	3′ 0″	
BT or total blowing cycle	8′ 0″	....	3′	% silicon in cast-iron.
VT or cycle of vessel work between blows: Without changing bottoms	3′ 25″	....	2′ 57″	
VT or cycle of vessel work between blows: Changing bottoms	19′ 0″	....	17′	
LT or cycle of casting-ladle	7′ 56″	7′ 13″	17′ 11″	Weight of charge and number of ingots.
MT or cycle of moulds	19′ 47″	....	18′ 37″	Thickness and No. of ingots.
CT or cycle of ingot-cranes	10′ 10″	....	9′ 20″	No. of ingots.

If, as we have assumed, blowing is to be continuous, and if we let

x = the number of casting-cranes,

y = the number of sets of moulds for which there is space in the casting pit, and

z = the number of ingot-cranes, then we must have

$$(1)\ldots\ldots x > \frac{LT}{BT};$$

$$(2)\ldots\ldots y > \frac{MT}{BT}; \text{ and}$$

$$(3)\ldots\ldots z > \frac{CT}{BT}.$$

As we shall shortly see, expressions (2) and (3) require modification, and become

$$(4)\ \ldots y > \frac{MT}{BT} + 1, \text{ and}$$

$$(5)\ldots\ldots z > 1.5\,\frac{CT}{BT} + 1.$$

Further, there must be enough casting- and ingot-cranes, x and z, to reach the y sets of moulds.

§ 377. APPLICATION OF THE FOREGOING DISCUSSION.—1. *Number of Vessels.* For rapid work it is clearly desirable that there should be at least two vessels, so that one may blow while the other receives and discharges metal and undergoes current repairs. If we take BT as 8′ and VT as 3′ 25″, then clearly with two vessels we can make a heat

(TO BE CONTINUED.)

every eight minutes, while with one vessel we can only make a heat every 11′ 25″, and practically the difference would be greater than this.

But, while with two vessels blowing may be continuous as long as only minor repairs are needed, since VT is so much shorter than BT, yet when we have to change bottoms blowing must be interrupted, since in this case VT is likely to be at least as long as 18′. Assuming VT at even 19′ the course of operations is as follows : As soon as vessel 1, whose bottom is worn out, finishes its heat, the work of changing bottoms begins ; even before the steel is poured into the ladle the bottom is partly unkeyed. Now while the bottom is changing, vessel 2 blows a heat taking, say, 8′ ; discharges and receives metal during, say, 3′ 25″ or VT ; and blows a second heat, taking 8′ more, or altogether 19′ 25″ from the time when vessel 1 ceased blowing. In these 19′ the bottom of vessel 1 has been changed, it has received a new charge of cast-iron, and is ready to blow as soon as the second heat of vessel 2 ends. Thus the total interruption due to changing bottoms is only 3′ 25″.

If now a bottom last 25 heats, then on an average there will be this interruption of 3′ 25″ every 25 heats, so that the blowing, instead of being absolutely continuous, will be continuous for 25 heats, or, say, $25 \times 8 = 200'$, and will then be interrupted for 3′ 25″, so that the interruptions on this account will amount to 1.6% of the total time.

But occasionally, especially towards the end of the week, the lining of the vessel at points other than the bottom needs repairs, so that it may be necessary to blow three or even four consecutive heats in one vessel while the other is undergoing repairs, which would bring the delay up to 10′ or even to 14′ out of every 200′. Again, it may occasionally happen that while the bottom of one vessel is changing that of the other may give out, though this should be extremely rare in well conducted mills. Taking all these factors into consideration, it does not seem probable that the interruptions due to changing bottoms and repairing linings of vessels should amount to more than 5% of the total time.

Now by having three vessels instead of two, one may always be ready when the bottom of another is to be changed, so that, but for the inevitable occasional delay, blowing may be absolutely continuous. This naturally leads us to study

The relative advantages of two- and of three-vessel plants.

We find that the conclusion which we have just reached, that only about 5% greater output should be expected from a three than from a two-vessel plant, is born out by the results reached in practice, both as regards tonnage and the number of heats made in given time: witness the latest "record-breaking" results in table 194.

It is true that two out of the three three-vessel mills, South Chicago and Edgar Thomson, are at a disadvantage in using direct-metal, while the Union, Homestead and Scranton mills use cupola-metal. Owing to unavoidable irregularities in the conditions in the blast-furnace, the composition of direct-metal is less perfectly under control than that of cupola-metal. Mills using direct metal, therefore, are liable to have occasional heats unduly high in silicon, and hence unduly long in blowing. But the third three-vessel plant, Harrisburg, labors under no such disadvantage ; its management, too, is able and energetic.

TABLE 194.—MAXIMUM OUTPUT OF AMERICAN BESSEMER WORKS.

		Tons.				Number of Heats.				Hours per shift.	Shifts per week.	Shifts in the month here given.
		Per 12 hours.	Per 24 hours.	Per week.	Per month.	Per 12 hours.	Per 24 hours.	Per week.	Per month.			
Two-vessel Mills.	Union	....	......	5,486	28,145	73	....	....	2,858	12	11	......
	Scranton	....	......	......	....	78	....	760	......	....	....	......
	Homestead. On rail-steel, 1887	477	891	4,477	19,572	91.5	170	809	3,636	8	16	71
	Homestead. Low-carbon steel, 1889	372	619	.....	13,291	69	116	....	2,436	8	16	71
Three-vessel Mills.	Edgar Thomson	729	1,384	7,557	31,120	71	133	719	3,014	12	11¾	Not given.
	Harrisburg	544	1,029	5,110	20,947	75	141	678	2,929	12	11	48
	South Chicago	701	1,393	6,402	27,427	60	119	556	2,441	12	11	50

Most of the results in Table 194 were given me in May, 1889, by the management of the several mills as their best record up to that time.

The Homestead shifts are of eight hours, instead of twelve hours as at the other works. To arrive at the maximum output per twelve hours at Homestead I have added one-half to the maximum output per eight-hour shift, so as to get data as nearly comparable with the others as practicable. Needless to say this is giving Homestead a slight advantage, for one may keep up a higher speed for eight than for twelve hours.

With this exception the numbers given represent actual results without qualification of any kind. Thus Union and Edgar Thomson have actually made 2,858 and 3,014 heats respectively in one calendar month.

Certainly there is nothing in our present experience pointing to a very marked difference between the capacity of a two- and that of a three-vessel plant. But the three-vessel plant has a real advantage in that, thanks to our being able to lay one vessel off for repairs without interfering with the output of the mill, the vessel-linings may be repaired more leisurely and at more convenient times, *e. g.*, during the week instead of on Sunday, by daylight instead of hurriedly at night ; and in that bottoms may be changed more leisurely; needless to say work is usually not only better but cheaper when leisurely than when hurried. Finally, the superintendent's energy, spared from the frequent hurried planning of how to make vessel one last till the bottom of vessel two is changed, how to make the nose-lining last through the week, etc., is available for other matters. In a word, the three-vessel plant works a little more easily and hence a little more cheaply.

On the other hand, the three-vessel plant is necessarily a more expensive one. First we have to provide the third vessel, with its rotating mechanism, supports, hood, etc. In a mill like Harrisburg, Figure 171, or Edgar Thomson, Figure 177, we have further to provide a longer building and a second casting-crane. In a mill on Forsyth's plan, like South Chicago, Figure 168, we can have three vessels without a second casting-crane, and probably without materially increasing the size of the building ; but we at least have to have an additional receiving crane.

With either the Edgar Thomson or Forsyth's plan the number and size of cupolas, the engine and boiler capacity, the number and size of ingot-cranes, and the general strength of the apparatus should be the same for a two- as for a three-vessel plant, for, as we have seen, the output is practically the same, the quantity of cast-iron to be hoisted, melted and blown, the quantity of air needed for blowing, the number and weight of ingots and moulds to be raised and lowered are all practically the same in one case as in the other. None can deny that during the hours when there is no changing of bottoms, the two-vessel plant blows as many and as heavy heats as the three-vessel plant: and that the blowing, hoisting and manipulating machinery must be designed for these hours of maximum output, not for the average of these with the slack hours. I have been surprised at the deliberate statements of eminent engineers, that the three-vessel plant must be made more substantial on account of its greater output.

Whether the greater ease of working pays for the extra cost of the three-vessel plant, is a question on which opinions are divided. If we assume that the extra cost of installation is $25,000,[h] a charge of 20% per annum for interest and amortization would amount to $5,000, or $0.025 per ton of ingots on an annual output of 200,000 tons, or of $17 per diem for a year of 300 working days.

2. *The Size of Vessels.*—There is nothing in the experience with ten-ton vessels to lead as to doubt the practicability of using larger ones. Indeed, the new vessel shown in Figures 198, 204 and 205 aims to hold from twelve to fifteen tons. If larger charges are to be blown, it will be necessary either to increase the size of ingots, so as to have fewer to cast per heat, or to provide some additional means of handling them, such as multiple casting, the use of a second or even a third casting-pit, etc. (See § 379, and the last part of § 378.)

3. NUMBER OF CASTING-CRANES NEEDED.—We saw in Table 190 that if, as in most plants, LT includes the time during which the steel is pouring from the vessel into the casting-ladle, it amounts to 7′ 56″ or dangerously near BT, which is 8′: if, however, the casting-ladle is not placed on the casting-crane till after receiving the steel, LT is considerably shorter, to wit 7′ 13″. Here LT is 47″ shorter than BT, so that a single casting-crane will perform its functions quickly enough to receive and distribute the steel as fast as it is blown. A single casting-crane then satisfies the formula $y > \frac{LT}{BT}$, which becomes $1 > 7\frac{13}{60} \div 8$, or $1 > 0.902$. This inference is in accord with the results of practice, for the work at the Union mill, with a single casting-crane which does not receive the molten steel till after this has been poured into the ladle, is practically as rapid as that at Harrisburgh and Edgar Thomson where there are two casting-cranes, and as that at Bethlehem where there are three.

In short, a single casting-crane, if it has to hold the casting-ladle while the steel is pouring into it, has so little margin of time that it is liable to hold the work back at least occasionally: but if it be free to attend to its other duties during the 45″ in which the steel is pouring from vessel to ladle, it can handle the steel as fast as the vessels can produce it. If, however, the number of ingots to be cast per minute were materially raised beyond its present maximum number, whether by shortening the blow or by increasing the number of ingots per heat, a second casting-crane as in the Harrisburgh type would be needed, unless some form of multiple teeming were adopted. This is true of both two- and three-vessel plants, and of Forsyth as well as of other types.

4. *Number of Sets of Moulds for which Space must be provided in the Casting Pit.*—According to (2) y must be greater than $\frac{MT}{BT}$: according to Tables 192 and 193 MT=19′ 47″ and BT=8′: hence $y > \frac{19' 47''}{8}$ or y=3.

In other words, if (Table 193) it takes 5′ 30″ to teem the steel of one heat; if we must allow the last ingot of the heat 10′ 20″ to cool before stripping it; and if to strip it, to remove the ingots, and to set a fresh lot of moulds in place takes 3′ 57″, we cannot begin to teem again in the place occupied by this set of moulds till 5′ 30″ + 10′ 20″ + 3′ 57″ = 19′ 47″ after the time when we began teeming the previous heat in this place. That is to say, this casting-space can receive a heat of steel only once in 19′ 47″: and in order that there may be a casting-space ready to receive a heat of steel every 8′, there must be space for at least $19\frac{47}{60} \div 8 = 2.5$ sets of moulds in the casting-pit, or, as we cannot have fractions, 3 sets. But in case of rapid working it is far better to have a spare set of moulds in the pit, or altogether four sets, so that

$$(4) \ldots\ldots y > \frac{MT}{BT} + 1.$$

This is desirable, both that the pit-men, whose labor in hot weather is extremely trying, may have an occasional breathing spell; and that, no matter what happens, there may always be moulds enough to take the steel. There is not enough margin between the temperature of the molten steel as it leaves the vessel and the melting-point of the metal, to allow us to hold it long in the ladle; moreover, the casting-crane is in constant requisition. It would, indeed, be trying to have a heat of steel blown and in the ladle, ready for teeming, and then to be forced to convert it into scrap for want of moulds.

A set of eight 14½″ ingot-moulds occupies at least 14 running feet; for four sets we need 56 running feet, and it is better to allow 60 feet. This should be measured on the arc of a circle about four feet less in diameter than the rim of the casting-pit, for the moulds come together only on the edges nearer the centre of the pit, gaping at the outer edges. In a 40-foot pit an allowance of 60 feet for the inner circle of the moulds calls for an arc of 191°.

5. *Number of Ingot-cranes Needed.*—As we have seen in Tables 192 and 193 that BT and CT are 8′ and 10′ 10″ respectively, to satisfy the formula $z > \frac{CT}{BT}$, we need more than $(10 + \frac{10}{60}) \div 8 = 1.27$, *i. e.*, we need two ingot cranes; that is, as it takes 10′ 10″ to strip and lift the ingots of a single heat and to replace their moulds for a subsequent heat, so in order that an ingot-crane may be ready to handle a set of ingots and moulds every 8′, there must be two ingot-cranes, supposing that each works continuously. But this cannot be the case, for each necessarily stands idle a considerable part of the time, *e. g.*, from the time when the moulds in its neighborhood are in place and ready for receiving steel, till they have been filled with steel, and till the steel ingots within them have so far solidified that they can be stripped safely. It is therefore found necessary in practice to have three ingot-cranes for a ten-ton plant. In addition, the crane which is used for removing the casting-ladle from the casting-crane, and for replacing it with another, and (in case it be unnecessary to change ladles) for inverting the ladle to empty the slag, though properly speaking a ladle-shifting or, as it is called, "dump" crane, is often classed with the ingot-cranes. Indeed, it is usually exactly like

h The charge of $25,000 is meant to cover simply those items which are necessitated by the addition of a third vessel to a two-vessel Forsyth or similar plant; to wit, the third vessel with its rotating gear, hood, receiving-crane, additional platforms, foundations, pit for receiving crane, etc.; but it does not cover any charge for additional engine or boiler-power, casting or ingot-cranes, cupolas, hoists, etc., which, from this point of view, remain the same as for a two-vessel plant.

them. Thus we actually need four ingot and dump cranes for rapid working with a 10-ton plant. I think that the empirical formula

$$(5) \ldots z > 2\frac{CT}{BT} + 1$$

gives a sufficiently close approximation for practical purposes. In case of a six-ton plant this formula would require three ingot-cranes.

In point of fact the American plants noted for their quick working have at least as many ingot-cranes as this formula calls for, Union, S. Chicago, Harrisburg and Homestead having four each, Scranton (a six-ton plant) having three, and Edgar Thomson five.

As the large number of ingot-cranes needed is chiefly due to their having to stand idle so much of the time, so it is clear that the number of ingot-cranes needed will not increase proportionally to the number of ingots cast from each heat.

The method I here use is less suited to the case of ingot-cranes than to the other cases to which it is applied.

§ 378. THE CAPACITY OF A CASTING-PIT is limited, 1st, by the rate at which the casting-crane or cranes can teem; 2d, by the room available for moulds within the pit; 3d, by the number of ingots and moulds which the ingot-cranes can handle.

We have seen that a single casting-crane can teem continuously at the rate of one 1.25-ton ingot per minute. I should think that it could teem 19-inch 3-ton ingots at the rate of one every two minutes, and 7-inch 750-pound ingots at the rate of two per minute. A second casting-crane would cast as much more.

If we measure the space available for moulds along the arc of a circle four feet less in diameter than the pit, the 250° of a 40-foot Forsyth pit available for moulds would give 78 running feet. If a second row of moulds were placed within the first, 70 running feet more would be available, or altogether 148 feet. In a 48-foot pit these numbers become 96 and 183 feet respectively. For a 10-ton heat of 14-inch ingots we have taken MT, or the period between beginning to teem into a set of moulds and again beginning to teem into a second set standing in the same place, as about 20 minutes; if we take MT provisionally as 30 minutes for 19-inch and 15 minutes for 7-inch ingots, and if there be a single row of moulds in case of 19- and of 14-inch ingots and a double row in case of 7-inch ingots, and if we assume that our ingot-cranes can do their share of the work, then it follows that, as far as mould-space is concerned, we could cast in a 40-foot pit 1.16 19-inch, or 2.3 14-inch, or 9.9 7-inch ingots per minute; and that in a 48-foot pit we could teem 1.4 19-inch, or 2.9 14-inch, or 12.2 7-inch ingots per minute.

Next, as regards the ingot-crane capacity. It is hardly practicable to have more than three cranes devoted solely to the care of ingots and moulds at a 40-foot pit, or more than four at a 48-foot pit, as explained in § 380 B. For each ingot three separate operations are needed, and to perform these we have seen that about 1.25 minutes are needed for each 1.25-ton ingot. Let us assume that two minutes would be needed for each 3-ton ingot and one minute for each 750-pound ingot. When casting 1.25-ton 14-inch ingots the ingot-cranes may have to stand idle half the time; but in casting smaller, say 750-pound, ingots, they would work much more nearly continuously, and I think that we may assume that each crane would stand idle only one-quarter of the time. Under these assumptions three ingot-cranes could handle 3-ton ingots at the rate of one in 1.3 minutes; 1.25-ton ingots at the rate of 1.2 ingots per minute; and 750-pound ingots at the rate of 2.25 per minute. With a fourth crane these rates would be increased by one-third.

Some of these inferences are summed up in the following table:

TABLE 195.—ESTIMATED CAPACITY OF A SINGLE PIT PER 24 HOURS.

	Number.	40-foot pit with three cranes for handling ingots and moulds.						48-foot pit with four cranes for handling ingots and moulds.					
		Casting 3-ton 19-inch ingots.		Casting 1.25-ton 14-inch ingots		Casting 750-pound 7-inch ingots: 2 rows of moulds.		Casting 3-ton 19-inch ingots.		Casting 1.25-ton 14-inch ingots.		Casting 750 pound 7-inch ingots: 2 rows of moulds.	
		Capacity for Twenty-four hours.											
		Ingots.	Tons.	Ingots.	Tons.	Ingots.	Tons.	Ingots.	Tons.	Ingots.	Tons.	Ingots.	Tons.
I.—As limited by the capacity of a single casting-crane	1	720	2,160					720	2,160				
	2			1,440	1,800					1,440	1,800		
	3					2,880	964					2,880	964
II.—As limited by the available mould-space	4	1,663	5,000					2,048	6,143				
	5			3,370	4,212					4,147	5,200		
	6					14,000	4,750					17,568	5,800
III.—As limited by the capacity of the ingot-cranes	7	1,080	3,240					1,440	4,320				
	8			1,728	2,160					2,304	2,900		
	9					3,240	1,100					4,320	1,400

These numbers indicate that the mould-holding capacity of even a 40-foot pit is far beyond the present blowing-capacity of two or three 10-ton vessels; but, before the tonnage indicated in lines 4 to 6 was reached, grave inconveniences from the excessive heat-radiation from so enormous a quantity of metal compactly stored in a single pit at one time, would arise.

It is quite otherwise, however, with the casting- and ingot-crane capacity. The former of these, even in case of 1.25-ton ingots, is barely equal to the actual rate at which a pair of vessels has turned out steel for a considerable period. On any considerable increase in the tonnage or in the number of ingots, the capacity of a single casting-crane would be exceeded. As regards the ingot-cranes, the case is not so bad, for with a 48-foot pit four ingot-cranes could, according to this estimate, take care of more 1.25-ton than two or three vessels are likely to turn out. But should the number of ingots be greatly increased, *e. g.*, by diminishing their size, additional ingot-crane capacity would be needed.

In short, further increase in blowing-capacity is likely to necessitate, first an increase in the teeming-capacity, and only later in the ingot-handling capacity.

The teeming-capacity may be increased by multiple-teeming, *e. g.*, by teeming through a funnel which delivers into several moulds, and by other devices which will be considered later; or by the use of a second, or eventually a third casting-crane. The casting-cranes may all stand in the same pit; but more casting-room can be had and a greater number of ingot-cranes can be used if we have a separate pit for each casting-crane. Pits may be arranged as in Figure 175, which may be considered as the logical development of Forsyth's plan.

The use of a second casting-crane has an advantage over multiple-teeming, in that it enables us to use more ingot-cranes. For very small castings multiple-teeming seems to be a necessity, unless proportionally small charges are blown in little vessels, as a large heat would chill before it could be teemed separately into a great number of small castings.

To increase the capacity of the ingot-cranes, we must cut down the number of motions per ingot which they have to execute. Usually they have to perform three distinct manœuvres, placing the mould, stripping, and removing the ingot. The number of motions may be reduced by placing several moulds on a single plate, which with ingots and moulds is lifted from the pit by a single motion of the crane; or by lifting ingot and mould together from the pit; or by placing the several moulds of a group of ingots in a common frame, so that they are lifted from the pit by a single motion of the crane, the ingots remaining behind. In the first two cases no real saving of labor is effected, if the ingots and moulds are simply carried off to be stripped elsewhere in the way in which they are usually stripped in the pit. This simply changes the venue; but by Laureau's or Jones' mode of stripping, a saving may be effected.

§ 379. KLEINBESSEMEREI, SMALL *versus* LARGE BESSEMER PLANTS.—The question as to the most desirable weight of charge naturally divides itself into two quite distinct parts. 1st. Do we with large or with small charges habitually get the better product (or the more readily make a product of given excellence) from given materials? 2d. Is it cheaper to blow large or small charges? We have two distinct questions, one of quality, the other of cost.

The question of quality can be considered better in treating of the chemistry of the Bessemer process. I may here say, however, that after pretty extensive enquiries and observations, I find neither good reason to expect better product nor convincing evidence that better product is made in case of small than in that of large charges. Nor is it clear to me that soft ingot-iron is more readily or more regularly made in small than in large vessels.

As regards the question of cost, much confusion has been brought into what should be a very simple discussion, by comparing small works which run continuously with larger works which run intermittently. Nobody will deny that the more nearly continuous the work the cheaper it will be, for most obvious reasons. We have in the first place the factors common to all industries: our workmen and machines work a greater proportion of the time, charges for amortization and interest, for administration and general expenses are less per unit of product. But beyond these, we have in metallurgial operations a very important factor: the loss of heat from furnaces, vessels and what not is less in continuous than in interrupted working.

Now, some advocates of small charges have assumed that large charges cannot be blown continuously, which is untrue; for in our large American works with 10-ton vessels the blowing is habitually continuous, one vessel turning up to blow a charge the moment that the blowing of the preceding charge ends, so that the blowing-engine often runs for hours without stopping. Thus Ehrenwerth's calculation that the little Bessemer plant at Avesta is more economical than the larger ones is most misleading, for he compares a four-ton plant making only fifteen heats daily with an 880-pound plant making fifty heats daily, while our ten-ton plants make twice this number of heats. Now it is not the greater size of the four-ton plant, but the very small number of charges which it makes daily, that puts it at a disadvantage. Whatever merit there was in the Avesta work was in its continuousness, not in the lightness of its charges.

This does not really merit discussion, but if proof is needed, it is at hand in the fact that the Avesta small charges were kept up for more than five years without an imitator, and that even here it was found best to increase the charges to 3,300 pounds.

In this country the little Clapp-Griffiths vessels at first had a capacity of two tons; the later ones have three tons capacity. Indeed the American Clapp-Griffiths practice can hardly come under the term "Kleinbessemerei," which was applied to the half-ton Avesta practice in distinction to the Austrian four-ton work, termed "Grossbessemerei."

What, then, is the most advantageous weight of charge? Usually that which with continuous blowing, or with an interval of not over two minutes between blows, will yield the output which is aimed at in the establishment under consideration, supposing this establishment to run say ten months out of the year. This, however, is only true within limits. I doubt whether it would be wise under most conditions to make the weight of the charge less than two tons, even when a very small output is aimed at.

What the expected output is to be must depend on many onditions, the kind of steel aimed at, whether for rails or steel pens, the supply of cast-iron, the expected demand, etc. If a mill is to be built to supply steel for fish-hooks alone, a pair of twelve-ton vessels would be absurd; no less absurd would the Avesta toy-vessels be for rail-making. I take it that the claim that steel can be made cheaper in little than in large mills does not deserve discussion. Other things being equal, *if the demand for steel will keep a ten-ton plant fully occupied*, that steel can be made cheaper in a ten-ton plant than in a one-ton or in a half-ton plant.

Many factors tend to concentrate industries into colossal establishments, ruled by giants of administration. Among these we have the increased facility of transportation, and the growth of scientific and technical knowledge applicable to industries to such an enormous

y I say ten rather than twelve months, because in case of many large manufacturing industries it is thought more profitable, if a given quantity of output is to be made in a certain year, to make that output in ten months, even if the mill be thereby slightly pressed, than to spread the work over the whole year. It is, moreover, better that the capacity of the establishment should be rather larger than the expected output, so that an unexpected demand can be taken advantage of.

volume and to such value that trained specialists, reservoirs of this knowledge, can be advantageously employed. Their salaries clearly form a smaller charge against a large than against a small output. The cost of engines, of plant, of administration,[a] clearly does not increase proportionally to the size of the establishment. Hence it occurs that, in many industries, enterprises large enough to employ the best administrative talent to their fullest capacity—but not larger, and not too large for their market—can be operated at less cost than smaller ones.

These considerations seem to apply with especial force to the manufacture of steel ingots; for the proportion of the total heat generated which is lost in case of large converters, large furnaces for heating and melting, is less than in case of small ones; the loss in scrap and by oxidation is less, the consumption of refactory materials and moulds is less, per unit of product in case of large charges than in that of small ones.[b]

But it is quite in accordance with these views that small works should sometimes be profitable. Local conditions, a small local demand for steel in a region which offers the raw materials, but is remote from other markets; the manufacture of a special or even secret kind of steel, suited to certain small demands; the need of unusual knowledge and skill or extraordinary care; in short, the conditions which permit little industries to flourish all over the world without being overwhelmed by the great producers, may permit small Bessemer works to live and even thrive. But as the increased facility of transportation and indeed the whole march of civilization favors the concentration of industries into large establishments, ruled by giants of administration, so the times seem to favor larger rather than smaller steel mills.

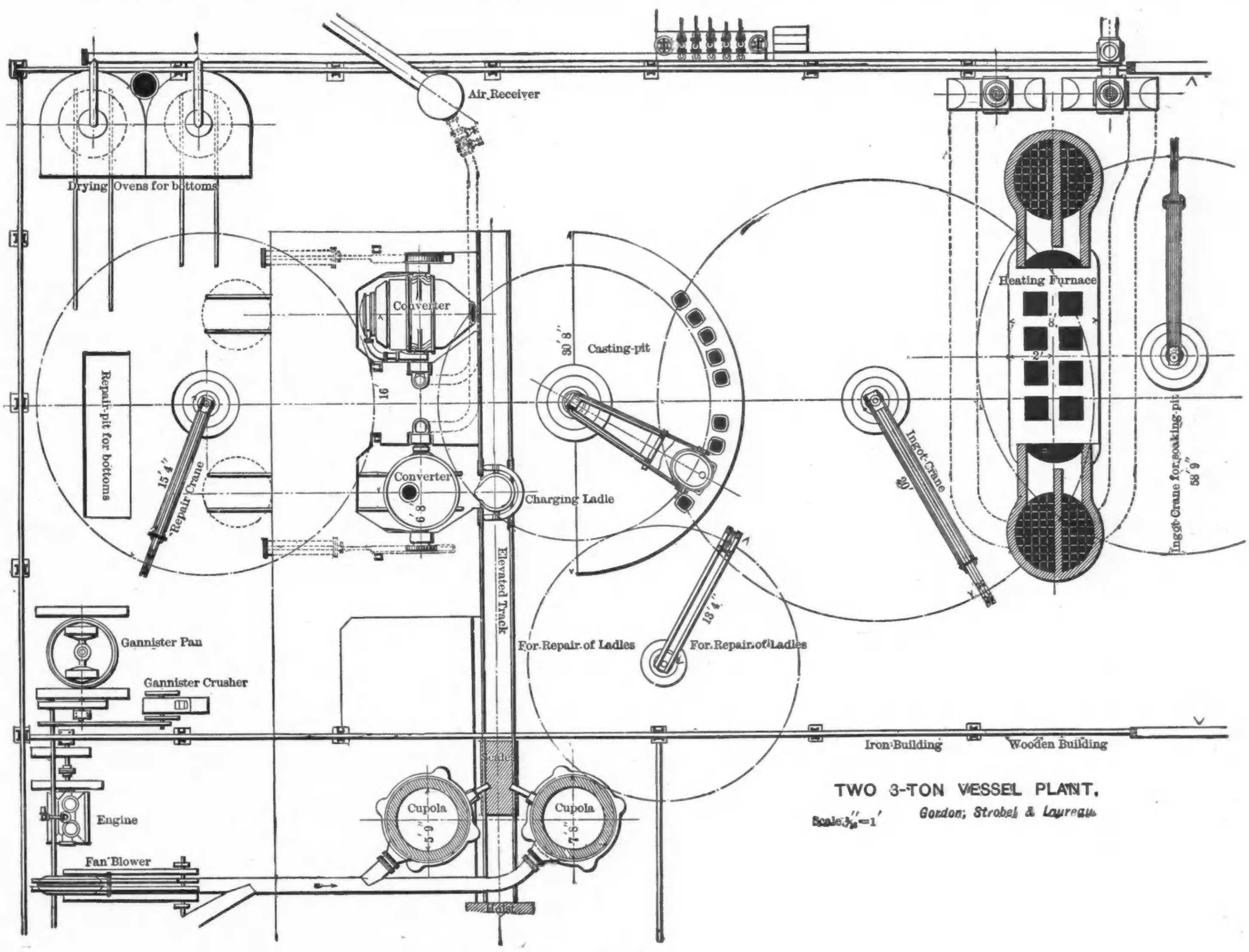


Fig. 165.

Again, while it is beyond question that well designed large works can turn out large ingots of usual sizes more cheaply than small works, most of them have not been equipped for turning out ingots, billets or slabs of a wide variety of sizes, shapes and compositions.

It may be much cheaper to make slabs for nail-plates, for instance, by making ingots in little vessels, and rolling those ingots down while they still preserve their initial heat, than to buy even cheaper but cold ingots from a large mill, pay freight and brokerage, and then heat these cold ingots at great outlay for fuel, labor, and repairs to

a In certain industries (*e. g.*, in making sewing machines) the cost of administration, advertisement, and collection is said to be far greater than that of manufacture proper.

b Classing as small all workshops with five workmen or less, and as large all with more than five workmen, Dr. H. Albrecht finds that in Germany, according to the trades census of 1882, 99% of the mining, smelting, and salt-making establishments are large, while the proportion is much less in other industries, running from 76% in chemical manufacture to 10% in clothing and repairing. ("The Nation," N. Y., XLVIII, P. 480, 1889, from "Jahrbuch für Gesetzgebung.")

heating furnaces. A pound of hot ingots is worth more in such cases than a pound of cold ones. This has been especially true in the past somewhat crude condition of our Bessemer industry, crude in the sense that it has been chiefly planned for turning out an enormous quantity of ingots of uniform size, to be rolled into one kind of product, rails. In this way the little Bessemer works have had a real reason for existence. As the manufacture of billets or slabs of a certain size and composition in small mills assumes serious proportions, the large mills equip themselves for making these very products, and roll their ingots, with their initial heat, into these very forms, and this special reason for the existence of the little works evaporates.

The same thing may happen in the case of little ingots. Our great mills with their one or two circular casting pits can make a thousand tons of large ingots daily; but they are not prepared to turn their product into little ingots. Let some little Bessemer works develop a valuable trade in little ingots, and the great works will establish some special form of pit or of multiple casting, swoop down and carry off the prey.

While the great works may drive the little ones from some positions readily, in others to which they are specially fitted the little mills may hold their own long, or even permanently.

This, however, belongs rather to political economy than to metallurgy. All that I can do is to point out, and indeed to insist, that the forces which make for concentration elsewhere are and will remain at work in case of the Bessemer process, in which they are reinforced by the special conditions of the process itself.

Figure 165 shows a good arrangement for a small Bessemer plant. Two cupolas deliver the molten cast-iron to a ladle which runs on an elevated track, and which in turn delivers it to the vessels. A common casting-ladle casts the steel into moulds standing along the rim of a semi-circular casting-pit. From this pit the ingots are drawn by a crane, which deposits them on end in a heating-furnace or soaking-pit, whence they are drawn later and deposited on the feed-rollers of the blooming-mill.

The refractory materials are prepared behind the vessels, in a space served by a 15 foot crane. Near here stands a small engine which drives the fan blowers for the cupola furnaces, and the crushing and pulverizing machinery for the refractory materials.

§ 380. THE GENERAL DISPOSITION OF THE VESSELS, PIT, AND INGOT-CRANES.[a]—In the early Bessemer plants, Figure 166, the vessel-trunnions were but three or four feet above the general level. This necessitated a very deep casting pit, so that the vessels might empty their slag through their noses on being inverted, that their bottoms might be removed and replaced from beneath, and that the casting-crane might raise the casting-ladle above the tops of the moulds standing in the casting-pit without having a very long lift, which would have increased its cost materially, especially as the British cranes are not supported at the top. "In this confined, unventilated and comparatively inaccessible," indeed, infernal abyss, hemmed in by red-hot ingots and moulds, bespattered by the vessel's white-hot spittings as it turned up or down, scorched by the slag which it dropped between heats, and threatened by the floods of molten steel which now and again broke through its nether parts, the salamandrine pit-men intolerably reeked and wrought.

The vessels were placed opposite each other.

In the early American or Holley[b] plants the vessels were raised, as shown in Figure 163, to nine feet above the general level, while in still later plants, *e. g.*, S. Chicago, their height has been further increased to 15′, and they have almost uniformly been placed side by side. This enabled Holley to use a shallow pit, only 30″ deep, though in later mills the pit is 36″ deep. At the same time its

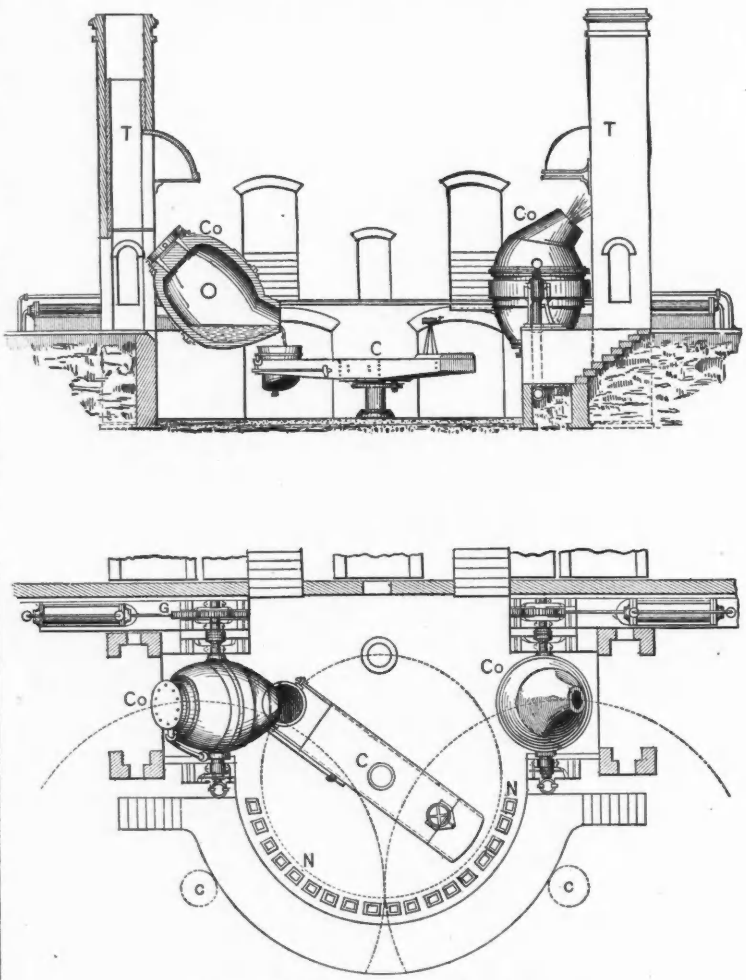


Fig. 166. STANDARD BRITISH BESSEMER PLANT.

C casting-crane. c ingot cranes. Co Converter. G rack for rotating vessel. N ingot moulds. I hoods.

diameter has been increased to 40′ and even to 48′. In some late British plants the vessels are supported aloft in Holley's style[c].

a For admirable descriptions of Bessemer plants see Macar, Revue Universelle, 2d Ser., XII., p. 143, 1882, from which I have borrowed several illustrations; also, Greiner, Idem, XI.; Daelen, Zeit. Vereins, Deutsch, Ing., XXIX., pp. 554, 1016, A. D. 1885. Other illustrations are borrowed from Trasenter, "L'Industrie Sidérurgique aux Etats-Unis," Rev. Univ., 2d Ser., XVII., p. 231, 1885.

b On Jan. 26th, 1869 (U. S. Patent 86,303), Holley patented supporting one side of the vessel on a beam, so that a car could be run beneath it (for removing bottoms, etc.), a hollow column for supporting this beam, and at the same time carrying the blast to the vessel-trunnion, and what appears equivalent to raising the trunnion-level high above the general level. I do not find that he patented placing the vessels side by side: indeed, he stated in 1871, that Bessemer did this in his early practice, but not in such a way as to realize the advantages of the Holley plant. (Lecture at the Stevens Inst. of Technology, 1872, p. 24: Journ. Franklin Inst., XCIV., pp. 252, 391, 1872).

c In the model of a (British) Bessemer plant exhibited at the Paris Exhibition of 1889, by J. Gjers, the vessels, pit, and cranes are arranged much as in Figure 169, save that the receiving-crane delivers direct to the casting-crane without Forsyth's transfer-track, and that the cast-iron is brought to the vessels by a hoist which stands between them, as at H in Figure 164.

A. *Raising the vessels and shallowing the pit* has had the following advantages:

1. The pit is much cooler.

2. The pit-level is so nearly that of the ground outside the works (indeed, in many works the pit-bottom is level with the ground outside, the general working-level of the converting-mill being raised some three feet above this), that the vessel-slag and the casting ladle slag, which may amount to some 150 tons daily, are readily removed by cars running on a track level with the pit-bottom, instead of being shoveled up as from the old deep pit a tremendous lift of nine feet, and then being shoveled again into cars.

3. The vessel-bottoms may be removed and replaced from the general level, and are thus readily brought by cars running on the general level to and from the repair-shop.

4. That we lift the, say, 1,000 tons of ingots and 2,000 tons of moulds handled daily only five feet in transferring them from the pit to cars on the general level, instead of eleven feet. A like saving is effected in lowering the moulds into place in the pit; and each time we raise or lower an ingot or a mould we have to lift the rising parts of an ingot-crane.

The short lift means not only diminishing the outlay for power by half, but lessening by about one-third that for labor, since the pit-men who guide the rising and falling ingots and moulds must stand in the unbearable heat about half longer for an eleven- than for a five-foot lift. Indeed I should put the saving in labor even higher than this: for with the shallow American pit the tops of the ingots and moulds are at such a level that crane-dogs and hooks can be attached to them conveniently by the men standing on the general level, and these same men swing the crane, after it has lifted the ingot or mould, around to the cars on which they deposit its burden: while they cannot readily reach down low enough, in case of the deep nine-foot pit, to attach the dogs, etc., to the ingots and moulds whose tops must be far beneath them.

5. The space on the general level occupied in the old British mills by the vessels and by the mechanism for rotating them, and by the runners through which the molten cast-iron is brought to them, as well as that which is occupied part of the time in examining and replacing the tuyeres between heats, is, in American mills, used advantageously for other purposes: for the vessel-trunnions and the working platform at their level is supported on cast-iron columns, leaving the space beneath free.

TABLE 196.—BESSEMER PLANT.

		Pit.			Vessels.						Tuyeres.						Cubic contents of vessels.	
	Number.	Diameter.	Depth.	Shape.	Number.	Cap'y, tons.	Height of axis above general level.	Diameter.	Concentric or not	Sides straight or contracted.	No. tuyeres.	No. holes per tuyere.	Size holes.	Gross area of tuyere-square inches.	Sq in tuyere-hole area per 2240 lbs. of charge.	Blast-pressure, lbs. per square inch	Cubic feet.	Cubic feet per ton cap'y.
	1	40′	5′	cir.	2	10		10′e / f8′ 3″	con.	con.	15	12	⅜″	19.8	1.98		650	65
	2			cir.	2	7—		6″ 6′			12	12	⅜″	15.9		20		
	3	40′	3′	cir.	3	10c / 10.7b		10e / 7′ 10½″f	exc.	str.	14 + 4	12 / 12	7/16″ / ⅜″	34.7k	3.47	21 @ 25	596	55.5
	4				2	10c					13	12	⅜″	30.6	3.06			
	5		4′		3	9.2i / 10		10±	con.	con.	15	10	⅜″	29.4	3.26		580	62.3
	6	48′	3′	sc. ann.	2	7		8			14	7	½″	19.1	2.72	20		
	7				2	4j			exc.	str.	12	7	⅜″	16.5	4.12			
	8				2	5.5j			exc.	str.								
	9	40p. 14′ 6″ q	3′ 6″	cir.	2	5.	10′ 3″	7′ 6″	exc.	str.								
	10			sc.	2	7b			exc.	str.	13	12	⅜″	30.6	4.37		277	36.9
	11	34′	4′		3	7½b	16±	8′	exc.		19	12	⅜″	25.2	3.36	20		
	12				2	7½g-9h		6′	exc.	str.	13	12	⅜″	17.2	1.91		295	32.7
	13				2	6a					17	19	⅜″	35.7	5.95	18 @ 25		
	14				2	6.95d			exc.	str.	19	12	⅜″	25.2	3.15			
	15				4	8cn		8′	exc.	str.	17	12	⅜″	22.5	3.00		303	41.7
	16				2	9	14′ 6″	10′	con.	str.	16	12	⅜″	21.2	2.35	20		
	17				1	6c					8	10	⅜″	15.7	2.61			
	18		3′	ann.	2	5½b			exc.	str.								
	19				2	4c		7″										
	20				2	10			con.	str.	15	7	⅜″	11.6	1.16			
	21				2	10			exc.	con.	7	12	11/16″	31.2	3.12			
U. S. Clapp-Griffiths	22				2	2												
	23					3.5b					9	12				17 @ 18		
	24	42′ 11″	4′ 11″	sc. ann.	2	b11.		10′ / 7′ 11″f	con.	str.	19	12	⅜″	25.1	2.28	18 @ 25	588	53.4
	25					4		5′f	con.	str.							201	50.3
	26				2	3			con.									
BRITAIN—Rhymney	27				2	7												
Sheffield	28																	
West Cumberland	29	28′	2′		2	8												
Eston	30				2	8												
" New	31							9f	con.	con.							636	78.2
Darlington	32				2	6c												
				r.	2	15′	20′	8′ 4″	con.		21							
Brown, Bayley & Dixon	33				2	8		6′ 11″	exc.		15	13	5/16″	15.	1.87			
	34				4	8					16	13	⅜″	23.	2.87			
SWEDEN—Långshyttan	35					2.4						1	⅜″	29.	12	10 @ 11		
Nykroppa	36					2.4		4′ 10″				1	.59	25.2	10	9 @ 17		
Bångbro	37			ann.		2.7	9′ 10″	4′ 10″	exc.			1	.59	22.	8.5	10 @ 17		
Vestanfors	38					2.2						1	.59	13.5	6.1	9 @ 11.5		
Avesta	39					.39		3′ 4″	con.	str.		1	.13	1.2	3.	14.8	6	15.2
Sandviken	40				2	3to / 6		5′ 7″@5′ 11″				1	.47m	20.2	3.3	17.		
Domnarfvet	41		2′		2				exc.		6	17				11.5 @ 10.8		
CONTINENT—Hoerde "old pit"	42			cir.	2	5												
Bochum "old pit"	43			cir.	3	8												
Seraing "old pit"	44			cir.	2	6		9′ 2″										
" " new pit" o	45	34′	3¹9″	cir.	2	6		9′ 2″									261	43.4
Oberhausen	46			cir.	2	8												

6. Raising the vessels enables us to raise the level of the casting-crane, which must be able to descend low enough to receive the steel from the vessel. Raising the casting-crane enables us to support its top with tie-bars level with the roof-trusses, and thus quite out of the way. Moreover, the cylinder of the casting crane is brought to a more accessible level.

Indeed, in late works the vessels stand so high that the top of the cylinder of the casting-crane is at the general platforms, on which many tons of cast-iron, etc., may be piled, cannot be suspended aloft for nothing. Yet it is doubtful whether this really costs much in the end, because for given surface of land we have more available working space, and the area which it is necessary to give our converting-mill is thereby lessened.

Raising the level of the vessels does not necessitate raising that of the cupolas materially. For the level at which the cupolas must stand in order to deliver their iron by

TABLE 196.—BESSEMER PLANT.—*Concluded.*

		Vessel-cylinder.		Iron-cupolas.			Blowing engines.					Cranes.									
							Steam cylinders.		Air cylinders.			Casting-cranes.			Ingot-cranes.			Other cranes.			
	Number.	Diameter.	Stroke.	Number.	Diameter.	Height.	Diamter.	Stroke.	Number.	Diameter.	Stroke.	Number.	Lift.	Radius.	Number.	Lift.	Radius.	Number.	Lift.	Radius.	Water pressure, lbs. per sq. in.
	1	...	...	5	9′	...	...	...	...	...	...	1	...	20′±	4	...	20′	1 s	...	15′	
	2	14½″	11′ 3″	...	8′	...	42″	5′	2	54″	5′	1	6′	15′ 6″	2 1	9′ 10′	22′ 22′	1	6′ 3″	19′ 3″	300
	3	20″	9′ 6″	...	10′	14′	54″	5′	2	66″	5′	1	5′ 6″	18′ 11″	4	11′	21′	...	...	...	300
	4	...	...	...	10′																
	5	18″	9′	4	8′±	14′±	4′± 3′	4′ 5″ 4′ 5″	2	40″± 4′ 5″	4′ 5± 4′ 5″	2	6′	20′ 6″±	4	9′	20′±	2	...	...	300
	6	16″	7′ 6″	3	8′	22′	42″	60″	...	60″	60″	1	6′	24′	2 1	9′ 9′	20′ 30′	2	7′	20′	
	7	...	...	2	8′	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	400
	9	16″	7′	3	8′	19′	36″	5′	2	48″	5′	1	6′	19′ 6″±	4	9′	20′	1 1 1	9′ 9′ 9′	16′ 18′ 22′	300
	11	...	...	4	8′±	16′	25″ 51″	70″	...	50″	70″	2	...	...	4	...	...	1			
	12	...	...	6	...	...	40″	4′ 6″	1	54″	4′6″										
Scranton	13	...	...	4	9′±	...	54±	60″	2	50″	60″										
	14	...	...	4	10′ 8′ 6″	...	50″	60″	...	60″	60″										
	15	...	...	8	9′	16′ 3″	36″ 60″	60″ 66″	2 2	48″ 54″	60″ 66″	2	...	...	6	...	...	3	...	...	300
	16	21″	...	4	9′	19′	32″	54″	2	48″	54″	1	...	16′	3	9′	22′				
	18	...	...	4	8′	24′	30″	36″	...	46″	36″	1	...	...	4	...	...	3			
	19	...	...	2	8′	16′±															
	20	...	...	4	...	...	42″	5′	2	54″	5′										
U. S. Clapp-Griffiths	22	...	...	...	...	...	20″	30″	2	48″	30″	1	...	...	3	...	...	...	...	...	350
	24	21″	10′	5	8′	29′	48″	72″	2	60″	72″	1	9′	18′	2	9′	20′	2 1	11′ 10″ 4′ s	20′ 3″ 13½′	
	26	...	...	2	...	...	...	...	1												
BRITAIN—Rhymney	27	...	...	...	...	...	45″	5′	...	54″	5′	1	...	...	2	...	...	...	...	...	450
Sheffield	28	...	...	...	...	...	...	...	...	...	...	...	...	...	2	8′	20′	...	...	...	
West Cumberland	29	...	...	...	7′	37′	40″	5′	2	54″	5′	1	6′	...	2	6′	12′	...	...	...	450
Eston	30	...	...	...	5′ 4″	...	40″	5′	...	54″	5′	...	...	...	...	...	...	...	...	...	500
" New	31	...	...	...	...	...	40″	5′	...	50″	5′	...	...	...	...	...	...	...	...	...	400
Darlington	32	...	...	2																	
Brown, Bayley & Dixon	33	...	...	...	...	...	...	...	...	...	...	...	20′	...	2 2						
SWEDEN—Bångbro	37	...	...	...	...	...	...	...	2	46″	46″										
Avesta	39	...	...	...	...	...	...	...	2	39″	39″										
Domnarfvet	41	...	...	...	...	...	...	...	2												
Hoerde "old pit"	42	...	...	4	...	...	...	...	...			1		...	3						
Bochum acid "old pit"	43	...	...	...	...	...	...	...	...			1		...	10						
Seraing "old pit"	44	...	...	3	8′ 3″ 4′ 11″	...	...	...	...			1		...	3						
" "new pit"	45	...	...	4	8′ 2″	...	...	...	...			1	10′±	19′	3		20′				
Oberhausen	46	...	...	6	...	...	...	...	...			2		...	3						

a Changed from 4 tons in 1886.
b Actual.
c Nominal.
d Average of 1 month.
e Outside diameter.
f Inside diameter.
g Formerly.
h Now.
i Average.
j Usual.
k Total.

l The total number of tuyere-holes for Avesta, 90; Långshyttan, 148; Nykroppa, 91; Bångbro, 84; Vestanfors, 49; Sandviken, 117.
m .47 Upper diameter.
.94 Lower diameter.
n I am informed that the usual charge is 7¼ tons.
o "American pit."
p Casting-pit.
q Receiving-pit.
r No pit.
s Receiving-crane.

cir. Circular.
sc. Semi-circular.
ann. Annular.
In several of the works there are four vessels, but where these are grouped in pairs, each pair having a separate pit, etc., I have regarded each pit with its pair of vessels as a separate unit, and thus have given the number of vessels as two, etc. In number 15, however, I have given it as four, for here all the vessels work together, and there is much less separation of the work than in other 4-vessel mills.

level, and the little pit in which this cylinder stands, being the higher, is the more readily drained.

7. Finally, by raising the vessels a little higher than would otherwise be necessary, we can in the basic Bessemer process easily remove the vessel-shell without disturbing its trunnion-ring, and carry it off on the general level to a repair-shop in an adjoining building, replacing it rapidly with another.

It is true that these ponderous vessels and their strong means of traveling ladles into vessels whose trunnion-axes are even as much as fifteen feet above the general, is but a few feet higher than that at which they would at any rate have to stand in order to dump easily.

B. *Placing the vessels side by side* instead of opposite, has the following advantages:

1. For given diameter of casting-pit a much longer arc of its rim is available for placing ingot-moulds, to wit, about 160° instead of about 125°; or, for given space avail-

able for placing moulds, the diameter of the casting-pit may be less than when the vessels stand opposite each other. A considerable arc is occupied part of the time by the repairing and shifting of ladles, and is hence unavailable for moulds. We have already seen that we must provide space along the rim of the casting-pit for many moulds. A further reason why a long arc of this rim should be available for moulds is this: we need three ingot-cranes for plants of even moderate large output, and four in case the output is to be great, or in case many ingots are to be cast per heat. It is important that these cranes should have fairly long jibs, so that each may command two railway tracks, one for moulds, the other for ingots, and beyond these tracks a considerable space on the floor of the converting-mill for storing moulds, which are thus in readiness in case at any time it be inconvenient or inexpedient to bring others in by rail.

The areas which the several cranes command must not overlap, lest their jibs collide. In a Pennsylvania mill, in which the areas of two of these cranes overlapped, annoying and well-nigh fatal accidents occurred: *e. g.*, the lower side of one jib in descending struck on the other jib, which was rising, and unshipping fell on the floor of the mill. Now it is impossible to place four long-jibbed cranes so that they all draw from the casting-pit, and that their areas do not overlap, without giving the casting-pit large diameter. This is readily verified by experimenting with a pair of dividers, pencil and paper, or indeed, by an inspection of the plans of Bessemer works, Figures 169, 171 and 177. A pit to be served by four cranes with 20-foot jibs can hardly be less than 32 feet in diameter, and is better if 40 feet in diameter, even if it be a complete circle, and if the cranes have access to the whole of its rim.

Now the cost of the casting-crane rises rapidly as the diameter of the pit and the consequent length of its own jib increases, rising perhaps with the square if not with a higher power of the jib-length; moreover, if its jib be very long, the casting-crane becomes extremely heavy and unwieldly, so that much time is lost in manipulating it. Hence it is desirable to keep the diameter of the casting-crane, and hence that of the casting-pit within bounds, and yet to have a long arc of the rim available for moulds and commanded by the ingot-cranes; and these two requisites can only be satisfied simultaneously by having an arc of many degrees available for moulds.

2. The vessels are much more easily charged with molten cast-iron. A single runner split at its lower end (Figures 171–173) readily carries the metal from a common point to either vessel; or, in case the cast-iron is brought in a traveling ladle drawn by a locomotive, a single straight track serves both vessels if they stand beside each other (Figures 165, 169), while if they stand opposite some more complex arrangement of tracks is needed.

On the other hand, placing the vessels side by side has the disadvantage that in turning up and down they bespatter the casting space.

It must be distinctly understood that the fact that the vessels in the old British pit stand opposite instead of side by side does not limit the output directly, but only indirectly. Of course it takes no longer to blow a heat, to recarburize, to charge, or to change bottoms in case of a vessel which turns its belly than in case of one which turns its side towards its mate: the difference is chiefly in the amount of space available for ingot-cranes and for casting.

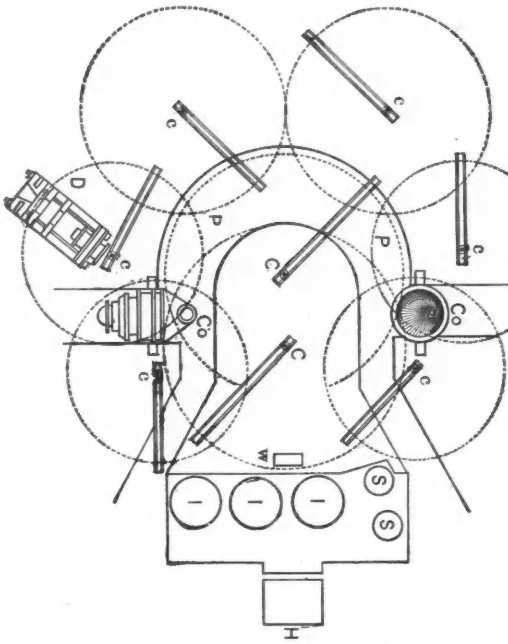


Fig. 167. HOMESTEAD BESSEMER PLANT.

Thus, on the one hand, about sixty heats are now made in the Holley pit at Seraing per twenty-four hours, while in the adjoining British pit only from thirty-six heats are made. At Homestead (Figure 167), on the other hand, the vessels indeed stand opposite each other in old British style, but here the casting-space has been enlarged, the pit shallowed, and the number of ingot-cranes raised to four: and here as many heats have been made in eight hours as in the Searing Holley pit in twenty-four. The charges are of about six tons in both cases.

Indeed Homestead has, I believe, made more heats in eight hours than any other works in the world. But this is a little deceptive, for only three ingots are made in each Homestead heat against eight in each Union heat, so that Union has for twelve hours cast more than twice as many ingots per hour as Homestead in her best eight-hours' work.

§ 381. FORSYTH'S PLAN.[q] Figures 168 and 169, adopted at South Chicago, Union and Wheeling, goes a distinct step beyond Holley's in still further removing the vessels from the casting space—a second instance of the advantage of separating the operations of one group from those of another—and in giving still more degrees of the rim of the casting pit for purposes of teeming, to wit, about 250°, while the old Holley and British types give about 160° and 125° respectively. Forsyth thus increases the casting-space by more than 50%.

The vessels stand apart from the casting-pit, and pour their steel into a casting-ladle standing on a special receiving-crane, (Rc. Figure 168), which may have a short jib. This crane delivers the ladle to a short transfer track Tr leading to the casting-pit, a hydraulic cylinder on the receiving-crane pushing it upon this transfer track, from which it is drawn upon the jib of the casting-crane, C, by the usual radial hydraulic cylinder of the latter.

[q] U.S. patent 276,384, April 24th, 1883: Trans. Am. Inst. Min. Eng., XII, p. 354, 1884.

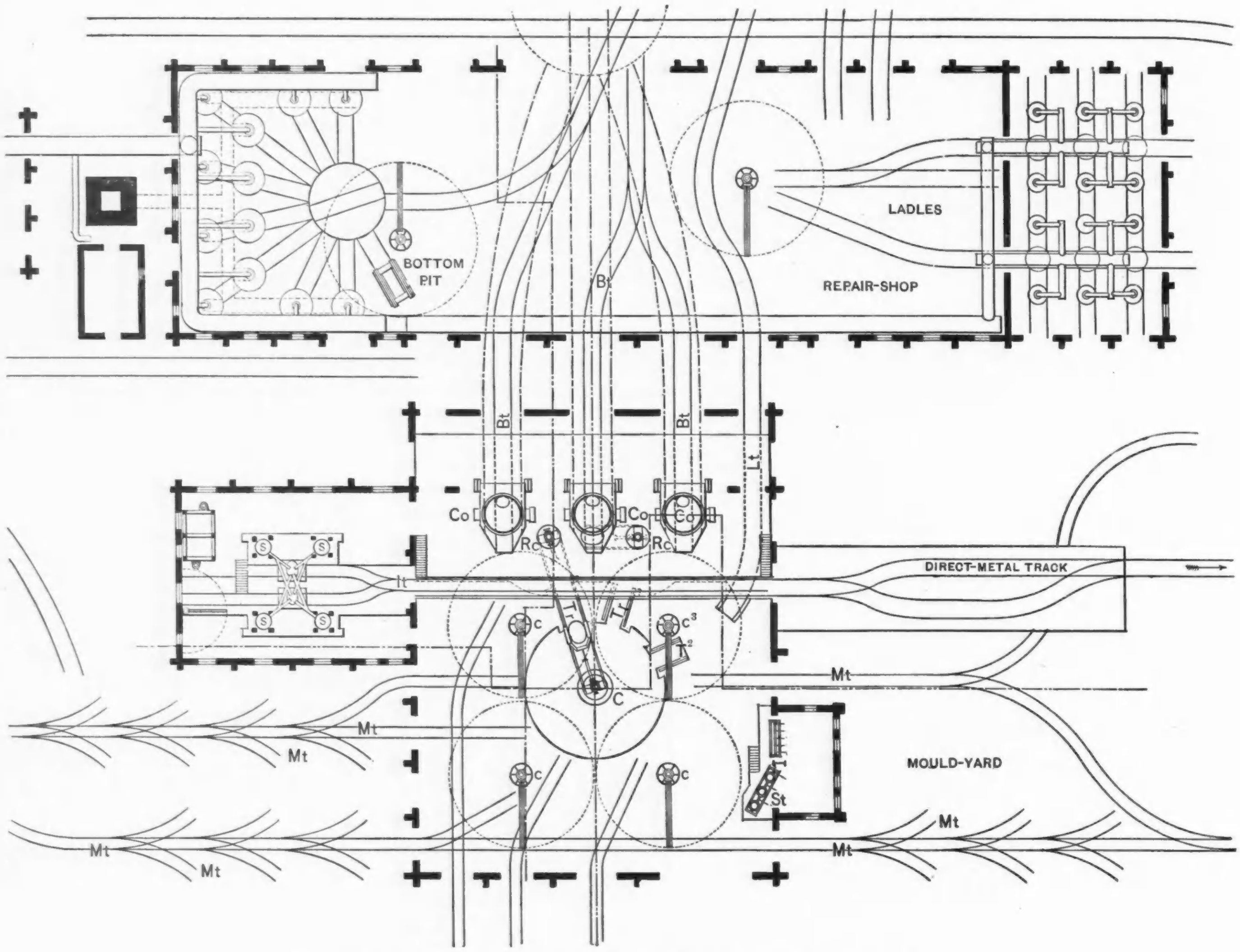


Fig. 168. Plan South Chicago Bessemer Works. Three 10-ton Vessel, Forsyth Plant.

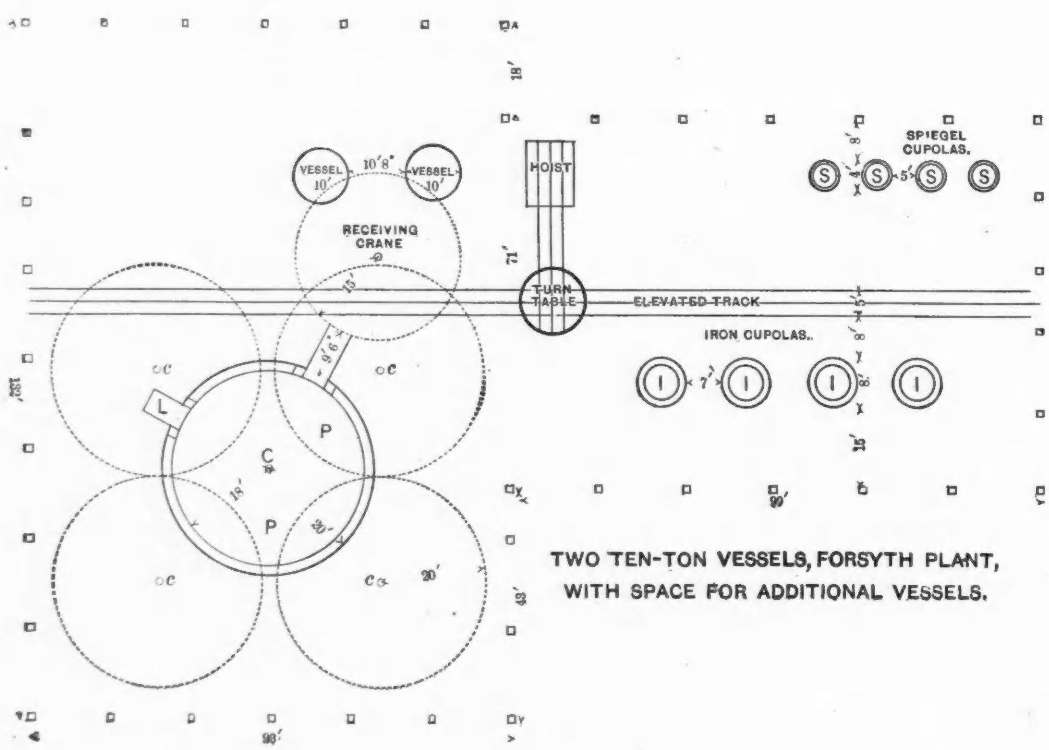


Fig. 169.

After teeming, the casting-crane delivers its empty ladle to the repair track T^2, and is then ready to receive a full ladle from the vessel which is blowing. Thus the casting-crane is free to attend to its other duties during the time when the steel is pouring from the vessel to the casting-ladle, a further advantage of this type. The ladle on the repair-track, inverted by the crane C^3, empties its slag into a pan beneath it which is later removed by this same crane; receives a new stopper; undergoes temporary repairs, and is then swung by crane C^3 to the transfer-track T, and, if need be, is taken to the further transfer-track. Slagged ladles are taken by a locomotive to the repair-shop, whence fresh ones are returned direct to crane C^3.

In this same repair-shop the bottoms also are repaired. We have here still another instance of the separation of one group of operations from the rest.

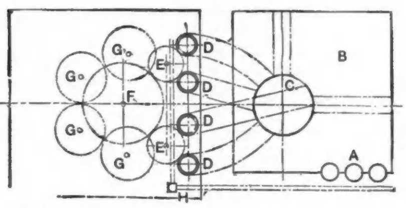


Fig. 170. NORTH-EASTERN STEEL WORKS.

A C Polas. B Repair-shop. C Turn-table for vessels and ladle-cars. D Converters. E Receiving-cranes. F Casting-crane. G Ingot-cranes.

§ 382. OTHER PLANS.—Intermediate between Forsyth's and the normal Holley type is that at the North Eastern Steel Works (Fig. 170) and at Rhymney, in which the casting-ladle stands on a receiving-crane while it receives the molten steel, and is then transferred to the casting-crane, by bringing the jib-ends of both cranes together. But this does not permit us to remove the vessels as far from the pit as seems desirable, while Forsyth's transfer-track has a certain further advantage "in that it admits of adjustment, both vertically and horizontally, to suit variations in the position of the crane-jibs due to wear of top-supports, elasticity of materials," etc.

In the North Eastern plan the receiving-crane may be so arranged that it holds a receiving-ladle from which the molten steel is repoured into the casting-ladle, to insure better mixing. It is, however, doubtful whether this is needed, for the heterogeneousness formerly attributed to imperfect mixing may be wholly due to segregation.

At Eston the cast-iron-ladle is or was raised to the vessels by means of the steel-casting crane; but this is very unwise, because, as we have seen, the casting-crane is fully occupied by its duty of casting the steel.

At Rhymney a receiving-crane stands, or stood, between the vessels and the casting-pit. It raises the molten cast-iron and pours it into the vessel; then at the end of the blow it raises the molten spiegel and pours this too into the vessel, then swings around and receives the steel in a ladle on its other end, and finally delivers this ladle to the casting-crane proper.

When matters are running perfectly smoothly these three operations of the receiving-crane need not interfere with each other, for, as we have seen, there is usually plenty of time during the blowing of one heat to charge in the idle vessel the cast-iron for the following heat, and this would naturally be done long before the vessel now blowing was ready to receive its spiegeleisen. But, owing to delays, we often cannot finish charging the idle vessel till just as the blow is ending in the other; and then the Rhymney arrangement would certainly cause delay.

Of the many other ways of grouping the vessels, some of them intermediate between the British and Holley's type, only the following seem to deserve especial consideration.

The converging-axed plan (Figures 174 and 176) has the advantage in case of three-vessel plants that a single casting-crane can receive steel from any of the vessels; while if the trunnion-axes are in a straight line, as at Harrisburg and Edgar Thomson (Figures 171, 177), a single casting-crane can hardly be arranged to serve all three vessels. This, however, is a doubtful advantage, for the three converging-axed vessels occupy so many degrees of the rim of the casting pit, that we can only get sufficient length of rim for the work of the ingot-cranes in the casting space, by having a very wide pit, and hence a costly and unwieldy casting-crane. For a three-vessel plant the Edgar Thomson and the Forsyth plan seem much better fitted than the converging-axed type.

When we come to two-vessel plants the converging-axed type lacks even the questionable advantage which it has in case of three vessels, for two vessels with their axes in line are readily served by a single casting-crane (Figure 173).

Further, whether there be two or three vessels, if their axes converge they bespatter not only the casting space, but what is really serious, the casting-crane, on which the man who is to rack the ladle as it receives the steel from the vessel should now be standing. Here Rothman's telescopic screen for the plunger of the casting-crane is especially needed (X Figure 163).

The Bochum plan, Figure 176, exaggerates some of these difficulties, and combines them with some of those of the British type; but it escapes part of their consequences by placing the vessels far from the casting-pit, thus going a step beyond Forsyth's plan. Here the converging-axed plan enables a single receiving-crane to serve three vessels: but the vessels are less conveniently placed for receiving cast-iron than when their axes are in line.

The Harrisburg Plan (Figure 171).—We have just seen the advantages which this plan has over the converging-axed plan for three-vessel plants. It was the natural outcome of an attempt to apply the Holley type to a three-vessel plant, for here a single casting-crane could not serve all three vessels, unless it had so long a jib as to be most unwieldy as well as expensive.

Compared with Forsyth's plan it has one disadvantage of the two-vessel Holley plant, the heat and spatterings of the vessels interfere with the casting; but in other respects it is as well if not better off than Forsyth's, for it offers a greater length of pit-rim for casting, and the length of the ladle-cycle (LT, § 376, 3), may be longer without holding the vessels back. In order that a ladle may always be ready to receive the blown steel it is only necessary that the length of the ladle-cycle, LT, should be less than twice as great as the blowing-time, BT. Indeed, as we have already seen, in case the number of ingots to be cast per minute were to be materially increased, Forsyth's plan would require a second casting-crane. It will be noted that, whichever pair of vessels is in actual use, whether the two outside vessels or either outside and the middle vessel, two casting-cranes will always be available for serving them.

The diverging-axed arrangement, Figure 172, has the advantage already pointed out that the vessels do not bespatter the casting-space. Indeed, they blow so wide of it in turning up and down that the pulpit or stage (St) from which the rotation of the vessels and the rise of the cranes is governed, can be placed immediately opposite

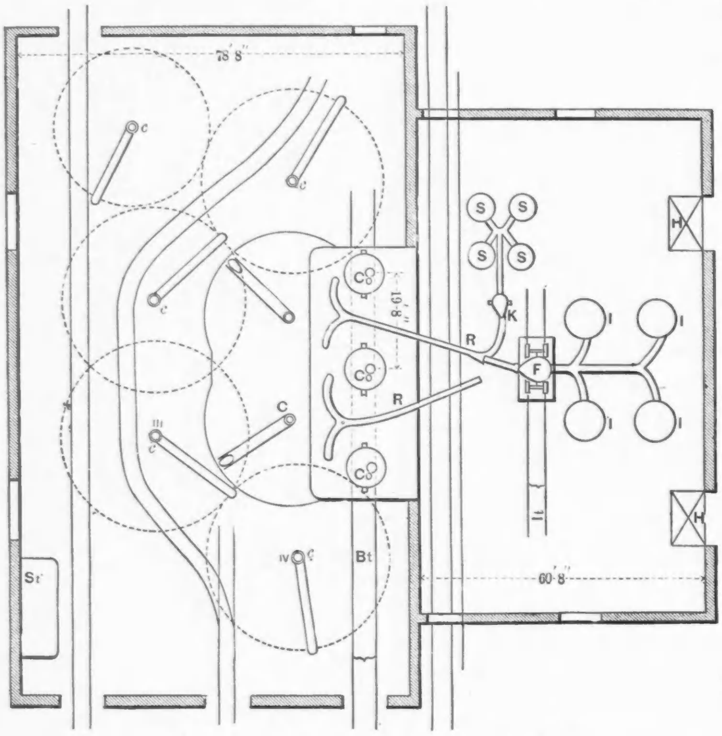


Fig. 171. HARRISBURG BESSEMER WORKS, NEW PIT.

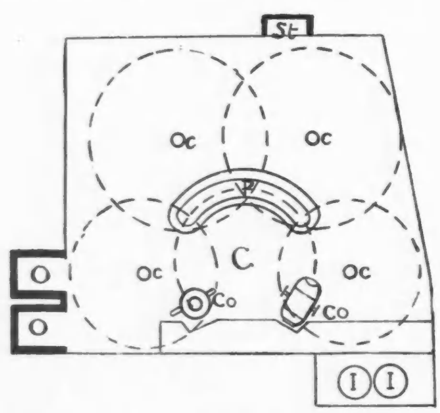


Fig. 172. BESSEMER PLANT, AXES DIVERGING.

the centre of the casting-pit and thus close to the work directed, without being bespattered. It has a further advantage in that the horizontal travel of the vessel's nose in pouring the steel into the casting-ladle may be wholly compensated for by swinging the ladle-crane, without radial motion of the ladle, so that the hydraulic cylinder usually employed to move the ladle radially, and the man who controls it, are not needed. The diverging-axed plan seems hardly applicable to three-vessel plants.

In the Joliet modification of the Holley type, Figure 173, the vessels turn down away from instead of towards the pit to receive the charge of cast-iron. If the casting-ladle is to stand on the casting-crane while receiving the steel from the vessel, and if at the same time "direct metal" is to be used, this modification is very desirable, as explained in § 395.

But if the vessels stand back from the pit, as in Forsyth's and in the North Eastern plan, the Joliet modification is not necessary. It is, however, a wholly unobjectionable modification; it necessitates some change in the shape of the vessel, making its nose "concentric" instead of eccentric, but this change, as we shall see, seems in itself desirable.

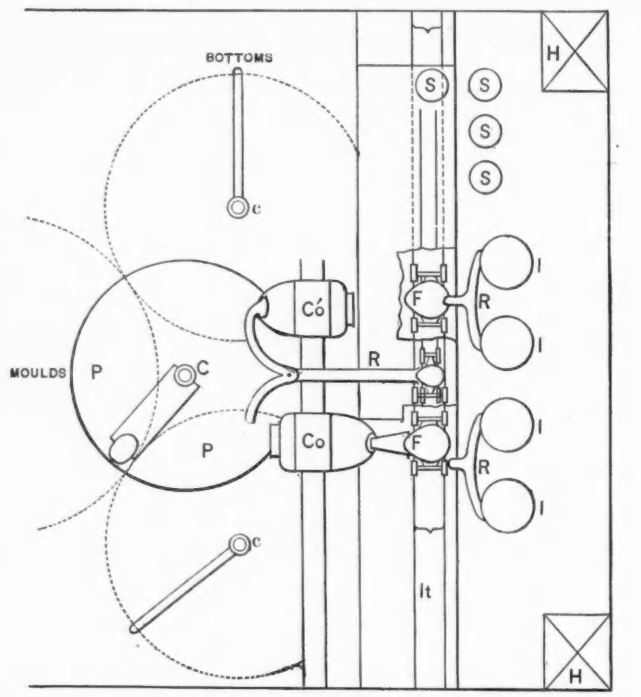


Fig. 173. PLAN OF JOLIET PLANT.

§ 383. OTHER FORMS OF CASTING PIT.—Up to this point we have considered the casting-pit chiefly in connection with the arrangement of the vessels; but there are certain forms of casting-pit whose value depends relatively little on the disposition of the vessels. Let us now glance at them, and at

I. The Suppression of the Casting-pit.—In several European works the casting-pit has been wholly suppressed, the ingots being cast either on the level, or on cars running on the level. It is often said by superficial observers that the pit is a useless nuisance. A nuisance it may be, but a most useful one. First, it gives ready access to the tops of the moulds, for teeming, for stopping them with sand or water, and for attaching crane-hooks to the ears of the moulds, and crane-dogs to the ingots themselves. Secondly, it restricts the area flooded by "messes," *i. e.*, by molten steel spilt from the ladle, from ill-fitting or cracked moulds, from bleeding ingots and what not. These cannot be ignored in providing for extreme celerity.

If there be no pit, an elevated platform, A, must be provided to give access to the mould-tops in teeming, etc,[a] unless only short ingots are to be cast. (See Figure 174.)

a Holley wrote in January, 1881, "Placing the moulds on the general level for casting, appeared to be very unsatisfactory. The moulds for 5 to 6 rail ingots are above 6 ft. high, so that there must a working platform about 4 ft. high around them. This platform is a series of planks laid on a temporary staging; it is narrow, insecure and inconvenient. The bursting of a mould endangers the lives of all the men about it. The steel cast when I was at the works was very rising. I saw it boil out of a mould, and drive all the men off the platform, twice in one afternoon." It is only fair to say that the platform need not be narrow and insecure.

If the ingot-moulds stand on the ground during teeming, I see no important advantage in suppressing the pit. If they stand on cars, we can remove them readily to a convenient place for stripping, and we may thus make use of some economical stripping-device, such as Laureau's or Jones', which we will consider later. But in either case we are likely to have much trouble with fouling the running-gear of the cars on which the moulds stand; and the fouling of a single wheel or of the track would detain a whole train of cars, and temporarily paralyze the establishment. Opinions are divided as to the detention which would be thus caused in actual rapid work. It is stated that this system has been used in some European works without serious trouble. But in these works the output is relatively small, and it seems to me that leaky nozzles and moulds are still common enough to form a serious menace, when such extreme rapidity of working as is common in this country is sought, and where every delay of even a few seconds is to be guarded against.

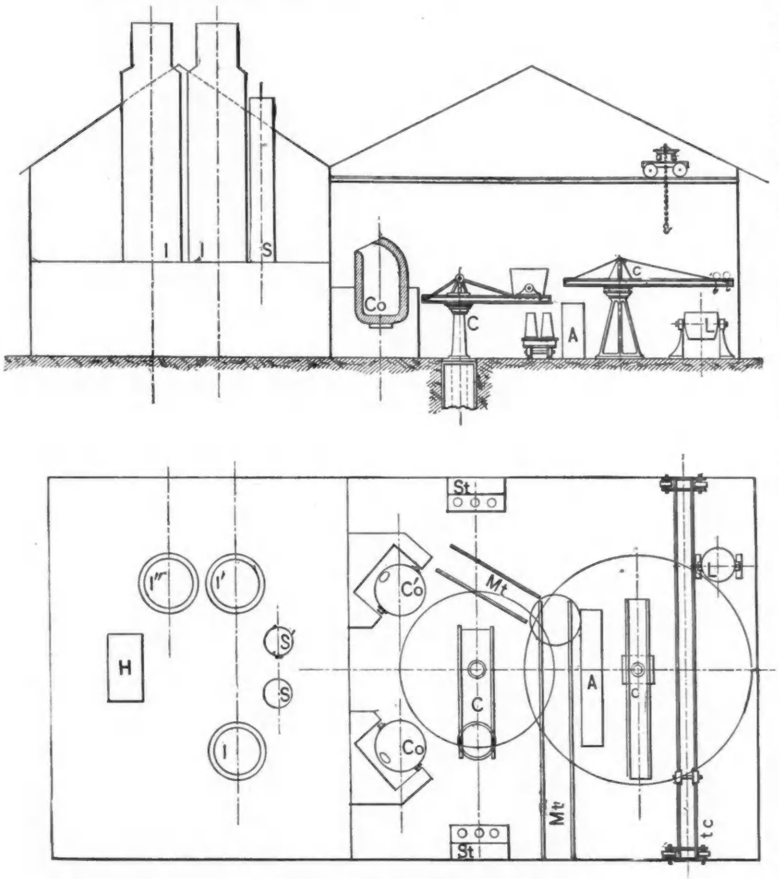


Fig. 174. PHOENIX BESSEMER PLANT.

2. Removing the casting-place from the converting-house. In this case the casting-ladle is carried by rail from the converting-house. If, as usual, the vessel pours the steel directly into the casting-ladle, this must stand on a crane while receiving the steel, in order that its position may shift and follow the motion of the vessel's nose.

It is asserted that in practice no serious trouble has arisen from fouling the running-gear, either by the bursting of the ladle or by spilling steel over its edge; and certainly the danger seems to be relatively slight, for the ladle need not be put on the car till after receiving the steel, and may be removed from it before teeming, so that no pouring need occur in direct connection with the track and cars. The danger is certainly far less than when the six or eight ingots of a heat are teemed while standing on cars; for here an ill-fitting mould would not be detected till it had begun to leak over cars and track, and the leakage from the nozzle in passing from mould to mould, very often a considerable matter, as well as the boiling over of imperfectly stopped ingots, would have to be cared for most jealously. Indeed it is clearly less dangerous to the running-gear to teem *from* a ladle which stands on a car, than to teem *into* moulds on cars.

This plan may be regarded as carrying Forsyth's a step farther. The casting-place is certainly freeer from the heat and spattering of the vessels, and the work of the pit-men is thereby facilitated; but in Forsyth's arrangement the distance between vessels and pit is already so considerable, and the quantity of heat radiated from vessels to pit seemed to me even in midsummer so slight, that I doubt whether any considerable additional outlay, for the sake of separating them still farther, would be expedient.

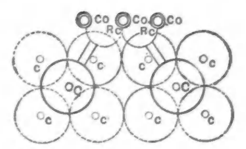


Fig. 175. 2-PIT FORSYTH PLANT.

C Casting-cranes. c Ingot-cranes. Co Converters. Rc Receiving-cranes. The black circles are the casting-pits.

3. Auxiliary Pits. Taking a hint from the Oberhausen plant, one or even two auxiliary pits might be arranged as in Figure 175, if it should be desirable to cast a very great number of small ingots from each of many heats following each other quickly. The casting-ladles would preferably stand on receiving cranes while receiving the steel from the vessels, and pass thence to whichever casting-pit was ready.

4. Straight Pits instead of circular ones have been used (Figures 176 and 176 *a*). Their advantage is that the casting place may be as long as you please, so that teeming and stripping may be more leisurely and hence cheaper than in case of a circular pit or pits, the length of whose casting-space is limited by the necessity of keeping the length of the crane-jib within bounds.

The cost of installation for straight pits may be somewhat less than that for circular pits with their costly casting-cranes. But the straight pit suffers under one very great disadvantage. There is no means by which the casting-ladle can be moved from point to point, and, as is necessary in teeming very soft steel, endlessly backwards and forwards, with anything like the ease with which it is swung while resting on the jib of a hydraulic crane. Locomotive ladle-cars and simple ladle-cars moved by stationary engines have been proposed, but it seems simpler to have a plain ladle-car drawn by a locomotive. At Hoerde the ladle-car has a steam-engine for locomotion, a casting-crane moved by hydraulic pressure, generated by a pump on the car itself; a system of wheels and chains for rotating the casting-crane, and arrangements for tipping the ladle in case of accident. One naturally shrinks from the use of so complex a machine for this purpose, where the first requisite is absolute certainty. In this particular case the casting-ladle stands on its traveling car while receiving the steel from the vessel.

In another case (Peine), the casting-car carries a ten-ton hydraulic casting-crane, with pumps; two steam-engines, one for locomotion, the other to drive these pumps; a twelve-horse boiler, and the levers needed for operating these machines.

between the radial and parallel arrangement of the casting-pit would probably be chiefly governed by the extent and shape of the available ground.

It seems on the whole wiser to adhere to circular pits, having, if necessary, two or even three pits, as in Figure 175: for, as we have seen in § 378, in case we are to cast ingots even of small size and hence numerous, whose moulds need not be in place till immediately be-

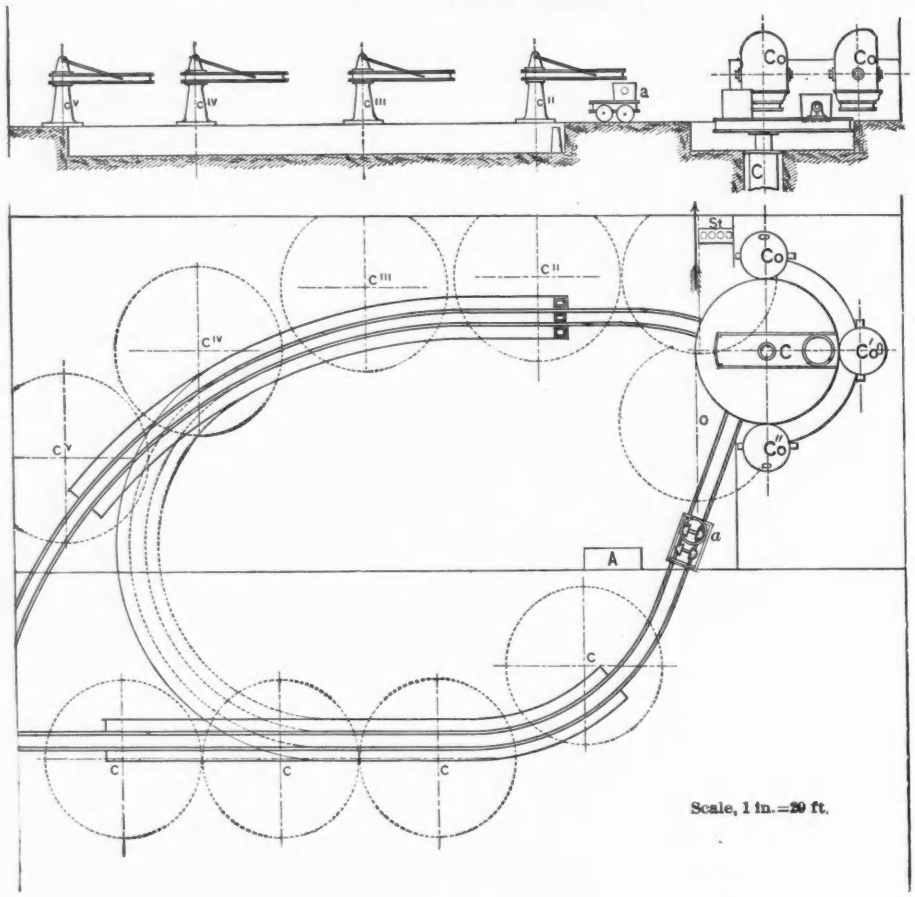


Fig. 176.

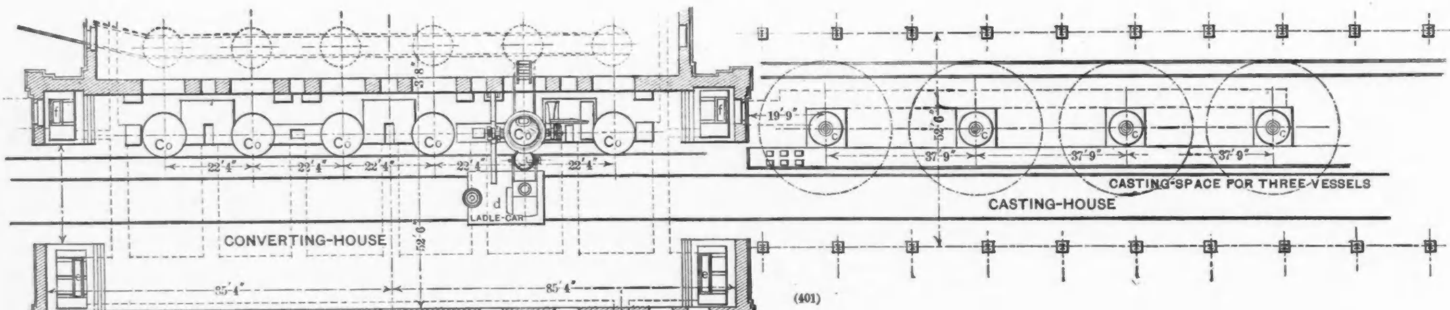


Fig. 176a. Peine Bessemer Plant.
c Ingot-crane. Co Converter. L Casting-ladle.

A straight pit may be either parallel with the vessel-axes, in case these stand in line, as in Figure 176 *A*, or it may, as in Figure 176, be radial to the orbit of a receiving-crane on which the casting-ladle rests while receiving the steel from the vessel. In the former plan the ladle may rest either on a receiving-crane or on the casting-car while receiving the steel. The usual advantages of the receiving-crane, removing the casting space from the vessels and leaving the casting-car or casting-crane at liberty for its other duties while the steel is pouring from the vessel into the casting-ladle, may apply here. The choice

fore teeming, we are likely to need increase of casting-crane capacity and after that of ingot-crane capacity, much sooner than of mould-space. Now, in a radial straight pit, as in Figure 176, we can use but one casting-ladle; in a pit like that in Figure 176A, but two, so that these are equivalent in casting-ladle capacity to a one- and to a two-casting-crane plant respectively. In order that more ladles should be used, some mode of switching the empty ladles back past the full ones to the vessels would be needed, as for instance, by uniting the two pits of Figure 176 by a Y, or by uniting them as indicated in dotted lines so that they formed one continuous pit. In such a pit any desired number of ladles could work simultaneously.

But the numbers in § 378 show us that in a pair of Forsyth pits we can have all the casting-crane, ingot-crane and mould capacity that is likely to be needed for two or three vessels, while preserving the advantage of moving the casting-ladle by hydraulic cranes.

In harmony with these views is the experience of Mr. John Fritz.[w] Having seen certain advantages of the straight pit at some German works, he fitted up two straight pits for his two new vessels at Bethlehem, with every convenience, determined to give the system a fair trial. But he was unable to teem and remove even the relatively small normal output of those days.

The single hydraulic casting-crane in the circular pit connected with his old pair of vessels did more work than the two straight pits and their casting-cars. He therefore returned to the use of the circular pit, putting in two casting-cranes each with its own pit to serve his new pair of vessels, to provide for rapid working.[w] So, too, many if not most European metallurgists seem to have come to the conclusion that, even for their relatively small output, the straight German pits are less convenient than circular ones.

We cannot conveniently use the circular pit and the hydraulic casting-crane when the casting work is to be like that of a common foundry, *i. e.*, when we are to teem a great number not of ingots but of small sand-castings, whose moulds occupy a great extent of floor-room for given weight of casting, require long preparation, cannot be swung about rapidly, but should, during teeming, stand in the place in which they are prepared.

Here the straight pit offers weighty advantages. But it is not probable that a large part of the enormous output of many large and rapidly working plants will be used for this kind of work: ingots are their normal product.

Multiple-casting and other means of casting many small pieces from a single heat will be considered in connection with the open-hearth process.

5. Annular casting-pits have been tried at several works. They indeed give a little more floor-room, the "Island," on the general level, Figures 167, 172; but it is not clear that this room, lying as it does in the centre of the pit, is much more useful for being at the general level instead of at the pit-level. The jib of the casting-crane sweeps across it so often that it is in either case little more than waste ground. Moreover, messes are certainly removed more easily from the open circular than from the relatively confined annular pit.

If an annular pit be used, the casting-ladle cannot be lowered so far as is possible in a plain circular pit, and hence the height at which the vessels must stand in order that they may pour the steel into the casting-ladle is greater. But in the best works lately built the vessels, even in case of a plain circular pit, stand quite as high as would be necessary were the pit annular.

§ 384. Minor Arrangements.—*The ingot-cranes* (cf. § 380, B) are usually placed as close to the pit as is possible without having their orbits intersect.

Place for Repairing Ladles and Bottoms.—In the earlier works, which aimed at what now appears to be a small output, ladles and bottoms were relined on the floor of the converting-room, and spaces along its walls were reserved for this purpose. The moulds, too, were allowed to cool on the floor of the converting-room. Thus a space to the left of the left-hand ingot-crane in Figure 173 might be reserved for repairing ladles, and the spaces indicated for moulds and bottoms.

But to provide for the enormous product of our later mills, ten times as great as that of sixteen years ago, a correspondingly great number of bottoms and ladles must be kept on hand, and must be simultaneously under repairs. The floor-space which this requires is so great that it is found far better to make these repairs in a separate building, as in Figure 168, or at least in a separate room, as at L, Figure 177, with ample floor-space. This enables us to keep a large number of both bottoms and ladles on hand, and to dry the bottoms slowly, a point of considerable importance.

So, too, in many of the works lately built, the moulds are removed from the converting-room immediately after stripping; they cool and are examined in the open air.

These are very important steps. The attempt to repair ladles and bottoms littered up the converting-room and cramped the operations of the pit-men; while the hot moulds not only did this, but, radiating great volumes of heat, raised the temperature of the converting-room, which even without them is tryingly hot in summer. But beyond this, it is necessary to throw a stream of water on the moulds, so that they may cool quickly and be ready for use. The steam into which they convert this water not only obscures the view and thus interferes with operations, but converts the converting-room into a Turkish bath. As the perspiration will not evaporate in the atmosphere thus saturated with moisture, we cut off the human body's chief means of keeping its temperature below that of the air and of the hot objects which surround it. We mercilessly enhance the sufferings and reduce the working power of these suffering and expensive men.

§ 385. General Arrangement of Tracks, etc.—This must of course be regulated by the shape and size of the ground available; I can therefore only point out what tracks are needed, and certain desirable positions for them. All the tracks, except that which brings the pig-iron and fuel to the works, may be of narrow gauge.

1. *The Pig-iron and Cupola-fuel* may be brought by an elevated broad-gauge track, running if possible over a series of bins standing behind the cupola room, each receiving iron of a certain grade. The bottoms of these bins should be on a level with the bottom of the hoists which raise the pig-iron and fuel to the cupola charging platforms, and within reasonable wheeling distance of them. Between the bins and the hoists stand scales for weighing iron and fuel.

2. *Iron-Hoists.*—Convenient positions for the hoists for pig-iron are shown at H in Figure 173 for the Holley type of plant, and in Figures 171 and 177. It is well to have two hoists, not alone on account of the enormous quantity of material to be lifted, which may reach 1,500 tons in twenty-four hours, but also lest the whole establishment be paralyzed by the temporary disablement of one hoist. Though a general discussion of the merits of different kinds of

w Holley, Engineering, XXXII., p. 428, 1881.

hoists is far beyond the limits of this work, I may point out that overwinding cannot occur in hydraulic elevators; that hydraulic pressure to drive them is always available in Bessemer works; and that there is always a number of men at hand skilled in the maintenance of hydraulic apparatus, and accustomed to guard it from freezing. In a word, hydraulic elevators are readily applicable here, and here their disadvantages are minimized.

As the cupola-charging platforms in the older works were very high, sometimes more than forty feet above the general level, it was found best to make the length of hydraulic lifting-cylinder but half the travel of the hoist-cage. This was therefore lifted by a chain running over a sheave fastened to the end of the piston-rod of the hydraulic cylinder; it is the common pulley-arrangement reversed.

3. *Track for Cupola-Débris.*—A track which may be of narrow gauge should run on the general level, and near the rear of the cupolas, for removing their débris.

4. *Track for Molten Cast-iron.*—If direct-metal is used, it may be brought from the blast-furnace in a ladle drawn by a locomotive, and by it carried up an incline, raising it to the level of the vessels. At South Chicago this incline has an average rise of 2%. It is stated that at Ebbw Vale direct metal was brought successfully a distance of six miles to the vessels.

At the head of this incline may be a siding, on which the locomotive places its full ladle or ladles, returning to the blast-furnace with one or more empty ones.

From this siding a special locomotive, which runs only on this elevated track, carries the molten iron to the vessels. The track may run either behind the vessels, as in Figures 163, 173 and 177, or in front of them, as in Figures 168 and 169, in case Forsyth's or a similar arrangement be adopted. In the former case the vessels must be concentric, in the latter they may be either eccentric or concentric. Or, finally, the track may run between the vessels, as in Figure 164.

In all direct-metal plants the cupolas should be so placed as to deliver their molten iron into ladles running on this same track. This arrangement works so admirably that it is well, even if cupola-metal only is to be used, to bring the molten cast-iron from the cupolas to the vessels by means of a locomotive. This incidentally allows us to remove the cupolas from the immediate neighborhood of the vessels, as shown in Figures 165 and 169, and as explained in § 373. This has been done in several of the best works lately built.

5. *The Tracks at and near the general level* have four chief functions; A, to remove the débris of the vessels; B, to carry moulds in and out of the converting room; C, to carry ingots away for further treatment; and D, to carry ladles and bottoms back and forth between the repair-shop and the converting-room. There are so many ingots and moulds to be carried in and out, and it is so important to remove them quickly from the converting-room, that there should be a track devoted solely to ingots, and another solely for moulds. Each track should be commanded by all of the ingot-cranes. Indeed it is better to provide two tracks for moulds, so that the removal of hot moulds may not interfere with bringing in cool ones. Admirable examples of track-arrangement are afforded by Figures 168 and 177. In the latter we have three parallel sets of tracks, a Y giving in addition a short branch. In the former works, by laying the ingot-tracks at right angles with the mould-tracks, the total number of tracks that can conveniently be laid is greatly increased. This facilitates handling, for cars standing on any one of the eight branches do not prevent bringing other cars to any of the other branches; while even with the three parallel tracks of the Edgar Thomson mill some planning and switching may occasionally be needed, *e. g.*, to bring cars to the end of a given track, at a time when its middle is occupied by other cars which are receiving ingots or moulds, etc.

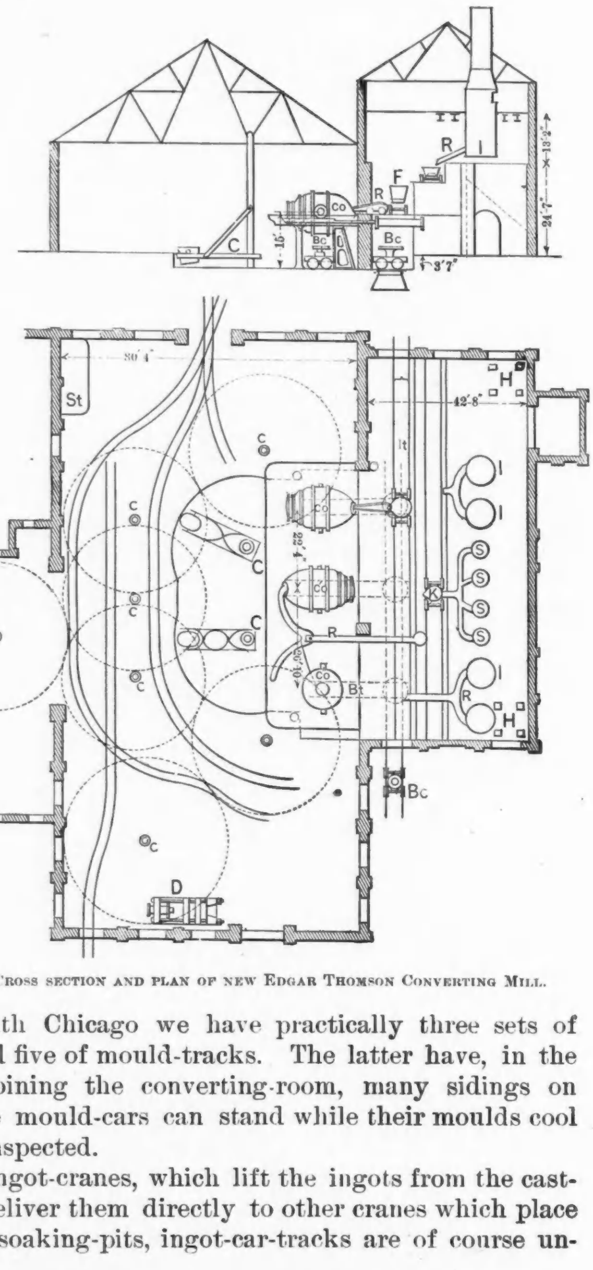


Fig. 177. Cross section and plan of new Edgar Thomson Converting Mill.

At South Chicago we have practically three sets of ingot- and five of mould-tracks. The latter have, in the yard adjoining the converting-room, many sidings on which the mould-cars can stand while their moulds cool and are inspected.

If the ingot-cranes, which lift the ingots from the casting-pit, deliver them directly to other cranes which place them in soaking-pits, ingot-car-tracks are of course unnecessary.

If, as at Edgar Thomson, the ladles are repaired in a room adjoining the converting-room, no track is needed for removing them, and they may be swung by a pair of cranes into this repair-room. But if, as at South Chicago, the ladles are repaired in a separate building, a track must be provided, as at Lt, in Figure 168. The bottoms at S. Chicago are removed by the tracks Bt shown in the same figure, running back from beneath the vessels. At Harrisburg (Figure 171) and many other works they

(TO BE CONTINUED.)

are removed on a track Bt, running beneath the vessels, but parallel with their trunnion-axes (Figure 163). It is evidently desirable that this bottom-track should run immediately beneath the vessels, so that the transfer of bottoms from car to vessel and back may be as direct and rapid as possible. The turn-table arrangement in Figure 177 enables us to side-track a bottom close by its vessel, leaving the main bottom-track free for bringing bottoms to or from other vessels, for removing slag, etc.

6. *The Vessel- and Pit-débris* is best removed by a track running at the level of the bottom of the pit. The cars may run directly beneath the vessels, which, after pouring the steel into the casting-ladle, are inverted and empty their slag directly into them. At South Chicago these cars run on the track which brings the bottoms to and from the vessels, a very good arrangement. At most works the vessel-slag track runs parallel with the trunnion-axes of the vessels.

§ 386. THE POSITION OF THE HEATING-FURNACES, SOAKING-PITS, ETC.—These usually stand close to the (blooming) rolls in which the ingots are to be reduced, and in a building apart from the converting-house. At Bethlehem the roll-trains, heating-furnaces and converting department are all contained in the nave of a single imposing building. There is a certain gain in facility of supervision and of communication between the superintendents of the different departments, so that they coöperate more readily. But it is doubtful whether this gain is equivalent to its cost. For the temperature in this stately hall must, other things being equal, be considerably higher than when each department stands in a separate building of its own, with abundant space for fresh (if not cool) air to blow in on all sides during summer.

The saving of time in carrying ingots from the casting-pit to furnaces in the same rather than in another building is inconsiderable, for once they are loaded on a car and once the locomotive has started, a few hundred feet more or less counts for little. I noted the following intervals in transporting ingots from the casting-pit to soaking-pits in another building at an American mill:

	Minutes.	Seconds.
Four ingots were placed on the car at the casting-pit at..................	0	0
They had been carried to out-door scales and had been weighed at........	0	27
They arrived at the soaking-pits in another building at..................	1	30
The first ingot was in the soaking-pit at.....	1	55
The last was in the soaking-pit at...	4	15

This is quicker work than I have happened to notice in mills in which the heating-furnaces and casting-pit are in the same room.

Here the length of time during which the locomotive and ingot-cars were detained because the soaking-pits were in another building instead of being in the converting-house, was less than one minute.

Another plan is to place soaking-pits so near the casting-pit that ingots drawn from the latter by one crane may be deposited by a second directly in the soaking-pits, or may even be deposited in the soaking-pits by the very crane which lifts them from the casting-pit, as indicated in Figure 165. This expedient certainly saves the whole expense of the transportation by locomotive. In a very large establishment it might wholly dispense with one locomotive by day and another by night. The number of motions of the ingot-cranes would, however, be the same as when the ingots are carried to the soaking-pits or other heating-furnaces in a separate building; for it does not take appreciably longer to place an ingot on or to remove it from a car than to set it on or pick it from the ground. From these soaking-pits[a] other cranes transfer the ingots directly to the feed-rollers of the blooming rolls. This appears to be an admirable arrangement in case of small output. Where a large output is sought we must weigh against the advantage just considered, the higher temperature which must prevail both in the converting and in the rolling department, owing to their proximity to each other. This is a serious thing in case of large output, owing to the enormous quantity of hot metal at hand at once, and to the frequency with which masses of metal are brought out into the air, radiating heat in all directions.

§ 387. THE SEVERAL LEVELS.—To recapitulate these we have:

1, The cupola-charging level;
2, The cupola-tapping level;
3, The vessel-trunnion level;
4, The general level of the converting-house;
5, The pit-level; and
6, The level of the subterranean passages in which the hydraulic and other pipes lie.

Of these we have seen that 2 and 3 are identical in some of the best works lately built, while 4 and 5 are identical in some works, but to doubtful advantage.

§ 388. THE BESSEMER CONVERTER OR VESSEL[a] is essentially a chamber lined with refractory material, and suited to carrying out the Bessemer process. In this view the many vessels which are now offered to the public are all Bessemer converters; there may be a Clapp-Griffiths Bessemer converter, a Robert Bessemer converter, which we may call simply a "Robert converter," remembering that this is merely an abbreviation, and that it is essentially a Bessemer converter still.

§ 389. BESSEMER'S EARLY VESSELS.—Figure 178 shows the apparatus in which Bessemer's earliest experiments were carried out, a 40-pound clay crucible, heated in a common crucible-furnace, and provided with a tap-hole for removing the molten metal and a central clay pipe through which the blast was introduced. In this ten or twelve pounds of cast-iron were melted and then blown.

Next a rotating converter (Figure 179) was designed by Bessemer, but not built, spherical, to reduce the loss of heat by radiation to a minimum, and with a clay tuyere inserted and withdrawn, much as in Figure 178.

Next came the vessel shown in Figure 180,[b] and used for Bessemer's public experiments at St. Pancras in 1856. Its resemblance to Figure 188 is striking, while its general arrangement is much like that of Figure 216.

a By soaking-pits I mean those with auxiliary gas-firing. There seems little sense in constructing furnaces so that we cannot use auxiliary gas if we wish. There is no reason for tieing our hands in this matter, except that we thereby cut down the cost of installation slightly.

a As far as my observation goes, metallurgical writers almost invariably use the word "converter," while in the steel works the word "vessel" is almost always used. Vessel has, of course, a generic sense, but it has acquired a distinct specific meaning—the Bessemer converter. It seems to me high time that this unobjectionable word should be recognized. Indeed, as the briefer name, and as the one in actual use, it seems on the whole preferable to converter.

b "This fixed converter has turned out to be the father of a very numerous family, all having a strong likeness to their ancient progenitor, and inheriting but too many of his defects and shortcomings. And it therefore affords anything but an example of the survival of the fittest."—Bessemer, Journal Iron and Steel Institute, 1886, II., p. 640.

Next came the first rotating vessel, Figures 181, 182. Its trunnions were concentric with the pouring lip, so that it poured readily into moulds set beneath it. In designing it Bessemer aimed chiefly to make the metal circulate, so that all parts would be acted on alike by the blast.

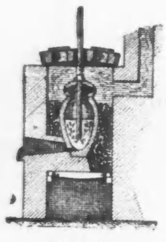


Fig. 178. Bessemer's original apparatus.

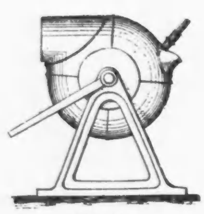


Fig. 179. Vessel first patented, 1855.

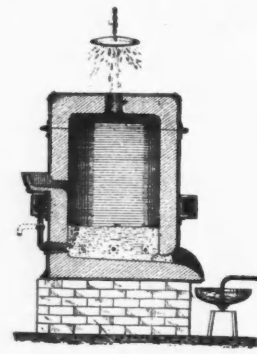


Fig. 180. St. Pancras, 1856.

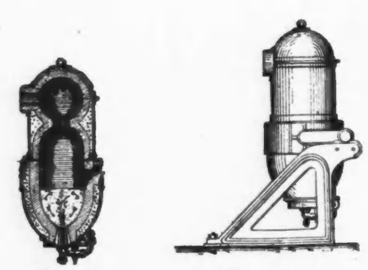


Fig. 181. *Fig. 182.* First rotating vessel, 1856.

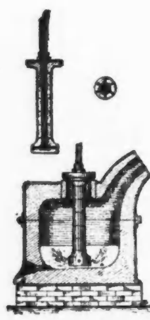


Fig. 183. Early vessel with internal tuyere, 1861.

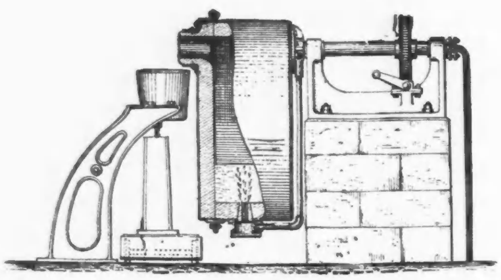


Fig. 184. About 1856. Rotating vessel, with emerging tuyeres.

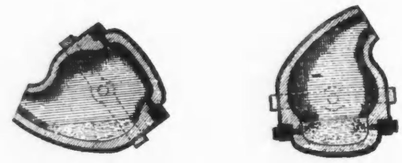


Fig. 185. *Fig. 186.* Rotating side-blowing vessel.

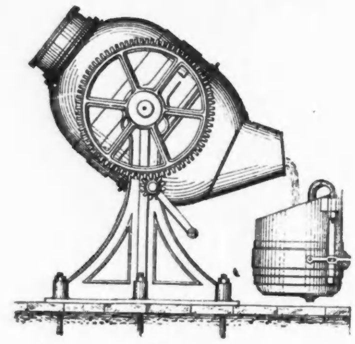


Fig. 187. 1858 (?).

BESSEMER'S EARLY CONVERTERS.

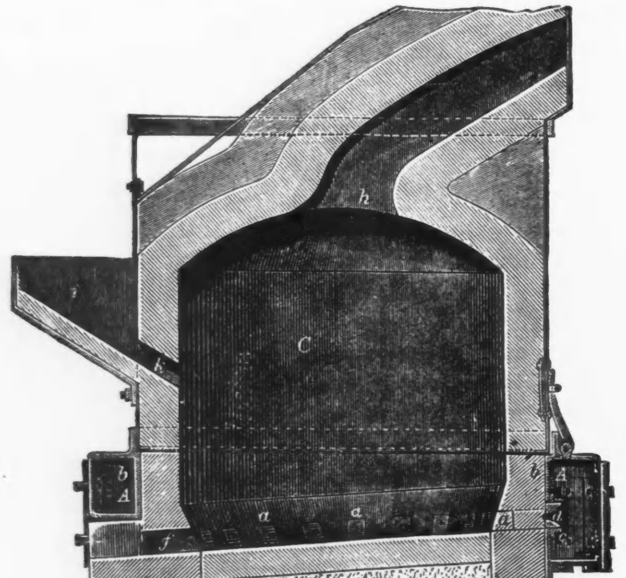


Fig. 188. OLD FIXED SWEDISH CONVERTER, WITH SIDE TUYERS.

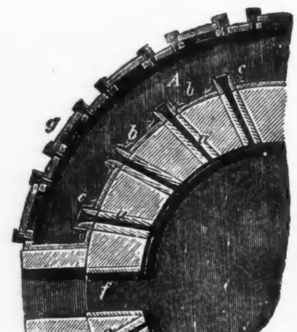


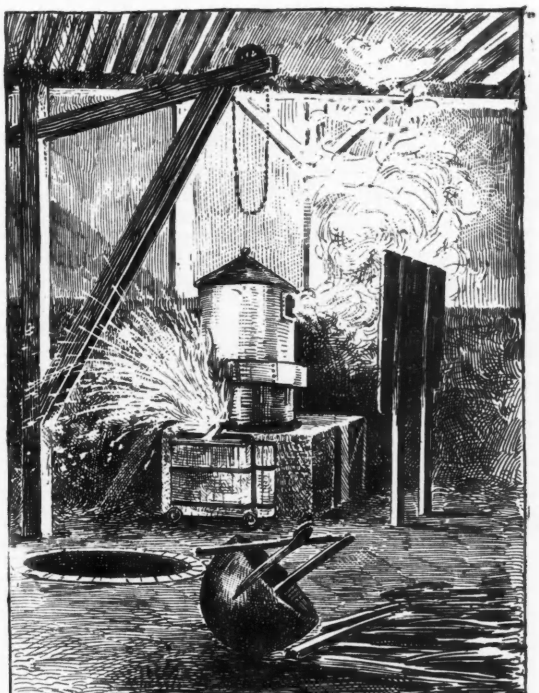
Fig. 189. PART PLAN OF OLD FIXED SWEDISH CONVERTER WITH SIDE TUYERES.

Soon followed the rotating vessel shown in Figure 184, which also was pivoted concentrically with its pouring lip, and had in addition the advantage that, when turned for receiving molten cast-iron or for discharging molten steel, its tuyere was above the level of the metal.

Later—in 1858—we have the vessels of Figure 187. This form was used with but little alteration till within a few years, when the form shown in Figure 204 was introduced.

Later still—in 1862—we have the rotating vessels, Figures 185, 186, with side tuyeres, which were readily brought above the level of the molten metal.

Of these all but that in Figure 204 are of Bessemer's design. The rotating vessel lies with its major axis horizontal when receiving or discharging metal; before the blowing operation, or "blow" or "heat" begins, the blast is let on and the vessel then turned so that its axis is vertical, submerging the tuyeres; the vessel is then said to be "turned up." At the end of the operation it is "turned down," *i.e.*, its axis is again made horizontal,



BESSEMER WORKS AT EDSKEN SWEDEN. BUILT AND IN OPERATION BY THE SANDVIKEN Co IN 1858.

and the tuyeres now emerge from below the metal. So, too, in case of the failure of a tuyere or in case the molten charge breaks through anywhere in the lower part of the vessel, we at once "turn down."

Some special forms of vessels are described in sections 405 to 408.

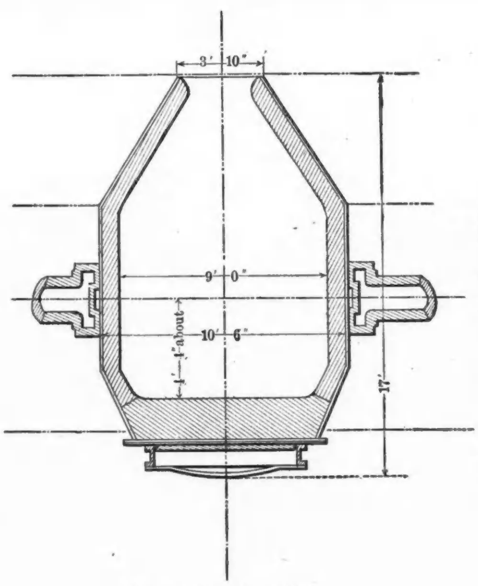
Figure 201 shows the names applied to certain parts of the vessel. In concentric vessels the side on which the charge of cast-iron is received is termed the "iron-side," that on which the steel is discharged the "steel-side." p

§ 390. Classification of Bessemer Converters.—The most important classification of vessels is into the fixed and the rotating, and into the side- and the bottom-blowing. They are also divided into those with straight and those with contracted shells; and into "eccentric" and "concentric," or "symmetrical," *i.e.*, into those in which the vessel is retort-shaped, as in Figures 187 and 202, and those in which the nose is almost concentric with the major axis (Figures 204, 205).

§ 391. Fixed *vs.* Rotating Vessels.—Fixed vessels (*e. g.*, Figures 188–9 and 216) have four chief defects.

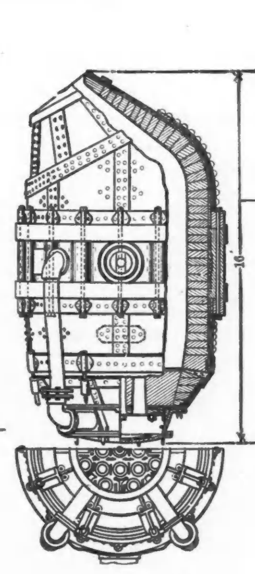
p This strange monster, "truly unique among organic forms," breathes through his nether parts, feeds, spits, roars and flames through his nose, which, like his breast, strangely enough grows above his back, while his shoulder lies beneath his middle.

Fig. 192.



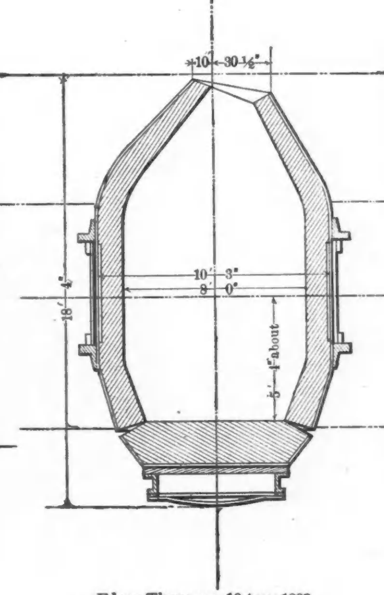
Eston, 15-ton, about 1880.

Fig. 193.



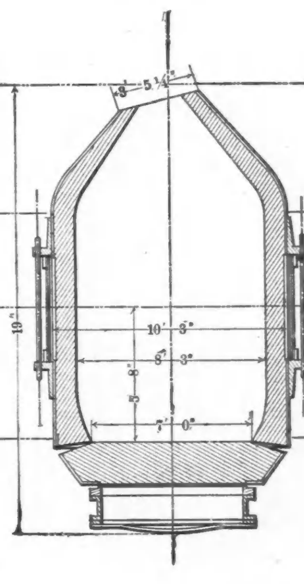
Bethlehem, 8-ton, 1881.

Fig. 194.



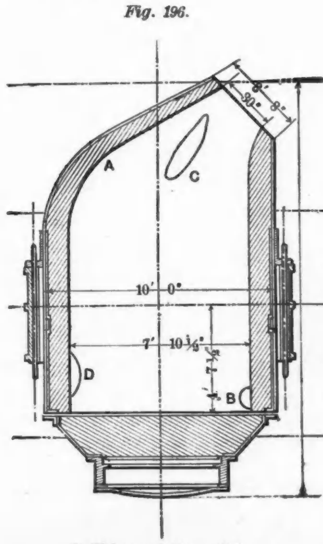
Edgar Thomson, 10-ton, 1889.

Fig. 195.



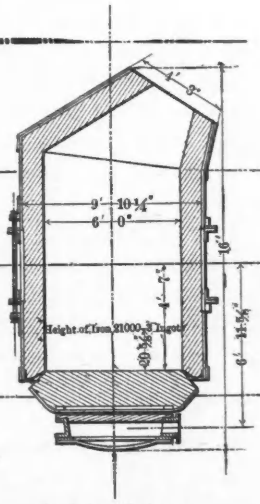
Union, 10-ton, about 1883.

Fig. 196.



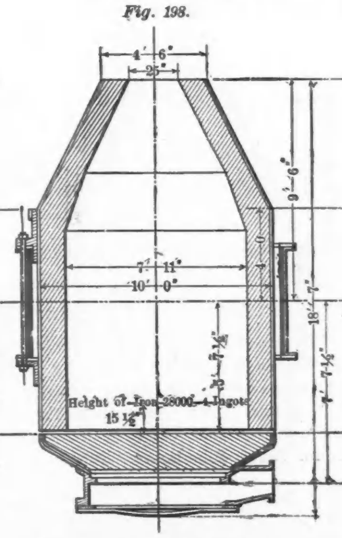
S. Chicago, 10-ton, 1882.

Fig. 197.



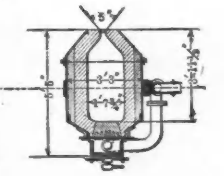
Cambria, old, 9-ton.

Fig. 198.



Cambria, new, 12 to 15 tons, 1888.

Fig. 199.



Avesta, 880-pound.

1st. They hardly permit bottom-blowing, hence they involve greater loss of iron in conversion. If the tuyeres were introduced through the bottom of a fixed vessel, the failure of a single tuyere would let the whole charge escape and might greatly injure the vessel. Should part of the charge be tapped out, it would be scrap. If a tuyere in a rotating vessel fails, the vessel is simply turned so as to bring the tuyeres above the level of the metal, when the faulty one can be repaired. The failure of a tuyere during the blow is no uncommon thing. It causes but a brief delay.

2d. Even in side-blowing the failure of a tuyere is a serious thing in case of fixed vessels, because it is then necessary to remove the charge from the vessel at once, converting it into scrap.

3d. At the end of the blow the charge has to be tapped out instead of being poured out of the vessel's nose. Formerly serious accidents were liable to arise through inability to open the tap-hole in case of a cold charge; but now that the proportion of silicon in the charge is more closely attended to, and that heats follow each other rapidly, this is of little moment. But, so far as my observation goes, the proportion of carbon in the steel is less closely under control in case of fixed than in that of rotating vessels, because the length of time taken to tap varies more than that needed for turning a rotating vessel down at the end of the blow, and for other reasons explained in considering side-blowing.

4th. It is impossible to recarburize within the vessel. This is relatively unimportant in case very soft steel is to be made, since in this case the metal may be recarburized advantageously in the ladle, but in case of rail-steel it is a serious thing.

Several minor objections, supposed greater difficulty in charging and in repairing, etc., are, I think, of little weight. The only serious difficulties, I believe, are the less complete control over the proportion of carbon in the steel; that the apparatus does not work as smoothly, as surely and as quickly as the rotating vessel; and that the loss of iron is heavier.

It must be admitted that the work done in the little fixed Clapp-Griffiths' vessels, as improved by Witherow, is extremely creditable. The difficulties which hung about the old Swedish fixed vessels, leading to their abandonment, and which caused even so broad-minded a man as Holley[c] to believe them beneath notice, have certainly been overcome to a most surprising degree. That 46 heats should be made in a pair of fixed vessels in eight hours, speaks volumes for the energy of the superintendent, and something for the possibilities of a vessel long despised and rejected.

The fixed vessel is certainly very much cheaper than the rotating one, and, where it is absolutely imperative that the cost of installation should be as low as possible, even at the cost of additional loss of iron in conversion and of some slight irregularity in the proportion of carbon in the product, it may be used with advantage. But under all common conditions the rotating vessel is to be preferred.

§ 392. Side- vs. Bottom-blowing.—The tuyeres have sometimes been placed at the sides instead of in the bottom, 1st, in *low* side-blowing (as in the old Swedish vessels, Figure 188), in which they were close to the bottom, to permit the use of a fixed and therefore cheap vessel: 2d, in *high* side-blowing (as in the Durfee vessel[d] and later in many others in which the tuyeres are raised far above the bottom), to lessen the blast-pressure needed to keep the metal from running into the tuyeres, and thus the power needed to drive the blowing-engines, and the cost of installation of these engines and of their boilers. To accomplish this object the tuyeres must be near the top of the bath of metal, or at least raised an appreciable distance above the bottom. The same object could be attained with bottom-blowing by making the bath of metal very shallow: but this would necessitate using extremely wide and hence expensive vessels.

The system has three chief disadvantages.

1st. The action of the blast is not uniform through the whole of the bath, as in bottom-blowing, but is strongest in the outer ring of metal above the tuyeres, the air bubbling up somewhat as sketched in Figure 186. Actually the whole bath is in active motion, and in tapping its different parts mix. But it is quite possible, if not indeed probable, that, at the moment of tapping, the metal immediately above the tuyeres contains considerably less carbon than the central part of the lower layer of metal does; and that this heterogeneousness is not fully romoved in tapping into the ladle and thence into the moulds, so that the ingots are less homogeneous than in case of bottom-blowing. Lacking direct evidence on this point, I cannot tell how much weight should be attached to this objection.

2d. The metal immediately around the points where the blast enters becomes highly oxygenated. In case of bottom-blowing the metal is so thoroughly mixed up, and the path of the blast through the metal is so long, that this iron-oxide yields up its oxygen in great measure to the carbon, silicon, etc., of the bath. At the end of the blow, when there is but a trifling quantity of these elements present, the iron-oxide is not so fully reduced, and much of it escapes along with the blast from the upper surface of the metal, in the form of a dense, brownish red smoke, and the metal is now over-blown.

In case of side-blowing, however, the mixing is so much less perfect that the iron-oxide produced by the blast comes in contact much less rapidly with carbon, silicon, etc., and is therefore less rapidly deoxidized. This is especially true towards the end of the blow, when the small proportion of carbon and silicon in the limited quantity of metal, with which a given lot of iron-oxide comes in contact, does not suffice for its deoxidation, and we get local over-blowing in the region immediately above the tuyeres before the rest of the bath is thoroughly decarburized. But the blast must be kept up till the middle as well as the outer part of the charge is decarburized. Now, all admit that side-blown charges give off very much more red

c "As recarburization cannot be performed in such a vessel," *i. e.* a fixed one, "and as it is otherwise impracticable for a maximum production, we may properly omit its consideration" (Holley "Bessemer Machinery," p. 8). Now a pair of fixed vessels has turned out in eight hours twice as many heats as Holley then thought the normal product of a pair of rotating ones for twenty-four hours. Still, Holley was right.

d In 1863-4 Z. S. and W. F. Durfee designed and built at Wyandotte, Michigan, a side-blowing fixed vessel, with the tuyeres near the upper surface of the metal, so that light blast-pressure might be used, and with a movable bottom. Trans. Am. Inst. Min., Eng. XIII., p. 771, 1885. Let us call this high side-blowing.

smoke than bottom-blown ones at the beginning of the blow[a], and to my eye they do towards the end of the blow also.

It is, therefore, natural that the loss should be heavier in side—and especially in high side—than in bottom-blowing. From the data at hand I think that it is about 4% greater.

In order that the action of the blast might be less localized, the tuyeres in the old Swedish fixed side-blown vessels, Figures 188, 189, were placed not radially but in a position intermediate between that of a radius and that of a tangent,[c] so as to give the metal a horizontal rotation. In the Robert vessel, Figures 217, 218, the same thing is done, while to induce a vertical as well as a horizontal rotation, the tuyeres are placed on one side only.

The third disadvantage of side-blowing is that, as the bottom, and the sides near and below the tuyeres, wear away, the weight of charge remaining constant, the depth of metal above the tuyeres diminishes, so that blowing becomes more and more localized. Now, even those who prefer to localize the blowing must admit that it is important that the conditions of blowing should be as nearly constant as possible, in order that the desired degree of decarburization may be hit accurately; or, if we seek to remove all the carbon, that we may arrest the operation as soon as possible after decarburization is complete, and so overblow and oxidize iron as little as possible. Clearly, the more constant the conditions of blowing, the more accurately can we hit the point of complete decarburization. In bottom-blowing the depth of metal above the tuyeres changes but very slightly, the corrosion being chiefly on the bottom proper, and the side of the vessel slagging away but slowly.

I have no direct evidence as to how serious this effect is, for, though I have found that the composition of the steel varies more from heat to heat with side- than with bottom-blowing, yet the side-blown vessels concerning which I have data are also fixed, while the bottom-blown ones rotate, and how much to assign to the side-blowing and how much to the fact of being fixed, I know not.

In the Robert vessel this wearing away of the bottom may be compensated for by tipping the converter more.

On the other hand, side-blowing, or at least high side-blowing, has two decided advantages. If the tuyeres be close to the bottom, as in the old Swedish vessels, side-blowing merely enables us to use a cheaper because fixed vessel.

High side-blowing, however, not only lessens the blast-pressure needed, but greatly prolongs the life of the tuyeres. In good American bottom-blowing practice the average life of the bottoms is usually about 18 or 20 heats, though under favorable conditions the average life rises to 28 heats, while single bottoms sometimes last more than 50 heats; but I am informed that the average life of the bottom in some Clapp-Griffiths (side-blown) vessels is as high as 120 heats, and that a single bottom has lasted 225 heats.[p] The average life in the Robert side-blown vessel is said to be 250 heats.[d]

This may be partly because the blast, moving relatively slowly through the tuyere because under lower pressure, corrades or abrades the edges of the tuyere-holes less as it issues from them, but chiefly because, in spite of its lower pressure, it holds the molten metal away from the tuyere-holes more fully than when there is a greater depth of metal above them (Cf. § 404).

The heavier loss of iron in high side- than in bottom-blowing naturally leads to a higher temperature, the excess of iron burnt giving out a great deal of heat; and we perhaps have a larger proportion of the carbon burnt to carbonic acid instead of carbonic oxide than in bottom-blowing, as the blast passes through a thinner layer of fuel.

Neglecting for the moment the minor disadvantages of side-blowing, that the composition is likely to vary more from heat to heat, and also more in the different parts of the metal from a single heat, we have to weigh against the greater loss of iron which it entails its advantages in saving blast-power and prolonging the life of the bottom and tuyeres.

If we assume that the loss is four per cent. greater in side than in bottom-blowing, side-blowing uses 121 pounds more of cast-iron than bottom-blowing does, per ton of ingots. If we further assume that the saving in blast-power in side-blowing is equivalent to saving half the total quantity of fuel burned under the boilers in bottom-blowing, and further if we assume that side-blown vessels need no repairs whatever to their refractory material, then side-blowing saves about 150 pounds of coal, 92 pounds of refractory materials (sand, clay, quartz), and 0.1 of a tuyere, per ton of ingots. But manifestly, even if we add a slight saving in the labor needed to make up the refractory materials, no calculation is needed to show that the value of this saving is much less than that of the 121 pounds of cast-iron with which side-blowing is charged. The data which I have

a "We have volumes pouring out at the very commencement, of brown iron-oxide smoke. The whole things looks as the Bessemer converter does when it is turned over, with air blowing across the top of the metal."—R. W. Hunt, Trans. Am. Inst. Min. Eng., XIII., p. 767-8, 1885. When a bottom-blown vessel is thus inclined so that some of the tuyeres emerge, or at least so that they are brought near the surface of the metal, enormous volumes of red smoke pour out; we thus raise the temperature by burning iron, and probably also by burning a large proportion of the carbon to carbonic acid instead of to carbonic oxide.

In the Clapp-Griffiths side-blown vessel a thick gray smoke appears the moment that the charge of cast-iron begins to run into the vessel. In about 30″, or probably at the instant that the level of the molten metal reaches the tuyeres, the smoke changes suddenly from gray to dense brownish red, and remains of this hue for about one to one and a half minutes, when the flame gradually assumes the same appearance as in bottom-blown charges. Towards the end of the blow, the reddish smoke again appears, and becomes very dense as the flame shortens. The blast is now partly shut off, and the metal is tapped almost immediately, the brownish red smoke continuing for about 20 seconds after the steel begins to run out of the tap-hole, when it ceases suddenly, probably just as the surface of the metal sinks below the tuyeres. In four observations I found that the red smoke continued from 12″ to 23″ after the steel began running, or an average of 17″.

In the few charges which I have seen blown in the Robert vessel, in which the blast enters still nearer the top of the bath, there was a great deal of smoke throughout the blow, which lasted twenty minutes. Though the smoke smelt very strongly of iron-oxide, it was less strongly red than that from the Clapp-Griffiths vessel. This difference, I think, is reasonably ascribed to a difference in the composition of the irons blown, that treated in the Robert vessel being highly silicious, and containing 1% of manganese,—a very "hot" iron.

The loss in this case is kept down by interrupting the blow very early, *i. e.*, by "blowing young:" but I learn that in spite of this it amounts to 15%. The difficulty in getting trustworthy information about the loss is too well known to need comment here.

c It is generally stated that the tuyeres were tangential; but I believe that this is inaccurate.

d Oliver Brothers and Phillips, private communication, June 7, 1889. In another American work the bottoms of the Clapp-Griffiths vessels last only 30 heats, their maximum life being 52 heats.

In 1886 I was informed that the life of the bottoms of some Clapp-Griffiths vessels had averaged 55 heats for one week, and that for many weeks it had averaged 48 heats.

indicate that the case is really less favorable to the side-blown vessels that I have here assumed.

Beyond this, the life of the shell-linings is usually shorter in side than in bottom-blown vessels. (Cf. § 403.) Doubtless, this is because the iron-oxide is formed locally along the sides of side-blown vessels, and the lining around and above the tuyeres is thus exposed to more iron-oxide and to a locally more basic slag than in bottom-blown vessels, especially if the tuyeres of the latter be concentrated near the middle of the bottom. In this case the iron-oxide, formed in excess in front of the ends of the tuyeres, is well reduced by the carbon and silicon of the metal before it reaches the shell-lining.

§ 393. Internal Blowing.—Whether the tuyeres be in the side or the bottom, it is in their neighborhood that the lining wears out the soonest, the iron-oxide formed in abundance by the entering blast rapidly corroding the silicious lining of the vessel. To remedy this, and also to have a ready means of stopping and starting the blow at any instant without the costly expedient of the rotating vessel, Bessemer early designed a vessel with an internal tuyere, Figure 183. Indeed, as Figure 179 shows us, the internal tuyere may be considered as older than that built into the lining, whether at side or bottom. As a simple clay tube was liable to crack, and as the slightest crack would be fatal, Bessemer used the built-up tuyere of Figure 183, an iron tube coated with silicious refractory material, much as ladle-stoppers now are. But it has been found, both by Bessemer and in later experiments in this country, impossible to maintain this internal tuyere, partly because of the difference in expansion between the intensely-heated immersed part and the rest of the tuyere.[g]

§ 394. Straight *vs.* Contracted Shells.—In the earlier vessels, Figure 187, the shell was contracted towards the bottom. The reason for this appears to be that, as the bottom is the place that wears out soonest and must most often be repaired, so it was desired to make it small in order that but little might have to be repaired and replaced. Contracting the shell at both ends, in that it is a step towards the spherical form, which has the minimum of heat-radiating surface, tended to preserve the heat generated within the vessel. Finally, the lining thus arched held firmly in place, tended less to fall out, *e. g.*, when the bottom of the vessel was removed for repairs.

But experience has shown that all this is false economy. Here, as in the case of the Siemens' furnace, it has been found best to sacrifice to other considerations part of that extreme compactness, which was at first sought in order to reduce the heat-radiating surface to a minimum. The fuel-economy thus gained was paid for too heavily in increased cost of repairs. A ring of stout angle-iron (Figures 202–204) at the bottom of a straight-sided vessel effectively prevents the well-sintered, tightly rammed, monolithic shell-lining from falling out when the bottom is removed. While contracting the lower part of the shell certainly made the bottom smaller, so that there was a smaller piece to repair, it really increased the cost of repairs, in two ways. First, it gave a greater depth of metal above the tuyeres, and this has been found by experience to shorten the life of the bottom, apparently because for given blast-pressure the metal, rich in nascent iron-oxide, is less fully kept away from the ends of the tuyeres by the blast. Next, because the shell-lining itself was liable to be eaten away near the bottom, and this is far more difficult to repair than the bottom itself. The vessels lately built have perfectly straight sides within and without. They are cheaper to build and to maintain, for the straight side within is so far from the tuyeres that it corrodes very little. With weekly repairs the linings of such vessels last a year easily.

§ 395. Excentric vs. Concentric Noses.—When a vessel with the old excentric nose was turned down (Figure 201), a very large charge of molten metal could lie in its belly, without running into the tuyeres or out of the nose. The excentric nose was further thought to hinder slopping, *i. e.*, to lessen or to guard against the tendency of the boiling metal to be carried out of the vessel through the nose. Finally, as works were then arranged, it discharged the molten steel and the gaseous products of combustion conveniently, and received the molten cast-iron without excessive inconvenience.[d] In designing the excentric nose, however, care had to be taken that the whole bottom of the vessel should be visible through it, so that the condition of this, the most perishable part of the lining, might be readily learned between blows.

This was all very well as long as the cast-iron was melted in reverberatory or cupola furnaces, for these could be placed at such a height that the metal ran from them through long runners to the vessel turned down towards the pit, like the upper vessel in Figure 173 and the middle one of Figure 177.

But even in this case, the greater height which we had to give the cupolas, and the greater length which the runners needed, in order to carry the cast-iron not merely to the vessels but past their whole length, was an inconvenience, even if it was not realized.

When, however, molten metal was brought direct from the blast-furnace, it was found too serious an inconvenience to raise it so high that it would run past the length of the vessels into their noses; and, in case the metal had for any reason become cool during its passage from the blast-furnace to the converting-mill, an excessive quantity of it would freeze in the long runners.

Two expedients suggested themselves. The cast-iron-ladle could be brought to a hoist H, standing between the line of the trunnion-axes and the pit, as in Figures 164 and 209, and here raised so as to pour through a short runner into the vessel; or the nose of the vessel could be made concentric or symmetrical, so that it could receive molten cast-iron when turned down *away* from the pit, and at the end of the blow receive spiegeleisen and discharge steel when turned down *towards* the pit, as in Figures 173 and 177.

We have already seen that the surface track of the Bethlehem plan occupies space which might be utilized for other purposes, and which is likely to be encumbered, and is hence not very well suited for the extremely frequent trips of the iron- and the spiegel-ladle.

g F. W. Gordon, U. S. patent 361,624, April 19, 1887, describes a movable tuyere, with elaborate and ingenious devices for moving and protecting it. It was inserted through the side of a stationary vessel, a little above the surface of the molten metal into which it dipped. Serious if not fatal technical difficulties arose in experiments made with it.

d Holley indeed said of it "We can hardly see how the shape can be improved, or how any other would be admissible." (Lecture at Stevens' Inst., 1872, p. 9.)

Thus the concentric vessel seemed to offer a very simple solution. It allowed the spiegel- and cast-iron-cupolas to remain in their old places behind the vessels, the spiegeleisen running though the old bifurcated runner into the vessel as this lay turned down towards the pit at the end of the blow; the cast-iron running into ladles standing on a track which ran behind the vessels, and to which the direct-metal was brought over an incline by a locomotive, a special locomotive always standing on the track, ready to move both the direct and the cupola-metal ladles to and from the vessels. (See Figures 163, 173, 177.)

But the concentric-nosed vessel must be made much larger than the excentric one, in order that, when turned down, it may hold a charge of given weight without allowing it to run either out of the nose or into the tuyeres, and hence is a much more expensive vessel. The old excentric vessels had from about 33 to about 42, the new concentric ones have from about 50 to about 80 cubic feet capacity per ton of charge (Table 196). The little Avesta vessel had about 15 cubic feet capacity per ton of charge. Now this increased volume turns out to be a great, if unexpected, blessing, for very much less slopping occurs with it. The vessel is so roomy, and the height from the upper surface of the metal to the nose is so great, that the metal which is carried up by the blast from the surface of the foaming bath falls back again before reaching the nose; indeed, even some of that which issues from the nose may fall back, for the flame passes vertically from the nose to the hood. This has diminished the loss of iron greatly; indeed, many metallurgists think that, even for given volume, the concentric vessels slops less than the excentric one; but why this should be, no one can explain. With our large vessels the loss, including that in remelting the cast-iron in cupolas, is sometimes repoted as below 8% for a month at a time; and, when direct-metal is used, the loss during a whole year has been reported as only 7.5%.

Still a third expedient is to remove the vessels so far from the casting-pit that the cast-iron can be brought by an overhead elevated track running between them and the pit, as in Forsyth's plan (Figures 168, 169). In this way direct- and cupola-metal are brought to the vessel easily, while it is turned down towards the pit. But even in this case the concentric vessel is often used to diminish slopping. Perhaps it is well that this plan was not worked out till after after the advantages of the concentric vessel had been found out.

A further advantage of the concentric vessel is that its lining wears out much less rapidly than that of the excentric vessel, as explained in § 403.

One inconvenience of the excentric vessel, which has lost some precious lives, is that the hood, or chimney K (Figure 209), must stand above the rear of the vessel. Now, this is just above where the vessel-men must stand while examining the tuyeres between heats, and here they are threatened with the masses of steel sloppings which hang over their heads on the walls of the hood, giving to the eye little indication as to how firmly they hang, or when they may fall. It has, indeed, been found desirable to provide swinging platforms or awnings to shield the vessel-men from these falling masses. The hood, in case of concentric vessels, stands directly over the trunnion axis, and the vessel-men work in comparative safety when examining bottoms.

The concentric vessel has been widely adopted by American engineers, but it seems to have met with relatively little favor in Europe.

§ 396. Size of Vessel-nose.—A small nose yields a higher working temperature within the vessel for two reasons. First the radiation of heat from within the vessel is less; second, by checking the escape of the products of combustion, it leads to higher pressure within the vessel, and thus not only lessens the absorption of heat due to the expansion of the blast as it emerges from the tuyeres, but also lessens the degree to which dissociation occurs. At Eston a four-foot nose was contracted to two feet, and the temperature of the blow is said to have increased plainly. Similar results were obtained at West Cumberland by reducing a large nose.[e]

In case of concentric vessels a small nose has a further advantage, in increasing the quantity of molten metal which the vessel can hold when "turned down."

It is thought by some that, with the broad flame which the wide nose affords, the point of complete decarburization can be hit more accurately than if the nose and flame be narrow. Others, however, think that, if the blowing be more accurate in case of wide noses, it is because the temperature of the blow is somewhat lower than if the nose be narrow; the cooler the heat the more accurately may the point of complete decarburization be hit.

§ 397. Details of the Construction of Bessemer Converters.—To fix our ideas I shall describe two large vessels (Figures 202 to 206) lately built, and designed by distinguished engineers.

The vessel consists, first, of the iron body, and, second, of the lining; the preparation of the latter will be described in § 402.

As the region around the tuyeres (*i. e.*, in bottom-blown vessels, the bottom) wears out very much sooner the rest of the lining, so the bottom is almost universally removable. The necessity of this is seen from the fact that, while a bottom lasts on an average from twenty to thirty heats, or in rapid running only about seven hours including the intervals between heats, the rest of the lining lasts a year easily in the best American and European practice.

The iron-work then consists of the body and of a removable bottom. The former consists of the trunnion-ring A, *i. e.*, that part to which the trunnions are attached, and which carries the whole weight of vessel, lining and charge; and the shell proper B C. The shell may be made as in Figure 202 in a single riveted piece, or as in Figure 204 it may be in two pieces, a cylinder B and a cone C, bolted together.

The trunnions themselves, D, are very heavy castings, preferably of steel. An excellent form is shown in Figure 204. One of them must be hollow, and conducts the blast through the goose-neck E to the tuyere box F. In Figure 202 the blast passes to the goose-neck through a space cored in the trunnion-ring. In Figures 204 to 206 the goose-neck is carefully shrunk directly upon the trunnion itself. Instead of coring a single large hole in the un-

e Holley, Priv. Rept., 1880, II., p. 12; 1881, I., p. 58.

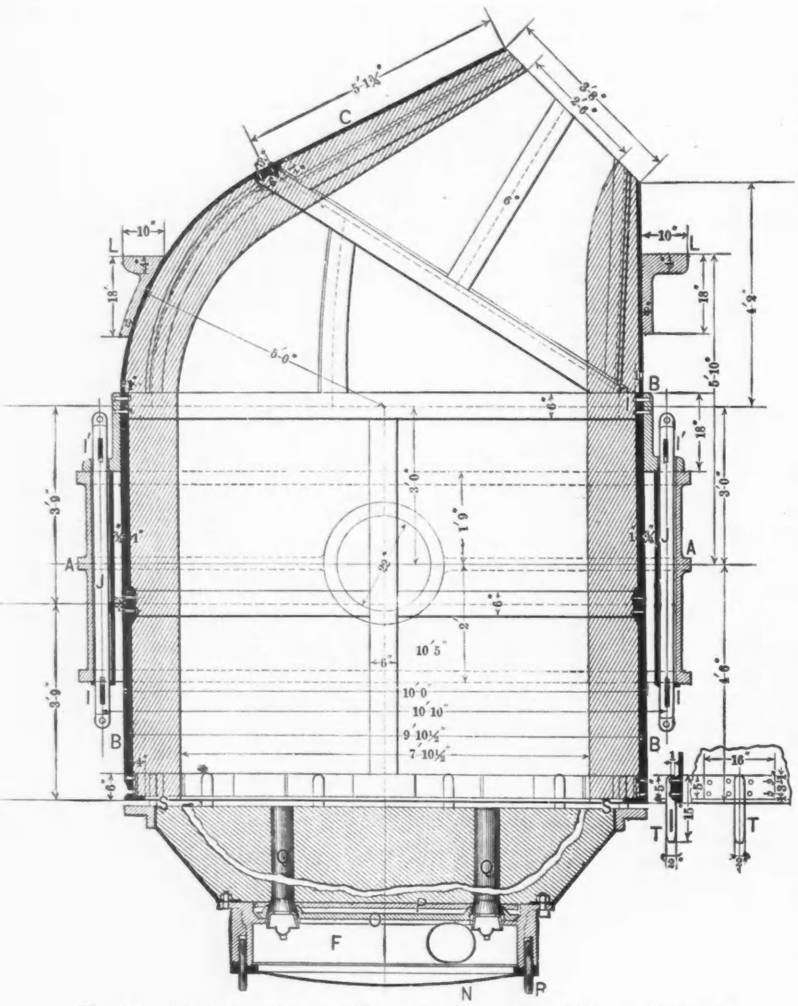


Fig. 202. 10-Ton Converter with Removable Shell, North Chicago Steel Co.

The shell itself is of heavy wrought- or ingot-iron plates. In Figure 202 the middle of the shell is of two plates, 1″ and ¾″ thick respectively, the upper part being of a single 1″ plate. In Figure 204 the middle of the shell is made of two plates, each 1″ thick. In another vessel lately built, with a capacity of ten tons, the middle of the shell is 1″ thick for three feet of its length, and only ½″ thick beyond this, and is strengthened with wrought-iron bands, 1″ x 12″.

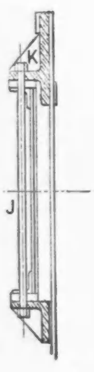
The method of attaching the shell proper to the trunnion-ring is important. Formerly the trunnion-ring was part of the shell proper, but in later vessels it is a distinct piece, separated from the shell itself by an air-space, which in great measure prevents the heat and expansion of the shell from heating the trunnions and shifting their position.

As the shell grows much hotter than the trunnion-ring, so these two parts should be so attached that, while the shell is held firmly, each is free to expand and contract independently. This is effected in the vessel shown in Figure 202 by hanging the shell, by means of stout cast-iron brackets, upon the upper edge of the trunnion-ring. This, of course, only holds the vessel as long as it is upright. When it is inverted it hangs from the trunnion-ring, resting on the keys I, which in Figure 202 are at the lower end of the bolts J. The whole weight of the vessel is now borne by these bolts,

der side of the trunnion to admit the blast to the goose-neck, the blast may be taken off through a number of radial slots, as in Figure 206, and gathered by a heart-shaped box, with wings G designed to prevent the different bodies of blast from interfering with each other. This trunnion is cast solid, and then bored out; it is an expensive one, but it should be very strong for its weight, and relatively free from internal stress.

To the other trunnion the shrouded cast-iron, or better cast-steel, pinion (Figure 209), which rotates the vessel, is keyed.

The trunnion-ring A was formerly a very heavy iron casting, stoutly ribbed, and bolted firmly to the trunnions. In some vessels lately built, however, as in Figures 204 and 205, it is of heavy wrought- or ingot-iron plate, say 1½ or 2 inches thick, with flanges at either end.



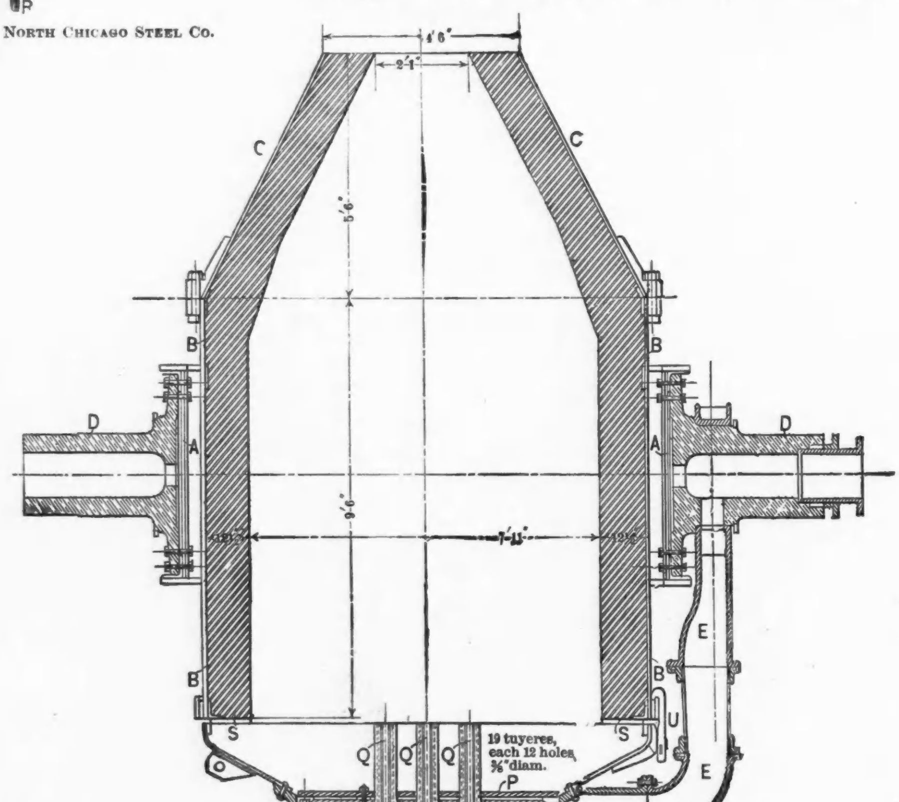


Fig. 204. 12 to 15-Ton Converter—Vertical Section.

J. At the same time a series of stout radial set-screws supports the vessel when it is inclined. Here the shell is clearly free to expand and contract longitudinally, simply sliding past the points of the set-screws. And, since these set-screws need not bind the shell tightly when it is cold, a considerable amount of radial expansion may also occur, the set-screws simply denting the shell slightly. Indeed, there might be a little play between shell and set-screws when the vessel is cold. This is especially true of eccentric vessels, for the set-screws on their rear sides are never called on to support much weight.

In the vessel shown in Figures 204 and 205, two sets of cast-iron brackets, one above and one below, bolted together by the bolts, J, attach the shell to the trunnion-ring. But here we have no means of compensating for the difference in expansion between the shell and the trunnion-ring, and in many cases this mode of hanging has given much trouble. Either the bolts, J, or the brackets, K, break. Indeed, in many vessels these brackets have purposely been of wrought-iron or steel, so that they might bend rather than break, and there they stand all bent out of shape.

Holley's Shell-shifting Device.—The cast-iron brackets, LL, Figure 202, are to enable us to remove the vessel-shell by Holley's method, shown in Figure 207, so that we may carry it to the repair-shop, and immediately replace it with a newly-lined shell, whose lining may be preheated.[a] In the basic Bessemer process the apparently unavoidably rapid destruction of the shell lining must greatly lessen the output, unless we are prepared to replace the worn-out lining rapidly. This is as nearly essential to large output in the basic process as quick changing of bottoms is in the acid process.

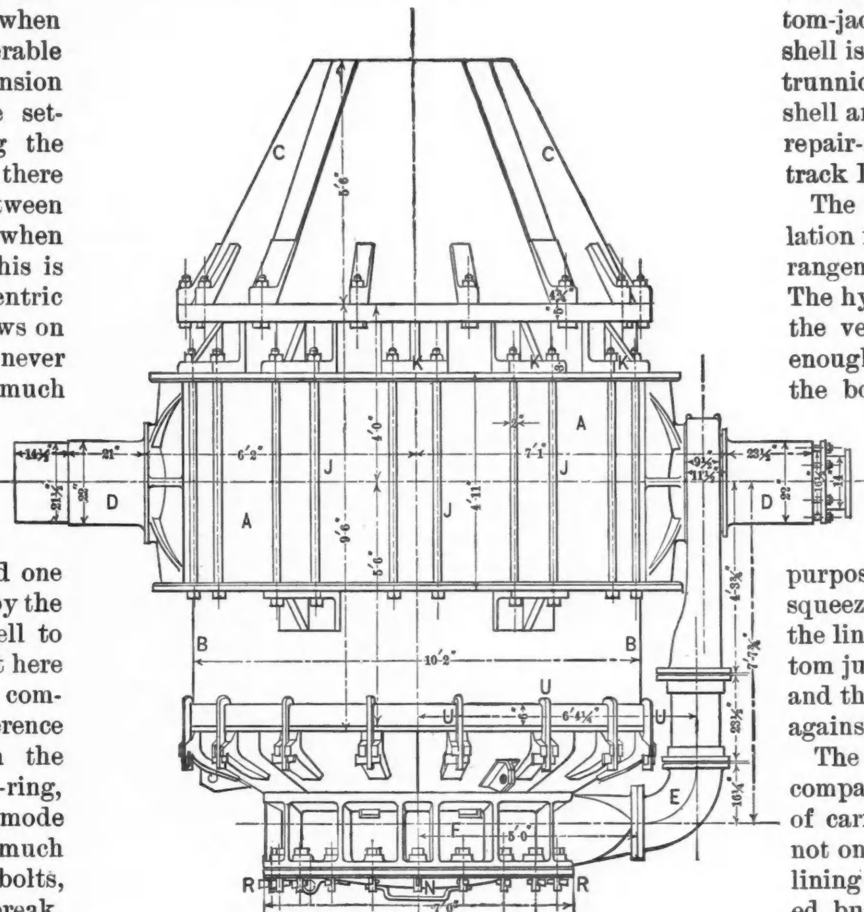


Fig. 205. New Bessemer Steel Works. 12 to 15-Ton Converter.

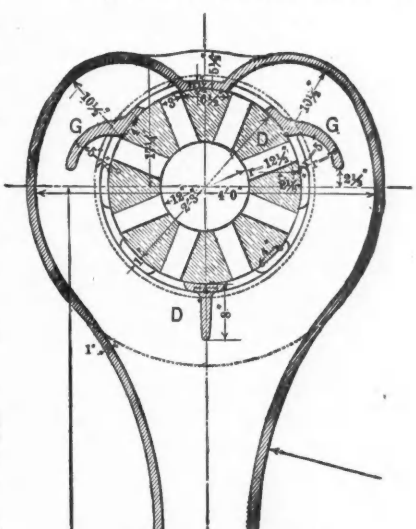


Fig. 206. Cambria Iron Works. 12-Ton Converter Trunnion.

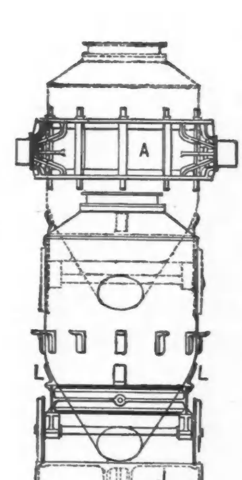


Fig. 207. Holley's Vessel-Shifting Device.

The vessel is inverted, and a heavy car standing on the bottom-jack J (Q in Figure 163) is raised so as to sustain the shell through these brackets, L. The keys I (Figure 202), are then drawn, thus releasing the shell from the trunnion-ring, A. The bottom-jack is lowered till the shell is wholly free from the trunnion-ring, when car and shell are carried away to the repair-shop, *e. g.*, by the track Bt, Figure 168.

The extra cost for installation for this admirable arrangement is not severe. The hydraulic jacks beneath the vessels must be strong enough to lift not merely the bottom, but the shell and lining: and a few strong cars are needed. The strong bottom-jacks are useful for another purpose: they enable us to squeeze the joint between the linings of shell and bottom just so much the tighter, and thus to guard the better against leakage.

The plan is obviously incomparably better than that of carrying away for repairs not only the shell, to whose lining alone repairs are needed, but also the exceedingly heavy trunnion-ring and trunnions, by means of an over-head traveling-crane. First, the cost of such a crane, strong enough to lift the shell and trunnions, and installed at such a height, is great. Next, its motions are relatively slow and clumsy, while nothing could be simpler than the plain up and down stroke of the hydraulic bottom-jack. Then vessel and trunnions must be coaxed into place while swinging from chains, steadied, guided, and lowered little by little; the bottom car, however, brings the shell exactly under its place in the trunnion-ring, and a single stroke of the bottom-jack sets it in place, to be merely keyed on. Again, removing the whole vessel implies duplicating or triplicating the costly trunnion-ring, trunnions and pinion. Finally, breaking and making the blast-pipe connections with the trunnions must waste some time.

a See Holley, Trans. Am. Soc. Mech. Eng., I., 10th paper, 1880.

Justice[h] very slightly lessens the difficulties just mentioned by splitting the trunnion ring, so that when the vessel is turned horizontally, it, together with the then lower half of the trunnion-ring, may be lowered upon a car standing beneath, and carried off for repairs. But then the vessel cannot be relined conveniently while thus lying on its side.

The Trunnion-axis may pass through the centre of gravity of the iron-work and lining of the vessel, bottom included; but it is probably better that it should pass rather below this point, so that the vessel may be slightly top-heavy when empty, for the following reason. We need the greatest rapidity of motion when turning the vessel down after the blow, for, until we have swung it somewhere about 30°, all the tuyeres are still submerged, and all the blast is still passing through the molten metal and burning iron. But at this time, as all the metal is at the bottom of the vessel, we have not only to overcome the inertia of the vessel and bath, but to lift the bath itself. And now, when we most need quick motion, the top-heaviness of our vessel itself comes to our assistance, and helps us turn down. Many vessels have a massive hook on their breast, to which heavy weights can be attached during the last part of the week, when the corrosion of the lining of the breast has lowered the vessel's centre of gravity.

§ 398. THE BOTTOM.—In the bottom itself we have, besides the tuyeres and the refractory matrix which we will consider in § 404, the tuyere-box, F, (Figures 202-4), which receives the blast from the goose-neck and distributes it to the butt-ends of the tuyeres.

The lid, N, which covers it, must be large, quickly removable, and very tightly fitting; large, that the ends of all the tuyeres may be easily accessible for examination and removal; quickly removable, that no time need be lost in examining the tuyeres between heats; and tightly fitting lest the blast be wasted. The importance of having it fit tightly is clear when we remember the length of the joint between lid and tuyere box, about 17 running feet in the case before us. These requirements are fully met by fastening the lid with many keys, R, and by facing it and the edge of the tuyere-box accurately, or even cutting in them a tongue and groove, as in Figure 202. In some cases the joint has been part of the surface of a sphere of long radius.

Though no gasket of any kind is provided, this joint leaves nothing to be desired. Though many bottoms are provided for each vessel, so that each may be long and carefully dried, one lid only is needed. Of course there should be a second lid in reserve, lest an injury to that in use paralyze the establishment.

A light crane, P, Figure 209, serves for handling the bottom-lid for inspection between heats, the vessel then standing turned down, as shown in dotted lines.

The tuyere-plate, O, has round openings which receive the butts of the tuyeres, and which are grooved (Figure 204) so as to make a tight joint with the luting with which the tuyere-butts are coated before they are inserted. The tuyeres are held in place, during the ramming of the bottom-lining, by dogs, clamps or screws of various designs, the important point being that they shall be quickly removable. In case of acid (silicious) linings, the tuyeres are bound so firmly by the lining rammed around them that these dogs are not needed after the bottom is rammed. In some cases, as in Figure 193, a sort of staple projects from the tuyere-plate on either side of each tuyere; a stick of wood or an iron rod is held by these staples across and tightly against the butt-end of each tuyere, during the ramming of the bottom-lining, and is then knocked out, leaving the tuyere-end free for examination.

By means of the false plate, P, an air-space which communicates with the outer air is left between tuyere-box and bottom-lining, for two purposes. First, if the joint between the tuyere-plate and one of the tuyeres be imperfect, the blast which works through simply escapes into the outer air, instead of cutting between the necessarily rather loose bottom-lining and the tuyere a ragged channel, and thus quickly destroying the bottom. 2nd, should a tuyere wear too short during a heat, the molten metal, instead of cutting through and filling up the tuyere-box, goes spitting out through this air-space into the outer air. The pyrotechnic effect of the escape of the first little portion of metal in this way is so striking, that the stage-boy in charge sees it at once and turns the vessel down before any harm is done. The lid or bottom-plate. N, is removed, the short tuyere knocked out, its hole rammed full of "ball-stuff" (plastic clay-balls), and the blowing is resumed with but a few minutes delay.

The sharp swift sparks, due to this escape of metal between bottom and tuyere-box, are readily distinguished from the slow droppings of white-hot metal due to leakage through the joint S, between the lining of the shell and that of the bottom, Figures 202–204. Such a leak can usually be stopped by raising it about the surface of the metal by rotating the vessel, chilling it if need be from without with the hose.

The bottom must be so attached to the shell of the vessel that it can be quickly and easily removed and re-attached. To that end it is almost always keyed on. Figures 202 and 209 show key-bolts, T, riveted to the shell, which pass through eyes on brackets on the bottom. While it is not likely that the shell can warp so much that these bolts would not enter their eyes readily, yet it may be well to avoid this danger wholly by using simple key-links, such as U in Figure 205. But others again object to these links on the ground that when the bottom is removed and the vessel is turned over, they fall off, or at least require attention. Another good form of link (W. R. Jones' design) is shown in Figure 208.

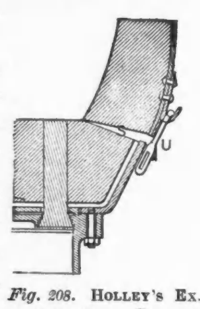


Fig. 208. HOLLEY'S EXTERNALLY RAMMED BOTTOM-JOINT.

TABLE 197—TOTAL AREA OF TUYERE-HOLES IN SQUARE INCHES PER TON OF CAPACITY OF VESSEL.

American, present	from	1.16 to 5.95
Swedish, 1885	"	6.1 to 12.
German, 1871	"	0.8 to 1.83
British, "	"	3.18 to 3.44
Obouchoff		3.73
England and Belgium, 1877		2.1 to 1.5

§ 399. THE SIZE OF THE TUYERE-OPENINGS still varies greatly. I condense Table 197 from the detailed data in Tables 196 and 198. It is at first very surprising that, as happens in some works, all the blast delivered by two 54-inch blast-pistons running at full speed should be squeezed through a lot of $\frac{3}{8}$-inch holes, whose collective

h Wedding, der Basische Bessemer oder Thomas-Process, p. 80, 1884.

area is less than that of a four-inch pipe. One would suppose that the consumption of power which this implies must be very considerable; yet it is hard to conceive any other arrangement by which we can have rapid and uniform blowing, without excessive loss of iron or excessive destruction of the bottoms. But as the total consumption of fuel under the converting-works' boilers is only 300 pounds and in some works only 200 pounds of coal per ton of ingots, and as a considerable part of this is chargeable to blowing the cupolas and to the movements of the cranes, hoists, etc., we can hardly charge more than 14 cents per ton of ingots for blowing-power, where fuel is of moderate price. Indeed, in some mills the fuel for generating the blast probably does not cost more than five cents per ton of ingots. And this, too, without compound engines and with but moderate expansion.

TABLE 198.—SIZE OF TUYERE-HOLES. (SEE ALSO TABLE 197.)

Authority.	Name of Works.	Capacity of the Converter in Tons.	Number of Openings in the Tuyeres.	Diameter of the Openings in Inches	Total Area of the Openings in Sq. Inches.	Area of the Openings in Sq. Inches per Ton.
1. Drown..	Königshütte...	3	49	¼	2.40	0.80
	Neuberg......	3	49	⅓	4.27	1.43
	Zwickau.......	3	42	⅖	5.12	1 71
	Heft...........	2	42	⅓	3.66	1.83
	Crewe...	5	144	⅜	15.59	3 18
	Dowlais........	5	156	⅜	17.22	3.44
2...........	Zeltweg.... ...	5	56	½	11.02	2.20
	"	5	84	½	14.70	2.94
	Obouchoff	5	189	⅜	18.63	3.73
3. Jordan...	England & Belgium about 1877	5 to 7	77	5/12	10.5	2.1 to 1.5
4. Holley...	Brown, Bayley and Dixon, 1879	8	195	5/16	15	1.87
5. Holley...	Another British Mill, 1881..	8	208	⅜	23	2.87

1. Drown, Trans. Am. Inst. Min. Eng., I., p. 88, 1871.
3. Jordan, Jeans, Steel, p. 370, from Album du Cours de Metallurgie, 1877.

§ 400. The ROTATING MECHANISM (Figure 209), almost always consists of a heavily shrouded pinion, preferably of steel, keyed to one of the trunnions (B) of the vessel, and driven by a rack, which is keyed to the end of the piston-rod of a powerful hydraulic cylinder (D). Eccentric vessels should be able to turn through an arc of 270°; concentric vessels—at least those which receive the charge when turned down away from the pit—should turn rather farther, say 300°.

At first placed horizontally, so as to be accessible, the hydraulic cylinders were next set vertically to save floor-room, and beneath the trunnions to secure easy foundations. In this position it was found hard to give the cylinder sufficient length, without carrying it to a depth inconvenient to drain. Of course, the longer its stroke the larger could be the radius of the pinion, and the lighter therefore the stress on the rack. Accordingly the cylinder was next placed above the trunnion—standing vertically. Here it could have whatever length was needed.

The position finally adopted, however, is that shown in Figure 209. The cylinder lies horizontally beneath the platform at the trunnion-level. It is thus wholly out of the way, while the platform prevents rubbish from falling between the teeth of the rack. It is better, however, to protect the rack and pinion further with sheet-iron cases, for even a small lump of metal lodged between the rack's teeth might lead to a serious or, indeed, a fatal accident[d]. I have known a vessel to be overturned, emptying its whole charge into the pit, from such an accident.

The ports of the hydraulic cylinder, shown beneath in Figure 209, should be above the cylinder, so that the breakage of a pipe may not allow the water to leak out of either end of the cylinder. To make this clear, suppose that the vessel-bottom has been removed so that the vessel is top-heavy; that the piston has been moved to the right-hand end of the cylinder, so that the vessel's nose is turned down to the left; that the pipe leading the water to the left-hand end of the cylinder has burst or broken, and that the water has run out. Now the stage-boy, ignorant of what has happened, turns the vessel over to the right by admitting water to the right-hand end of the cylinder. The moment that the center of gravity of the

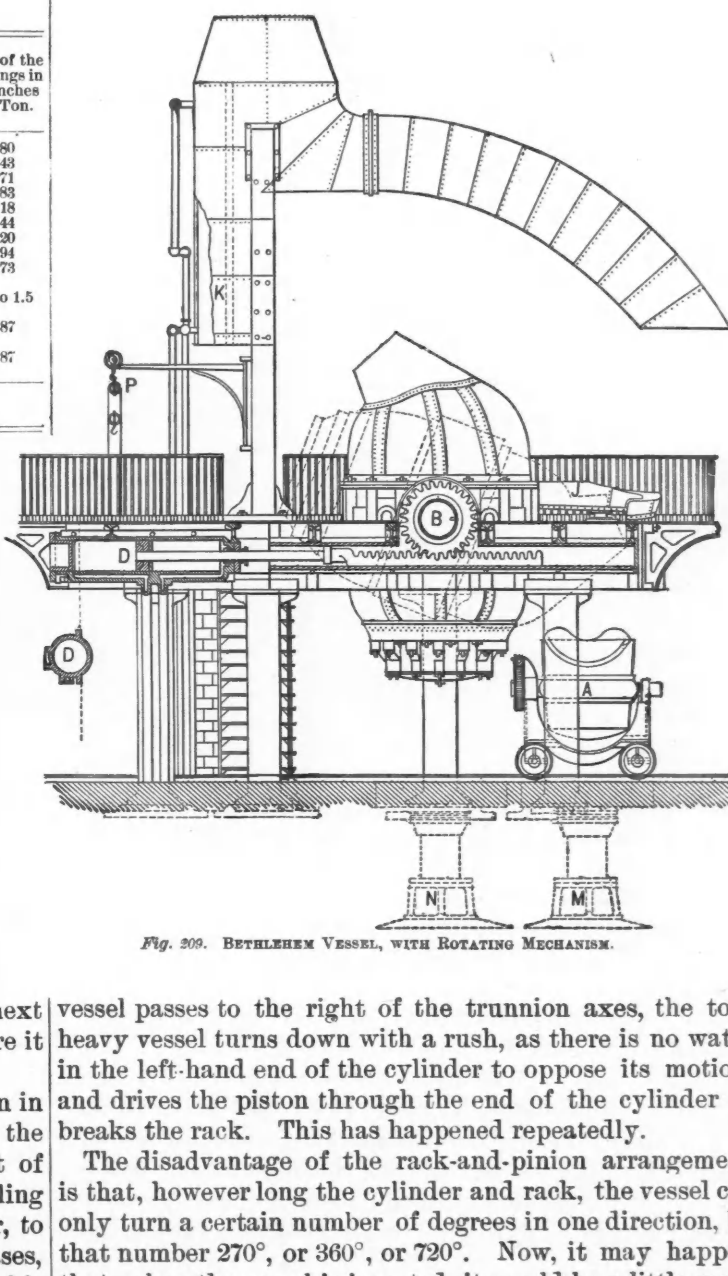


Fig. 209. BETHLEHEM VESSEL, WITH ROTATING MECHANISM.

vessel passes to the right of the trunnion axes, the top-heavy vessel turns down with a rush, as there is no water in the left-hand end of the cylinder to oppose its motion, and drives the piston through the end of the cylinder or breaks the rack. This has happened repeatedly.

The disadvantage of the rack-and-pinion arrangement is that, however long the cylinder and rack, the vessel can only turn a certain number of degrees in one direction, be that number 270°, or 360°, or 720°. Now, it may happen that, when the vessel is inverted, it would be a little more convenient to turn it 90° farther away from the pit to receive a charge of iron on the rear side- than to turn it back 270° to reach this same position. Practically, this disadvantage is of little moment; but to avoid it the ves-

d Some have recommended placing the rack and cylinder horizontally, but so that the rack would be above, instead of below the pinion, in order that lumps of metal and splashings might not lodge between its teeth. Here, however, rack and cylinder would be badly in the way, and enclosing them in sheet-iron cases protects them fully.

sel is sometimes rotated by a worm and worm-wheel, in which case it can, of course, turn indefinitely in either direction. The worm is probably best driven by two or three hydraulic engines. While no serious objection can be made to such a design, probably the great majority of engineers prefer the simpler and wholly satisfactory rack and pinion.

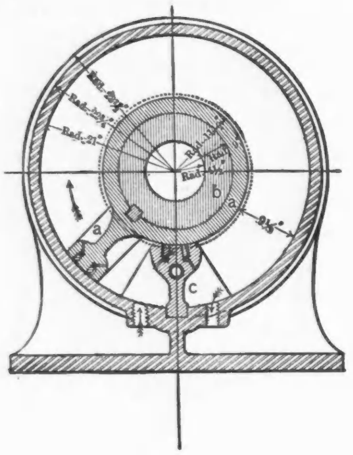


Fig. 210.

Durfee[e] would rotate the vessel by means of a wing-piston, a, (Figure 210), keyed directly to the vessel trunnion b, and turning nearly 360° in a cylinder concentric with the trunnion. In this cylinder is a fixed abutment c, which takes the place of both heads of a common cylinder. Water admitted on either side of this abutment drives the wing-piston in the desired direction. The attachment is certainly more direct than in the rack-and-pinion arrangement, and there should be a saving in power as well as in cost of installation.

§ 401. The Joint Between the Lining of the Shell and that of the Bottom.—In early practice, as soon as the bottom was worn out the stumps of the old tuyeres were knocked out, new tuyeres inserted, and the space between them filled by pouring "slurry" (a semi-fluid mixture of fire-clay, quartz or ganister, and water), through the vessel's nose, and allowing it to set around them. Of course blowing was interrupted during the long time needed for drying this bottom, which, moreover, was most untrustworthy, flaky, inadherent and full of drying cracks. Another way was to allow the vessel to cool, and then make up the bottom from within by ramming "ball-stuff" (a stiff, slightly plastic mixture of clay and quartz) around the tuyeres; or better by placing a previously baked bottom within the vessel, and then ramming ball-stuff into the joint from within the vessel. But here, too, great delay arose, since for twelve or even twenty-four hours after blowing, the vessel was still too hot to enter. Cooling was sometimes hastened by removing the vessel's nose, but then this had to be replaced, and the joint thus made had to be rammed: or by pouring water into the vessel, a practice which injured the lining greatly.[x]

e Trans.—American Institute of Mining Engineers, XII., p. 271, 1884.

x Even as lately as 1879 bottom-joints were made in some British works by pouring slurry through the vessel-nose, so that it ran between the shell-lining and a previously baked bottom. Setting a bottom in this way took five hours, and the bottom itself, soaked and weakened by the slurry, lasted but seven heats (Holley, Priv. Rept., 1880, No. 2, p. 30).

It is strange that Holley and Pearse's simple expedient, of ramming the joint between a previously baked bottom and the vessel lining from without, was not earlier thought of.[a] This, as improved by Holley,[b] Figure 211, lasted till lately, and is in use in some mills even now. The iron-work of the bottom was so shaped that, between the brackets by which it was keyed to the shell, lumps of

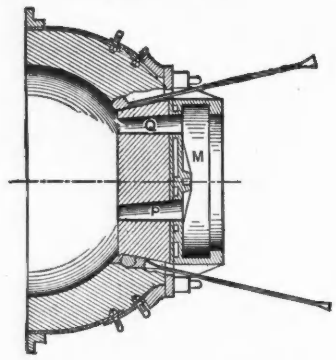


Fig. 211. Holley's Externally Rammed Bottom-Joint—Old Style.

ball-stuff could be inserted and rammed. The bottom was first keyed on while the vessel stood upright. The vessel was then turned on its side, and the balls were rammed in as shown in Figure 211. The vessel was then turned up again, and a few pailfuls of slurry were poured through its nose to fill any cracks in the ball-stuff joint.

In later practice, in the few cases in which this form of bottom is used, the vessel is held upright until a single row of clay balls has been rammed between the upper edge of the bottom and the shell-lining, and is then turned on its side for ramming the rest of the joint. This is done lest the bottom break apart by its own weight when the vessel is turned on its side.

A later form of the joint is shown in Figure 208. This joint is rammed from the pit-level while the vessel stands upright. There is evidently less danger of tearing the shell-lining of the vessel in breaking this flat joint, than in pulling out the conical, tightly wedged bottom of Figure 211. I am informed that this form of joint is very frequently used in Europe.

The dish-bottom, Figures 202–204, is the form now generally used here. Its upper service is level. The joint is made by spreading on the upper side of the bottom a ring or "noodle" of ball-stuff, covering this with a little graphite, and squeezing the bottom tightly against the shell-lining by means of the bottom-jack. The graphite preserves a good parting, so that the bottom, when worn out, may be removed without tearing away the lining of the shell, instead leaving it so smooth that a sound joint is easily made with the next bottom. The powerful bottom-jacks in some recently built works exert a pressure of about 2,000 pounds per foot on the joint, which thus made never leaks. In some works which have neither bottom-jacks nor hydraulic bottom-car, the vessel is inverted, a ring of ball-stuff set on the edge of the shell-lining, the bottom placed on this by means of a crane, and merely keyed tightly. Even this uncompressed joint serves admirably.

As stated in § 376, 2, the total time between blows of a

a U. S. Patent 86,304, Jan. 26, 1869, A. L. Holley and J. B. Pearse.

b U. S. Patent 106,162, Aug. 9, 1870, A. L. Holley.

single vessel, including changing bottoms, has been as short as 17 minutes at the Union (Illinois) works.

§ 402. THE VESSEL-LININGS are usually monolithic, a mass of clay and quartz rammed solidly together and thoroughly dried: some vessels, however, are lined with blocks of stone, which give good results, but so far as my observation goes do not last so long as the monolithic lining. In either case the vessel stands inverted and without its bottom during re-lining.

The monolithic lining is usually made of a mixture of was rammed around an iron core set within the vessel, by a gang of eight or ten men, who marched slowly in the annulus between core and shell, ramming the mixture with butt-rammers like those in Figure 211, a few shovelfuls of the mixture being added at intervals.

In what is perhaps the most successful present practice (columns 17, 18 and 20, Table 199), the mixture, whose materials (quartz, sand and clay) are finely ground together, has so much water that it balls readily, and is indeed a stiff, decidedly plastic mass or "ball-stuff."

TABLE 199.—VESSEL LININGS AND BOTTOMS (CF. TABLE 196).

	1872 1	1872 2	1871 3	1872 4	1872 5	6	7	8	9	10	11	12	13	14	15
Weight of vessel-charge, gross tons						6	6 @ 7	6	7¼	9	7½	10	4	5½	9
Percentage of silicon in vessel-charge						2.2	1.25			1.25		1.45		1.5	
Diameter of vessel									8′						6′
Estimated depth of bath over tuyeres, inches								18±							
Length of blow, minutes and seconds								8′ @ 10′	9′ 30″ @ 15′	12′		21 @ 22′ 45″	11′ 10″—12′ 45″	13′ 28″—14′ 55″	20⅝
COMPOSITION OF VESSEL-LINING BY WEIGHT—															
Quartz, %	53⅓	e 41⅔–f 41⅔	71 3/7 g					Ground millstone grit.	Mica-schist blocks.	66	Ground ganister.	Mica-schist blocks.	Ball-stuff.	Mica-schist blocks, c.	
Fire-sand, %	40		14 2/7							17					
Loam-sand, %															
Fat clay, %	6⅔	16⅔	28 4/7							17					
DURATION OF VESSEL-LINING—Months								9 @ 18			4 @ 7	5	2	12	
Heats									3,750			3,400			
Blast-pressure, pounds per square inch						18		18 @ 25		20					
Diameter of tuyere-holes, inches							⅜	⅜″	⅝″	⅜	½	⅜	½″		⅜
Gross area tuyere-holes, square inches							15.9	35.7	22.5	21.2	30.6	11.6	16.5		17.2
Kind of bottom		Holley.						dish.			i	dish.	i		dish.
Thickness of bottom, inches															
COMPOSITION OF BOTTOM—Fire sand, %	37.5		12½				Ganister bricks.	i	i			Ball-stuff.	Ball-stuff.		Holley bricks, j.
Crushed brick or chammotte, %				60	40					60					
Quartz, %	50	66⅔ h	62½ g		20 h	100 h									
Fat clay, %	12½	33⅓	25	40						40					
Calcined clay, %					40										
Length of time bottom is dried, hours									8 @ 10		24			24	
Number of bottoms kept on hand															
DURATION OF BOTTOM—															
Usual, Heats		4 to 8				14	11.45	25 @ 30	12 @ 16	13		19	24±	16	20 @ 26
Usual, Time collectively									2h. 35′	2h. 36′		6h. 55′	4h. 47′	3h. 46′—6h. 32′	
Maximum, Heats						25	22					23	36 @ 40		
Maximum, Time collectively												8h. 23′	7h. 34″		

TABLE 199.—VESSEL LININGS AND BOTTOMS.—*Concluded.*

	16	17	18	19	20	21	22	23	24	25	26	27	Bångbro. 28	Avesta. 29
Weight of vessel-charge, gross tons	10	6 @ 7		9.2	10.73	5.5	7½	7	7	11	3.5	2 q	2.7	0.39
Percentage of silicon in vessel-charge			1.25	1.8		1.4	1.5	1.6	1.75		2.0		1.02	1.4
Diameter of vessel		6′	10	10±			8′		8′	10′			4′ 10″	3′ 4″
Estimated depth of bath over tuyeres, inches			12¾	13.7	12¼					15½″				
Length of blow, minutes and seconds	13 @ 14		10′ 30″	16	10 @ 11		11′ 30″—13′	10 @ 17			13	10′—16′ 30″	5 @ 7	9′—13′.5
COMPOSITION OF VESSEL-LINING BY WEIGHT—														
Quartz, %		61	66 n	83 n		Ganister blocks.		88					5 vol.	
Fire-sand, %		16	17					Mill-stone grit, p.						
Loam-sand, %														
Fat clay, %		23	17	17									1 vol.	
DURATION OF VESSEL-LINING—Months		12	18	12		6	2	1.5 @ 2						
Heats												4000 @ 8800	200 @ 300	
Blast-pressure, pounds per square inch		20			21 @ 25		20		20	25	17 @ 18		10 @ 17	
Diameter of tuyere-holes, inches	½″	⅜	⅜	½″	½ & 7/16		⅜	⅜	½	⅜			.59	.13
Gross area tuyere-holes, square inches	30.6	15.9	19.8	29.4	34.7		25.2	25.2	19.1	25.1			22	1.2
Kind of bottom		Hol., e.	dish.		dish.	Hol.	i		dish, i.	dish.	dish.			
Thickness of bottom, inches		18							26					8″
COMPOSITION OF BOTTOM—Fire-sand, %		12	26		12		17							
Crushed brick or chammotte, %			20	50	25 o		55							
Quartz, %		47	17		43									
Fat clay, %		41	23	50	21		27							
Calcined clay, %			16 m											
Length of time bottom is dried, hours		24 a—14 b		24	48 @ 96	48	24 @ 48	24	48					
Number of bottoms kept on hand				12			26					10		
DURATION OF BOTTOM—														
Usual, Heats		14	20.56	11±	22.23	20±	15 @ 17½	20	28		15	30 @ 100	150	7
Usual, Time collectively			3h. 38	2h. 56″	3 h. 53″		3 h. 24′	6 h. 10′			3 h.			
Maximum, Heats		25					25		52			52 @ 225		
Maximum, Time collectively							5h. 14′							

a Usually.
b Occasionly.
c With ball-stuff, pin-rammed in the joints.
e Fine ganister.
f Coarse ganister.
g Chickies rock, fine.
h Ganister.
i Like Figure 212.
j Like Figure 213.
l Like Figure 214.
m Coke-dust.
n All materials ground fine.
o Coarse.
p In blocks.
q Clapp-Griffiths.
Hol. Holley conical bottom, like Figure 211.
1 to **5**, Early American.
6. British, 1875.
7. American, 1875.
8 to **26**, Present American.
27. U. S. Clapp-Griffiths.
28-9. Swedish, about 1885.

from 50 to 66 % of coarsely crushed quartz, in pieces whose largest dimension is not over two inches, and from 17 to 25 % of finely pulverized fat fire-clay, the remainder consisting of some finely ground silicious material, such as old fire bricks, fire-sand or loam-sand.

No more fat clay is used than is needed for binding the mass. As this would not be enough to fill the interstices between the large lumps of crushed quartz, some finely ground silicious substance is needed.

Formerly this mixture, only very slightly moistened, This is spread on the floor in a thick layer, and trodden under foot, but not under bare feet. It is then cut up into lumps, which a man standing within the vessel throws against its sides: he then smooths and pats them into shape with a wooden mallet. The lining thus made is dried by a fire within the vessel.

A ten-ton vessel has been lined in the same general way in seven hours. But quick and hence cheap as this way of lining is, it is so effective that at many works the vessels are relined but once a year, during which each may make 14,000 heats, or some 140,000 tons, so that the cost of relining is insignificant when reckoned on the ton of product.

In many works, however, the lining must be patched every week, and with rapid running temporary patching must often be applied during the week.

In 1872 linings made of American refractory materials lasted from 400 to 500 heats: the best British materials gave double this life, or about one-fourteenth the life of our present American linings.

The linings of the Alpine Bessemer vessels last 200 heats of 30 minutes each, according to Ehrenwerth, who estimated that the Avesta little-vessel linings would last 500 heats of 10 minutes each[e]. At Eston the linings are said to last 1,000 heats. Allowing for the difference in the length of the heats, the American linings appear to last about 25 times as long as the Alpine.

In some American works monolithic linings are made from ground ganister[b] or ground millstone grit, both of which give admirable results. The latter is said to last from 12 to 18 months.

Blocks of mica-schist and of millstone-grit are also used in this country for vessel-linings, and with good results. The life of mica-schist linings has been as long as five months, in which 3,400 heats, or 34,000 tons of steel were made in one vessel. I am informed that, at another American mill, stone blocks have lasted a year; in this case they were laid dry, and ball-stuff was rammed carefully between their joints.

In other cases the blocks of mica-schist are laid in thin mortar. They are usually about one to two inches thick, and are laid with their cleavage horizontal: but at either end of the shell a ring of these blocks or slabs is laid with their cleavage vertical, apparently so that the ends of the lining may be thus tightly wedged into place.

Blocks of mill-stone grit, roughly shaped to the circle of the vessel's shell, (10″ wide measured radially, 18″ long measured circumferentially, and 6″ thick measured parallel with the length of the vessel), are also used with fair results, lasting about six to eight weeks, or say 1,200 to 1,600 heats. It is necessary to place a layer of one-inch boards between the blocks and the shell of the vessel, for if the blocks are laid flush with the shell their expansion bursts the iron-work. After a campaign neither boards, charcoal nor ashes can be found.

Silicious brick linings are used in some European works.

The life of certain vessel-linings, the proximate composition of the mixtures used, and the ultimate composition of some of the components of these mixtures are given in Table 199.

TABLE 200.—ULTIMATE COMPOSITION OF REFRACTORY MATERIALS AND MIXTURES FOR THE BESSEMER PROCESS.

Number.	Authority.		Composition. SiO₂										
			SiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	CaO.	MgO.	MnO.	H_2O.	Na_2O.	K_2O.	NaCl	Organic Matter.
		GANISTER—												
1	Maynard	British	93.22	1.36	3.23		0.03	0.35		1.71	0.05			
2	"	" Imported in 1867	94.79	2.89	1.03		0.32	0.12			0.15	0.11		
3	Holley	" Average	84.86	8.15		3.22	0.78	0.48		2.93		0.35		
4	"	"	83.75	4.45		7.00	0.392	0.517	trace				0.73	
5	Snelus	Sheffield	89.55	4.85	0.85		0.60	0.11				0.94		
6	"	Dowlais	93.5	4.23	0.80		0.26	trace						
7	"		82.94 @ 97.31	1.61 @ 10.48	0.19 @ 4.02		0.10 @ 0.78	trace @ .52			.18 @ .30	trace @ .94		
8	Maynard	Chickies Rock	96.54	2.50	.93		0.09	0.20				0.13		
		QUARTZ—												
9		Lake Superior Quartz	93.18	2.37		2.74		.81		.70	.48	.03		
10	Forsyth	" " "	95.5	1.5	2.75		0.40							
11		MOULDING SAND	78.81	12.76	2.71		0.99	1.08	0.91		.13	0.11		2.30
12	Holley	Sand for Ladle, Sheffield	79.75	12.30		1.75	0.55	0.68		4.5				
13	Holley	VESSEL-LININGS, Seraing	87.	8.5			1.			3.6a				
14	"	" " Sheffield	88.2	7.3		1.15	0.13	.27		2.12a				
15	Walker	" " American, 1888	81.5	13.7	3.67		0.75	0.25		2.7				
16	Holley	Ball-stuff, Seraing	78.	17.			1.6			3.5a				
17	Holley	Bottoms, Seraing	67.5	26.5			1.00			5.5a				
18	"	" Sheffield	89.3	3.8		3.6	0.67	.36		2.5				
19	Forsyth	" Illinois	85.5	8.75	2.00					2.85				
20	Holley	Cupola-lining, Seraing	97.8	1.02		.75	0	0		.5				
21	Forsyth	Bottom-bricks, baked	78.5	13.5	2.25					5.				
22	Holley	Tuyeres, Seraing	69.	23.5			2.			5.				
23	Walker	" American	53.4	37.5	5.36		0.70	0.40						
25	Snelus	Tuyeres, British	64.9	30.9	2.60		0.40	0.25				.95		
26	"	" "	58.9	39.3	trace		0.70	.36				.74		
27	"	" "	67.7	27.1	4.05		0.30	trace				.85		
28	Holley	Nozzles	70.	24.			1.2			4.5a				
29	Walker	"	59.25											

a. Water and volatile matter.
Maynard, Private Communications.
Holley, Private Reports.
9-10. Lake Superior quartz used in mixtures for vessel linings, etc.
Snelus, Jour. Iron and St. Inst., 1875, II., p. 516.
Forsyth, Trans. Am. Inst. Mining Eng., IV., p. 132, 1876.
11, Waterford (N. Y.) moulding sand.
Stoppers and nozzles are those of the steel-casting ladle.

e Das Eisenhüttenwesen Schwedens, p. 109, 1885.

b The name "ganister," originally applied to a slightly argillaceous sandstone found near Sheffield, is now applied generically to like silicious rocks containing a little clay, and indeed sometimes to an artificial mixture of ground quartz and fireclay suitable for vessel-linings.

§ 403. WEAR OF THE SHELL-LININGS.—Under certain conditions the shell-lining grows thinner, under others it grows thicker during use. In the former case it must be patched from time to time, chiefly on Sundays, but occasionally also during the latter days of the week. Where accretions form they must be cut out, or sometimes even blasted out with dynamite, so excessively hard are they. J. H. Cremer found in one of these kidney-shaped accretions,[h]

Manganous Oxide,	Silica,	Alumina and Iron-oxide,	Total,
5 %	69 %	25.5 %	99.5 %.

The lining may grow thin from actual wearing away, or from corrosion by the slag and metal. But while the slag may corrode at a given temperature, if the temperature be but slightly lower the same slag may freeze against the sides of the vessel and form accretions. Where the slag comes most in contact with the lining, there will it tend most to cut the vessel if it be sufficiently hot and hence fluid, and sufficiently basic to cut: and here will it tend most to form accretions if so cool as to stick instead of cutting. Other things being equal, the hotter parts of the lining will tend to cut more than the cooler ones.

Now the shape of the vessel, the position of the tuyeres, the depth of metal, and other factors affect the distribution and position of the slag so much, and its composition is so much affected by the proportion of silicon and manganese in the cast-iron, by the depth of metal, the rapidity of blowing, etc., and indeed changes so much during the blow, that a complete analysis of the conditions would be extremely difficult. Suffice it to point out a few considerations.

The path over which the cast-iron runs into the vessel, and that over which the steel runs out, are heated very highly by the passage of the metal, and being the more highly heated tend to cut the more. In certain cases we actually find grooves, which appear as if worn by the passage of the metal, and sometimes a sort of pocket as at A, Figure 196. It is probable that the metal does not itself wear these grooves, but merely heats the lining here so highly that it is readily corroded by the slag, or actually melted out.

This cutting is naturally more severe in vessels which receive and discharge their metal on the same side, than in those which receive cast-iron when turned away from the pit, and discharge steel while turned toward the pit: and it is especially severe in excentric vessels, as in these the blast and the rush of metal during the blow impinge more directly on this spot, which has been so highly heated and softened by the entering and departing charge.

Further, when the vessel is turned down at the end of the blow, as in Figure 201, the pasty slag lies as a placid layer above the molten metal, and has a good opportunity to attach itself to the vessel's sides. As the vessel is turned down still farther to pour the steel out, the fall of the tide beneath leaves the slag adhering to the vessel's sides, especially towards the nose, against whose sides the flow presses the slag which had been in the middle of the surface of that fiery pool, and which floats towards and in part out of the nose with the stream. In a narrow nose the slag engorges, like freshet-ice in a narrowing stream. Hence the nose-blocking so troublesome in the basic process, and hence the ridges of slag at C, Figure 196, which sometimes form even in silicious vessels along the sides, at and beneath the level of the surface of molten metal when the vessel is turned down. Slag so infusible as to be pasty during the blow, becomes hard and solid as it cools between blows.

h Private communication, A. D. 1874.

Still another place where action is apt to be serious appears to be along the level occupied by the slag during the blow itself, say at D, Figure 196.

Finally, there is often a strong tendency to form accretions near the very bottom of the bath of metal, just above the joint between the bottom and the shell lining, as at B, Figure 196. What the cause of this is I know not; but the following is a possible explanation. Just at the end of the tuyeres the metal is highly oxygenated; as we travel farther and farther from this point the proportion of iron-oxide decreases, that of silica increasing, as the silicon is oxidized by the iron-oxide. Now it may be that, at a certain distance from the tuyere-ends, at certain stages of the blow, and with iron of certain composition, there is developed within the bath a silicate of extremely infusible composition. If the swirl and eddy be such as to project this mixture in its infusible yet slightly pasty state against the lining, there it sticks, and, being of the same composition as the iron-silicate in the surrounding bath, is not fluxed or cut by it.

In acid vessels the accretions or skulls may be removed by making the slag more basic, *e. g.*, by addition of lime or of iron-ore, or by intentional over-blowing; this last is surely a costly way of introducing iron-oxide, but we get a very high temperature, while if iron-ore be thrown in it lowers the temperature of the vessel rapidly. So, too, it is thought that when direct-metal is used the vessels skull less than in treating cupola-metal, because of the basic blast-furnace slag, a little of which is apt to run into the vessel along with the cast-iron. The cupola-slag on the other hand is silicious. At certain works hard silicious kidneys form, when the cast-iron is unusually rich in silicon. In others irons with much manganese and little silicon cause skulling, while those relatively free from manganese but rather rich in silicon cut the lining instead of skulling.

Again, there is much less skulling when the steel is recarburized in the vessel, than when, as in making very soft steel, it is recarburized with ferro-manganese in the casting-ladle; for in the former case the oxide of manganese, formed by the reaction between the oxygenated blown metal and the spiegeleisen or ferro-manganese, makes the slag more basic, and especially more fusible and fluid.

The linings of side-blown vessels usually endure fewer heats than those of bottom-blown vessels, because, as pointed out in § 392, the former are much more exposed to iron-oxide, or at least to locally basic slag, than the latter. The linings of British Clapp-Griffiths vessels are reported to last from 400 to 600 heats.[a] The American Clapp-Griffiths vessel-practice is much better than this; at one works the linings usually last 4,000 heats;[b] at another they are said to last 8,000 heats usually, and one lining has lasted 8,800 heats.[b]

At one French works the brick lining of a Robert vessel

a J. Hardisty, Journ. Iron and St. Inst., 1886, II., pp. 657, 660.
b Information from the management, June 7th, 1889.

is patched after about every fifteen heats, and is almost wholly replaced after from 200 to 300 heats: in making soft steel the repairs are still heavier. But, as the blowing is confined to one side of the vessel, parts of the lining, like the greater part of that of common vessels, last indefinitely. On the whole the repairs to the linings of Robert vessels seem much more severe than those of common vessels.[c]

§ 404. Preparation of the Bottom-linings.—In this country the holes through which the blast is admitted are almost if not quite universally contained in previously thoroughly burned fire-clay tuyeres, usually bought from makers of fire-bricks, who burn them in kilns much as in making fire-bricks.

The spaces between these tuyeres may either be wholly filled with "bottom-stuff," a mixture of clay and silicious matter; or they may be partly filled with tiles standing on end, between which in turn bottom-stuff is rammed, as in

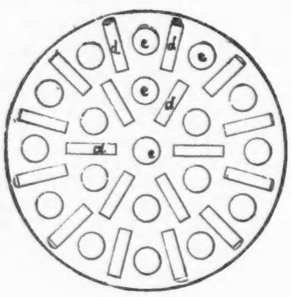


Fig. 212.

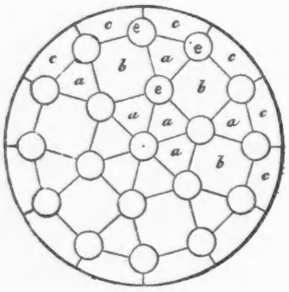


Fig. 213.

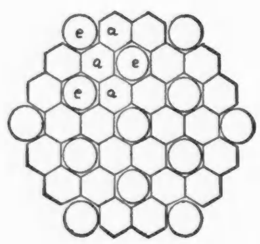


Fig. 214.

Figure 212; or they may be almost wholly filled with bricks shaped so as to fit around the tuyeres closely, as in Figures 213 and 214, a very little bottom-stuff being rammed between these bricks and around the tuyeres, to fill the slight crevices which are unavoidable.

Tuyeres may be wholly dispensed with, the bottom-stuff being rammed around pins which are withdrawn later, leaving holes for the entrance of the blast; but this system can be considered to better advantage in connection with the basic Bessemer process.

In case drying has to be wholly dispensed with, as may occur owing to the sudden unexpected failure of a large number of bottoms in succession, we may build up a bottom wholly of bricks laid with the least possible quantity of mortar, and attach it to the vessel at once. This, however, is but a makeshift.

Cone-shaped bottoms, like that in Figure 211, are made up by ramming within a conical mould. Dish-bottoms clearly need no mould.

The bottom-stuff usually contains much more clay than the vessel linings, from 20 to 40 and even 50%. At some mills all the bottom-stuff is finely ground and thoroughly mixed. In others the ground fire-brick used is in lumps, some of which are 1½ inches long. These coarse lumps promote drying, and also bind the mass together.

Usually a few shovelfuls of bottom-stuff are added at a time, and thoroughly rammed with rammers like those shown in Figure 211, sometimes heated red-hot, that they may not adhere to the bottom-stuff, and that they may assist in drying it. It is barely moist enough to be balled with the hand; it is indeed almost dry. This is so that it may dry the more thoroughly and more quickly, and that the escape of moisture may not crack it.

The bricks and tiles inserted between the tuyeres, Figures 212 to 214, further facilitate drying, at the same time opposing any tendency to flake. Further, the kiln-burning which they receive makes them harder than the simply baked bottom-stuff. But while they probably prolong the life of the bottom, they increase its cost. In one American works these bricks are made of bottom-stuff rammed in a mould, and baked for twenty-four hours.

After thorough ramming the bottom is carefully dried. Enough bottoms should be on hand to allow us to dry each of them for forty-eight hours, though in many works the bottoms are dried but twenty-four hours or even less. Works which are to run rapidly should have at least twelve bottoms. One American works has twenty-six bottoms on hand. The South Chicago repair-shop has twelve bottom-drying hoods.

In the older works the bottoms were placed on a car which was then run into a brick chamber containing a fire-place, and here car, bottom and all were baked, to the great detriment of the running-gear of the car. An excellent arrangement is that shown in Figure 215. The bottom, when its lining is worn out, is removed by means of the bottom-car, which to that end is raised by the hydraulic bottom-jack (*e. g.*, Q, Figure 163), so as to press against the bottom while this is still attached to the vessel. The bottom-jack presses directly against the cast-iron funnel (Figure 215) which hangs down from the car, and the length of stroke which it is necessary to give the bottom-jack is thus shortened by the length of the funnel.

The keys holding the bottom to the shell of the vessel are then withdrawn, and car and bottom lowered and removed to the repair-shop. The bottom does not leave this car until it is again attached to the vessel. The car is run over a pit (see Figure 168), where the stumps of the tuyeres are knocked out, and after them the remaining bottom-stuff. New tuyeres are then inserted, wooden dummies, however, being set in three of the places left for tuyeres. The ends of the tuyeres are then covered, so that the tuyere-holes may not be stopped up by grains of bottom-stuff falling into them and lodging, and the bottom is carefully rammed as above described. It is then placed under the hood shown in Figure 215, which has above a gas blow-pipe, with air and gas supply regulated by the butterfly-valves shown. The flame from this hood passes down through the three holes left by the removal of the wooden dummies, which are knocked out as soon as the bottom is rammed up, and through the cast-iron funnel to a flue leading to the chimney. We can thus heat the bottom gradually at first, while it is still steam-

c Information from the management, July 29th, 1889.

(TO BE CONTINUED.)

ing, and so avoid drying it so fast as to crack it, and later thoroughly bake or even burn it, and that without first burning the iron-work of the car. We apply the heat just where it is wanted, to the bottom-lining itself, and thus with good efficiency.

After thorough baking, tuyeres are inserted in the holes left by the removal of the dummies, and the bottom, while still highly heated, is brought with its car to beneath the vessel, raised again by the bottom-jack, and again attached to the vessel for blowing. It is not well to allow the bottom to cool, as its contraction during cooling may break off some of the tuyeres. In some cases as many as five or six tuyeres have been thus broken in a single bottom.

Certain data connected with the composition and life of bottoms are given in table 199.

The increase in the life of bottoms has been remarkable. In 1872 bottoms lasted but from four to eight heats. In 1875 their life had increased in at least one mill to an average of eleven heats, taken over a period of eight months. The bottoms in this case were made with bricks of baked bottom-stuff, somewhat as sketched in Figure 214.[f] There are now many works in which the average life of the bottoms is more than twenty-five heats.

Heavy blast-pressure, short and cool heats, small tuyere-holes, small depth of metal above the surface of the tuyeres, as well as proper materials, careful ramming, and above all very thorough baking, all lengthen the life of the bottom. The heavy blast-pressure, small tuyere-holes and small depth of metal probably lengthen the life of the bottom by lessening the intimacy of contact of the tuyeres (and it is they that cut out before the surrounding bottom) with the bath of metal, which in the neighborhood of the tuyere-ends is highly charged with iron-oxide, a powerful flux for the silicious tuyeres. The smaller the tuyere-holes the more rapidly will the blast emerge from them, and the more will it lift the metal from them.

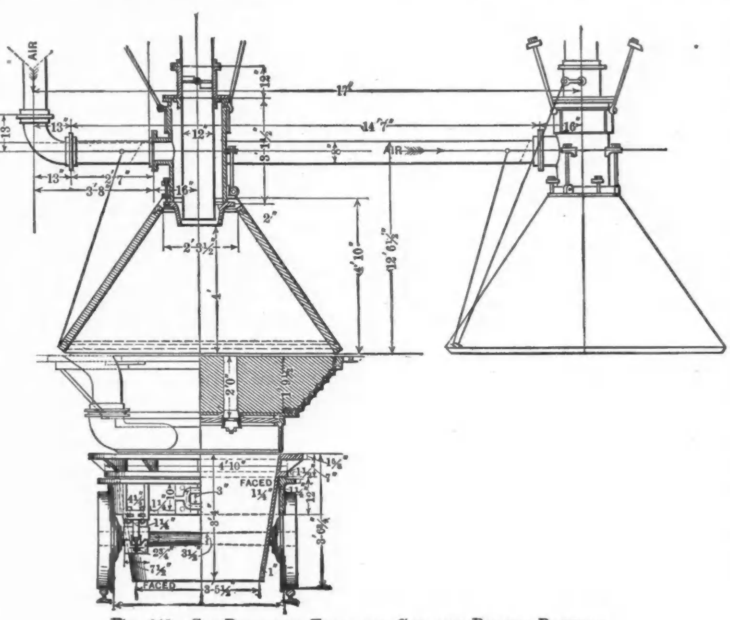


Fig. 215. GAS-BLOWPIPE HOOD AND CAR FOR DRYING BOTTOMS.

The direct effect of heavy blast-pressure is probably to corrade the ends of the tuyeres, but this effect is outweighed by its holding the metal away from the tuyere-ends. I have already pointed out in § 392 that the life of the tuyeres, and hence of the bottoms, is very much greater in side-blown vessels, such as the Clapp-Griffiths and the Robert, in which the blast enters near the upper surface of the metal, than in bottom-blown vessels, rising even to 225 heat.

While, in view of the many factors which influence the life of the bottom, the data at hand do not indicate decisively the most long-lived type, yet they corroborate in a rough way some of the points which I have just noted. We find in case of the bottom-blown vessels of Table 199, that, taking *the average of the average life of each class* the monolithic bottoms, rammed around tuyeres, last 17.5 heats, bottoms like Figure 212 last 21.4 heats, and those like Figure 213 last 23 heats, which indicates in a rough way that the burnt fire-bricks set in the bottoms prolong their lives. I am informed that in Continental Europe, where the space between the tuyeres is almost completely filled by burnt bricks, the bottoms usually last 25 heats or say 15 minutes. So, too, bottoms which are dried for 24 hours or less last on such a general average 15 heats, while those dried 48 hours or more last 23 heats.

In the Walrand (Robert) vessel, instead of using the common fire-clay tuyeres, the blast was formerly admitted through openings in the sides of the monolithic silicious vessel-lining, formed by ramming basic material around little wooden plugs.[f] The strong local corrosive action of the iron-oxide of the metal on the lining was thus lessened. This practice has since been abandoned.

In bottom-blowing, after a bottom has been in use for a number of heats, partly determined by experience, partly by inspection through the vessel's nose between heats, the length of its tuyeres must be determined by actual measurement, *e. g.*, by passing a wire with a hooked end through the tuyere-holes from behind, while the vessel is turned down between heats. Starting with a length of two feet, the bottom is used in some mills till the shortest tuyeres are only 4″ to 5″ long. As 2.5″ to 3″ of the length of the tuyere lie below the false-plate P, this means that the bottom is used till its lining is only from 2″ to 3″ thick in the thinnest parts.

A convenient device for learning when the bottom is worn thin is to insert in the bottom, before ramming it, a short dummy tuyere, say seven inches long, which projects only some five inches above the false-plate P, Figure 203. When the bottom is worn down to the end of this dummy tuyere, which can readily be learned by inspection through the vessel's nose between heats, the bottom may be removed, or at least the length of its tuyeres should be examined carefully by direct measurement.

In earlier practice if one or two tuyeres were worn too short while the rest of the bottom was still in condition to blow another heat, the vessel was turned down on its side, the bottom-plate was removed, the short tuyeres were cut out, and the holes thus left were rammed full of ball-stuff. There is usually time between heats to do this without delaying matters, for a tuyere can be thus "blinded" while the cast-iron for the succeeding charge is running into the vessel.

In present practice it is found better to cut out the old

f. Forsyth, Trans. Am. Inst. Mining Eng., IV., p. 132, 1876.

f J. Hardisty, Journ. Iron and Steel Inst., 1886, II., p. 660.

tuyere and insert a new one, preferably of smaller diameter and coated with wet fire-clay.

But tuyeres are still sometimes "blinded," wholly or in part, by inserting in the tuyere-holes "rat-tails" of fire-clay, which are then rammed lightly; or, if we are greatly hurried, by throwing a ball of wet plastic clay against the butt of the tuyere, and covering it with a thin iron plate, which the blast-pressure and the adhesion of the clay hold in place.

When the bottom is worn out, its upper surface looks somewhat as sketched in Figure 202, with deep-gougings here and there at one or more of the holes of some of the tuyeres.

§ 405. Special forms of converters.—Within the last few years several forms of converters have been brought forward, which are said by certain interested persons and by some others to produce results which are so different from those attained in the converters previously used as to constitute new processes, *e. g.*, the Clapp-Griffiths and the Robert "process." Thus the "Directory to the iron and steel works of the United States" for 1887 divides the steel works of the country into Bessemer, open-hearth, crucible and Clapp-Griffiths, implying that the difference between the Bessemer and Clapp-Griffiths process (?) is co-ordinate with that between the Bessemer and the open-hearth process. So, too, most astonishing accounts of the Robert process (?) have appeared in the non-technical papers.

A change in the shape of the vessel or in the manner of introducing the blast is likely to induce some modification in the process itself, perhaps trifling, perhaps important. But it certainly seems that those pecuniarily interested have given others, and probably themselves, a very exaggerated notion of the importance of these particular modifications. They have, in some cases through inadvertence or hasty judgment I believe, put themselves in a wholly false position, by claiming to obtain startling results by means which appear wholly inadequate, without offering sufficient evidence that these results have actually been reached. From this position they might extricate themselves by showing that the means are really adequate, or by properly substantiating their claims.

§ 406. The Clapp-Griffiths vessel, Figure 216, is essentially a high-side-blown stationary vessel, with a spout H at such a level that the slag runs out of it during the boil. This slag-spout is the only real novelty.* Its effect can better be considered under the chemistry of the Bessemer process. Thus far I have found no jot of evidence that it accomplishes anything valuable; nor is there strong reason to expect that it should. At G is shown the tap-hole through which the steel is removed at the end of the blow. The blast enters the wind-box C through the goose-neck K, in which the valves L enable us to shut off the blast almost or quite wholly.

Arrangements have been devised for preventing the steel from backing into the tuyeres when the blast is shut off at the end of the blow. The simplest way, however, is not to shut the blast off entirely, but to admit just enough of it into the wind-box to keep the metal out the tuyeres. In practice this is found wholly effective.

For cleaning the tuyeres a readily opened door is provided in the wind-box opposite each.

The bottom section of the vessel is removable, the joint as shown being high above the tuyeres. As already pointed out, the life of the bottom is excellent.

Beneath the vessel is a hydraulic cylinder, P, for removing and replacing bottoms.

There was but one Clapp-Griffiths vessel in this country in 1884; there were 13 in August, 1886; 16 in November, 1887, and 15 at the end of 1888, one having been removed to Mexico.

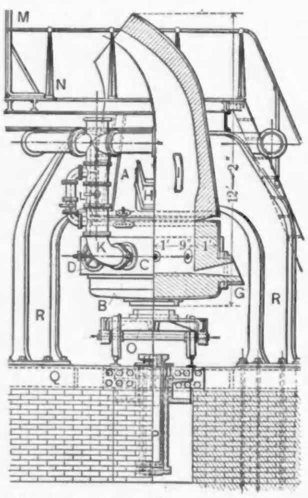


Fig. 216. Clapp-Griffiths Bessemer Converter.

The increase in the number of other Bessemer vessels was 13 between September 1884 and August 1886; 16 between August 1886 and November 1887; and 8 between November 1887 and December 31st 1888.

In short, between August 1886 and January 1889 only three Clapp-Griffiths vessels were built, against twenty-four other Bessemer converters.

It is not easy to make a fair comparison between the rate of increase of the production of Clapp-Griffiths and of other vessels, because the great mass of the non-Clapp-Griffiths Bessemer steel goes into rails, while none of that made in Clapp-Griffiths vessels does, and the demand for rails bears no close relation to that for the ingot-iron made in the Clapp-Griffiths vessels. The best approach to fairness, and it is not a very close approach, which I can make, is to compare the increase of the output of the Clapp-Griffiths vessels with that of Bessemer steel used for purposes other than rails. This class includes the soft steel made in common Bessemer vessels, which is used for the same purposes as that made in Clapp-Griffiths vessels; indeed, the two are probably wholly undistinguishable by any but transcendental tests.

Table 201.—Increase in the Number of the Clapp-Griffiths Vessels in the United States, and of their Output.

Date.		Sept. 1884.	Aug. 1886.	Nov. 188?.	Dec. 1888.
1. Vessels existing.	Clapp-Griffiths	1	13	16	15
	Other	45	58	74	82
Period.			1884 to 1886.		
2. Vessels built...	Clapp-Griffiths	....	12	3	-1 1
	Other	....	13	16	8
Year.			1886.	1887.	1888.
3. Output	Clapp-Griffiths	....	46,371	68,679	81,157
	Other than rail	....	473,907	587,115	931,105
Total Bessemer		....	2,541,493	3,288,357	2,812,500
Year.				1887.	1888.
4. Percentage of increase of output over that of preceding year.	Clapp-Griffiths	....	....	48.1	18.3
	Other than rail	....	....	23.9	58.6

Thus the construction of Clapp-Griffiths vessels took a sudden start between 1884 and 1886, owing, we may sur-

* I have heard it said that this slag-spout is no real novelty, as it was used on the old Swedish vessels (Figure 188); they certainly had such a spout, but I am informed that it was not used for removing slag. Indeed, the Swedish steelmakers wisely preferred to retain the slag, so as to keep the metal hot while in the casting-ladle. (Consul Goransson, private communication, April 13th, 1888.)

† Trans. Am. Inst. Min. Engineers, XIII., pp. 745, 753; XIV., pp. 139, 919; XV., p. 340. Science, VI., p. 342, 1885. Stahl und Eisen, VII., No. 5, 1887. Journ. Iron and St. Inst., 1886, II., p. 654.

mise, to the remarkable claims made for the so-called process; but it seems that experience has not verified these claims to such a degree as to induce manufacturers to adopt these vessels farther. In accord with this is the great increase in the output of the Clapp-Griffiths vessels in 1887, following the completion of those built in 1886. In 1888, however, the ratio of increase in the output from Clapp-Griffiths vessels is much less than that of steel for purposes other than rails and made in other vessels (line 4, Table 201).

The fifteen Clapp-Griffiths vessels existing in 1888 had a nominal capacity of 43 tons per heat collectively, and should be able to turn out some 1,000 tons per 24 hours, or to turn out the total output reached in 1888 in some 80 days of active running. The other Bessemer converters existing in 1888 had a nominal capacity of somewhere about 500 tons per heat collectively, and should, if turning out as many heats per 24 hours as the Clapp-Griffiths vessels, have a total capacity of about 11,500 tons per 24 hours. At this rate they would turn out the total output reached in 1888 in about 175 days. This gives the Clapp-Griffiths vessels an unfair advantage, for their small heats should be more rapidly handled in the casting-pit. But even taken in this way it would seem that the Clapp-Griffiths vessels were less than half as fully occupied during 1888 as the other vessels, although the output of rails in 1888 was much below that of 1887. In other words, while the capacity per heat of the Clapp-Griffiths vessels is about one-tenth of that of the other Bessemer vessels, the actual output of the latter in 1888 was more than twenty times that of the Clapp-Griffiths vessels.

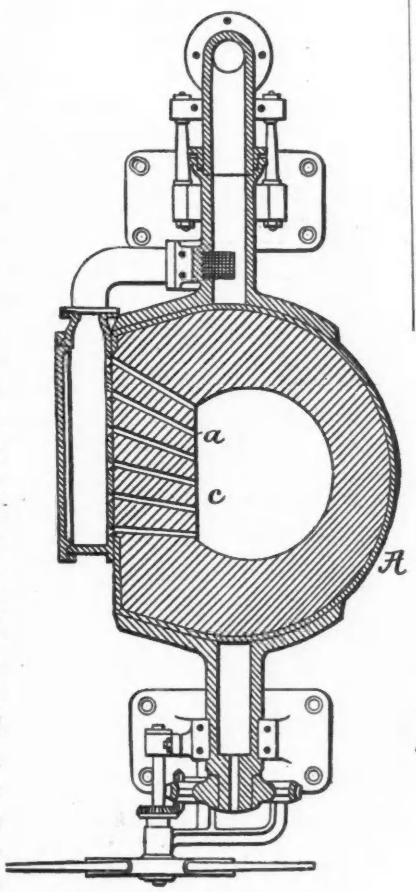


Fig. 217. THE ROBERT CONVERTER PLAN.

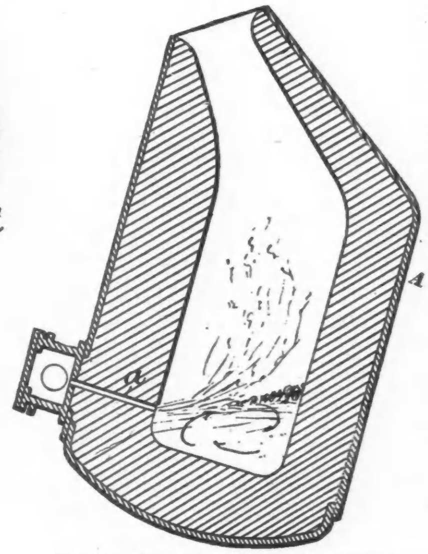


Fig. 218. SECTION OF ROBERT CONVERTER.

The Clapp-Griffiths vessels in Britain seem to be doing well, but the French ones have not been successful: several have been abandoned, and I do not learn of one now running.

Hatton's Converter seems to be essentially like the Clapp-Griffiths, except that it lacks the slag-spout.

§ 407. IN THE ROBERT OR WALRAND VESSEL[k] (Figures 217, 218) the blast is introduced through horizontal tuyeres near the upper surface of the metal, and placed semi-tangentially, so as to give the bath a rotary motion. The vessel itself is rotary; it is tipped so that during the first part of the blow the tuyeres almost emerge from the bath, and as the blow proceeds the level of the tuyeres is gradually lowered.

Rotary motion of the bath is sought, in order that the action of the blast may be less strongly localized. This, of course, is no novelty, having been adopted in the old Swedish vessels. Great stress is laid on the highly localized "stripping" or "atomizing" action of the blast, on the gyrations of the bath, and on regulating them so that, while they may expose each particle of the metal to the blast in turn, they may not draw down into the bath of metal the "impurities" already separated.

As far as I can make it out, the idea is that in bottom-blown vessels "the impurities" eliminated from the cast-iron become mixed up with the iron, while in the Robert vessel they do not. First, bottom-blowing is not essential to the Bessemer process: the earlier successful vessels were blown from the sides. Rotary motion was induced in a way closely similar to that of the Robert "process" by setting the tuyeres semi-tangentially. High-side blowing was adopted long ago by Durfee, and later by Clapp and Griffiths. Here, then, is no novelty. It is claimed, apparently, that restricting the blowing to one side of the vessel leaves the "impurities" in a quiescent state on the leeward side of the vessel, while if the blast enters on all sides this repose is lost. What now are these impurites eliminated during the process, whose return is to be dreaded? Gases, which rush out of the vessel's nose; slag, which cannot be made to unite with the iron by any possibility; iron-oxide, the purifying substance itself, licked up voraciously by the slag, probably wholly removed by the recarburizer.[m]

Where is the evidence that injurious impurities, removable by such purely mechanical means, exist in Bessemer steel, or that one-sided blowing furthers their removal? What the reason to expect that it should? Shall in-

[k] U. S. Patents 395,633, Jan. 1st, 1889: 400,010, March 19th, 1889: Harper's Weekly, XXXIII., No. 1679, p. 151, Feb. 23d, 1889: Iron Age, XLIII., p. 656, 1889: Journ. Iron and St. Inst., 1886, II., p. 659. We are informed in Harper's Weekly that "the Bessemer converter must be relined after a very few blasts; the Robert after 1,000 blasts;" that the metal is heated much hotter than by the Bessemer process and is therefore more fluid. Actually the lining of the Bessemer converter lasts many thousand blows, and the difficulty usually is to keep the temperature down, not up.

In the earliest description of this vessel which I have seen (Hardisty, Journ. Iron and St. Inst., 1886, II., p. 659), it is spoken of as the "Walrand" converter. It is now always called the "Robert" vessel so far as my observation goes: and M. Robert informs me that the design is his solely. A letter of inquiry on this subject which I have sent M. Walrand remains unanswered.

m During casting, when metal and slag become cool and viscid, there is indeed danger of their becoming mixed. But this danger is not lessened by keeping them separate during the blow while molten, for then they separate automatically and need no aid. It is mixing during and immediately before their pouring, and not during the blow, that we should avoid.

The oxide of iron is the purifying substance itself, to borrow the language of the ventors next patent stirring porridge to left instead of right; methods of making wood float and lead sink?

The chief advantage claimed for the Robert over the common converter is that it yields a better product and a higher temperature, so that it can be used advantageously for making small steel castings.

The present evidence that its product is superior is of the usual wholly unsatisfactory kind, and merits neither presentation nor rebuttal.

I see nothing in the many castings which I have seen, made from the Robert vessel, which indicates that an extraordinarily high temperature is reached; some of them were doubtless cast at a decidedly high temperature, yet not higher than can be readily attained in common vessels. I am sure that the temperature in the vessel when it was turned down after the blows which I have seen was not higher, and I think that it was decidedly lower, than that of the common vessel at the end of a normally hot blow: and so said an eminent metallurgist who was with me. Yet the conditions at hand should have insured an unusual temperature even in a common vessel, for the cast-iron was an unusually "hot" one, containing 2.4% of silicon, 1% of manganese and 3.75% of carbon; the walls of the vessel were unusually thick, about 16″ I was informed; and the charge was recarburized with only 1% of ferromanganese, so that the chilling effect of a large recarburizing addition was avoided.

But suppose that that we conceded that an unusually high temperature may be reached thanks to these precautions, to the combustion of an excessive proportion of the iron of the charge (it is admitted that the loss is 15%, and, judging from the amount of smoke and from the well-known tendency of the siderurgical mind to persuade itself that the loss is much lower than it actually is, I should put the loss at nearer 18%, or say half greater than in common vessels), and perhaps to the combustion of an unusually large proportion of the carbon to carbonic acid, due to introducing the blast near the top of the bath—admitting all this, what follows? That these same conditions can be reproduced in the common converter, by inclining it so as to bring some of the tuyeres near the top of the bath, as has long been habitually done in case of unduly cold heats.

But as this is not patentable, while the mysterious gyrations, moderation and regulation of currents, and atomizing stripping action seem to be, the cynic readily surmises why the former simpler explanation is less palatable to the promoters of the Robert process than the latter, which, foggy, mysterious, incomprehensible, is certainly of the kind which, rightly or wrongly, we involuntarily associate with charlatanry and imposture. Therefore, while I believe that M. Robert is quite sincere though clearly mistaken as to the rationale of the effects of his particular modification of the Bessemer converter, it seems well to warn the public that wholly disinterested experts regard the extravagant statements of the promoters of his process (?) most incredulously, and are most skeptical as to its possessing any real value.

Laureau's Converter.—The corrosion of the lining is, of course, much more rapid at the tuyeres than elsewhere. In these high-side-blown vessels the renewal of the tuyeres implies renewing a considerable mass of lining below them. To obviate this the tuyeres in Laureau's high-side-blown vessel lie in a separate zone or ring of the lining, quite distinct from the bottom proper. When this ring is worn out a new one is inserted, the old shell-lining and the old bottom remaining in use.

Instead of introducing tuyeres all around the circumference of the vessel, he groups them close to the plane of the trunnions, *i. e.*, just beneath the trunnions and slightly to right and left. As there are no tuyeres in the front of the vessel (*i. e.*, the part nearest the pit), we do not have to turn the vessel through so many degrees to bring the tuyeres above the surface of the metal as in Bessemer's rotating side-blown vessel, Figures 185, 186[e].

§ 408. DAVY'S PORTABLE CONVERTER, Figure 219, is a half-ton bottom-blown rotating vessel, whose trunnions rest in fixed supports during blowing. At the end of the blow the vessel is turned down by a hand- or power-driven worm, gearing into a worm-wheel on one of the trunnions. The charge is then recarburized and rabbled, and the vessel, together with its trunnions, is carried by a crane to the casting place, leaving the standards free to receive another vessel.

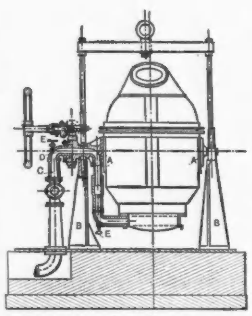


Fig. 219. DAVY'S 10-CWT. PORTABLE VESSEL.

This arrangement aims to avoid the loss of heat which occurs when the steel is poured into a relatively cold ladle, and which is the more serious the lighter the charge. A vessel so small as to be portable is not suited to the production of ingots, while, if castings are to be made, a serious difficulty arises:—in dispensing with the casting-ladle we have thrown away the only certain way of keeping the infusible slag from running out of the vessel into the moulds, and so ruining the castings.

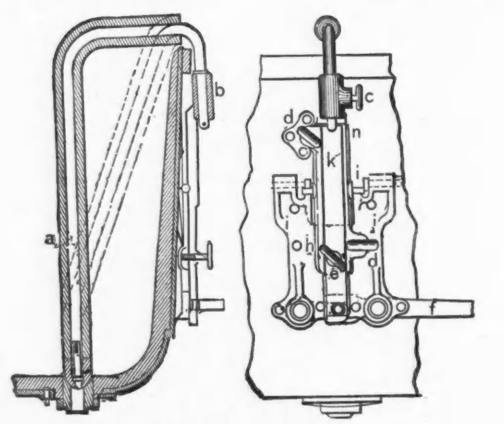


Fig. 220. CASTING-LADLE.

a Stopper-Rod. b Socket. c d e Hand-Screws. f Lever. h Guide. i Casting riveted to Ladle. k Sliding-Bar. l Trunnions.

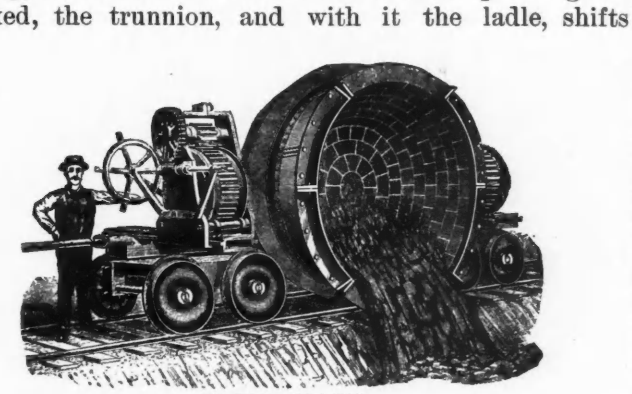
§ 409. THE LADLES.—Those for cast-iron discharge their metal by tipping. They are made of boiler-plate, and

quack It is by oxide of iron that the carbon, silicon and manganese are removed. To prevent oxide of iron from impregnating the bath, if it were possible, would be to arrest the process. Now it is only the last traces of iron-oxide that can remain mixed up with the molten metal during the blow. The great bulk of it either oxidizes carbon, etc., or separates itself by gravity from the metal, which is able to dissolve but a minute portion of it. As this minute portion must be and is mixed u with the metal in the Robert vessel, it profits nothing to attempt to keep the rest of the iron-oxide from the metal. Such propositions do not deserve serious consideration.

e U. S. Patent, 358,559, March 1st, 1887.

suspended from trunnions. An arrangement for tipping is shown at F and K in Figure 163.

Figure 221 shows a ladle for carrying molten cast-iron from the blast-furnace to the Bessemer converters. In tipping, as the rack into which the trunnion-pinion gears is fixed, the trunnion, and with it the ladle, shifts



Tilting Ladle-Car, with Ladle Tilted.

Fig. 221. WEIMER'S DIRECT-METAL LADLE.

towards the side to which we tip it, so that the stream of metal the more readily falls clear of the ladle-car and the tracks.

The Steel-ladles discharge the steel through a fire-clay nozzle in their bottom, as shown in Figure 220, and also at L in Figure 163. If we attempted to cast the steel over the edge of the ladle, as in foundry practice, the infusible slag which floats above the steel in the ladle, and which acts as a blanket to keep it hot, would run into the moulds. It would, moreover, be impossible to pour rapidly, much scrap would be made, and the fall of the stream of molten metal would be excessively long, cutting the mould-bottoms (stools) and agitating the metal. Still, it is necessary to provide rotating gear as shown at L in Figure 163, so that we may adjust the ladle to deliver its stream of molten steel vertically into the moulds, thus compensating for any irregularity in the shape of the nozzle. It might be thought well to provide the ladle-trunnion with a whole worm-wheel instead of only a sector of one, as shown, so that in case the steel chilled in the nozzle of the ladle it could be poured out over the upper edge, lest it freeze into a solid unmanageable mass. In this case, however, it is less easy to invert the ladle after teeming, so as to pour out the slag.

The Nozzle is stopped by a graphite or fire-clay plug or "stopper," keyed to the end of an iron stopper-rod, as shown in Figure 220. This rod may be covered with a sleeve of annular fire-clay bricks, or it may be coated with a plastic mixture of fire-clay and sand and then baked. Examples of the proximate composition of such mixtures are given in Table 202, and of the ultimate composition of fire-clay nozzles in Table 200. The stopper-rod coatings are generally richer in fire-clay than the "ball-stuff" and other refractory mixtures used in the Bessemer process, and are applied to the stopper-rod in a very soft state. After baking, the drying cracks are plastered over.

It is important that the stopper should fit the nozzle closely. We adjust the stopper-rod in one direction by turning it in the socket *b*, and then clamping it with the hand-screw *c*. To adjust it in the other direction Holley's ingenious device is used[j]. In this the stopper-rod is as usual raised and lowered by the lever *f*, but the guide *h*, in which the sliding-bar *k* plays, instead of being fastened rigidly to the shell of the ladle, rests by its trunnions *s* on a casting *ii* which is riveted to the ladle. By means of the hand-screws *dd* the sliding-bar, and through it the stopper-rod, can be rocked about the trunnions to adjust the stopper. The guide *h* is then clamped by *dd*.

The stopper thus adjusted, the hand-screw *e* clamps the sliding-bar down till teeming begins, lest the molten metal buoy up the stopper-rod and allow the steel to escape through the nozzle. It is well to make the stopper-rod straight, as shown in dotted lines, lest its expansion when heated by the metal uncenter it, as may happen with the bent stopper-rod shown.

The Linings of ladles for carrying direct-metal from the blast-furnace to the vessels should be thick to diminish the loss of heat during the transit, and especially in winter. They are usually of fire-brick.

The steel-ladles should have as light a lining as practicable, as their weight must be supported at arm's length by the casting-crane. Formerly lined with a more or less clayey mixture, and even now in some European works with three inches of fire-brick, in this country they are almost, if not quite, always lined with moulding sand about as moist as in common foundry moulding. After lining, the ladle must be thoroughly dried, and, especially in case of soft steel, well heated. This was formerly done by inverting the ladle over a coke fire, or by a coke fire within it, blown with a gentle blast. A better way to dry the ladles is that already shown in Figure 215 for bottoms. The composition and life of some ladle-linings is given in Table 202.

TABLE 202.—MIXTURES OF REFRACTORY MATERIALS FOR APPARATUS FOR THE BESSEMER PROCESS.

	Works.	Weight of Charge, tons.	Kind product.	Proximate Composition. Fire-sand.	Moulding-sand.	Quartz.	Loam-sand.	Fat Clay.	Life. No. heats endured.	Period covered.	Life Cupola Lining. Days per campaign.	Tons melted per campaign.
LADLES	American	6 @ 7	Rail-steel	..	..	..	100	..	40 @ 50	1887	......	....
	" d	8	"	..	..	..	100	..	25	"	......	....
	" d	9.2	"	..	..	..	....	..	10	"	......	....
	"	5.5	Soft-steel	..	..	..	100	..	8 @ 10	"	......	....
	"	4	"	..	..	..	100	..	....	"	......	....
	"	7	"	..	..	..	100	..	....	"	......	....
	"	7½	Rail-steel	..	..	..	....	..	40	"	......	....
	"	7	"	..	..	..	....	..	32	"	......	....
	"	7¼	"	..	..	..	....	..	15	"	......	....
	"	......	....	20	60	..	....	20	....	1872	......	....
	"	......	....	..	34	..	....	66	....	1872	......	....
	Seraing	6	....	Fire-brick lining				..	Sides 50, bottom 25		......	....
STOPPERS	American d	10	Rail-steel	..	..	..	....	..	2.25	1888	......	....
	"	6 @ 7	"	..	..	..	100		....	1887	......	....
	" d	10	"	..	..	..	....	..	2.5	"	......	....
	"	7 @ 8	"	..	..	..	....	..	5	"	......	....
	"	7	"	..	..	..	....	..	3 @ 4	"	......	....
	"	7¼	"	..	..	..	....	..	....	"	......	....
	"	......	....	29	28	..	....	43	....	1872	......	....
	"	......	....	44	..	..	....	41	... .	1872	......	....
STOPPER-SLEEVES	American d	9.2	"	..	..	..	....	..	2.5	1888	......	....
	"	7¼	"	..	..	..	....	..	3.	1887	......	....
	"	10	"	..	..	..	....	..	1.99	1888	......	....
NOZZLES	" d	10	"	..	..	..	....	..	3.25	1888	......	....
	"	7	"	..	..	..	....	..	4	1887	......	....
	"	7¼	"	..	..	..	....	..	2	"	......	....
	"	7 @ 8	"	..	..	..	....	..	5	"	......	....
	" d	9.2	"	..	..	..	....	..	4	"	......	....
	"	10	"	..	..	..	....	..	7.11	1888	......	....
CUPOLA-LININGS	"	10	"	32	..	50	....	18	....	1888	2 @ 5	....
	"	6 @ 7	"	15	..	62	....	23	....	1887	1⅓ @ 2	....
	" d	8	"	66	..	..	17	17	....	1888	3	....
	"	5.5	Soft-steel	Sand-stone				..	....	1887	3	....
	"	4	"	Ball-stuff				..	....	"	3	....

d Direct-metal is used, *i. e.*, cast-iron direct from the blast-furnace, while still molten.

Our loam-sand ladle-linings are so trustworthy that, visiting one American mill fourteen years after it started,

j U. S. Patent 86,303, Jan. 26th, 1869. A. L. Holley.

I found all the original ladles still in use. I was informed that, during all this time, there had been but four cases in which a ladle had burnt through.

§ 410. CASPERSSON'S CONVERTER, LADLE[m] aims to diminish the loss of heat, and consequent formation of scrap and skulls, which occurs when small charges of soft steel are poured from the vessel into a common casting-ladle, by diminishing the size of the ladle, and by allowing any given particle of steel to remain in it but a few minutes. The ladle DDD, Figure 222, is luted and firmly keyed to the mouth of the vessel, after the latter has been turned down at the end of the blow. No recarburizer is used at Westanfors where the converter-ladle is in use. If the charge were to be recarburized, it would have to be mixed before attaching the converter-ladle by rabbling, by turning the vessel up for a few seconds, or otherwise.

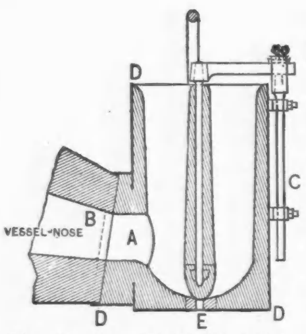


Fig. 222. CASPERSSON'S CONVERTER-LADLE.

After attaching the ladle five minutes are allowed for the luting to dry, and then the vessel is turned a little lower so as to let a little steel run into the ladle. This is purposely made very small so as to abstract as little heat as possible from the metal. Indeed, most of the metal is held back at first in the extremely hot and thick-walled converter, and only runs gradually into the ladle, passing rapidly through it into the moulds.

On raising the stopper by means of the stopper-rod, C, the metal runs through the nozzle of the ladle into moulds standing on a turn-table, which brings them in succession beneath the ladle.

Before teeming begins the tuyere-box must be opened, *e.g.*, by removing the lid N, Figure 204, so that air may enter the vessel to take the place of the steel that runs out; but for this the air would bubble in through the ladle, interfere with teeming, and cool the metal.

The small size of the ladle, and the short stay of the steel in it, give us a higher casting-temperature for given temperature of blow, an important thing especially when small ingots of soft steel (ingot-iron) are to be cast. As the steel is hotter there is less danger of its freezing in the nozzle, and thus causing scrap by preventing the stopper from shutting off the stream as we pass from mould to mould; this is especially important in case of very soft steel, in casting which we have, in common practice, to pass back and forth repeatedly to fill the mould with the foaming metal. Freezing in the nozzle also roughens the ingots, by making the metal squirt against the side of the moulds, into which it cuts, and against which it freezes in lumps which may not later unite completely with the rest of the ingot.

Moreover, we can safely pour the hotter steel more slowly without incurring risk of its chilling, and the small depth of metal in the ladle causes the steel to rush less rapidly through the nozzle. The thinner and slower-falling stream cuts the bottoms of the moulds less; causes less foaming, both because of the slower arrival of the metal and because less air is dragged down; and thus enables us to fill the mould at a single pouring, instead of going back and forth from mould to mould. Thus more solid ingots are obtained, and we avoid the surfaces of imperfect union which often occur when an ingot is filled by several separate additions instead of at one pouring.

In Sweden the use of this device seems to have reduced the proportion of scrap materially. Akerman reports the results condensed in Table 203.

TABLE 203.—EFFECT OF CASPERSSON'S CONVERTER-LADLE IN REDUCING THE PROPORTION OF CASTING-SCRAP, ETC. ÅKERMAN.

Works.	Kind of Steel Made.	Period.	Per 100 of Cast-iron (Direct-metal) treated, there resulted				On using the converter-ladle.	
			Clean ingots.	Scrap	Clean ingots.	Scrap	The % of ingots increased by	The % of scrap decreased by
			Without the converter-ladle.		With the converter-ladle.			
Westanfors	Ingot-iron,	1878	84.48	2.69	....	......	....	....
	22%+; ingot-steel, 78%—.	20 weeks 1880	....	......	88.11	0.11	3.63a	2.58a
Westanfors		....	....	......	88 b	0.9	....	....
Bjorneborg	Ingot-iron..	....	83—	3.4	87.25±	......	4.25a	....
	Ingot-steel.	....	86 @ 87	......	89.5±	......	3±a	....
Nykroppa..	55% of ingot-iron, 45% of ingot-steel.	....	88.74	......	89.58	......	0.84a	....

a Per 100 of cast-iron blown.
b This number is given as 80 in the original, but apparently incorrectly. I believe that 88 is the right number.

Hainsworth[n] would accomplish results like those attained by the converter-ladle, by pouring the steel from the vessel into a deep, stopperless runner, which discharges into the moulds, preferably through an intermediate stopperless funnel which has several nozzles, one over each mould. The runner and the moulds are carried by vertical hydraulic plungers, so that as the vessel turns down lower and lower in pouring, they may sink and follow its travel. The flow of metal is thus regulated wholly by turning the vessel down faster or slower, and by changing the inclination of the runner, which to that end is mounted on trunnions. It may have a dam for holding the slag back, but in spite of this one anticipates that the last part of the metal will be accompanied by slag.

m Åkerman, Jour. Iron and St. Inst., 1880, II., p. 599; 1881, I. p. 36; Hardisty, Idem, 1886, II., p. 662.

n U. S. Patent 284,005, Aug. 28th, 1883.

NOTE.—Owing to an accident, Chapter XVII. was omitted from its proper order, and will be published next week, when the work will be finished, with the exception of a table of *errata*.

NOTICE.

The following pages complete the series of papers on the Metallurgy of Steel, by Mr. Henry M. Howe, begun in The Engineering and Mining Journal March 5th, 1887 (Vol. XLIII., No. 11). The arrangement of topics discussed has been as follows:

For the more convenient reference of the many metallurgists and others who have followed with interest Mr. Howe's able treatment of the subject, Metallurgy of Steel will shortly be published in book form by

THE SCIENTIFIC PUBLISHING COMPANY,
27 Park Place, New York, U. S. A.

The hearth is usually covered, and the sensible heat of the products of combustion is utilized somewhat as in the Lancashire hearth.

The distinctive features of this process, then, are that the bloom from the preceding heat is reheated in the refining hearth; that gray cast-iron is used; that the pigs are pushed forward in melting instead of being charged all at once; that the metal or part of it is melted thrice; that the hearth is covered, and its waste heat utilized.

§ 354. Melting Scrap-Iron in the Lancashire Hearth (Cf. Table 171, Col. XIV.).—Owing to the relative prices of scrap malleable iron (steel and wrought iron) and of pure cast-iron, most of the American-Lancashire hearths now treat the former material exclusively.

The process is practically the third period of the cast-iron refining process already described. The ball from the previous operation being drawn, the hearth is cleaned and partly filled with charcoal, and cold malleable-iron scrap is thrown on it. If, as often happens, much light scrap is used, such as sheet-iron clippings, broken wire from wire-drawing establishments, etc., this is charged first, and after a few minutes whatever heavy scrap is at hand. The charge is covered with charcoal as before and melted down, the chief work being to raise the upper mass (the still unmelted part) occasionally, so that the blast may enter between it and the lower mass (*i. e.*, the metal which has melted, dropped, and accumulated on the bottom), and care is taken not to touch the lower mass with the tools, lest slag become mixed with it. As soon as all the material has reached the lower mass, this is pried out and hammered, quite as in the case of cast-iron.

In the last six months of 1888 the loss from scrap to cropped billets at an American mill was 22.75%, of which the croppings formed 0.66%, and 9.20% occurred in the two reheatings and hammerings which followed the hammering of the ball, so that the loss from scrap to hammered bloom was 12.89%. As most of the scrap was thin, with much surface, this loss is certainly small. Column XIV., Table 171, represents practice at this mill.

As the scrap is nearly free from silicon and silica, the slags are more basic than in treating cast-iron. There is thus a considerable fining, and I am informed that about 10 to 15% of the phosphorus present is removed, that the sulphur, even if initially as high as 0.10%, falls to a mere trace, and that the carbon, even if initially as high as 0.40%, usually falls to about 0.03%.

The operation is of course much more rapid than fining cast-iron, and fourteen heats are made per shift instead of seven, by two workmen.

The cast-iron plates which line the hearth last much longer, three or four times as long, as when cast-iron is treated. The difference is probably due to the fact that in the latter case the product of the first fusion, being much more fusible, and hence remaining fluid longer, penetrates to the lining-plates to a greater extent. Further, the energetic prying and scraping along the bottom during the second period of the treatment of cast-iron probably tend to wear the bottom plate out.

As the plates are less attacked, and as the addition of a little silica to the very basic slags formed in treating scrap-iron is less to be dreaded than in treating cast-iron, so the rear lining-plate is usually omitted, the brick-work of the rear wall being exposed to the heat.

§ 355. Steel.—It is much harder to make weld-steel than wrought-iron in the charcoal-hearth, for, instead of carrying decarburization as far as it can go, we have to interrupt it at a given point, and there is little to indicate when this point is reached. Here, as in making puddled steel, the decarburization must proceed slowly in order that we may interrupt it with more certainty. Further, in limiting the final action which removes the carbon, we also limit the removal of phosphorus; hence, and because phosphorus is more hurtful to weld-steel than to wrought-iron, especially pure cast-iron should be used for making charcoal-hearth steel.

In order to retard the decarburization we use, when making weld-steel, an abundance of a liquid and less strongly fining slag than when wrought-iron is aimed at, less strongly fining through carrying less iron-oxide, and instead carrying more silica or more manganese. The slag is made manganiferous either through the direct addition of oxide or silicate of manganese, or by using manganiferous cast-iron. Manganese-silicate is less strongly fining than iron-silicate for reasons already given.

CHAPTER XVII.

The Crucible Process.

§ 356. The Crucible Steel Process in its broadest sense consists, 1st, in melting iron of like or unlike carbon-content, and with or without carburizing or decarburizing additions, in crucibles; 2d, in tranquilizing the molten mass so that it may yield compact castings, either by holding it molten so that it may absorb silicon from the crucible walls, or by the addition of ferro-aluminium or other quieting substance; 3d, in casting or "teeming" into ingots or other forms.

Of this process the most important varieties are:—

1, *Huntsman's*, the original method, in which small pieces of blister or other highly carburetted steel are melted alone, or with a slag-making flux (*e. g.*, glass).

2, *Josiah Marshall Heath's*[a] modification of adding manganese, either previously reduced by heating its oxide with carbonaceous matter, or reduced in the process itself by the action of charcoal on oxide of manganese.

Huntsman's method thus modified, it is said, is now the prevalent one in Sheffield.

3, *The carburizing-fusion* (or cementing-fusion) method, in which the percentage of carbon in the product is regulated by the addition of carbonaceous matter (practically

[a] For an account of Heath's invention and litigation, Cf. Percy, Iron and Steel, p. 840. Percy concludes, apparently quite justly, that Heath's invention virtually covered the present method of using a mixture of charcoal and oxide of manganese, though the courts held otherwise.

charcoal), is said to have been used in the last century by Chalut and Clouet[b], and is the prevalent method in this country.

4, *Uchatius'*, or the pig and ore method, of melting granulated cast-iron with iron ore, till lately, if not now, practiced at Wykmanshyttan in Sweden.

5, The *pig and scrap method* of melting wrought iron or steel, or both, raising the proportion of carbon by adding cast-iron.

In all the above methods the molten metal is tranquilized by killing, *i. e.*, holding it molten, so as to yield sound ingots.

6, *The Mitis method*, in which the charge originally constituted any of the above ways, is tranquilized by the addition of ferro-aluminium immediately after fusion, and is teemed a few minutes later.

7, *The basic method*, or fusion in basic instead of silicious crucibles, while it has not been worked out so far as I know, is likely to be tried in the near future.

TABLE 173.—COMPOSITION OF SLAG OF THE CRUCIBLE PROCESS.

		SiO_2	P_2O_5	FeO.	Fe_2O_3	MnO	Al_2O_3	CaO.	MgO	S	Ca	S	Alkales
1	L.	44.40	....	1.08	....	24.04	28.80	0.87	tr.	....	.29	.23	....
2	M.	41.24	....	2.30	....	18.45	35.85	....	....	....	....	....	....
3	M.	40.86	....	4.00	....	30.52	....	....	....	....	....	....	....
4	B.	44.36	....	4.41	3.66	17.43	18.05	7.74	....	....	....	....	4.11
5	B.	3.72	.89	34.10	1.51	6.40	tr.	25.79	27.43	....	....	....	....

1. Bochum, Ledebur, Handbuch, p. 856. Slag present during teeming.
2. Slag accompanying steel, No. 40 of Table 179. Lumps, gray ; powder, nearly white. Insoluble in hydrochloric acid 179. Müller. Stahl und Eisen, VI., p. 698, 1886.
3. Slag of steel 41, Table ; color, gray. Idem, p. 699.
4. Slag of steel 72, in Table 501.; dark, brown-gray. translucent ; very brittle ; vitreous; Sp. Gr. 3.11. Insoluble in acids.
Brand, Berg und Hütten. Zeit., XLIV., p. 105, 1885.
5. Slag from No. 83, Table 180 (basic). Hardly melted, brown-gray with violet sheen, porous, with shots of iron ; powder light brown. Sp. Gr., 4.11., Idem, p. 119.

§ 357. THE CRUCIBLE AND OTHER PROCESSES COMPARED.—The crucible process is on the one hand very much more costly than the Bessemer and open-hearth processes, both as to material and cost of conversion, as to labor, fuel and refractory materials. On the other hand, its process is apparently justly thought much better than that of these other processes, even for like composition. Its costliness limits it to the production of steel of high quality, designed for cutting-tools, springs, fire-arms, etc. It affords less control over the percentage of carbon in the product than either the Bessemer or the open-hearth process. Hence, when making large castings by pouring together the contents of several crucibles, to insure homogeneousness we should observe certain precautions, which are needed to a much smaller degree, if at all, in the Bessemer and open-hearth processes. When a very great number of crucible-fuls are poured together, the differences in composition probably nearly offset each other : this should be the case with Krupp's guns, which are said to be made wholly of crucible steel ; but when a smaller number of crucible-fuls are poured into a single casting, it would seem desirable to mix them thoroughly, *e. g.*, by pouring into a common mixing ladle, from which the casting is teemed.

It is not easy to see why crucible should be better than Bessemer and open-hearth steel of like composition. The crucible differs from the open-hearth process,

1, In treating smaller charges ;

2, In usually treating material which is not only purer but less liable to occasional serious impurity ;

3, In nearly completely excluding the fire-gases ;

4, In exposing the charge to a clay instead of a silica lining ;

5, In being under less perfect control as to temperature, additions, time, etc. This sounds heretical, but I am convinced that it is true. In the open-hearth furnace the charge is ever open to easy inspection, so that we readily determine what additions and what changes in temperature are needed at a given instant. The closed crucible cannot, as the process is usually carried out, be thus examined readily at short intervals, and practically we are confined to a single examination ; though it is not absolutely necessary that we should be so restricted. The Bessemer process is under as good control as the open-hearth.

Of these differences we summarily reject the first, fourth and fifth, as wholly improbable causes of superiority.

The second does not bear on the question of the relative merits of crucible and other steel of given composition.

The exclusion of the fire-gases, in that it prevents the absorption of sulphur from them, is in the same way beside the present point. But it may well be, as Metcalf conjectures (§ 174, p. 109), that the greater opportunity which the open-hearth and especially the Bessemer process offers for the absorption of nitrogen (and hydrogen he might add) injures their product. Whatever be the reason, there seems to be little doubt that crucible steel is better than Bessemer and open-hearth steel of like composition as actually made. However, as its superiority is unexplained, we cannot now tell whether it is due to conditions unattainable in the competing processes, or to conditions which, though as yet overlooked, are still attainable. If to the latter, we may expect that, once the needed conditions are known, the improvement of our dephosphorizing processes, basic open-hearth and Bessemer, Bell-Krupp washing, etc., will gradually bring the quality of the product of these cheaper processes up to that of crucible steel, and thus remove the reason for the existence of the crucible process.

The belief in the superiority of crucible steel of like composition rests rather on general observation than on conclusive direct evidence, and it must be confessed that the quality of much of this evidence is not of the best : this, however, from the nature of the case is almost unavoidable ; but the quantity of evidence goes far to make up for its quality. Some of the evidence, however, cannot be simply ignored. Thus, eminent steel-makers assure us that Bessemer and open-hearth steel remelted in crucibles is little, if at all, better than before. A very distinguished maker of both crucible and Bessemer steel assures me that he finds much of the Bessemer and open-hearth tool steel, of which great quantities are actually sold, almost as pure as the best crucible steel, yet hardly as good as the much less pure common grades of spring crucible steel. I am informed that the only American open-hearth tool-steel plant has lately been sold to a maker of springs.

Bessemer's assertion[a] that half the crucible steel in

[b] Gruner (Smith), the Manufacture of Steel, p. 127.

[a] Journ. Iron and Steel Inst., 1884, I., p. 397 ; Cf. Stahl und Eisen, V., 1885, p. 111.

Sheffield is simply Bessemer or open-hearth steel remelted in crucibles, helps not, for we do not know that this half contains any of the most excellent steel: if it does, this excellence may still be due to the remelting in crucibles.

If the foregoing be true we may conclude that, if we are to bring the quality of Bessemer and open-hearth up to that of crucible steel, while equal purity of product is surely necessary, the first step is to discover the cause of the inferiority of the former classes for given composition, the next to provide a remedy.

But, granting that there is little doubt of the superiority of crucible steel of given composition, we see causes which have probably given us an exaggerated idea of it. First, in the Bessemer and open-hearth processes we actually use, in large part, the crude product of the blast furnace, which is not only usually less pure but less uniform in purity, more subject to the occasional presence of serious quantites of impurities (phosphorus, sulphur) than the material used for the crucible process, cast-iron purified by puddling, etc., the pure iron of the bloomary fire, etc. Again, relatively little effort has been made to produce in the Bessemer and open-hearth processes the tool-steels to which the crucible process chiefly owes its high standing. From the fact that in the Bessemer and open-hearth processes we habitually and intentionally aim at a product much poorer (because cheaper and, all things including cost considered, better suited to its habitual uses) than the habitual product of the crucible process—from this fact we easily and loosely infer that the habitual great inferiority is necessary. In the Bessemer and open-hearth process we wisely habitually avoid, in the crucible process we habitually adopt, those expensive precautions which give great excellence. It is not wise, it is casting pearls before swine, to demand for a given purpose material better than the conditions of the case, cost included, warrant: to insist that rails shall have no more than 0.02% of phosphorus, taking an extreme case. While it is better to err on the side of superiority if at all, while such errors spring from the better side of our nature, to err is still to err.

§ 358. CRUCIBLES are of two chief kinds, graphite and clay. The graphite crucibles last much longer, endure much rougher usage, at least as to changes of temperature, and hold a heavier charge than the clay ones, and are thus much more convenient and more economical of labor: they cost rather less per pound of ingots, but give up carbon and silicon to the metal to a much greater extent, and probably more irregularly than clay ones. Finally, the loss of iron is less in graphite than in clay crucibles.

In making steel of the best quality care is taken that the cover of the crucible fits tightly; this is thought less important in making steel of common grades. The cover of a European crucible, according to Ledebur, has a round hole through which a rod is introduced for examining the charge. The hole is closed with a clay plug during melting[a]. In the Mitis process the crucible cover has such a round hole, never closed, through which the ferro-aluminium is introduced; but with this exception, American crucible covers, so far as my observation goes, are always holeless.

Graphite crucibles, almost always used in this country, usually hold a charge of from 60 to 90 pounds. Heavier charges are occasionally used; in one establishment the charge was at one time 200 pounds. The objection to large crucibles is that, in order that they may be strong enough to hold the heavy charge and to endure the pressure of the tongs in drawing from the furnace while intensely hot, their walls must be made thick; this, beside increasing the difficulty of making and drying them, lengthens the time of melting, the thicker walls conducting heat more slowly to the charge. The very heavy charges possible in a cool operation like brass founding, running up to 500 and occasionally even to 700 pounds, are hardly to be hoped for; yet the attempts to increase the weight of the charge have met with a certain measure of success. The 200 pound charges above referred to were melted at the rate of three per shift like the 80 pound ones; they have, however, been abandoned, not because of technical failure, but because opposed vigorously by the labor union. As they should effect a very considerable economy, we may expect further efforts to employ them. At the Mitis works, already referred to, charges running up to 130 pounds are used.

The average life of graphite crucibles, in this country, is from four to six heats whether in gas, anthracite or petroleum furnaces. It is shorter, naturally, when making soft than making hard steel. Thus, in making soft Mitis castings in the Noble petroleum-furnace, crucibles last but three heats.

From the fact that crucibles last no longer when making hard steel in the Noble furnace than in others, although this furnace is used only for the Mitis process, in which the heat is much shorter than the common heat of other furnaces, killing being omitted, one might infer that the Noble furnace was exceptionally trying to the crucibles.

European graphite crucibles usually last only from one to three heats.

Use.—Graphite crucibles are usually charged quite cold in the white-hot melting furnace and are cooled off after each heat without care, being thrown out on the cold ground while white-hot, even in the dead of winter. At Mitis works, however, they are hastily refilled while still hot, and immediately returned to the furnace. They are examined, usually after each heat, to learn whether they can be used again safely.

In many works the charge is lessened slightly from heat to heat, so as to lower the slag-level, since the crucible corrodes more deeply here than beneath, where it is simply in contact with molten metal. The successive charges may be say 85, 80, 78, 75, 72 pounds, etc., in case of graphite crucibles. The reduction is heavier for clay crucibles, successive charges weighing say 50, 44 and 38 pounds. But, in many other establishments using graphite crucibles, the crucible is packed full at each heat, without attempt to regulate the slag-level.

At the Wayne works the crucibles are clay-washed within after each heat, as soon as they begin to show serious wear: this is said to increase their life to from 5 to 8 heats[a].

Manufacture.—Graphite crucibles are made[b] from a

a Handbuch der Eisenhüttenkunde, p. 843.

a Jour. Iron and St. Inst., 1887, I. P., 418, from Iron Age, XXXVIII, No. 18.

b My description of graphite-crucible making is based chiefly on information given by Mr. W. F. Downs, of the Dixon Crucible Company, private communication, Jan. 12, 1889, and on an article by Dr. J. C. Booth, Journ. Am. Chem. Soc., VI., p. 283, 1884, and VII., p. 4, 1885.

mixture of graphite, fire-clay and sand, say in the following proportions by weight.

TABLE 174.—PROPORTIONS BY WEIGHT USED IN MAKING GRAPHITE CRUCIBLES.

Graphite.	Air-dried Clay.	Sand.	Loss on Burning.	Authority.
50	45	5	5%	Booth.
50	43	7	10%	"
50	41	9	10%	"
50	33	17	....	Downs.

The burnt crucible pretty constantly contains about 50 to 55% carbon. The proportion of clay to sand, however, differs according to the experience of the maker and the details of the method of manufacture (Cf. Table 180, § 368).

Ceylon Graphite is generally used, though some American graphite has given good results. The Ceylon graphite is nearly pure, containing (Booth) about 6%, but sometimes not more than 1%, of pyrite and quartz. The elastic-scaly or laminated variety, or the elastic-fibrous, only should be used, not the amorphous; the first two bind the matrix of clay firmly.

The graphite is crushed in "bark mills," then pulverized between common mill-stones, to from 40 to 100 "mesh," the coarser part being bolted out in a common flour-bolter; Booth recommends that none should be coarser than $\frac{1}{20}''$ to $\frac{1}{50}''$ diameter. If the graphite be too coarse the crucible is apt to become porous, and to be weakened by cleavage planes; if too fine, the crucible is too dense and is apt to crack under the extreme changes of temperature to which it is exposed, and conducts heat slowly.

The clay is usually of the best German "Klingenburg" or "crown" brand. It is at once very fat, refractory and wholly free from grit.

The sand should be rather coarse, passing a screen of about 40 meshes to the lineal inch, and not liable to fly on heating. Burnt infusible fire-clay has been found as good, but not better: its action is mechanical, making the air-drying uniform, and acting as a skeleton to resist the pressure of the tongs.

Mixing.—The clay is made into a thin paste with water, the sifted sand and graphite are stirred in with a shovel, and the mass is then mixed thoroughly by repeated passage through a pug-mill; it is then tempered by a few days', or better weeks', repose in a damp place, covered with cloths which are moistened occasionally. During this repose any little bubbles of air are gradually squeezed out by the sinking together of the soft mass.

Moulding.—A weighed lump of the tempered mass is slapped and kneaded, thrown into the bottom of a thick, strongly banded, plaster-of-paris (or more rarely wooden) mould, whose interior has the shape of the exterior of the crucible, and centered on a potter's wheel. While this revolves, a cast-iron or steel profile of the interior of the crucible is lowered into the mass. As in moulding pottery, so here the clayey mass is pressed against the sides of the mould and raised gradually to its top, jointly by the revolution and by the moulder's hand. The very slight excess which protrudes above the top of the mould is pared off, and the inside of the lip, if any, is cut out.

This method of moulding on a potter's wheel is said to give much better results than simple pressing into shape, not only through its kneading action, but especially because it arranges the graphite flakes tangentially, so that they bind the mass very effectively.

Drying.—The crucible is left in the plaster mould about three hours, the plaster absorbing its moisture, and thus partly drying and stiffening it so that it can be handled. The mould loses during the night part of the moisture thus taken up, but by the end of a week or so it has become so wet that it must be specially dried to regain its bibulousness.

Burning.—The crucible thus partly dried is removed from the mould, and air-dried on racks in a warm room, say at 70° to 80° F., for about a week. Each crucible is then inclosed in two seggars,[a] one inverted over the other, the joint being sometimes luted for better exclusion of air.

The seggars, with their contents, are closely packed in a common pottery-kiln, which has many fire-places to insure uniform heating. In this country it is fired with anthracite, and towards the end of the firing with long-flaming pine wood, to fully heat the extreme upper parts of the kiln. To limit the oxidation of the graphite, as little excess of air as practicable should be admitted. Booth would further enclose a little coal or coke within the seggars themselves, to take up any oxygen which entered them.

Burning takes a week, of which one day is occupied in charging, three days in firing, and two and a half days in cooling down. Some lately built kilns burn much more rapidly, but perhaps not so well. The temperature reaches a strong but not dazzling white heat, say 1,350° C. (2,463° F.), but is much lower in the cooler part of the kiln.

Indications.—In burning, the graphite of the very skin is removed, leaving the crucible drab. But the graphite should not be burnt out to a considerable depth, as the strength of the crucible at low temperatures depends on it. Hence in well-burnt crucibles the black interior region, in which the graphite still remains, should lie so near the surface that it can be exposed by rubbing with the fingers. A thick drab coating means a heavy burning out of graphite and a worthless crucible. A black skin *may* be due to remarkably perfect exclusion of air. More commonly it means that the crucible is soft because not burnt enough.

The cost of graphite crucibles in this country is given approximately in the following table:

TABLE 175.—SIZE AND COST OF AMERICAN GRAPHITE CRUCIBLES.

Height Outside. Inches.	Diameter Outside.			Weight.	Capacity.	Price per Crucible. Nominal.	Actual for large lots.
	Top.	Bilge.	Bottom				
13	9⅝"	10½"	7¾"	24 lbs.	80 lbs.	$1 20	$1 00
14½	10¾"	11 9/16"	8⅛"	32 "	100 "	1 50	1 30
16	11½"	12½"	9"	45 "	130 "	1 80	

These dimensions are given by the Joseph Dixon Crucible Company. They seem to me to be more stumpy than those of most crucibles.

The designation numbers used by different makers for a given size of crucible are far from constant.

Very poor graphite crucibles (number 4, Table 176), lasting only one heat, cost 23 cts. in Styria about the year 1878.

Figure 150 shows an American 100-pound steel-crucible for anthracite shaft-furnaces. For gas-furnaces the

a Conical or cylindrical fire-clay vessels, which protect the crucible from the air, prevent sudden changes of temperature, and prevent the soft crucibles from crushing each other by their own weight.

crucible-walls are thicker towards the top, where the flame is sharpest, and thinner near the bottom than in this figure.

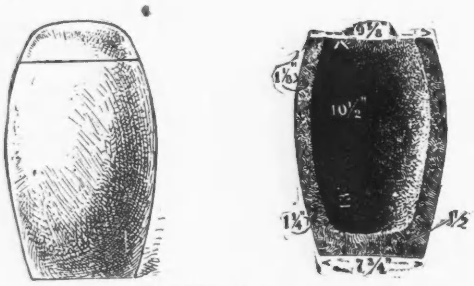


Fig. 150. CRUCIBLES.

Clay crucibles, though decidedly tough while hot (indeed, they are thought tougher than graphite crucibles at a steel-melting heat), grow very brittle when cooled. They are therefore used continuously without cooling, being returned to the white-hot furnace immediately after teeming and inspection. Further, on account of their tendency to crack under abrupt changes of temperature below bright redness, they are heated very gradually for their first heat. They last three heats or less, while American graphite crucibles last five or six heats.

The clay crucibles always, I believe, contain a little coke, say 5%, which hastens drying, probably strengthens the crucible when hot, and hastens killing by promoting the absorption of silicon by the steel.

For the preparation of clay crucibles let two examples suffice.

Swedish Practice.—A 20-crucible batch of 540 pounds of finely-ground, sifted, dried clay, and 13 pounds of coke is mixed, moistened and worked, rests for about twelve hours, is trodden and worked again with extreme care, and divided into 20 weighed lumps. Each is worked thoroughly to expel air-bubbles and to make it homogeneous, solid and tough. After pressing to shape, the moist crucible is dried first at 20° to 30° (C.) then at 50° to 70°, for three or even four months, and is then gradually heated for 18 hours to incipient redness. A handful of chamotte (powder of old crucibles) is thrown in, and the crucible is placed in the barely red-hot melting furnace, whose temperature is gradually raised till the chamotte partly sinters, when the crucible is filled with metal.[a]

British Practice.—The almost impalpably pulverized and carefully weighed meterials are wetted and thoroughly mixed, usually in a mill, sometimes still, and it is thought with better results, by treading systematically under men's bare feet for several hours, with periodical cutting and turning by spade. The mass is then cut into balls each sufficing to make one crucible. The ball is further hand-worked, thrown into the smooth well-oiled mould *b*, Figure 151, and squeezed macaroni-like into shape by forcing down the oiled plug *a*, centered by the pin *c*, the clay rising into and filling the annular space between mould and plug. In hand-manufacture *a* is alternately raised and pressed down, the last time being driven down by a mallet, and is then withdrawn twistingly. In machine-manufacture it is driven down and withdrawn by mechanism, the centering pin *e*, now unnecessary, being dispensed with. Its upper edge now being trimmed, the crucible and mould are placed on a post *k*; the mould is dropped; the crucible is thus bared,

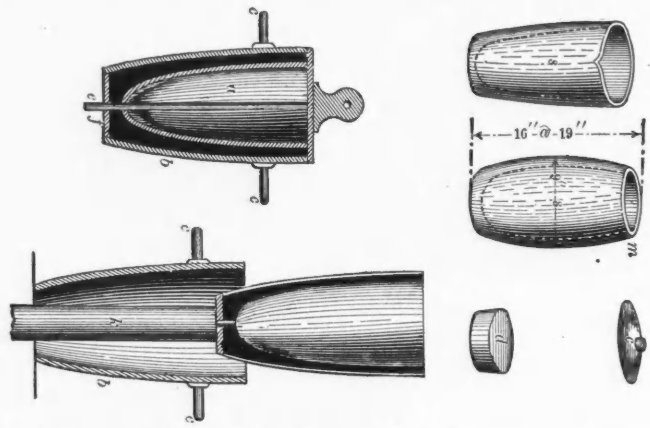


Fig. 151. BRITISH CLAY CRUCIBLES AND THEIR MANUFACTURE. GREENWOOD.

and its top is forced inward to the barrel-shape *m* shown, by pressing on it a conical-frustum-shaped mould. The crucible is lifted with well fitting sheet-iron plates to a shelf in the pot-house; dried here for one or two days; further dried in the melting-house on a shelf next to the flues for at least ten, but preferably for 30 to 40 days; heated to incipient redness with others during some fourteen hours, mouth downward, on a bed of burning coke, and surrounded with fine coke, in a tightly luted anneal-

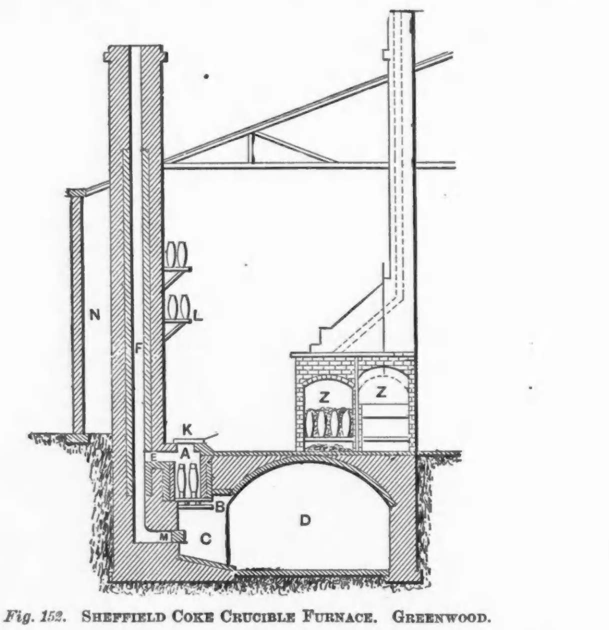


Fig. 152. SHEFFIELD COKE CRUCIBLE FURNACE. GREENWOOD.

ing furnace Z, Figure 152, which permits but very slow combustion. It is now placed on its stand (*d*, Figure 151), in the melting hole which has previously received a little live coal, and which is now filled with coke to the tops of the crucibles. These, on reaching redness in some thirty minutes, are filled with metal,[a] if hand-made first receiving a handful of sand, which frits, closes the hole left by the centering-pin, and cements crucible to stand.

Clay crucibles cost in Sheffield about $0.15 (8d.), in 1864,[b] and about 23 to 29 cts. at present (1 sh. to 1 sh. 3d). Their present cost is thus about 20 cents in Sheffield

a Practice at Österby, Sweden. Hermelin, Stahl und Eisen, VIII., p. 340, 1888, from Jernkont, Ann. XLIII., pp. 338–343.

a Greenwood, Steel and Iron, pp. 26, 420.

b Percy, Iron and Steel, p. 835.

per 100 pound of ingots, or about the same as that of graphite crucibles in this country. But as clay crucibles would doubtless cost more here than in Sheffield, they would be more expensive per pound of ingots than graphite crucibles.

As they are corroded more by the slag than graphite crucibles are, it is important to change the slag-level by lessening the weight of successive charges. A common weight is 50 to 52 pounds for the first charge, 48 to 50 for the second and 43 to 45 for the third.

TABLE 176.—COMPOSITION OF STEEL-MELTING CRUCIBLES. (See also Tables 179, 180.)

	Proximate.				Ultimate.					
	Graphite. %	Coke %	Raw Clay. %	Chamotte etc. %	C %	SiO_2. %	Al_2O_3 %	FeOx %	Alkalies. %	Other bases. %
A.—GRAPHITE CRUCIBLES.										
1. Usual composition. Ledebur..	20%@75	......	33%@66	......	15@60	......	......	......	......	......
2. Wedding.........	44	......	12b	44	......	......	......	......	......	......
3. "	30a	......	30a	40a	......	......	......	......	......	......
			17							
4. Blomberg	83		......	......	......	......	......	......	......	......
5. American, the author............	51	......	......	......	......	......	......	......	......	.....
B.—CLAY CRUCIBLES.										
13. Mushet's.........	....	12	80b	8	......	......	......	......	......	......
14. Wedding.........	Charcoal.	21a	31a	48a	......	......	......	......	......	......
15. Wedding.........	....	4	88	8	......	......	......	......	......	......
16. Sheffield, Percy...	....	7@9	......	......	......	......	......	......	......	......

1. Ledebur, Handbuch der Eisenhüttenkunde, p. 844.
2. Wedding, Darstellung des Schmiedbaren Eisens, p. 611.
3. Döhlen Cast-steel Works, Idem, p. 617.
4. Eibiswald (xvii., Table 499); last 1 to 2 heats; cost 23 cents (0.48 florins); hand-made; dried at 77 to 104° F., 25 to 30 days. Met. Rev., I., p. 584, 1878.
5. A piece cut from an American 80 lb. steel-melting crucible, after long drying at a temperature well above 100° C., lost 51.17% by weight, on ignition in a platinum crucible over a blast lamp, Jan., 1889.
13. The mixture used by Mushet Greenwood, Steel and Iron, p. 26. It is not stated explicitly that the proportions are by weight.
14. Used at Sollinger Hütte, Wedding, Darstellung des Schmiedbaren Eisens, p. 616.
15. Wedding, Idem, p. 511. The proportion of raw clay, "Rohem Thon," seems excessive.
16. Percy. Iron and steel, p. 834.
a Proportions by volume.
b It is not stated explicitly that all this clay was raw.

§ 359. FURNACES.—In nearly all cases either direct-firing shaft-furnaces or Siemens regenerative gas-furnaces are used. Gas furnaces of other types, and direct-firing reverberatory furnaces have been used to a certain extent, and Nobel's petroleum furnace is now used with success for the Mitis process.[a]

The Sheffield 2-pot coke shaft furnaces or melting-holes, Figure 152, consist of oval chambers three feet high from the bars, by 26″x19″, and three feet from center to center, arranged in rows along one or both sides of the melting house, and lined with about six inches of fire-brick or of ganister, the latter rammed around a wooden core. In older works each hole has its own chimney-flue F, the flues of five or six holes being built into a single flat block-chimney: but in many modern works the little flues E from each hole unite in a common flue and square chimney. The draft is regulated by bricks inserted in the flues E and M. Full access is given to the grate B by the deep cellar D, so that leakage from the crucibles can be detected, and, it is said, even stopped.

The American 4-pot anthracite shaft-furnaces (usually standing in long rows on either side of boilers, which run lenthwise of the melting-house and are heated by the waste gases), have closed and luted ash-pits, into which three-inch pipes deliver low-pressure blast from a fan-blower. The compact slow-burning anthracite offers so little surface that it is necessary to have a much thicker bed of it than of coke; hence American furnaces are much deeper than Sheffield ones. On the other hand the great depth of the Sheffield ash-pit, which permits easy removal of clinkers during a heat and gives access to the crucibles from beneath for stopping leaks, is unnecessary in American furnaces, the clinkers forming more slowly with the slower burning anthracite, and the greater depth of fuel beneath the crucible preventing access from below. Indeed I do not know that it would be possible to stop a leak in a graphite crucible even if it were accessible.

It were vain to seek fuel-economy by prolonging the shaft-furnace, so as to make the descending column of fuel intercept the escaping heat. This would lower the temperature by causing reduction of carbonic acid to oxide; further, the crucible must be near the top of the fire for examination and drawing.

Shaft-furnaces are usually run by day only, and every other day at that.

The Siemens crucible-furnace, Figure 154, is of the common Siemens regenerative type, with a pair of regenerators *a a a a* (section N P) on either side of the melting chamber *b*, which is cut up by cross-walls *p p p* (section A B), into from two to ten melting-holes, each of which usually holds six crucibles. The flame travels so short a distance in the melting-hole or laboratory that gas and air must be mixed intimately, so as to shorten the flame. To this end the gas for each melting-hole is shot up through three small orifices *c c c* (plan and section N P) into the horizontally moving stream of air, while the velvetry *d*, probably eddies and thus further mixes the streams, beside deflecting the flame downward so as to warm the bottom of the crucibles.

Each melting-hole has a single opening above for drawing and charging, closed with clamps *e e e* (section A B), each of which covers two crucibles, and is hung by a chain to an overhead telegraph, or is lifted by a hook supported by the axle of a small two-wheeled buggy, Figure 157.

The bottom of the melting-hole has an eight-inch layer of coke-dust, and beneath this a hole *f* (section N P), temporarily closed with an old crucible-cover. Should a crucible break, a hole is forced through this, letting the molten steel run through into the vault *g* beneath. This hole is generally opened each Saturday afternoon, and all melted matter, clinker, etc., run through. The coke bottom is usually made up afresh after each shift.

The Siemens furnace is run continuously from Monday morning till Saturday afternoon. The consumption of fuel is indicated in Table 172. In one Pittsburgh mill only half a pound of slack coal was used per pound of steel made, in a test-run of one week; an accurate account of a year's work showed that with Wellman steam-blown producers 0.75 pounds, and with common Siemens producers one pound of slack coal was used per pound of steel.

It is very important that the flues *s*, *s*, *s′* beneath the regenerators, shown in section N P, should be very large, especially in the long 42 and 60-pot furnaces. The gas and air must travel through these flues the whole length of the furnace; the travel for the first melting-hole is much shorter than for the further ones, and unless these

[a] For notices of old and rare furnaces see Kerl, Grundriss der Eisenhüttenkunde, p. 409.

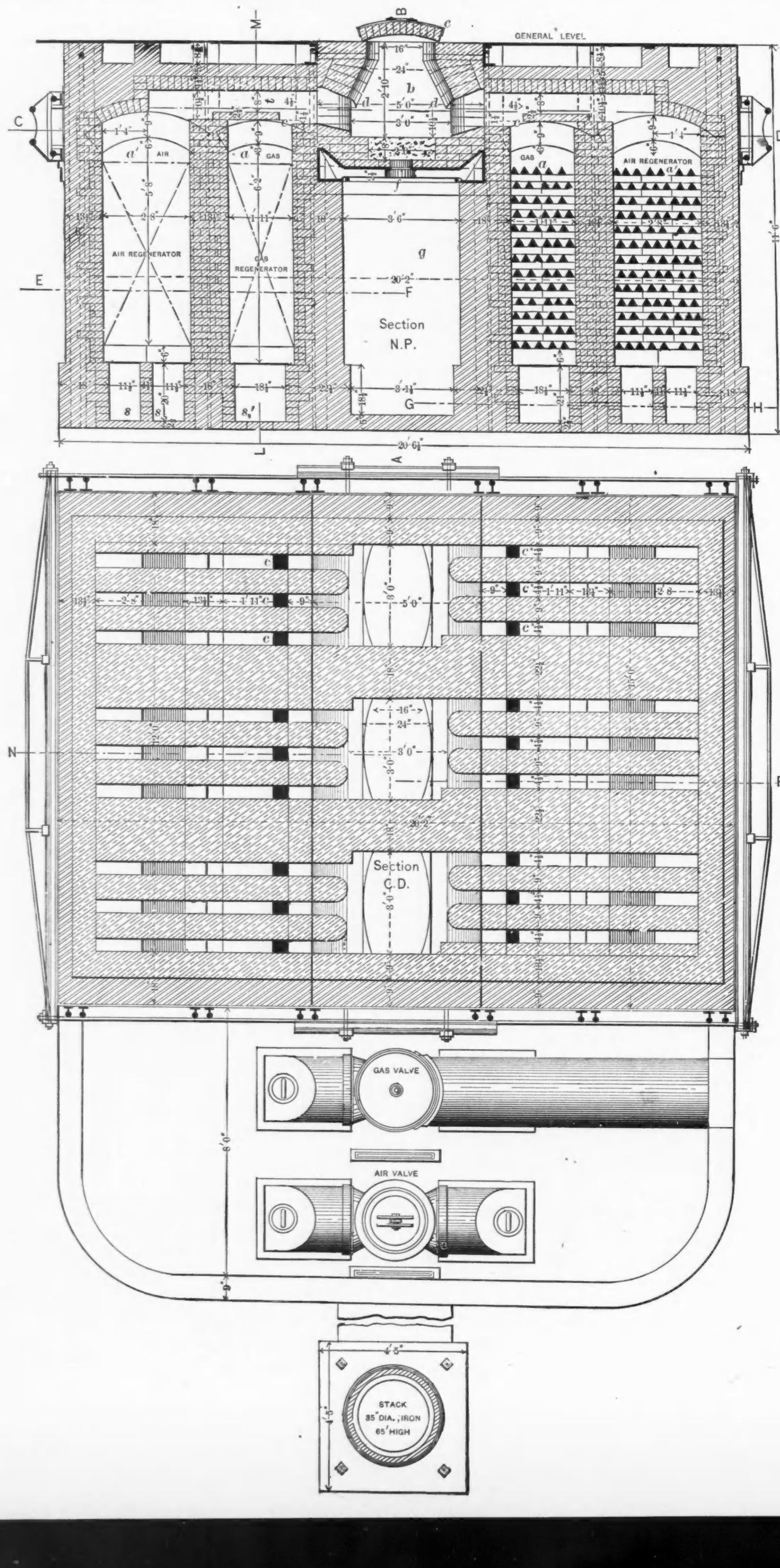


Fig. 154.

a a Gas Regenerators. a' a' Air Regenerators. b Melting-Chamber. c c Gas Ports. d Velvetry. e e e Clamps. f f f Holes Leading to Vault. g Vault. h Gas Reversing Valve. i Air Reversing Valve. Gas Admission Valve. k Air Admission Valve. l l Chimney Dampers. p p Cross-Walls.

flues be very large, so as to supply the ports c and t with more air and gas than they can transmit, an undue proportion of gas and air will enter the nearer melting-holes and the further ones will work cold. The dimensions given in section N P are standard ones, but they would be better if somewhat larger, so that the sectional area of the $\{{}^{air}_{gas}\}$ flue should be 50% larger than the sum of minimum areas of all the $\{{}^{air}_{gas}\}$ ports on one side of the furnace, or so as to make

$$2s = 9t \times 1.5$$
$$S' = 9c \times 1.5$$

s, s', t and c being the sectional areas of the passages s, s', t and c shown on section NP of Figure 154.

For larger furnaces the ratios $\frac{2s}{t}$ and $\frac{S'}{c}$ should be still larger, on account of the longer travel through the flues. Here, if we let N = the number of gas or air ports on each side of the furnace, it is well to make

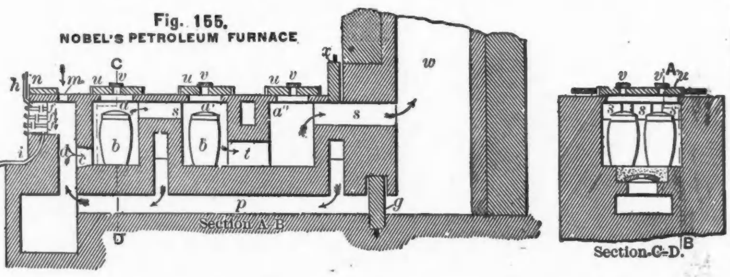
$$2s = 2NT;\ S' = 2NC.$$

In one admirable 60-pot furnace $S' = 60'' \times 18''$ and $S + S = 60'' \times 27''$ so that

$$2s = N \times T \times 2 = 60\ T.$$
$$S' = N \times C \times 2 = 60\ C.$$

The Nobel liquid-fuel furnace,[a] Figure 155, has two chambers, a and a', each containing two crucibles, and a third a'', originally intended to hold a pair of crucibles,

Fig. 155.
NOBEL'S PETROLEUM FURNACE



but not utilized. The fuel is a somewhat refined petroleum, costing, I am told 5 cents per gallon, while crude Pennsylvania petroleum costs about 1.6 cents per gallon. At one works attempts to use crude oil failed. I am informed that crude oil has been successfully used at another works, but I have been unable to verify this statement to my satisfaction.

The petroleum is fed from an over-head tank through the pipe h, on the upper of a series of pans f. An overflow from each pan carries any excess of oil to the next lower pan, and from the lowest back to an underground tank, whence it is pumped at intervals to the overhead tank. Air is admitted between the pans, through the slot m (regulated by the plate n), and through the passage p in the side and bridge-walls. We thus cool and preserve them, while preheating the air somewhat. The flame passes staggeringly through the passage d, the ports c, s, t, s, and the chambers a, a' a'' to the chimney w. The draft is regulated by the slide-valve x. Each chamber is covered with a large tile u, having a peep-hole v, temporarily stopped, above each crucible. When drawing and charging crucibles the tile is slid lengthwise, uncovering half a chamber at a time, while, to protect the puller-out, the flame is drawn straight to the chimney through the flue p by opening the valve g.

a U. S. Patent 321, 840, L. Nobel, July 7th, 1885.

The staggering path of the flame, in that it impinges well on the crucibles, makes the furnace efficient as to fuel-consumption; in that it impinges sharply on the bridge-walls, it shortens the life of the furnace and increases the cost of repairs. Actually, the hottest bridge-wall is rapidly cut out by the flame.

A layer of coke is arranged at the bottom of the furnace quite as in the Siemens' furnace, for running the steel from broken crucibles into the flue p beneath. It would be well if there were a vault beneath this flue into which molten steel could be run; it should be hard to remove a mess of steel from the little flue p, without tearing the furnace to pieces.[a]

Repairs.—The Sheffield coke furnaces are relined with gannister every four weeks; their walls are rebuilt once a year; and after about five or seven years thorough repairs are needed.

Anthracite shaft-furnaces at one American works are repaired about every four months, with an outlay of one day's time of a bricklayer and helper, and 388 fire-bricks. American gas-furnaces are repaired about once in six months, with an outlay of about $350 in case of a 60-pot furnace.

A Nobel furnace runs probably about 18 days; the longest run at one American Mitis works has been 27 days.

From these data I estimate the cost of repairs per pound of steel roughly as follows:

Furnace.	Pots.	Output per month.	Output per campaign. lbs.	Repairs total.	Repairs per lb. steel.
		pots. heats. days. lbs. lbs.			
Anthracite..	4	4 × 3 × 12 × 75 = 10,800	10,800 × 4 = 43,200	$25.00	0.06.
		pots. hts. shfts. wks. lbs.			
Gas.........	60	60 × 3 × 11 × 4 × 75 = 594,000	594,000 × 6 = 3,564,000	$350.00	0.01
			heats. days. lbs.		
Nobel.......	2		2 × 9 × 20 × 110 = 39,600	$40.00	0.10

Comparison.—*Gas-furnaces* have great advantages over shaft-furnaces in that they are much more convenient, the crucibles being always readily accessible; use less than half (sometimes less than one-quarter) as much fuel, and usually much cheaper fuel at that; and avoid the corrosion of the crucible by the ash of the fuel which occurs in shaft-furnaces, which probably shortens the life of the crucible appreciably. On the other hand, their first cost is much greater, and, strangely enough, the Sheffield steel-makers think that they afford less control over the temperature than shaft-furnaces. It is further objected that the crucibles next the walls in gas-furnaces

a P. Ostberg, Trans. Am. Inst. Min. Eng., xiv., p. 775, 1886, states that wrought-iron is melted in this furnace at the rate of 11 meltings in 12 hours, the last taking only about fifty (exceptionally forty) minutes, while in common furnaces to melt steel, which is more fusible, it takes four to six hours. Actually a heat occupies from three to four hours in common furnaces. As only two of the four crucibles in the Nobel furnace are drawn at a teeming, the true length of a heat is double the interval between successive teemings. Actually the crucible remains in the furnace at American Mitis works about 2 hours and 15 minutes, or just about the time required for *melting* in good American practice. Remembering that on the one hand, the time of killing is saved in the Mitis process, and that, on the other, the charge is less fusible than in the common crucible practice, the Nobel furnace seems to melt rather more rapidly than is usual with Siemens' furnaces. But the temperature in a properly designed Siemens' furnace is limited only by the refractory nature of the brickwork *and crucibles*; and it may be owing to an excessively high temperature employed in the Nobel furnace, but avoided in good Siemens' practice, that the Mitis crucibles are used only about one-half as many heats (hotter but shorter heats) as those in American Siemens' furnaces; and that there are only as many days in a Nobel furnace campaign as weeks in the campaign of a Siemens' furnace. Mr. Ostberg indeed states that in common furnaces crucibles are only exceptionally used more than thrice, while in Nobel furnaces they last six or seven heats. Actually it seems to be just the other way. In common American practice the crucibles last five or six heats; in the Nobel furnace at the Mitis works of whose practice I have direct information, they last but three.

heat more slowly than those in the middle; but the difference is probably unimportant. In this country gas-furnaces are habitually used, and are fast driving the shaft-furnaces out of existence. But I am informed that only one Sheffield firm of importance, Sanderson Brothers, uses the gas-furnace.

The Nobel furnace uses as much if not more fuel per ton of product than the best gas-furnaces, and of a more powerful and usually more expensive fuel at that, and it requires more labor. Its repairs, moreover, are exceedingly expensive. It is said to yield a higher temperature than other furnaces; but, while one may not estimate these high temperatures confidently, the Nobel furnace did not seem to me materially hotter than a Siemens' crucible furnace, and certainly not hotter than an open-hearth furnace. Nor can I readily believe that we cannot develop in a well-designed Siemens' furnace, as high a temperature as in this furnace. Indeed, the temperature attainable in the Siemens' furnace seems to be limited by the melting-point of our refractory materials only.

In comparing the Nobel with the Siemens' furnace we must recollect that, on the one hand, its usual product, almost carbonless steel, demands a higher temperature than the high-carbon steel usually made in Siemens' crucible furnaces; and that the Nobel furnace is run intermittently, the Siemens' continuously. On the other hand, a Nobel furnace heat is much shorter, killing being omitted, than that of a Siemens' furnace. Considering these facts, and considering that the design of the Nobel furnace, allowing the products of combustion to pass to the chimney very hot, would not lead us to expect anything like the economy of a Siemens' furnace its fuel-consumption is surprisingly low, if, indeed, this has been trustworthily determined. The Nobel furnace is certainly much cheaper to build than the Siemens', and it uses less fuel than the shaft-furnace. It therefore commends itself for small establishments, in which castings are made only on a few days in each week; for these the Siemens' furnace is unsuited, as it must run continuously to be economical.

It is only fair to add that my direct information about the Nobel furnace is chiefly confined to the practice of a single mill, which I am credibly informed is much less intelligently managed than several others in which the furnace is used. In spite of several endeavors, I have failed to obtain information in detail and sufficiently direct to be accepted, touching the practice in these other works.

§ 360. Charging.—In Sheffield the charge is introduced through a sheet-iron funnel into the red-hot (usually clay) crucible, resting on its stand in the melting-hole.

In the United States the graphite crucible is carefully filled by hand while cold. The larger pieces of metal are packed at the bottom, on these is poured the carburizing charcoal, usually with a little oxide of manganese, and often with a little "physic," such as salt, ferrocyanide of potassium, etc. Above the charcoal are packed the smaller and closer fitting pieces of metal, probably intercepting during melting nearly all the free oxygen and carbonic acid which enter from above, and thus protecting the charcoal from oxidation. The crucible is then introduced, without any stand, either into the anthracite shaft-furnace, here resting directly on the glowing coal, the several crucibles in actual contact with each other, or into the white-hot melting-hole of the Siemens' furnace, resting on the coke bottom.

The usual practice is to introduce the whole charge into the crucible at the same time; but at Österby, in Sweden, the spiegeleisen or ferromanganese is added (apparently shortly) "before the charge is wholly melted." This doubtless gives better control over the proportion of manganese in the product, and diminishes the loss of this metal.

§ 361. The heat consists of two periods, "melting" and "killing."

Melting.—The crucible introduced and its cover placed, gas and air are turned on, in case of gas-furnaces, while in case of shaft-furnaces the anthracite or coke is piled up to a little above the top of the crucible, which is nearly level with the bottom of the flue E, Figures 152 and 153. The bulky coke burns so rapidly that it is necessary to add more after about 45 to 55 minutes, that hanging to the sides of the pots being first poked down so that we may have a solid bed of fuel next the bars, and so avoid cooling the lower part of the pots; and this is repeated at least once during the heat, so that we have at least three firings to each heat. The compact anthracite both burns away and heats up so slowly that this is neither necessary nor practicable. An anthracite fire is not replenished during the heat, for the addition of cold fuel would chill and retard the operation unduly. It is probably at least partly due to this that the crucibles in anthracite practice rest, not on stands and through these on the grate bars, but directly on a bed of anthracite so deep as to last, without replenishing, through the four hours of a heat.

When it is thought the charge is melted, the crucibles are uncovered and examined to ascertain the progress of the fusion. Care must be taken that no coke or anthracite falls into the crucible; it is said that if this happens the steel becomes very hot-short and "stares," *i. e.*, has a splendent fracture. The carbon of a pound of coal (say 34 cubic inches, a lump 3.25 inches cube), if absorbed by the metal, would raise the carbon-content of a 50-pound charge by two per cent.; were the charge initially highly carburetted, this would change it to cast-iron.

In the six-pot melting hole of a gas-furnace only the two middle pots are examined.

The melter's eye at once recognizes by the temperature whether the charge is but partially melted and therefore at the melting point, or superheated much beyond that point. In the former case it is necessary to learn how much metal is still unmelted; to this end the melter feels about in the pot with a thin iron rod, a course which is unnecessary, and often dispensed with if the temperature is clearly above the melting point. If the temperature be very high, no steel adheres to the rod. According to Ledebur[a], European melters judge from the appearance of slag and metal as to the progress of operations. At first the slag is highly ferruginous, and hence black; later it grows lighter. American melters are rather close-mouthed as to

a Handbuch der Eisenhüttenkunde, p. 851.

the indications which they watch for; but I have never detected them in examining the slag removed by the rod.

This examination occurs at the time of the third firing in case of coke furnaces. In anthracite furnaces the crucible has by this time sunk some distance toward the bars, thanks to the burning away of the fuel beneath it. It is therefore lifted up a short distance (say 5″ or 6″), through the fuel by the puller-out, just before removing its lid for examination, the melter simultaneously packing the coal down beneath the pot with a bar.

The charge now looks like slowly boiling porridge, and bright specks, probably of metallic iron, may be seen on the upper surface of the slag.

Killing.—Were the charge teemed as soon as melted, the steel would be full of blowholes. By *killing* it, *i. e.*, holding it molten in the crucible, which still remains in the melting-hole, some change occurs which removes the tendency to form blowholes, and, on teeming, sound, deeply piping ingots or other castings are now obtained. Killing probably acts chiefly through enabling the metal to absorb silicon from the walls of the crucible, thus increasing its solvent power for gas, and thus enabling it to retain in solution during solidification the gas which it contains when molton. The common belief is that killing expels the gas which is present, so that less remains to escape during solidification. But, in the first place, we find that silicon is absorbed rapidly during the killing, and we have already seen that silicon seems to prevent blowholes by increasing the metal's solvent power for gas. In the second place, when the conditions are such that the metal cannot absorb silicon, holding the metal molten in this way does not kill it, *i. e.*, does not cause it to solidify without blowholes. Thus in numbers 14, 38, 43 to 45 and 47 of Table 179, we find that only from 0.006 to 0.06 % of silicon is absorbed, and here in each case the steel contains blowholes. In number 57 the metal (after-blown basic steel), though held molten for three hours, yet took up but 0.012 % of silicon; it then scattered and rose more on teeming than that which had not been thus killed[a]. It is moreover, the experience in Mitis works that when the charge is wrought-iron, the resulting metal, being nearly free from silicon and carbon, is not rendered tranquil by being held molten, or, as they put it, will not kill.

On the other hand, it is but fair to point out that in numbers 35 and 45 of Table 179, the product is relatively free from blowholes, though the metal absorbs but 0.09 and 0.11 % of silicon, or but little more than in some of those cases in which blowholes form. Again, in numbers 18 and 22, in which wrought iron is melted, 0.29 and 0.28 % of silicon is absorbed, yet porous ingots result. If killing be unduly prolonged, the metal becomes hard and brittle, teems "dead," *i. e.*, very tranquilly, and yields very solid ingots. This, again, may be due to excessive absorption of silicon. It is very doubtful whether moderate over-killing, say of 15 or 20 minutes more than is actually necessary, produces appreciable effect. Steel of only common grade is usually made on Mondays, because, as the furnace is not up to its normal temperature then, the proper length of time for killing cannot be readily determined.

a This case should pretty effectually dispose of the belief that the escape of gas during solidification is due to a protracted reaction between carbon and oxygen.

The melter practically predetermines the length of the killing period, judging from the appearance of charge and furnace at the time of the examination already described, and from the known proximate composition of the charge, how soon it will be ready for teeming. As soon as this predetermined period (modified, of course, in case the temperature of the furnace should be changed abnormally during killing) has passed, the charge is drawn and teemed without second examination.

Killing usually lasts from 30 to 60 minutes; sometimes it does not last more than 15 minutes, and sometimes as long as an hour and three quarters. In general the hotter the furnace the shorter may killing be. It is the nearly, if not quite universal, belief of steel-melters that the better the steel, *i. e.*, the freer from phosphorus, etc., the longer killing does it need. It is said that, if the charge consists wholly of Bessemer or open-hearth steel scrap, no killing is needed.

Just what the elements are whose presence hastens killing is not known. We can understand that manganese might have this effect, since we see in § 368, D. E., that it increases the absorption of silicon. Or the presence of oxide of manganese in the slag may here, in some imperfectly understood way, promote soundness.

In the Mitis process, killing is dispensed with. A little of what is said to be ferro-aluminium is added as soon as the charge is melted, and the metal teemed a very few minutes thereafter.

Teeming.—The moulds for the small ingots usually made in the crucible process are split (Figure 158), and held together with a pair of rings and keys. Before use both halves of the mould are laid flat, with their inner faces down, and smoked from beneath by holding a pan of burning resin (used in many American works), coal-tar (British works), or birch-bark (Österby), under them (Figures 156–7). Some American steel-makers report that coal-tar yields a rather wet coating, which roughens the surface of the ingot.

Killing ended, the clamps over the melting hole are removed, *e. g.*, by a chain and telegraph as in Figure 156, or by a little buggy as in Figure 157; and the blast, or draft, or gas and air, as the case may be, shut off. In case of an anthracite shaft-furnace the fire by this time has burnt down so that most of the crucible projects above it. The puller-out, his arms and legs thickly wrapped with sacking, wet to prevent ignition, and at Mitis works with his head covered with a thick cloth and his eyes protected with dark blue glasses, now grasps the crucible with his tongs, Fig. 160, straddles the melting-hole, and with a single motion lifts the pot and swings and rests it on the melting-house floor[a], then swings it across to the teeming-hole, close to the ingot-mould to be filled. It is now grasped by the teemer with the tongs, Figure 161. The puller-out or one of the moulders pries off the cover with his tongs, the slag is swabbed up by means of a mop, *i. e.*, a light iron rod with a ball of slag from previous operations attached to it. This chills the slag, and by a dexterous twisting motion is made to take up most of it.

The teemer, his right hand and arm thickly enveloped

a At an American Mitis works the puller-out's tongs (Figure 159) weigh 27 pounds, the crucible 35, and the charge occasionally 130, or altogether 192 pounds. This, while a light load under favorable conditions, here clearly demands considerable strength. Actually it is swung without apparent difficulty.

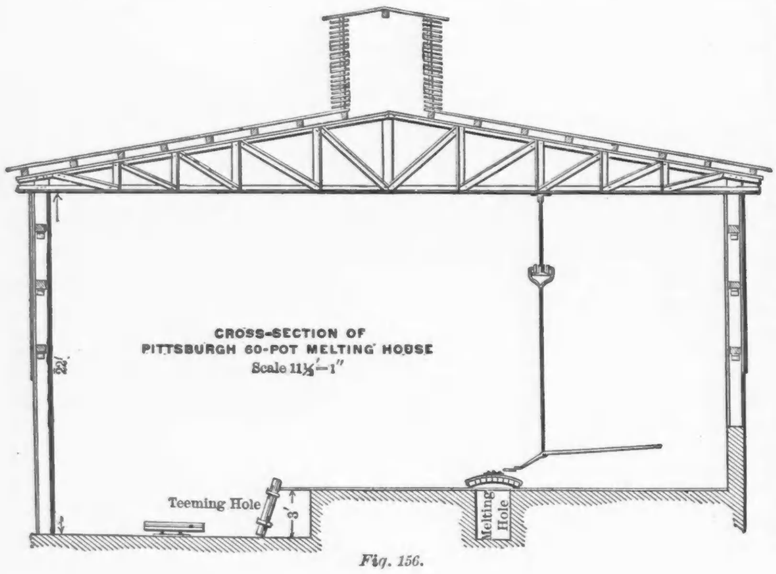


Fig. 156.

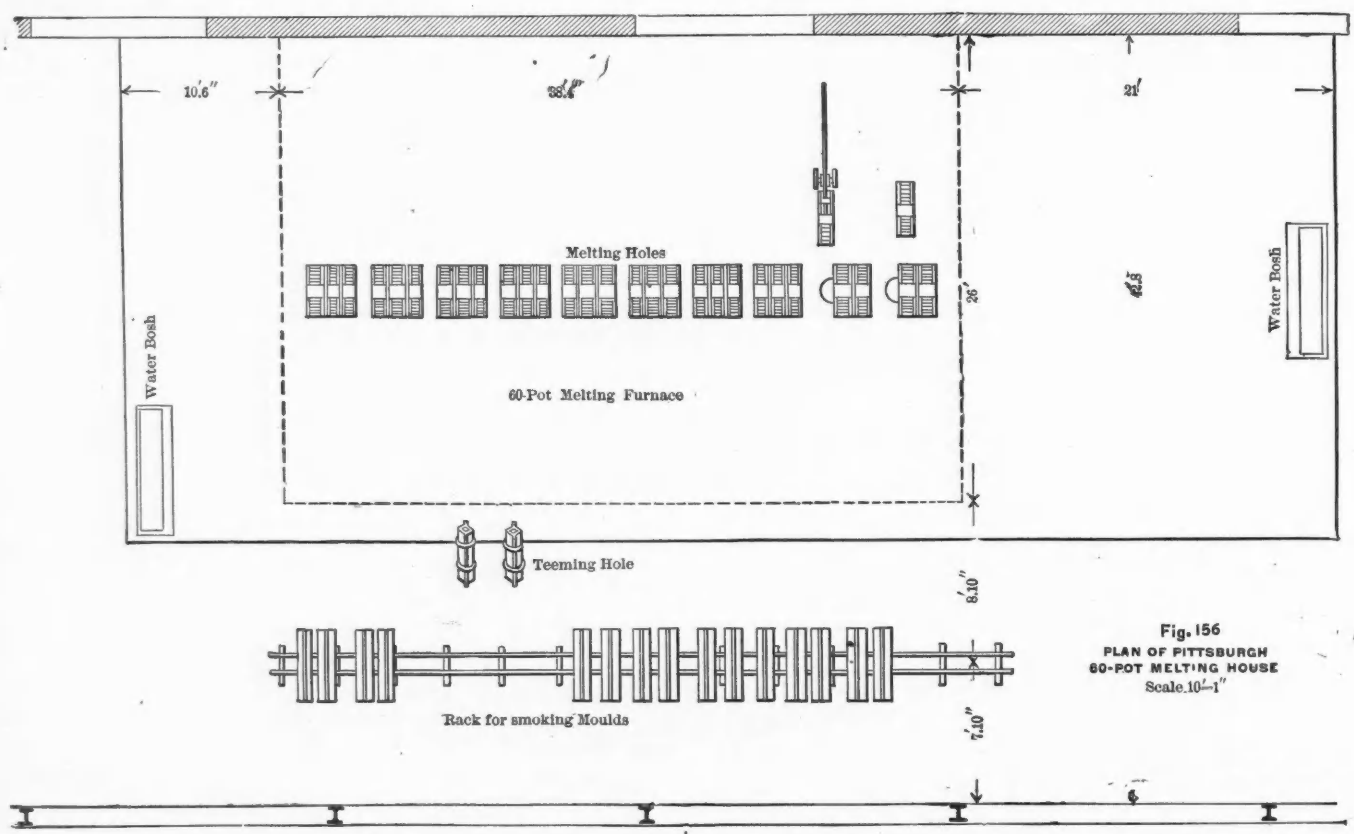


Fig. 156
PLAN OF PITTSBURGH
60-POT MELTING HOUSE
Scale 10′–1″

in cloth, and standing with crucible and mould at his right, rests the tongs about midway of their length on his bent left knee as a fulcrum; raises the crucible, partly by throwing his weight on the left-hand end of the tongs, partly by lifting with his right hand, and pours the metal gently into the mould, whose top is but a few inches above the floor-level, taking care that the stream is continuous, and that it does not strike the sides of the mould; to prevent this the mould may be slightly inclined toward the teemer (Figure 156). If the stream were interrupted, the surface of the metal would crust over and a cold-shut would form; if it struck the side of the mould the metal would freeze there, and an unsound spot on the ingot's surface would result. It is that he may guide the stream more accurately that the teemer bears the weight of the crucible on his knee, and does not at first allow the crucible to rest on, or even touch, the mould; but later, when the ingot is nearly teemed and the stream, having but a little distance to fall, is easily guided, the teemer rests the weight of the crucible in part on the top of the mould.

If the weight of the ingot is to exceed that of a single crucible-charge, part or even the whole of the charge of one crucible is poured into another; or two teemers keep up a continuous stream of metal; or, finally, the contents of many crucibles are emptied into a single loam-lined wrought-iron teeming-ladle, from which the metal is teemed.

In Britain the crucible is carried from the melting to the teeming-hole with "a pair of tongs, forming a barrow mounted on a central pivot fixed to the axle of a pair of wheels, whereby the pot can be inclined for teeming, and also raised from the ground so as to be run along the iron-plated floor."[a]

The crucibles from all the melting-holes of a given furnace are teemed in rapid succession, the teemer indicating which in his judgment are ripest for teeming. If a pot is too hot when drawn from the melting-hole, it is allowed to stand by the teeming-hole till sufficiently cooled.

The moulds for the usual small ingots are unkeyed as soon as the ingot within has set, say six or eight minutes after teeming, and after teeming two or three later ingots.

Graphite crucibles are immediately thrown out and dragged away, for examination after cooling. Clay crucibles are examined while hot, and, if sound, immediately returned to the melting-hole and refilled.

During teeming the metal in the crucible is quiet, a very few bubbles escaping from it, and is said to be quite

a Greenwood, Steel and Iron, p. 422.

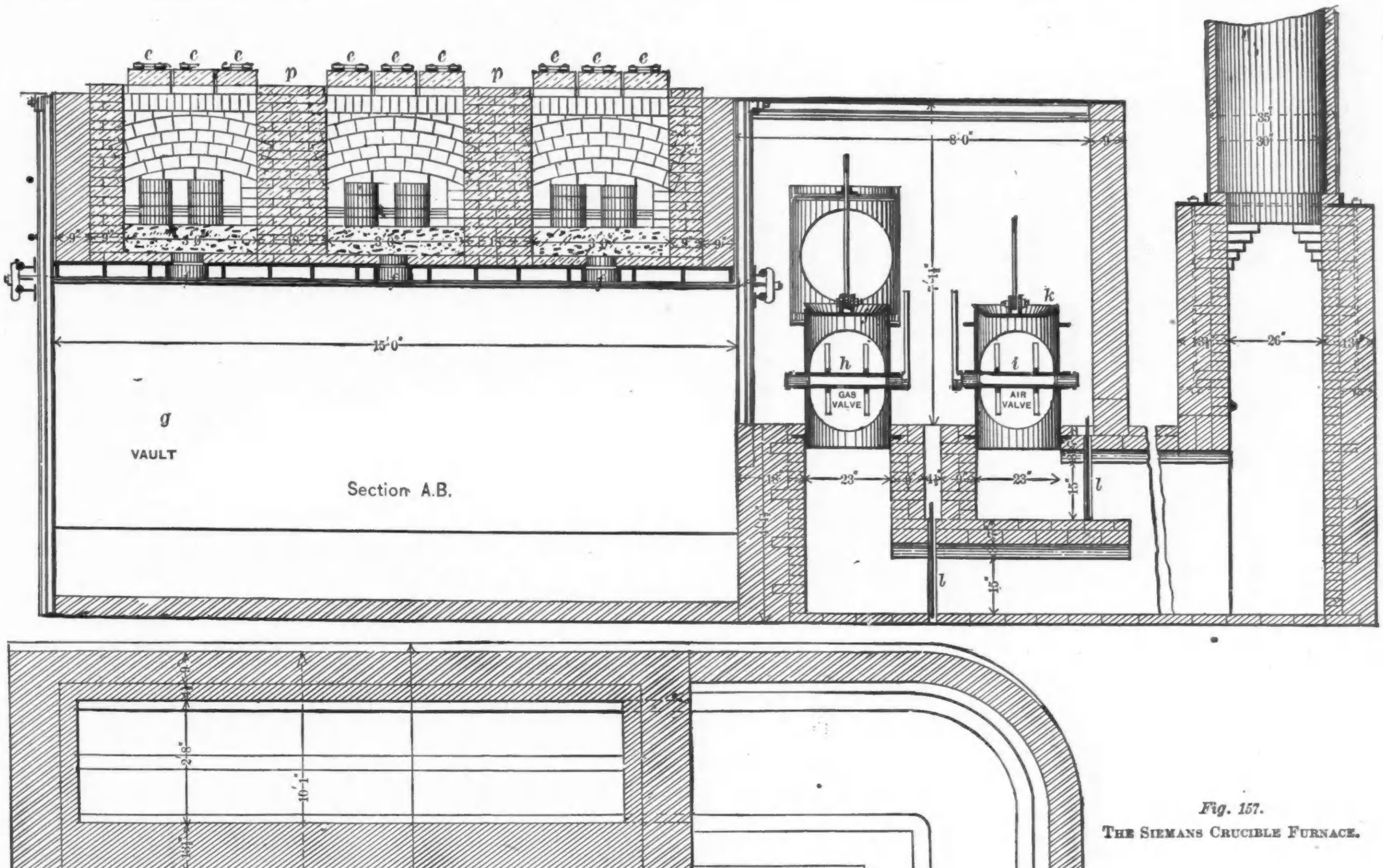


Fig. 157.
THE SIEMANS CRUCIBLE FURNACE.

transparent to the practiced eye ; this, however, I venture to doubt. I have never found a credible witness who would affirm without hesitation that he was sure that he had seen through it. I have always found it quite opaque. A very little pale flame curls slowly across the crucible. In the mould the metal gives out a very pretty shower of sparks, solidifies tranquilly, and, if highly carburized, pipes deeply.

If the metal be soft it may be desirable to stop the mould with sand, so as to chill the ingot-top and prevent rising. In American practice the mould is either not stopped at all, or a cast-iron plate is placed on the top of the mould, several inches above the ingot-top, whose chilling it probably hastens.

Pulling the crucible from the melting-hole by hand is certainly very crude. As he straddles the hole the puller-out is exposed to almost intolerable heat, which, should a crucible break while he is pulling it out, must become simply agonizing, if not indeed dangerous. Fortunately he is only exposed to the very intense heat for from two to three seconds, as nearly as I have been able to measure it, or for perhaps three minutes collectively in a whole shift.

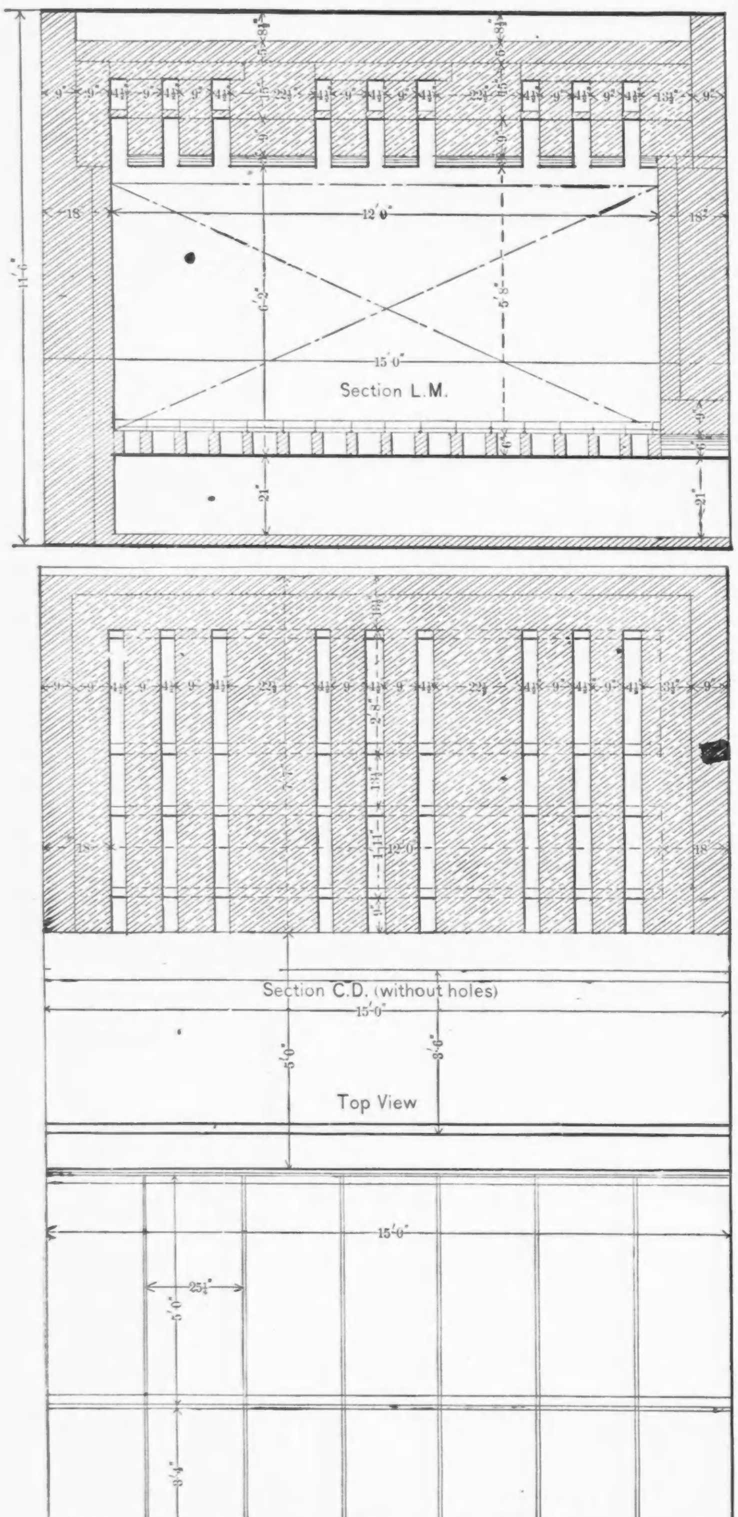


Fig. 157.

The 200 pound crucibles already described were, indeed, pulled out by a crane, and by it swung to the teeming-hole.

Like most hand-work, hand-pulling is surer than machine-pulling. The crucible must be grasped so firmly that it will not slip, but not so tightly that it crushes, as it readily may at this exalted temperature. The grip is more readily adjusted by hand, the feeling insensibly guiding. Indeed, it is said that the puller-out, in grasping an old weak pot, feels for the strongest points; but so rapid is he and so intense the glare, that an on-looker cannot detect this.

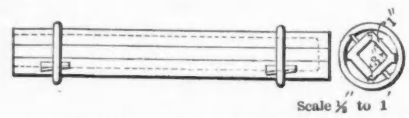


Fig. 158. AMERICAN SPLIT MOULD FOR CRUCIBLE-STEEL INGOTS.

Grading.—The ingot after cooling is "topped," *i. e.*, the piped upper part broken off (about 10 to 20% by weight in case of mild steel ingots, and about 20 to 35% in case of those of hard steel, Table 78, p. 153), and is graded by the appearance of the fresh fracture. It is said that a difference of 0.10% of carbon is readily distinguished, at least between the limits of 1% and 1.5%, and that an experienced eye detects even a difference of 0.05%.

Labor.—The number of men per gang and their respective duties naturally vary much. Let a few examples from American practice suffice.

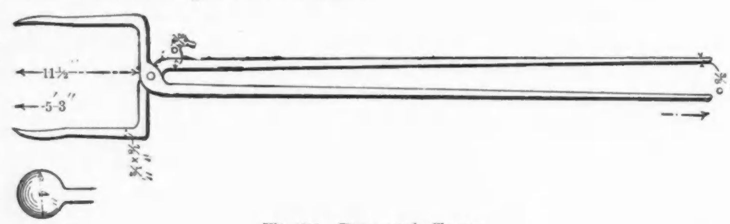


Fig. 160. PULL-OUT'S TONGS.

Works A.—The gang for each 24-pot anthracite shaft furnace consists of seven men: 1 melter, 1 puller-out, 1 setter-in, 1 mould-tosser, 1 coal-wheeler, 1 pot-packer, 1 pot-packer's helper.

The melter is in general charge of the furnace, examines the charge when melted, decides the length of killing, teems the steel, examines the emptied crucibles, and decides whether to use them again.

The puller-out raises the crucibles at examination time,

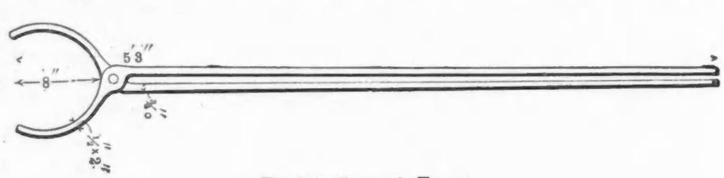


Fig. 161. TEEMER'S TONGS.

pulls them from the melting hole for teeming, and unclinkers the melting holes which are not running.

The setter-in places the already filled crucibles in the melting-hole, charges the coal around them, and cleans the fires after drawing and teeming. He follows the puller-out closely, charging the first melting-hole while the puller-out is drawing from the third, etc.

The mould-tosser smokes the moulds, sets them up and removes them and draws the ingots from the teeming-hole.

The coal-wheeler brings coal to the melting-holes.

The pot-packer and his helper fill the crucibles, swab up the slag at the time of teeming, drag away the emptied pots for examination, and bring new ones from the storehouse.

Works C.—Each 12-pot anthracite furnace has

1 melter who teems, cares for the fire and takes all the labor on contract, at $6.00 per ton of steel; 1 puller-out and 1 moulder; total, 3 men.

Works E and F.—Each 42-pot Siemens furnace has 1 melter, 1 helper, 3 pullers-out and 4 moulders; total, 9.

The melters duties are the same as at Works A, except that he teems only half the pots, the helper teeming the rest.

The three pullers-out lift the pots from the melting-holes, relieving each other.

The moulders smoke, set and remove the moulds, remove the ingots, and fill the crucibles. During teeming one moulder removes and replaces the clamps above the melting hole; a second pulls off the pot-lids; a third swabs out the slag; a fourth drags away the emptied pots. This is the common Pittsburgh arrangement. Charging does not begin till all the crucibles have been drawn and emptied.

With 60-pot Siemens furnaces, drawing and teeming are done by two gangs working simultaneously, one under the melter, the other under the teemer.

In Sheffield (III., Table 172), the gang for twelve two-pot coke melting-holes is, to-day, 1 melter, 1 teemer, 2 pullers-out, 1 or 2 cellar-boys, 1 odd man, 1 yardman; total, 7.

Mitis Works.—Two Nobel furnaces, each holding four crucibles, of which two are drawn at a heat, are worked by one melter and one puller-out, the engineer lending a hand. In addition there are the casting gang and the moulders. The labor is clearly heavier than in case of Siemens' and shaft furnaces, owing to greater care required in feeding the fuel and regulating the temperature, and to the necessity of transferring the crucibles from the middle to the hot chamber, which increases the puller-out's labor by at least half; but no accurate comparison is possible, because more labor is needed to prepare and teem into the numerous small moulds for the mitis castings than when, as in usual crucible practice, common ingots are made. I give a rough estimate in Tables 172 and 178.

The labor in the crucible process is excessively costly. The melter usually provides all the labor on contract, receiving on the Eastern seaboard of this country about $6.00 and in Pittsburgh $5.50 to $6.50[a] per 2,000 pounds of ingots, though here the use of gas furnaces lightens the labor greatly. From data at hand I estimate that the melter's gangs in Pittsburgh receive on an average about $3.00 to $3.60 apiece per eight-hour shift. The melter and puller-out must have strength and judgment, but it seems to me that the price paid is wholly out of proportion to to the intrinsic needs of the case. It is rarely wise to dispense wholly with skilled men, but that one may get along after a fashion without them is shown by the experience of an American crucible steel works whose manager, discharging imported steel men in disgust, hired a sailor and a butcher, neither with any knowledge of steel-making, as melter and as puller-out. He certainly keeps his works running, though with much waste of his own tissue.

§ 362. TIME OF OPERATION.—Shaft furnaces run one shift at a time, every alternate day, *i. e.*, one shift out of four. While not running they are unclinkered. Three heats per shift is the usual stent.

Gas furnaces run continuously from Monday morning till Saturday afternoon, with two gangs working alternate shifts of three heats apiece, each gang beginning work as soon as the third heat of the preceding shift is ended, no matter at what hour this happens. Thus they sometimes work twelve shifts between Monday morning and Saturday noon.

Melting may take 45 minutes or even an hour longer for a very soft than for a hard, *i. e.*, highly carburetted charge. The usual time is from 2 hours 15 minutes to 2 hours 45 minutes. Killing usually lasts from 30 minutes to 1 hour in this country. At Osterby, in Sweden, it is said to last only from 10 to 30 minutes. The discrepancy may be due in part to a different estimate of the time when killing begins, which is not accurately defineable. Charging and drawing usually take about 15 to 20 minutes collectively. With graphite crucibles and gas-furnaces, weight of charge and initial temperature of crucible and of furnace-walls being nearly constant, there is no very great difference between the length of successive heats, unless the degree of carburization of the charge changes considerably. But with clay crucibles and coke-shaft-furnaces the first heat of the day takes much longer than the later ones, in which the furnace walls are hotter; the crucible, returned to the melting hole immediately after teeming, is much hotter initially; and the charge much lighter. Thus the first charge may take from four to five hours, the second, according to Greenwood, about 2 hours 30 minutes.

§ 363. THE LOSS is generally very small, less than two per cent, and sometimes inappreciable. It is probably rather less with graphite than with clay crucibles, the carbon of the former not only lessening the oxidation of iron, but by causing a marked absorption of carbon and silicon, offsetting the loss of iron. The loss is doubtless relatively heavy when the charge consists of small and rusty pieces. In the Mitis process the loss sometimes rises to 10% when very rusty small pieces are used.

At Works A an 85-pound charge yields 84 pounds of ingots and about 66 pounds of rolled bars, so that 1.2% is lost in melting and 21% is removed by topping and in further oxidation during heating and rolling. At Österby 100 of charge yields 96.3 of ingots and 1.8 of scrap, with 1.9 of loss.

§ 364. THE MATERIALS used in this country are chiefly puddled bloomary iron, and wrought-iron and steel scrap. There is a belief that for the very best quality of steel nothing but Dannemora Swedish iron is suitable, and even that the employment of blister-steel of uniform carbon-content made from Dannemora iron is essential. Certain it is that relatively little blister-steel is made or used in this country. In 1886 only 2,651, and in 1887 only 6,265 net tons of blister, puddled, patented and apparently certain other minor classes of steel were made collectively in this

a Of two thoroughly trustworthy correspondents in Pittsburgh, one assures me assures me that he pays his melting gang $5.50; the other that he pays his $6.50 per 2,000 pounds of ingots. The difference is probably due to a slight difference in the range of duties, the higher price including topping, weighing, etc. We note in Table 172 that the labor in American mills using shaft and gas furnaces is much less per 100 pounds of ingots than in British and continental mills—0.09 to 0.13 days against about 0.20. The difference is too great to be wholly referred to the somewhat heavier charges and shorter heats of American practice.

country, while 80,609 and 84,421 tons respectively of crucible steel were made in these two years[a]. Of this probably nine-tenths was made from American Iron,[b] so that imported blister-steel cannot have been an important component.

The only apparent explanation of the superiority of Dannemora iron is its almost complete freedom from phosphorus, of which it is reported to contain from trace to 0.034 %.[c] Åkerman reports that the ore contains about 0.003 % of phosphorus.[d]

In Sheffield, however, blister-steel seems still to be generally used. While we may have better control over the percentage of carbon in the cast-steel when using blister-steel than when using wrought-iron and charcoal, it is extremely hard to believe that, starting with a given wrought-iron, it should make any difference whatsoever in the excellence, apart from carbon-percentage, of the product whether carburization be effected by charcoal in the large crucible of a converting-furnace, or by charcoal in the small crucible of a melting-furnace. The crucible process seems to delight in and to generate an atmosphere of superstition and empiricism.

Bell-Krupp washed metal is bought, and therefore probably used, by several crucible-steel makers. If thoroughly dephosphorized it should be an excellent material.

In using scrap, especially high-carbon steel scrap, there is much uncertainty as to its quality, and hence as to that of the product, since it is absolutely impossible to make good steel from phosphoric or sulphurous materials in acid crucibles. By selecting scrap of classes from which good materials are habitually used (clinch-nails, screws, etc.), the uncertainty is greatly diminished, but is not removed. When really excellent material is needed, we must use scrap of known and guaranteed phosphorus-content, such as shearings of boiler-plate from some of the few most careful mills, etc.

The size to which the pieces of bar-iron are cut may be 6″x1″x3″. That of pieces of scrap is usually from this size down, but of course varies greatly, sometimes reaching 6″x2½″x2½″. For making very hard steel, chromium, tungsten and manganese are added (cf. pp. 48, 75, 81).

The only evident objection to the use of cast-iron and iron ore is that they usually hold much more phosphorus and sulphur than the wrought-iron and steel made from them. Where this objection disappears, as with some very pure Swedish material, the percentage of carbon of crucible-steel may be advantageously and very cheaply governed by using them.

There is a common belief that, for given composition, crucible-steel made from open-hearth or Bessemer steel is not nearly as good as that made from wrought-iron or blister-steel (§ 357).

Additions.—Besides the charcoal for carburizing the metal, a little ferromanganese or spiegeleisen is usually added to prevent blowholes and promote forgeableness; about a struck teaspoonful of oxide of manganese, to form a thin slag (it also increases the absorption of silicon and carbon); and often physics, not to say nostrums, such as salt (it may thin the slag), ferrocyanide of potassium, (it should promote carburization), sal ammoniac, etc. Without direct experimental evidence we cannot tell whether these physics have any valuable action, or whether, as one strongly suspects, they are mere gingerbread pills. The crucible-steel maker is very secretive about his mixtures; it is doubtful whether we would be much wiser than now if he told us frankly all he certainly *knew* about them.

As regards the quantity of charcoal to be added to produce steel of given carbon-content, I can give no sure rules. Probably from 60 to 75 % of the carbon of the charcoal is taken up. The charge may take up probably not more than 0.25 % of carbon from the walls of a new common graphite crucible, and probably not more than 0.15 % from those of an old one. In a coke-clay crucible the charge may gain a little carbon (say 06 %) from the crucible, but usually loses, say up to 0.23 %. Spiegeleisen, ferromanganese and oxide of manganese, and long and hot killing, increase the absorption of carbon (see § 369).

§ 365. Uniformity.—Clearly, the percentage of carbon in the ingot depends not only on that in the charge, but on the proportion of rust and scale; on the tightness of the crucible; on the degree to which the graphite or coke of its walls are exposed to the charge, and thus on the age of the crucible and the amount of corrosion which it undergoes during melting; on the temperature; and on the length of melting and killing. So great is the uncertainty thus introduced that a well-known steel-maker informs me that, with like charges, the percentage of carbon in the ingot may vary from 0.80 to 1.50 %. This seems to me rather an exaggeration, and the statement of another and very eminent crucible steel-maker, that the carbon of the ingot may vary by from 0.15 % to 0.20 % either way from the point aimed at, seems nearer the mark.

Taking considerable numbers of heats at random, I found that, in the Bessemer process, the greatest deviation of the carbon-percentage from the average was usually from 0.01 to 0.03 % for soft steel, and only 0.04 % even for rail steel made from remelted pig. For open-hearth steel the maximum deviation was about 0.07 % to 0.08 %.[a] Doubtless the deviations would be somewhat greater in making highly carburized steel such as the crucible process usually produces: but, allowing for this, it is probable that the variations between the different ingots of a single heat in the crucible process is considerably greater than that between different heats of either the Bessemer or the open-hearth process.

With regard to silicon the crucible process stands at a still greater disadvantage, to judge from the experiments of Table 179, and from our general knowledge of the subject. I found the range of variation of silicon in Bessemer steel in no one series over 0.015 %, and in one series it was only 0.009 %.

§ 366. In the Mitis process Nobel's petroleum furnace (Figure 155) is used. It runs only one shift at a time; four crucibles are placed in the furnace, two in the middle and two in the hottest chamber. As actually practiced at one works, the charge consists solely of wrought-iron

a Ann. Statistical Rept. Am. Iron and Steel Ass., p. 30, 1888.
b Testimony of Wm. Metcalf, Rept. Select Committee on Ordinance and Warships, p. 318, 1886.
c Percy, Iron and Steel, p. 736.
d The State of the Iron Manufacture in Sweden, Stockholm, 1876, p. 13.

a Trans. Am. Soc. Mining Eng., XV. p. 347, 1887.

scrap, when the softest product is sought, mixed with more or less steel scrap and even cast-iron for harder products.

The furnace is fired the night before melting: by seven the following morning the first heat of two pots in chamber *a* is melted. This ascertained by inserting a rod through the cover of the crucible a cold ingot said to be of ferro-aluminium (say enough 8% ferro-aluminium to introduce .05 to .10 % of aluminium) is introduced through this same hole, the lid of the furnace melting-hole having for this purpose a little hole immediately above the crucible, usually closed. After about three minutes the metal is stirred vigorously with a little iron rod. After two or three minutes more the cover of the melting-hole is removed, one crucible is drawn, then the cover is replaced; the crucible uncovered; the abundant black glassy slag, full of shots of metal, swabbed up (I am told that sometimes a quart of it is removed), and the metal teemed. Then the second crucible is drawn in like manner. Then the two crucibles from the middle are transferred to the hot chamber *a*, and two cold ones previously filled placed in the middle chamber *a'*. From this time on a pair of crucibles is drawn about every 75 minutes till say 5 P. M., making 9 heats per shift. Table 172, and §§ 359,360 give further data. Table 177 gives the actual time of certain parts of the operation by my own observation.

Watch in hand, I noted that this transferring the crucibles from one chamber to the other, and charging fresh ones occupied 60 to 65 seconds for each furnace, excluding the time occupied in getting ready. To transfer a crucible from one chamber to the other took fifteen seconds, counting from the time of uncovering the first to that of covering the second chamber. The sliding covers of the melting-chambers permit very rapid movement.

TABLE 177.—TIME OF OPERATIONS IN THE MITIS PROCESS.

	I.	II.	III.	IV.	V.
Ferro-aluminium charged....	....	....	— 5′ 35″	....	— 6′ 7″
Charge examined.	....	....	— 4′ 10″	....	— 3′ 2″
Melting-hole uncovered......	0′ 0″	0′ 0″	0′ 0″	0′ 0″	....
Crucible out..................	....	0′ 5″	....	....	....
Melting-hole closed..........	....	....	....	0′ 10″	0′ 7″
Crucible in teeming tongs....	0′ 12″	0′ 30″	0′ 20″	0′ 20″	....
Teeming begins.............	0′ 30″	0′ 50″	0′ 45″	0′ 54″	0′ 48″
Teeming ends................	1′ 40″	1′ 45″	1′ 55″	1′ 47″	1′ 28″
Number of flasks teemed.....	....	8	5	12	5

Though it was nearly two minutes from the time of leaving the furnace to teeming into the last flask, the whole charge seemed to run out, leaving the crucible surprisingly clean and not badly corroded.

The quieting effect of the ferro-aluminium is very marked, and more sudden than that of ferro-silicon in the open-hearth process. Watch in hand, two and a half minutes after adding ferro-aluminium to a charge, which was boiling gently, I found it almost absolutely quiet. Poured within three or four minutes of this observation it lay perfectly quiet in the crucible and mould, much like cast-iron. Examining it later I found it extremely tough.

But, while the addition of ferro-aluminium quiets an almost carbonless charge effectively, there has been great trouble in getting solid castings of steel of about 0.25 per cent. of carbon, and the use of ferro-silicon for this purpose is contemplated. This accords with Davenport's observation (p. 87, foot note [c]), that the addition of ferro-aluminium, while it thinned non-carburetted iron, seemed to stiffen carbutted steel.

Hatchets cast by this process and wholly unforged are now selling in this country. Their polished surfaces show only a moderate number of blow-holes. But the very soft Mitis-castings are indeed remarkable. The neck of one of these, which contained 0.14 per cent. of carbon and 0.24 per cent. of silicon [a], which had not been annealed, and which was said to have been made from horse-shoe nails, was $\frac{3}{16}''$ x $\frac{3}{8}''$ and about $2\frac{1}{2}$ inches long. Fastening one end in a vise, I twisted the neck two complete revolutions (of 360°) before it broke. Nicked and broken with a sledge without heating, its fracture was fine crystalline; forged, cooled, nicked and broken, its fracture was extremely, indeed extraordinarily, silky, more like that of copper than that of iron. In both cases serious blowholes appeared.

The natural field for Mitis castings is to replace castings of common malleable-iron.

They are necessarily more costly, and actually, so far as my observation goes, much more liable to contain serious blowholes than malleable castings are. My inquiries among those who have used Mitis castings corroborates my own experience, that they are as yet very untrustworthy. Besides the serious and often fatal blowholes, there is much variation in shrinkage, so that the castings often fall short in finishing, and many of them have hard spots. On the other hand, they are incomparably tougher than malleable castings.

Thus the Mitis process has gone a step beyond the forms of the crucible and open-hearth processes hitherto used, in producing extremely tough castings, almost free from carbon: but it does not seem to have overcome the chief obstacles which the production of castings, hard or soft, by these processes has met, the liability to blowholes, uncertainty as to contraction, and heterogeneousness, whether from segregation or imperfect mixing. Nor do I see that it is more likely to overcome these difficulties than the processes with which it competes, while the very nature of the castings which it habitually produces tends to exaggerate them.

Mitis castings, then, seem to commend themselves for purposes where extreme toughness is so necessary as to compensate for greatly increased first cost, and where failure owing to presence of large cavities will not lead to serious consequences. They are used for the armatures and field-magnets of dynamo-electric machines, thanks to their extremely low magnetic retentiveness, due, of course, to their purity.

Their price, depending greatly on their size, shape and number, is not often much below 12 cents per pound in this country; that of small malleable-iron castings of usual simple shapes is commonly between 4 and 6 cents per pound.

On pages 87 and 88 I gave reasons for doubting that soft Mitis castings contained any appreciable quantity of aluminium; none had been found in them, and it seemed like to oxidize and scorify instantly. If aluminium remained unoxidized in any of these castings it would be

a I have to thank Messrs. Hunt & Clapp, of Pittsburgh, for kindly analyzing this casting for this work.

in those which are highly carburetted, the carbon, of course, tending to prevent the oxidation of other elements present, aluminium included. But a careful analysis in Drown's laboratory, by a method which this eminent chemist has devised and believes trustworthy, failed to detect more than 0.02 per cent. of aluminium in a tool-steel high-carbon Mitis casting, to which the usual dose of ferro-aluminium had been added. The analytical method is of such a nature that this result indicates that *not more* than 0.02 per cent. of aluminium was present; while it is not unlikely that a considerable part of this 0.02 per cent. consisted of substances other than aluminium.

I am informed that the Mitis process is in actual use in five American works, in four different States; in Sheffield, in France, and in Belgium[a].

§ 367. THE COST of the crucible process is roughly estimated in Table 178. The cost of the materials varies so widely, according to their purity, that any assumed cost would be more likely to mislead than to instruct. It is, therefore, left blank.

TABLE 178.—ESTIMATED COST OF MAKING 100 LBS. STEEL BY THE CRUCIBLE PROCESS. SPECIAL CHARGES ONLY.

	Pittsburgh gas furnaces.	New Jersey anthracite furnaces.	Mitis process a.
Material, 102 lbs. of iron, according to quality	....	....	....
Fuel. 100 lbs. slack coal @ 3 cts. per 76 lbs	$0.04	....	....
230 lbs. anthracite @ $4.25 per 2,240 lbs.	....	$0.43	....
87 lbs. petroleum @ 5 cts. per gal	....	....	$0.60 ($0 19)b
Labor	.28	.27	.33a
Repairs	.01	.06	.10
Crucibles	.22	.22	.45
Moulds, charcoal, sundries	.03	.03	.03
Total, excluding material	$0.58	$1.01	$1 51 ($1 15)b

a For comparison with the other processes the steel is supposed to be cast in common ingot-moulds. I assume that the puller-out's labor is half greater than in anthracite and gas furnaces, but that in other respects the labor requirement is the same for all. To allow for moulding, and for teeming many small castings by the Mitis process, the cost of labor should be increased considerably.

b Supposing that crude oil at $0.016 per gallon is used.

In France graphite crucibles now cost about four cents per pound of steel which their normal charge contains.

But the crucibles made by Muller of Paris, have in some works an average life of from seven to nine heats in case of hard, and from five to six in case of soft steel. They contain about 50% of carbon.

THE CHEMISTRY OF THE CRUCIBLE PROCESS.

§ 368. The following sketch, while partly speculative, is in large part based on and in harmony with the results of practice and of the experiments detailed in Tables 179 and 180.

The charge contains initially a moderate quantity of oxygen as rust, scale, and the slag of weld-iron. This, as well as the trifling quantity of atmospheric oxygen initially present, and free oxygen and the oxygen of any carbonic acid or aqueous vapor which may enter by leakage or diffusion, should tend to form oxide of iron and (if the charge contain spiegeleisen or ferro-manganese) of manganese. This tendency is opposed by the carbon of the crucible-walls, which, especially in case of new graphite crucibles, tends to take up the free oxygen and to reduce the carbonic acid present.

The metallic oxides, melting first to a very basic, corrosive, oxidizing slag, should collect at the bottom of the crucible and react on its walls, and later on the gradually accumulating bath of molten metal. The first action of this slag on the metal should be strongly fining, tending to oxidize carbon, silicon and manganese. As the slag-level is gradually raised by the accumulation of the molten metal beneath, the slag corrodes ring after ring of the crucible-walls, exposing their graphite or coke to the rising underlying metal, which absorbs carbon voraciously. The fining action should thus weaken rapidly as the slag grows acid, through absorption of silica from the crucible, and through the reduction of its oxides partly by the metal's carbon and silicon, partly (in case of strongly graphitic crucibles chiefly) by the carbon of the crucible. Thus, fining probably soon gives way to carburization, the carburized metal reducing and absorbing silicon[a] from the now acid slag, and from the acid crucible-walls, from these probably the more readily the more silicious the clay which composes them.

The net result, under usual conditions, as indicated by our experimental data, is that *in graphite crucibles*, the metal gains in carbon (usually by from 0. to 0.25%), and in silicon (usually by from 0.05 to 0.20%); that, if spiegeleisen or ferro-manganese is charged before melting, much of its manganese is slagged, and the absorption of carbon is increased very greatly, rising even to nearly 2% (numbers 31 and 41), and that of silicon greatly, rising sometimes to nearly 0.50% (numbers 30 and 39), when about 3.5% of ferro-manganese is added; and that if oxide of manganese is charged, part of its manganese is sometimes if not usually reduced and absorbed by the metal. The more highly carburetted the crucible-walls, the greater will be the net absorption of carbon, manganese and silicon.

In clay crucibles the charge either loses carbon (say up to 0.23%) or gains but slightly (say up to 0.06%), while, if we may trust our scanty data, gaining but slightly in silicon, unless manganese or its oxide be present.

If the charge contains charcoal or graphite, this both carburizes the metal during heating to the melting point (probably most of its carbon is absorbed by the steel), and greatly shortens and weakens if it does not eliminate the fining period, by protecting iron and manganese from oxidation, and by reducing at least a part of their oxides.

If, on the other hand, oxide of manganese is charged, it tends to intensify and prolong the fining, to postpone and enfeeble the carburization, opposing the action of the charcoal.

Risking repetition, let us now take up the behavior of silicon, carbon and manganese separately.

THE ABSORPTION OF SILICON.—Unless basic crucible be used, the steel always takes up silicon, the proportion absorbed in general increasing,

A, with the proportion of graphite or coke in the crucible walls;

a Private communication, The U. S. Mitis Co., Jan. 7th, 1889.

a From a basic slag iron may be reduced, as is indicated by numbers 82–4 of Table 180. The fusion in this case occurred in limeless magnesia crucibles. Ferric oxide and lime were added to the charge in the proportions 225 ferric oxide to 100 of lime. The iron remaining in the resulting slag corresponded to only 153 of ferric oxide to 100 of lime. The slag can hardly have received lime, and it can hardly have lost iron except by reduction to the metallic state. This view is favored by the presence in the slag of many globules of iron, some visible to the naked eye, others microscopic. There is, unfortunately, a possibility that the apparent reduction of iron may be due to heterogeneousness of slag, as Brand states that the slag was sintered rather than molten, and that its color was not uniform.

B, probably with the proportion of carbon in the metal itself;

C, with the length of killing;

D, with the proportion of metallic (*i.e.*, unoxidized) manganese present;

E, the addition of oxide of manganese, however, probably usually diminishes the absorption of silicon.

A. The Influence of the Proportion of Carbon in the Crucible-Walls.—In the perfectly carbonless crucibles, 43 to 47, and in the clay crucibles with only 5% of coke, 48 to 52, wrought-iron takes up almost no silicon, and steel relatively little; with 28% of carbon or more in the crucible walls the absorption of silicon is much more marked, amounting on an average to something like 0.30% in the usually manganiferous charges of Table 179. Further increase in the proportion of carbon present in the crucible-walls seems to increase the absorption of silicon very much more when the charge itself contains but little than when it contains much carbon. Thus we find relatively little increase in the silicon-absorption by high-carbon steel as the carbon content of the crucible-walls rises from 28% to 39% in numbers 4 and 5; from about 40 to about 50% and again to about 70% in numbers 12–13, 24–25 and 16–17. Yet these same increments in the carbon-content of the crucible-walls increase the silicon-absorption greatly when the charge is wrought-iron, as Table 181 shows:

TABLE 181.—ABSORPTION OF SILICON AS AFFECTED BY THE PROPORTION OF CARBON IN THE CRUCIBLE-WALLS.

Carbon content of crucible-walls, %	0	40±	50±	70±	
Absorption of Silicon by wrought-iron, %	0.006	0.06	0.18	0.29	0.28
Number in Table 179	44	14	26	18	22

The following explanation seems to cover the ground fairly. The reduction of silicon is probably effected by the carbon of the metal and that of the crucible-walls jointly, but chiefly by the latter, thanks to the much more intimate and extended contact of the graphite with the acid and easily reduced silicates of the walls, than of the steel with the supernatant slag. (Needless to say, the presence of the molten steel is essential to this reduction of silicon, cf. § 61, p. 36.) Thus we note that when even highly carburetted steel is melted in carbonless crucibles (Nos. 43–7) the absorption of silicon is very slight, from .04 to .11%. But in order that the silicon reduced from the walls and absorbed by the metal should remain in the metal, the latter must contain a fair proportion of carbon.

Now, the metal takes up carbon from the crucible walls to a degree which probably increases rapidly with their proportion of carbon. But a given *absolute* absorption of carbon from the crucible-walls has a vastly greater *relative* effect on the carbon-content and consequent silicon-reducing power of metal initially almost carbonless, say wrought-iron, than on those of initially highly carburetted metal: *e.g.*, an absorption of 0.25% of carbon increases by 400% the carbon-content of metal holding initially but 0.05% of carbon, but that of metal with 1.00 of carbon by only 25%. Add to this the fact that the absolute absorption of carbon seems in general to be decidedly greater with charges of wrought-iron than with those of steel.

Probably more silicon is absorbed from the walls of new than of old and partly decarburized ones (cf. § Absorption of Carbon, 369 A).

B. The influence of the proportion of carbon in the metal on the absorption of silicon is illustrated in Table 182. Here we note that a charge of steel in general takes up much more silicon than one of wrought-iron; and that when the carburetted ingot resulting from the fusion of wrought-iron (in which much carbon is always absorbed) is again melted, more silicon is absorbed than in the fusion of the wrought-iron itself. This for reasons given in *A*. An exception seems to occur in numbers 16 and 18. Whether this is due to the fact that in these experiments the crucibles were perforated, thus introducing the oxidizing fire-gases, probably to different degrees in the two cases, or to some other and unnoticed factor, I cannot say. In a Mitis casting, said to be made from melted horse-nails, Hunt and Clapp found 0.24% of silicon with 0.14 of carbon; but how much of this came from the crucible-walls and how much was introduced with the ferro-aluminium, I know not.

TABLE 182.—INFLUENCE OF CARBON-CONTENT ON SILICON-ABSORPTION.

Steel	First Fusion.	Gain of Si. %	.34	.28	.33
		Number	12	16	24
Wrought-Iron	First Fusion.	Gain of Si. %	.06	.29	.18
		Number	14	18	26
	Second Fusion.	Gain of Si. %	.18	.33	.19
		Number	15	19	27

C. The influence of the length of killing is illustrated in Tables 180 and 183. In the first and third sets of the latter table there is an actual loss of silicon in melting down, but the gain during killing is invariably continuous (except, of course, in case basic crucibles are used). This may be referred to the progressive acidification of the slag, already pointed out, which makes the reduction of its silicon more easy; and to the higher temperature during killing, which, raising the affinity of carbon for oxygen relatively to that of silicon, favors the reduction of silicon from slag and crucible by the carbon of crucible and steel.

TABLE 183.—INFLUENCE OF LENGTH OF KILLING ON SILICON-ABSORPTION.

	Graphite crucible.			Pure clay crucibles.	
No. in Table 179	38	39	40	45	46
Length of killing	15 min.	1 hr. 45 min.	3 hr. 15 min.	45 min.	7 hr.
Gain of carbon, %	+.01	+.33	+.22	−.19	−.22
Gain of silicon, %	+.05	+.49	+.65	+.063	+.11

D, E. The influence of manganese is shown in Table 184; here in each case the addition of ferro-manganese increases the absorption of silicon, and in two cases very greatly. The addition of oxide of manganese, however, diminishes the absorption of silicon. Thus, in numbers 20 and 21 (Table 179), in which 1% of oxide of manganese is added to a charge of weld-steel, only 0.15% of silicon is absorbed; while 0.28 and 0.31% respectively are absorbed in the parallel cases numbers 15 and 17, in which oxide of manganese is omitted; indeed, in cases 12, 13, 24 and 25 of Table 179, in which like steel is melted without oxide of manganese, the minimum silicon-absorption is 0.26%, in spite of the lower carbon-content of the crucible walls.

TABLE 184.—INFLUENCE OF MANGANESE ON THE ABSORPTION OF SILICON AND OF CARBON.

Number in Table 179		4	33	5	6	12	30
Absorption of Silicon, %	Weld-steel alone	+.22	......	+.23	......	+.34	......
	" " with ferro-manganese	......	+.48	......	+.44	......	+.39
Absorption of Carbon, %	" " alone	−.15	......	−.05	......	+.25	......
	" " with ferro-manganese	......	+1.25	......	+.52	......	+1.47
Absorption of Manganese, %	" " alone	−.02	......	+.03	......	−.02	......
	" " with ferro-manganese	......	−.80	......	−.26	......	−.56
Carbon in crucible walls, %		28±		39±		40±	

Ledebur, with hardly his usual acuteness, believes that manganese increases the absorption of silicon by increasing the steel's affinity for this metalloid, pointing out that if the excess of silicon in number 6 over that in number 5 were due to the deoxidation of silicon in 6 (Table 179) by the reaction

$$2Mn + SiO_2 = 2MnO + Si.$$

Then $(0.44—0.23)\frac{x2x55}{28} = .825\%$ more of manganese should be oxidized in 6 than in 5, while actually only $0.26 + 0.03 = 0.29\%$ is. So[a], too, if the manganese simply protected the silicon from oxidation by itself taking up the oxygen present, .825% of manganese would be needed to lessen the oxidation of silicon by .44—.23 = .21%.

Without denying that manganese may have such a tendency to *attract* silicon to iron, I may point out that the manganese-content of 6 exceeds that of 5 by an amount which seems hardly large enough to attract so much more silicon; and, further, that simpler explanations are at hand.

Unoxidized manganese may affect silicon-reduction in several ways:

1, *favorably*, by directly reducing silicon from slag or crucible-walls by the reaction just given;

2, *favorably*, by combining with oxygen which would otherwise have attacked silicon;

3, *favorably*, by increasing carbon-absorption. The fusible ferromanganese, melting early, gives rise to a highly manganiferous corrosive slag. This eats deeper into the crucible walls and exposes their carbon more fully to the rising molten steel, which thus absorbs more carbon than in case of non-manganiferous charges with their less corrosive slags. Note that in each case in Table 184 the carbon-absorption is very much increased by the addition of manganese. Now, this excess of carbon naturally reduces silicon vigorously from both slag and crucible walls. In harmony with this view is the fact that, in numbers 41–2 of table 179, the absorption of carbon is very much and that of silicon decidedly greater when the ferromanganese is charged before, than when it is charged after melting. In Ledebur's view one might expect the reverse, since, when the manganese is charged after melting, the resulting steel is the more manganiferous and should attract silicon the more vigorously.

4, *Unfavorably*, the oxide of manganese charged as such, or formed during fusion, directly increases slag-basicity, thus opposing the reduction and favoring the oxidation of silicon.

5, *Favorably*, the corrosive oxide of manganese, attacking the crucible walls, increases the quantity of slag, so that a given reduction of silicon per 100 of slag means a greater silicon absorption per 100 of steel.

Of these actions (of which the last is probably relatively unimportant) the fourth should be strong relatively to the others when the proportion of manganese-oxide is very large.

While one could hardly foretell confidently the net effect of manganese under new conditions, it is not surprising that the first three outweigh the fourth considerations, and lead to a net increase of silicon-absorption when a moderate quantity of ferromanganese is charged in carburetted, well-closed crucibles, in which only a moderate quantity of manganese is likely to be oxidized; and it is very natural that, when manganese-oxide is charged as such, the first two actions being thus eliminated, and the fourth pronounced, the silicon-absorption should be diminished, as in numbers 18 to 21 of Table 179.

§ 369. THE ABSORPTION OF CARBON, much more variable than that of silicon, increases

A, with the proportion of carbon in the crucible-walls;

B, with the proportion of metallic manganese present;

C, probably with the proportion of oxide of manganese present;

D, usually slightly with the length of killing, in case graphite crucibles are used;

E, probably with the temperature reached, in case graphite crucibles are used;

F, the carbon of charcoal or graphite added is in large part absorbed by the metal.

A. The influence of the proportion of carbon in the crucible-walls, often masked by that of other variables, can be traced in a rough way in Table 185. It needs no explanation.

TABLE 185.—INFLUENCE OF THE PROPORTION OF CARBON IN THE CRUCIBLE WALLS ON THE ABSORPTION OF CARBON BY THE METAL.

Steel	Number in Table 179	45	43	48	51	40	53	4	34	13	12	25	24	16	17
Steel	Gain of Carbon	from —.19	to —.45	from —.08	o — .23	+.22	+.02	from —.15	to +.06	from +.08	to +.25	from —.04	to +.03	....	....
Wrought-Iron	Number in Table 179	44	....	....	....	....	....	....	....	15	14	27	26	22	23
Wrought-Iron	Gain of Carbon	+.006	....	....	....	....	....	....	....	from +.10	to +.20	from +.07	to +.23	from +.63	to +.67
Percentage of Carbon in Crucible-walls		0		5		15	25±	28		40±		50		70 ±	

Very experienced steel makers assure me that the charge may take up 0.25% of carbon from a new pot, but not more. This agrees with the data for normal conditions in Table 179. Here 0.25% is, with one exception, the greatest carbon absorption when the final proportion of manganese is below 0.83%, and when the crucible walls contain less than about 70% of graphite.

Thanks to the progressive decarburization of its walls (which doubtless extends for an appreciable distance beyond their inner faces), the crucible naturally imparts more carbon to the steel (and hence more silicon) during the first than during later fusions. This effect is readily traced in numbers 58 to 60, 61 to 63, and 69 to 71 of Table 179, and is well known in practice. It is, perhaps, intensified, as Böker[a] points out, by the fact that in teeming

a The numbers which I give here differ slightly from Ledebur's, but not enough to affect the argument.

a Wedding, Darstellung des Schmiedbaren Eisens, p. 678. Böker further points out that, thanks to this protection of the crucible-walls, the slag formed in a second and third melting is less able to take up silica from the walls, hence is more ferruginous and hence tends the more to oxidize the carbon and silicon of the underlying metal. While one may not speak positively without experimental evidence, he seems to me to exaggerate this protective action of the residual slag.

some of the slag adheres to the crucible walls. During the following heat this slag to a certain extent protects them, if not after fusion is complete, at least during fusion, from the action of the early-formed corrosive slag.

B. The influence of the presence of manganese is shown in Table 184. It is probably due chiefly to the corrosive action of the oxide of manganese formed during and after fusion, which exposes the carbon of the crucible-walls more fully to the molten metal ; in part to the presence of this oxide of manganese, which, by its affinity for silica, favors the oxidation of silicon instead of carbon by what oxygen is present, and opposes the reduction of silica at the expense of carbon ; and in part to the fact that the manganese unites with oxygen which might otherwise have attacked carbon.

C. Oxide of manganese, charged as such, should for the first two of these reasons favor the absorption and retention of carbon, while favoring decarburization, by tending to be reduced at the expense of the carbon. We note that from 0.11 to 0.42 % of manganese is reduced from the oxide of manganese charged in numbers 8, 20, 21 and 52 of Table 179.

D. Influence of the length of killing.—Prolonging the killing should, on the one hand, tend to increase the carbon-absorption by prolonging the period of contact of steel with the carbon of the crucible-walls ; on the other hand, the rise of the temperature during killing should favor the oxidation of carbon at the expense of silica and oxide of manganese. The former action should be most powerful in strongly graphitic crucibles, the latter in crucibles holding but little carbon. Further, the progressive increase in the silicon-content diminishes the steel's solvent power and probably its affinity for carbon.

We seem to find these expected results in a rough way. Thus, in the Mitis process, in which killing is extremely brief, I am informed that only about 0.05 % of carbon is taken up from a new crucible and less from old ones. I have already stated, however, that a casting selected at random and made from horse-nails held 0.14 %. In current American practice (in which, however, more highly graphitic crucibles are used) we have seen that as much as 0.25 % of carbon may be taken up. Again, in Table 183, with our graphite crucible 105 minutes' killing increases the carbon-absorption, but when the killing is prolonged to 195 minutes, the carbon-absorption again falls off. In Table 180 the carbon-absorption in carboniferous crucibles slackens as killing is prolonged, while in carbonless crucibles we have a continuous loss of carbon. Number 84 forms an exception: some coke fell into the crucible probably.

Finally in numbers 9 to 11, in which the metal is initally nearly saturated with carbon, as the silicon rises from .58 to .76 and to 1.07 %, the absorption of carbon first diminishes, then turns to a loss, and at least part of this loss very probably occurs during killing.

E. A high temperature during killing, in that it increases the affinity of carbon for oxygen relatively to that of silicon and of manganese, should lessen the absorption of carbon ; in that it increases the action of the slag on the crucible-walls, and thus the exposure of graphite to steel, it should increase carbon absorption. The experience of crucible-steel makers who use highly graphitic crucibles, indicates that the second influence outweighs the first. The higher the killing temperature the greater, so it is said, is the absorption of carbon.

F. The proportion of the carbon added as charcoal or graphite which is absorbed by the metal, varies with the strength of the factors which favor carbon absorption, *e. g.*, probably declining as the proportion of carbon present from other sources (crucible-walls, initial carbon-content of the metal, etc.), increases, and as the quantity of oxygen from rust, manganese, oxides, leakage, etc., increases. A distinguished crucible-steel maker thinks that usually about 75 % of the carbon of the charcoal charged is taken up by the steel.

Comparing numbers 66 and 67 of Table 179, we find that the addition of 250 grammes of graphite to one of two like charges increased the carbon in the resulting steel by about 272 grammes, which certainly goes to show that a very large part of the carbon of the graphite was absorbed, though especially as commercial graphite is usually very impure, some unnoted variation doubtless exaggerated the carbon absorption in number 67.

§ 370. THE ABSORPTION OF MANGANESE.—In Table 179 we find that while the manganese of ferromanganese or spiegeleisen is slagged to a considerable extent ; yet when highly carburetted crucibles are used manganese initially present in steel containing even as much as 1.52 % of manganese is but slightly affected (numbers 29, 32, 34 lose from nothing to .07 % of manganese); finally oxide of manganese charged as such is in part reduced. This harmonizes fully with the role of manganese in influencing the absoption of carbon and silicon already given. First, metallic manganese promotes the retention of silicon and carbon in part by being oxidized in their stead, and the absorption of silicon by being oxidized at the expense of this metalloid ; next, oxide of manganese in part lessens the net gain of these elements by being reduced at their expense.

When the charge contains spiegeleisen or ferro-manganese, as these substances are much more fusible than the rest of the charge, the first formed bath of molten metal may contain 60 %, 70 %, or even more manganese. Its richness in manganese favors the rapid oxidation of this metal, whose oxide is greedily devoured by the acid slag. But when we charge simply manganiferous steel, even if the manganese-content reckoned on the whole charge be the same, we do not get this early highly manganiferous metal bath and resulting oxidation of manganese, because the manganese and iron of the charge melt *pari passu*. When we charge oxide of manganese, in that we make the slag both basic and manganiferous, we favor the reduction of manganese at the expense of carbon and silicon, and its transfer from slag to metal.

Table 186 illustrates the very rapid slagging of manganese when a highly manganiferous iron is melted. In the first line we have the loss of manganese on melting a mixture of ferromanganese and weld-steel. The loss when the resulting ingot is remelted, given in the second line, falls below the original loss by a far greater amount than can readily be referred to the difference in the initial manganese-content.

TABLE 186.—A MIXTURE OF FERROMANGANESE AND STEEL LOSES MUCH MORE MANGANESE THAN A SIMPLE MANGANIFEROUS STEEL MELTED ALONE.

Loss of Manganese — On Melting Steel and Ferro-manganese	—.99	—.80	—.20
Loss of Manganese — On Remelting the Resulting Ingot	—.58	—.07	+.01
Number in Table 500	50-1	33-4	28-9

So, too, in numbers 41-2 of Table 179 we note that when ferromanganese is charged before melting, 1.05% of manganese is lost, against 0.62% when, all other conditions apparently remaining constant, it is charged after melting. Numbers 30-31 of Table 179 show that the slagging of manganese is increased by acidifying the slag. Other conditions being constant, a little fusible clay was added in 30 but not in 31; in the former this addition exactly doubled the loss of manganese from the metal.

Naturally, the oxidation of manganese charged in the metallic state will be less and the reduction of oxide of manganese greater in highly graphitic than in clay crucibles; because the carbon of the crucible walls directly tends to reduce manganese, because it increases the steel's carbon-content and its tendency to take up manganese and part with carbon, and because the abundance of carbon tends to reduce silicon from the slag, which thus becomes the more basic and the readier to permit the reduction of its oxide of manganese. These are but three different faces of the same tendency. Table 187 illustrates the influence of the carbon-content of the crucible-walls on the loss of manganese.

TABLE 187.—INFLUENCE OF THE PROPORTION OF CARBON IN THE CRUCIBLE WALLS ON THE LOSS OF MANGANESE.

Steel — Loss of Manganese	—.99±	—.63	—.80	—.26	—.28	—.20
Steel — Number	50	38	33	6	31	28
% Carbon in Crucible-walls	5	15	28	39	40	40±

During killing the loss of manganese should be much less than during melting, the molten metallic bath, if at first highly manganiferous, being constantly diluted by the fusion of the rest of the charge; while both the higher temperature of the killing period and the accession of carbon from the crucible-walls favor the reduction of manganese at the expense of carbon in highly carboniferous crucibles; with a high temperature the manganese may return from slag to metal (this occurs in number 75 of Table 180, even though the crucible is not highly carburetted). With crucibles relatively free from carbon and with other conditions favoring, the slagging of manganese may continue during killing, as occurs in 38-9 of Table 179.

The effect of increasing the length of killing on the loss of manganese cannot be readily traced in the data at hand, being masked by that of other variables. In 38-9 of Table 179 lengthening the killing nearly triples the loss of manganese; in numbers 72-5 of Table 180 it turns a loss into a slight gain. One would expect that prolonging killing would diminish the loss of manganese when highly carburetted steel is melted in highly carburetted crucibles, and increase it under the opposite conditions.

Sulphur, in the cases given in Table 180, increases gradually but constantly, being taken up perhaps from the pyrites of clay or graphite, perhaps from that of the fuel, very small quantities of sulphurous anhydride entering the crucible.

Copper increases very slightly in numbers 71-5 and 81.5-84 of Table 180, as shown below, doubtless because concentrated in a slightly smaller mass, owing to slight removal of other elements.

NUMBER IN TABLE 180.

	Nickel. Cobalt.	Copper.	Phosphorus.
72. Initial Composition	0.049	0.092	0.223
75. Final "	0.047	0.094	0.224
81.5 Initial "	0.049	0.092	0.223
84. Final "	0.050	0.097	0.043

Phosphorus, in like manner, increases slightly when clay or graphite cruibles are used, but is eliminated gradually in basic crucibles.

Nickel and cobalt once increase slightly, once decrease slightly.

NOTICE.

In the preceding pages we give a very valuable appendix to Howe's "Metallurgy of Steel," carrying the work forward to the present time.

This appendix and numerous corrections and additions made to the work since its appearance in the ENGINEERING AND MINING JOURNAL, will be found in the book, which will soon be ready for delivery.

TABLE OF CONTENTS.

APPENDIX I.

SPECIAL STEELS.

§ 413. MANGANESE STEEL.[a]—Since § 86, p. 48, was written, Hadfield's extremely important papers on manganese-steel have very greatly increased our knowledge of this remarkable substance, discovered by him; yet much remains to be learnt.

Briefly, manganese-steel of the best composition, with say 14% of manganese and not more than 1% of carbon, is very fluid; solidifies rapidly and with great contraction; does not form blow-holes, but pipes deeply; does not seem subject to segregation; is forgeable, but welds poorly if at all. Naturally brittle, only moderately strong, and with very low elastic limit, it is made extremely tough and very strong and (under impact) stiff by quenching from whiteness, which neither cracks small bars of it, changes its fracture (which before forging is strongly crystalline), nor greatly raises its elastic limit; this, however, is greatly raised by cold-stretching, only to fall on reheating. Test-bars stretch nearly uniformly, like brass, instead of necking like iron. It is so hard that it can barely be machined, but is slightly softened by sudden cooling from very dull redness (F);[b] is not brittle at blueness, nor (apparently) made brittle by blue-work, but is rapidly made brittle by cold-work, ductility being restored by reheating and quenching; does not recalesce during cooling; its density (sp. gr. 7·83 for manganese 13·75), modulus of elasticity and (apparently) its rate of corrosion are about the same as those of common iron; its electric resistance is enormous, thirty times that of copper and eight times that of wrought-iron, but thrice as constant with varying temperature as that of iron; it can be magnetized very considerably temporarily, but only with most extreme difficulty, and hardly at all permanently. Now to examine some of these points in more detail.

TABLE 206.—MANGANESE-STEEL, FORGED.—Hadfield.

NUMBERS.	Composition.					Physical properties.									
						In the "natural state."			Air-toughened.		Oil-toughened.		Water-toughened.		
	C.	Si.	Mn.	P.	S.	Tensile strength, lbs. per sq. in.	Elongation % in 8 inches.	Contraction of area %.	Tensile strength, lbs. per sq. in.	Elongation % in 8 inches.	Tensile strength, lbs. per sq. in.	Elongation % in 8 inches.	Tensile strength, lbs. per sq. in.	Elongation % in 8 inches.	Contraction of area %.
1	·20	·03	·83	·09±	·06±	73,920	31	46							
2	·40	·15	2·30	"	"	125,440	6	7							
3	·40	·09	3·89	"	"	85,120	1								
4	·52	·37	6·95	"	"	56,000	2		47,040	2	42,560	2	51,520	2	
5	·47	·44	7·22	"	"	60,480	2		60,480	5	56,000	3	56,000	2	
6			7·50	"	"	87,360	4	9							
7	·50	·28	7 90	"	"				62,720	8	67,200	7			
8	1·00	·42	9·15	"	"						94,080	17			
9			9·20	"	"	89,600	6	10							
10	·61	·30	9·37	"	"	73,920	5		85,120	16	85,120	15	87,360	15	
11	·95	·21	10·11	"	"	85,120	5		87,360	14	91,840	20			
12	·85	·28	10·60	"	"	76,160	4		91,840	17	94,080	19	89.600	17	
13													103,040 *a*	22 *a*	
14	·72	·37	10·83	"	"								112,000 *a*	25 *a*	
15													118,720 *a*	29 *a*	
16						87,360	4	8							
17													141,120	45	
18	·85	·37	12·29	"	"								143,360	45	
19													145,600	50	
20	1·10	·16	12·60	"	"	87,360	2		82.880	11	112,000	28	120,960	27	
21			12·70	"	"	105,280	6								
22	·92	·42	12·81	"	"	87,360	5		107,520	20	129,920	32	136,640	37	
23													143,360	45	
24	·85	·23	13·75	"	"								143,360	45	
25													147,840	49	
26													136,640	48	
27	·85	·23	13·75	"	"								143,360	50	
28													145,600	51	
29	·85	·28	14·01	"	"	80,640	2		107,520	14	123,200	27	150,080	44 *b*	
30	1·15	·84	14·27	"	"								154,560	46	37
31	1·15	·84	14·27	"	"								156,800	40	
32	1·10	·32	14·48	"	"	87,360	1		109,760	5			141,120	37	
33	1·24	·16	15·06	"	"	109.760	2		105,280	2			136,640	31	
34	1·54	·16	18·40	"	"	114,240	1		87,360	1			118,720	10	
35	1·83	·26	18·55	"	"	96 320	1						123,200	5	
36	1·60	·26	19·10	"	"	116,480	1		91,840	1			132,160	4	
37	1·90	·32	19·98	"	"						51,520	0			
38	2·10	·46	21·69	"	"	80,640	9		76,160	12	73,920	11			

"Natural state" means that the metal was simply cooled slowly after forging ceased.
"Air-toughened" means that, after cooling, it was reheated to a yellow heat and allowed to cool slowly in the air.
"Oil-toughened" and "water-toughened" mean that, after forging, it cooled slowly, was then heated to a yellow heat, and quenched in cold oil or water.
The fractures of bars with from 3 to 9% of manganese were always coarse and granular: those of bars with more than 9% of manganese which had been water-toughened were silky and fibrous.
The contraction of area of the water-toughened pieces is usually from 30 to 40%.
a Lowest, highest and average results of twelve tests.
b This piece is still unbroken. Hadfield, Journ. Iron and Steel Inst., 1888, II.; Excerpt Proc. Inst. Civ. Eng., XCIII., III., 1888, p. 40 et seq.

While, as already pointed out, the effect of small proportions of manganese on the strength and ductility of steel is probably slight, that of higher proportions is astonishing. Beginning at some point now unknown, but probably at about 2·5%, further increase of manganese diminishes both strength and ductility, while conferring remarkable hardness. This effect reaches a maximum when the manganese has risen to somewhere between 4 and 6%. With further increase the strength and toughness both increase while the hardness diminishes slightly, the maximum of both strength and toughness being reached with somewhere about 14% of manganese, the hardness still remaining so high that the metal can hardly be machined.

As the manganese rises above 15% the ductility falls off

[a] Journ. Iron and Steel Inst., 1888, II.; Proc. Inst. Civ. Eng. XCIII., III., 1888. U. S. Patents 303,150-1: British Patents 200 of 1883, and 8,268 and 16,049 of 1884.

[b] It has been stated that manganese-steel is greatly softened by water-quenching. This, however, is an error. Mr. Hadfield informs me that water-quenching makes it more pliable, but changes its hardness as measured by indentation, etc., very little.

abruptly, the tensile strength remaining nearly constant till the manganese passes 20%, when it in turn falls off quickly. The effect of these high proportions of manganese is obscured by that of the accompanying carbon, which rises unavoidably with the manganese.

Steel containing from 4 to 6.5 % of manganese, even if it has only 0·37% of carbon, can be powdered under a hand-hammer, yet it is extremely ductile when hot. With 11% of manganese the metal after heat-treatment has an elongation of 22% and a tensile strength of about 110,000 pounds per square inch, while with about 14% of manganese we have 51% of elongation in 8 inches and a tensile strength of 145,600 pounds per square inch. This combination of strength and elongation is far greater than any other which I have met, better even than that of nickel-steel, with the exception of one reported instance of 25% nickel-steel: and I do not know how trustworthy is the authority which gives this case.

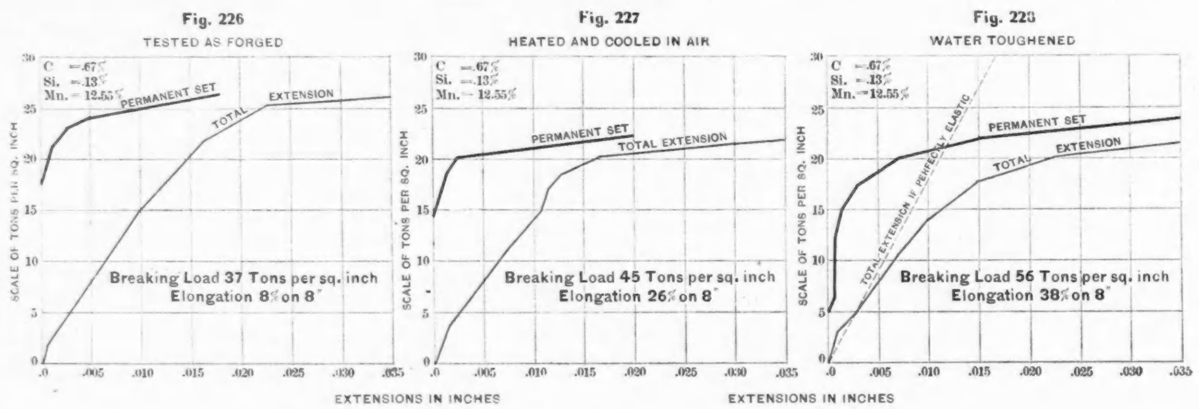
Manganese-steel wire is reported with a tensile strength of 246,000 pounds per square inch. This, while good, is by no means remarkable, as wire with 344,900 pounds tensile strength has already been described. (Foot note to page 33.) the strongest and toughest group of manganese-steels. Beyond these limits the influence of heat-treatment on tensile strength is not very clearly traceable in Hadfield's results, but its influence on ductility persists till the manganese reaches about 18%.

Within these limits reheating manganese-steel forgings to whiteness with slow cooling usually increases strength and ductility wonderfully, while, if quenching be substituted for slow cooling, the increase of strength and ductility is simply marvelous, tensile strength being sometimes nearly doubled, and elongation jumping from 2 to 44 % in one case.

TABLE 207.—PROPERTIES OF MANGANESE STEEL AS AFFECTED BY RAPIDITY OF COOLING.

	Tensile strength, pounds per square inch.	Elongation, % in 8″.
Quenched in water at 202° F	53	32·8
" " 72° F	57 to 63	39·8 to 50
" sulphuric acid	65	50·7

These effects may be traced in Table 206, in which we note that, within the above limits of composition, oil-quenching gives better results than air-cooling, and water-quenching gives better still: while Table 207 indicates that cold water is a better quenching-medium than hot, and that sulphuric acid, represented as a still better conductor, is better yet.



MANGANESE-STEEL UNDER TENSILE-STRESS (HADFIELD).

Manganese-steel is benefited by forging, and some varieties of it are improved wonderfully by heat-treatment.

Forging destroys the very marked crystallization of unforged manganese-steel castings, and according to Hadfield increases their strength and ductility: but he gives us no quantitative data on this point, as his transverse tests of the cast metal and the tensile tests of the forged are not readily comparable. Indeed, the "natural state," *i. e.* unquenched forgings of Table 206 seem surprisingly brittle. Even when containing as much as 21·69% of manganese and 2·1% of carbon, manganese-steel can be forged. But the engineers of Chatillon et Commentry, where manganese-steel was tried for making armor-plates, report that even when hot it is so extremely hard that the difficulty of forging it is prohibitory. If manganese-steel ingots are heated too strongly, they burst in forging.

Heat-Treatment.—Both castings and forgings are strengthened and toughened by heating to a yellow or, better, to a white heat, especially if then suddenly cooled. The higher the temperature (probably provided this is not above bright whiteness), and the more sudden the cooling, the more is the metal benefited.

The effect of heat-treatment on the tensile strength and ductility of forgings is very marked in case of steel containing from about 12 to about 15 % of manganese, *i. e.* Indeed, it seems quite necessary to quench manganese-steel rapidly in order to give it any considerable value. Fortunately, pieces of moderate size do not crack on quenching: but in attempting to quench large pieces such as armor-plates, in which the quenching-stresses would naturally be much greater than in small ones, Chatillon et Commentry found great liability to crack.

The improvement caused by quenching is partly lost on subsequent heating followed by slow cooling, such for instance as usually occurs after forging has ceased. Hence it is usually loosely stated that the improvement caused by quenching is removed be subsequent forging: but Mr. Hadfield informs me that his experience indicates that it is not the forging as such that injures the metal, but the slow cooling which habitually follows forging (Cf. § 54 A, p. 34). The injury due to slow cooling may, however, be removed by again quenching from whiteness. Still, the matter is obscure: for in this view it is hard to explain why manganese-steel forgings are improved by heating to whiteness and cooling slowly.

Heating and quenching, however, instead of increasing seems rather to lower the elastic limit, already unfortunately low, and it is possible that it may thus injure rather than benefit the metal for many important purposes (Cf. Figures 226–8).

Under stress manganese-steel acts very differently from wrought-iron and carbon-steel. As Figure 228 shows, manganese-steel with 125,000 pounds (56 tons) tensile strength may begin taking serious permanent set under stress of about 35,000 pounds per square inch, so that in this respect it is little better than common soft steel with say 60,000 pounds tensile strength.

Moreover, the enormous elongations reported may be found later to have given a greatly exaggerated notion of the metal's ductility. A test-bar of iron or carbon-steel undergoes a certain amount of elongation over its whole length, but much of its elongation occurs just at and near the point of rupture, where the metal "necks." It is owing to this that the percentage of elongation of short iron test-bars is so much greater than that of long ones. Manganese-steel, however, like brass, stretches more nearly uniformly over its entire length, without much necking. Its elongation would exceed that of equally strong carbon-steel much less if measured over a length of ⅛th inch than if, as now, measured over 8 inches. Now, elongation is indeed an index of toughness and ductility: but the relative toughness of different metals under given conditions can be safely inferred from their elongations only when those elongations occur in like manner. For certain conditions it may be better, for others worse, that the elongation should be distributed as in manganese-steel rather than concentrated as in carbon-steel. But, while we may dispute whether the toughness of manganese-steel of 25% of elongation is on the whole greater or better rather than less or worse than that of carbon-steel of like elongation, the important point is that it is a different toughness, which does not necessarily fit the metal for the purposes to which carbon-steel of 25% elongation is properly put.

Thus, Stromeyer found that manganese-steel, whose elongation under tensile stress led him to expect that it could be bent back and forth many more times before rupture than wrought-iron and carbon-steel, was actually rather brittle when tested in this way, enduring only 7 bendings when in its natural state and from 10 to 18 after quenching from redness, while wrought-iron and carbon-steel endured in four cases 20, 26, 12·5 and 21 bends.

Again, the results in Table 209 show that, while the shock-resisting power of manganese-steel of 12·55% of manganese is much greater than that of the best carbon axle-steel with which it was compared, yet in spite of its enormous *elongation* under static tensile stress, its ultimate *deflection* on rupture under transverse shock is less than half as great as that of the carbon-steel.

TABLE 208.—MANGANESE- AND SILICO MANGANESE STEEL SHOWN AT PARIS BY HOLTZER. (Cf. § 86, p. 48.)

Number.	% of manganese.	Tensile strength, pounds per square inch.			Elastic limit, pounds per square inch.			Elongation, % in 7·9″.			Contraction of area, %.		
		Natural state (forged).	Oil-hardened and tempered.	Oil-hardened and annealed.	Natural state (forged).	Oil-hardened and tempered.	Oil-hardened and annealed.	Natural state.	Oil-hardened and tempered.	Oil-hardened and annealed.	Natural state.	Oil hardened and tempered.	Oil-hardened and annealed.
1..	·20 @ ·30	83,488	146,210	112,075	42,668	109,230	91,026	22	12·5	13	42	45	38
2..	......	87,612	149,197	131,134	49,210	110,227	98,706	14	11·8	10		46	46
3..	......	97,710	154,175	161,571	46,366	119,756	129,285	20·8	8·5	13	42	36·5	40
4..	......	107,382	163,277	141,232	57,033	133,409	122,600	16	10	11·8	35·5	41	43·5
5..	......	102,546	175,651	154,175	57,033	146,210	133,409	19	7·5	8·5	51	31	45
6..	10 ±	98,706	176,863	148,201	55,042	155,882	121,605	23·5	8	11·5	49·2	31	40
7..	12 @ 14	115,631	122,316	137,107	58,882	61,869	52,908	29	28	41·5	26	28·5	36·5
8..	......	51,202	87,328	68,553	38,970	63,575	52,197	36	15	24·5	73	76	72·5
9..	......	96,572	139,098	128,289	47,219	19,200	100,555	14	10·5	11·2	21	42·2	46
10..	......	91,026	159,580	133,409	44,517	118,760	104,538	21·5	13	10·5	42·2	38·5	46
11..	2 ±	92,021	161,571	146,210	47,504	139,098	121,605	23	10	12·5	50·5	38·5	46

The "natural state" pieces are simply cooled slowly after forging.
The oil-hardened and tempered pieces are quenched in oil from about W, a low yellow, and slightly reheated.
The oil-hardened and annealed pieces are similarly quenched, then reheated to very dull redness, say V, and cooled slowly.
It is possible that the labels of tempered and annealed pieces have been misplaced in the show-case in certain instances. In Number 8 I have transposed them, feeling confident that they have been thus misplaced.
The compositions given are only rough guesses made at my request by M. Brustlein.

As the elastic limit and modulus of elasticity of manganese-steel are low, while its permanent set seem to increase at normal rate under increasing load, its stiffness under shock is a little puzzling. We have here another instance of the discrepancies between ductility under static stress and under shock.

TABLE 209.—EFFECT OF TRANSVERSE SHOCK ON MANGANESE- AND CARBON-STEEL (HADFIELD).

	Energy developed in foot tons.	Sum of permanent deflections, inches.	
		Special carbon-steel axle.	Manganese-steel axle.
At the 5th blow	79·883	24·953	8·501
" 10th "	208·531	66·188	19·403
" 15th "	348·591	105·248 broke.	30·212
" 20th "	497·988	....	39·491 broke.

Bars 4½″ in diameter and 4′ 6″ long, on bearings 3 feet apart, were struck by a 20·75-cwt. ram, and reversed after each blow.

Cold-working influences manganese-steel greatly. Thus in drawing wire it is found necessary to anneal the metal by quenching from whiteness after every two draughts. As in case of iron and carbon-steel, the stretching which occurs in tensile testing raises the elastic limit so that when again tested it equals the maximum stress previously applied (Cf. § 270, p. 213), *e. g.* while the first application of a stress of 50,000 pounds per square inch gives a strong permanent set, no further set arises on repetition of this same stress. But, unlike that of iron and of carbon-steel, the elastic limit of manganese-steel in the few cases which have been described declines instead of rising during rest after stretching, so that in one case the elastic limit which had been raised to 56,000 pounds per square inch by a stress of that amount, fell in about two months to about 40,000 pounds, distinct permanent set arising with this stress.

As regards friction the statements are not easily reconciled. On the one hand Mr. C. W. Hubbard is quoted as believing that manganese-steel has the very essence of "anti-friction": on the other brake-blocks are said to "bite" manganese-steel wheels much better than cast-iron ones. This certainly seems like blowing hot and cold. The presence of grease in one case and its absence in the other may, however, cause the discrepancy.

Compressive Strength.—Under a load of 224,000 pounds per square inch, blocks one inch long and 0·79-inch in diameter, of steel (A) with 10 and (B) with 15 to 20% of manganese, shortened (A) by 25% and (B) by from 10 to 13% respectively. The compressive strength thus is lower than one would anticipate from the hardness proper.

Structure.—The fracture of manganese-steel ingots is strongly crystalline, and is not changed even by strongly reheating and quenching, though this treatment strengthens and toughens the metal. The crystalline structure is broken up by forging. The brittle group with 3 to 7·5% of manganese, if cast in a 4-inch square mould, has strongly marked brittle needles about 1·5 inches long, normal to to the cooling surface, at the outside. In the centre is a heterogeneous mass of crystals.

With 8 to 12% of manganese the fracture resembles that of "scalded" carbon-steel, and is completely covered with bundles of little, hard, and very tough needles normal to the cooling surface.

With more than 12% of manganese the acicular structure gradually gives way to a coarsely crystalline structure like that of coarse cast-iron.

According to Hadfield, the fracture of manganese-steel with less than 13% of manganese has a peculiar burnished or polished appearance, especially if metal be very hot when cast.

The ingot from which Holtzer's manganese-steel, Number 6, Table 208, appears to have been made has a most remarkable fracture, made up almost wholly of fine fibres like very fine cambric needles, normal to the cooling surface, and highly splendent. Seen through the glass showcase the central non-acicular part looked fine hackly. Around the outside is a sub-acicular fringe about 0·12″ deep.

Pieces of the manganese-steel of numbers 8 and 9 of Table 208 have, after melting in crucibles and rolling into bars, been "converted," *i. e.* carburized, by the cementation process. Their fracture is very remarkable. There are long-bladed faces in it, recalling in a most striking way the prism-faces of crystals of hornblende in crystalline rocks.

Segregation.—Hadfield detected no serious segregation in 16-inch square ingots containing 14% of manganese: but it is not clear from his statements whether his borings were so taken that they would have detected segregation had it occurred.

Carbon-condition.—Manganese-steel, which by combustion showed 1·11% of carbon, gave stead 0·90% of carbon by Eggertz' coloration test: as in case of carbon-steel, the coloration test showed less carbon in quenched than in slowly-cooled metal. This indicates that the carbon is in combination: whether its condition of combination resembles that of carbon in carbon-steel remains to be shown.

Magnetization.—Exposed to a gentle magnetizing force, wrought-iron is about 8,000 times as susceptible of magnetization as manganese-steel, but as the magnetizing force increases this difference diminishes greatly. A magnetizing force of 10,000 C. G. S. units produced in manganese-steel an intensity of magnetism of nearly 400 C. G. S. units, which is as high as the intensity commonly found in permanent magnets. This, however, was a tour de force; for practical purposes manganese-steel may be regarded as wholly unmagnetizable (Ewing).

Preparation.—Manganese-steel is made by mixing molten iron, decarburized by the open-hearth or Bessemer process, with ferromanganese in a ladle. It is less desirable to mix them in crucibles, because these are cut by the manganiferous slag. The steel usually contains about 0·5% less manganese than the ferromanganese added would imply were there no loss. It gives off a strong sulphurous smell while molten, confirming the observations recorded in §81, p. 43. But, as the composition of ferromanganese (Table 20, p. 43) had already shown, even a large proportion of manganese may not bring the proportion of sulphur below say 0·06%: this is shown by the analyses in Table 206.

Uses.—Manganese-steel is as yet used only tentatively. Among the objects for which it seems specially fitted are car-wheels, on account of its combined hardness and toughness; resistance-coils on account of its electrical resistance; and the bed-plates of dynamos on account of its low magnetic susceptibility. At first sight it seems admirably fitted for armor-plate: but, owing to its relatively low crushing strength, it may prove to have much less power of resisting penetration by projectiles than its hardness as measured by its resistance to abrasion would lead us to expect. At present its use is greatly hampered by the extreme difficulty of machining and apparently also of forging it. These and its liability to crack in quenching led Commentry et Chatillon to wholly abandon the serious attempts which they made to use manganese-steel for armor-plates. Moreover, its extremely low elastic limit is a serious defect. Indeed, ductile as it is, one is not sure that its combination of elastic limit and *useful* toughness for most purposes is as good as that of carbon-steel. Still, its combination of ductility with tensile strength is so great that it should give it some important uses, while its simply marvelous combination of ductility with certain kinds of hardness, unapproached so far as I know in any material whatsoever, unless it be nickel-steel, may well give it great value for the many purposes for which this combination seems important

The thoroughness with which its discoverer[a] has examined it, and especially the modesty with which he has described it and the candor and impartiality with which he has laid stress on its shortcomings, command admiration.

§ 413 A. Effect of Small Quantities of Manganese.—An important French manufacturer is now intentionally introducing about 1% of manganese into thin armor-plates, believing that the resistance to penetration is thereby increased, without incurring brittleness under shock. So, too, St. Chamond shows steel with 0·90% of manganese and 0·85% of carbon, yet with 142,000 pounds tensile strength per square inch and 7% of elongation. Again, two armor-plates lately made by an eminent British maker have over 1·25% of manganese. Their composition follows:

No.	C.	Si.	Mn.	P.	S.
1	0·91	0·28	1·26	....	....
2	0·98	0·04	1·37	0·04	0·11

1 is a plate which a Krupp shell failed to pierce: 2 is the face of a compound plate. These facts harmonize with the conjecture expressed on page 48 that the effects of moderate quantities of manganese in causing brittleness have been grossly exaggerated.

414. Silicon-Steel.—The ferro-silicons and silico-spiegels (*i. e.* ferro-silicons rich in manganese) whose composition is given in Table 210, are shown at the Paris Exhibition. The tendency of manganese to raise and of silicon to lower the saturation-point for carbon is readily traced in this table (Cf. §§ 18, 19, pp. 8, 9).

Table 210.—Ferro-silicon (Cf. p. 36).

Number.	Composition.									Makers.
	C.	Si.	Mn.	P.	S.	As.	Cu.	Fe.		
1	1·40	12·05	2·10	·04	·01	tr.	·01	84·39		Gjers, Mills & Co.
2	....	12·	3@4	....	....	....	....	....		St. Louis.
					Silico-spiegel.					
					S.	As.	Cu.	Fe.		
11	1·39	12·25	19·25	·05	tr.	tr.	·01	67·05		Gjers, Mills & Co.
12	....	12·	15@20	....	..	....	....	....		St. Louis.
13	1·42	17·00	18·09	·085	tr.	....	....	....	Fine gray, very bubbly, half voids.	Firminy.
14	3·5	10·30	18·00	·08	....	....	....	....	Very course open gray, bubbly.	"

Ferro-silicon with about 10% of silicon and at most 2·5% of manganese is made on a considerable scale, and sells in England for less than $20 per ton.[b] Some of it has but little phosphorus, but some with 1·5 to 1·7% of phosphorus is also made, for foundry work. According to Gautier four establishments only are now making ferro-silicon.[b]

In order to make ferro-silicon in the blast-furnace, the slag should be acid, and often contains 10 or 12% of alumina; the burden must be very light, and the blast very hot. Two or even three tons of coke per day may be needed per ton of ferro-silicon produced.

Alumina, acting perhaps as an acid, is thought to facilitate the reduction of silicon. Pourcel added sulphate of baryta to the blast-furnace charge, believing that baryta was a less powerful base and would thus hold the silica less firmly than lime, and because the presence of baryta gave a more fluid slag. In England ferro-silicon is also made in the blast-furnace by charging iron-silicates with but little lime and much alumina.[b]

For making silico-spiegel in the blast-furnace we need similar conditions, save that the burden must be rich in oxide of manganese. Gautier gives the following as an example of the charge:

Coke	2,500	Combined silica	420
Ferric oxide	940	Carbonate of lime	460
Manganese oxide	570	Sulphate of baryta	190
Free silica	350		

Table 210A gives the calculated and the actual slag of another blast-furnace, making silico-spiegel of about 17% of silicon and 18% of manganese, closely like number 13 of Table 210.

Table 210A.—Calculated Slag, actual Slag, etc., Made Together with Rich Silico Spiegel in the Blast-Furnace.

	1. Calculated Slag.	2. Probable Slag.	3. Actual Slag.	4. Fume.
Silica	50·0	39	33·9	33·6
Lime	41·5	....	50·0	27·9
Alumina	8·5	....	13·2	....
Oxide of manganese	....	....	2·0	6·5
Ferrous oxide	0	....	tr.	....

1. Calculated on the assumption that all the silica of the charge enters the slag.
2. Calculated on the assumption that enough of the silica of the charge is reduced to give the metal produced 17% of silicon, and that the rest enters the slag.
3. The slag actually made.
4. The fume found in the flues of the blast-furnace. It is thought that the fact that the ratio of silica to lime in the flume is much higher than that in the "actual slag" explains why the latter contains so much less silica than the "probable slag." The relatively high proportion of oxide of manganese in the fume recalls Jordan's statement (§77, p. 42) that 10% of the manganese charged in a certain blast-furnace could not be accounted for by the contents or the metal, the slag and the dust.

The slag actually made has in this case nearly the same composition as that which accompanies common Bessemer cast-iron, nearly all of the excess of silica charged being either reduced to silicon, or carried away in the fume.

Firminy's statement that their blast-furnace, which turns out from 110 to 120 tons of common cast-iron daily, may not produce more than from 10 to 15 tons of silico-spiegel, which sometimes contains over 20% of silicon, is instructive. Here, as in making ferro-silicon, two or even three tons of coke may be needed per ton of product.

Ferro-silicon is used in the iron-foundry for softening cast-iron, and for enabling the founder to use a larger proportion of scrap. It is also used as a final addition in making ingots and other steel castings, to prevent the formation of blow-holes. Silico-spiegel is used for this latter purpose and at the same time for giving forgeableness. The choice between these two alloys depends chiefly on the relation between the composition of the bath to which the addition is to be made and that which the

a M. H. A. Brustlein informs me that he discovered the properties of these manganese-steels in 1879, but was deterred from making them by the difficulty in machining them, which he thought would effectually prevent their use. But, as he kept his discovery to himself, it is to Hadfield's wholly independent discovery that we owe our knowledge and thanks.

b Gautier, Des Alliages Ferro-metalliques, pp. 94-96. Excerpt Bull. Soc. Indust. minérale, Ind. Ser., III., 1889.

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Number.	Tensile strength, pounds per square inch.			Elastic limit, pounds per square inch.			Elongation, % in 7·9 inches.			Contraction of area, %.		
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1	100,555	179,349	114,067	66,705	168,967	75,949	22·5		18·5	54·5	47	54·5
2	142,228	198,977	159,722	77,087	178,354	147,063	10·8	2·3	7·8	19	10·8	31
3	97,710	170,674	159,580	65,567	152,184	131,134	22·2	10·5	14·2	59	38·5	50

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0·826	0·840	0·430	0·019±	0·941	0·877	0·360	0·028
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TABLE 212.—FERRO-CHROME. (Cf. Table 31, p. 76.)

		C.	Si.	Mn.	P.	S.	Cr.	
1	Boucau (St. Chamond)...	11·1	·40	4	·06	tr.	65·	Not magnetic, made in cupolas.
2	″ ″ ...	8·50	0·40	0·40	″	·01	44·80	
3	″ ″ ...	8·75	0·32	0·40	″	″	51·10	
4	″ ″ ...	9·10	0·56	0·35	″	″	55·50	
5	″ ″ ...	9·38	0·45	0·50	″	″	57·96	
6	″ ″ ...	9·55	0·60	0·45	″	″	60·35	
7	″ ″ ...	10·05	0·40	0·42	″	″	63·10	
8	″ ″ ...	11·80	0·38	0·38	″	″	65·20	
9	Firminy	3·80	4·50	2·50	·08	·02	23·00	
10	Holtzer	7·30	2·10	0·40	—	—	42·00	
11	″	7·50	8·20	—	—	—	82·00	Made in graphite crucible. } Silico-chrome.
12	″	5·00	8·00	—	—	—	30·00	
13	″	5·00	8·00	—	—	—	30·00	
14	″	9·00	—	—	—	—	84·00	Made in magnesia crucible.
15	″	11·00	—	—	—	—	80·00	Made in brasqued crucible.
16	″	8·60	—	—	—	—	60·00	Made in a crucible.
17	″	9·00	—	—	—	—	16 00	
18	″	2·25	—	—	—	—	15·00	
19	″	2·70	—	—	—	—	16·00	
20	″	3·80	—	—	—	—	25·00	
21	″	2·00	—	—	—	—	12·00	
22	″	4·35	—	0·30	—	—	7·00	Fractures like spiegeleisen.a
23	″	1·25	—	—	—	—	7·±	
24	″	5 00	0·40	0·38	—	—	7·±	
25	″	4·50	0·25	0·36	—	—	7·±	
26	″	3·46	—	—	—	—	71·5	Very magnetic.
27	Assailly (St. Chamond)...	—	—	—	—	—	42·	Made in crucibles.

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Chrome-steel is shown by no less than ten exhibitors,[c] and has evidently become of considerable commercial importance. Thus, Holtzer has made about 5,000 projectiles, 10,000 thin plates for cuirasses, and several hundred tons of plates 0·16-inch thick for protection against musketry; Firmany has made over 4,000 projectiles, etc. The more

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1	St. Etienne.	1·00	·30	·20	·01	·01	1·5	Razors, milling tools, wire dies, lathe-tools for white cast-iron, etc. Made in a basic open-hearth furnace.
2	Holtzer	2·00	....	.	...	....	12	Limit between chrome-steel and cast-iron.

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The thin chrome-steel armor-plates, 0·16 inches thick, are hardened and subsequently fully annealed, so that they can be bent double and hammered close. At the same time it is specified that they must not be pierced by a lead musket-ball with a velocity of about 1,500 feet, at a distance of 33 feet.

The chrome-steel projectiles, I am informed, are hardened in cold-water, and only tempered by heating in boiling water, after which they are again plunged into cold water.

St. Etienne, though a maker of chrome-steel, has sought to make a material which, in the form of plates, would resist light projectiles nearly as well as chrome-steel, and would be considerably cheaper. The special plate, however, which St. Etienne makes for this purpose has to be 25% thicker than a chrome-steel plate in order to offer equal resistance to impact.

Holtzer points with pride to the comparative tests of his chrome-steel projectiles with projectiles of Krupp and St. Chamond, given in Table 215. At Firminy is shown a most instructive wooden model of a 20-inch wrought-iron armor-plate, pierced at an angle of 20°, and apparently like so much butter, by a 14½-inch chrome-steel shell, which seems wholly uninjured. Another of these shells, 16½-inches in diameter, has pierced a 21½-inch Creusot steel plate in direct fire, but here the shell itself was broken.

TABLE 215.—TRIAL OF CHROME-STEEL AND OTHER PROJECTILES.

Number.	Maker.	Penetration, inches.	Condition of projectile after fire.		
			Broken or intact.	Shortening, inches.	Bulging, inches.
1	Holtzer, chrome.	9·37	Intact.	·12 @ ·24	·04 @ ·06
2	" "	9·45	"		
3	" "	9·76	"		
4	Krupp.	8·66	"	·47 @ ·55	·08
5	"	8·78	"		
6	"	8·90	"		
7	St. Chamond.	9·76 and	"	·08	0
8	"	9·84			
9	"	....	Broken.	Fell into the sea.	
10	"	....	"		
11	"	....	"		

Trials at Spezia, September, 1886. 79 to 82-pound projectiles 5·9 inches in diameter were fired with 40-pound charges of powder from a 5·9-inch Armstrong gun with a velocity of 1,870 to 1,900 feet, against a Creusot steel plate 18·9 inches thick, at a distance of 295 feet.

Holtzer also shows chrome-steel which he claims will drill through Mushet's tungsten-steel, and chrome-steel with 12% of chromium and 2% of carbon which can be forged, but which lies at the limit between chrome-steel and chromiferous cast-iron.

TABLE 214.—PHYSICAL PROPERTIES OF CHROME-STEEL AND TUNGSTO-CHROME STEEL—HOLTZER AND OTHERS. (Cf. Table 32, p. 76.)

Number.	Tensile strength, pounds per square inch.			Elastic limit, pounds per square inch			Elongation, % in 7·9 inches.			Contraction of area, %.		
	Natural state.	Oil-hardened and tempered.	Oil-hardened and annealed.	Natural state.	Oil-hardened and tempered.	Oil-hardened and annealed.	Natural state.	Oil hardened and tempered.	Oil-hardened and annealed.	Natural state.	Oil-hardened and tempered.	Oil-hardened and annealed.
1	156,877	199,017	104,538	....	152,184	63,575	9·5	8	19·5	54·5	43	63
2	109,230	195,421	136,112	64,571	....	118,760	18·3	6	13	59	30·5	58·1
3	93,443	212,772	124,592	55,753	....	109,230	22·5	0·5	6	38·5	0	17·5
4	94,439	172,949	122,600	55,753	159,580	106,386	26·5	6·5	12·2	50·5	26	30
5	95,292	204,096	116,769	56,749	190,017	104,538	20·8	2·5	7	30	6	33
6	103,115	212,772	137,107	65,425	193,430	123,596	17·5	1·8	6·2	33	7	15
7	114,635	210,497	148,201	72,251	189,163	133,409	14·5	....	5	24	....	13
8	142,000@156,000			113,800@128,000			10@12% in 3·9″			42@45		
9	114,000			68,300			13·5a			....		
10	128,000@142,000			....			9@10a			....		

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It is possible that the labels of some of these pieces have been misplaced.
Numbers 1 to 6 are chrome-steels; numbers 5, 6 and 7 contain both chromium and tungsten.
1 to 8, inclusive, are Holtzer's; 8 is for plates 0·59-inch thick, for the French navy.
9. Railway tire which has resisted 14 blows of a 1-ton ram falling 32 feet 10 inches. St. Chamond.
10. St. Etienne: usual properties of their armor-plates 0·16 to 1·18 inch thick.
a, the length in which the elongation is measured is not given.

St. Etienne shows a 13·4-inch chrome-steel projectile which has pierced a 15·7-inch iron plate obliquely without appreciable deformation, while Holtzer points with pride to the comparative tests of his chrome-steel projectiles with projectiles of Krupp and St. Chamond, given in Table 215.

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Most of the chrome-steel is made in crucibles, but that of St. Etienne and of another maker is made in the basic open-hearth furnace. The procedure at one mill is as follows: The carbon of the bath in the basic open-hearth furnace being brought to the desired point, enough ferro-chrome is added to give the desired proportion of chromium, allowing for a loss of 20% of the chromium added. This loss is fairly constant. Neither ferro-silicon nor product should have, ferro-silicon alone being used if the bath is already rich enough in manganese. It is in general cheaper to add silico-spiegel than to add ferro-silicon and ferro-manganese separately.

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4	" " ...	9·10	0·56	0·35	"	"	55·50	
5	" " ...	9·38	0·45	0·50	"	"	57·96	
6	" " ...	9·55	0·60	0·45	"	"	60·35	
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20	"	3·80	....	....	....	..	25·00	
21	"	2·00	....	....	...	....	12·00	
22	"	4·35	....	0·30	....	....	7·00	Fractures like spiegeleisen.a
23	"	1·25	....	....	....	...	7·±	
24	"	5·00	0·40	0·38	..	....	7·±	
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8	142,000@156,000			113,800@128,000			10@12% in 3·9″			42@45		
9	114,000			68,300			13·5a			......		
10	128,000@142,000			......			9@10a			......		

The "natural state" pieces are simply cooled slowly after forging.
The "oil-hardened and tempered" pieces are quenched in oil from a low yellow heat, and slightly reheated.
The "oil-hardened and annealed" pieces are similarly quenched, reheated to very dull redness, and cooled slowly.
It is possible that the labels of some of these pieces have been misplaced.
Numbers 1 to 6 are chrome-steels; numbers 5, 6 and 7 contain both chromium and tungsten.
1 to 8, inclusive, are Holtzer's; 8 is for plates 0·59-inch thick, for the French navy.
9. Railway tire which has resisted 14 blows of a 1-ton ram falling 32 feet 10 inches. St. Chamond.
10. St. Etienne: usual properties of their armor-plates 0·16 to 1·18 inch thick.
a, the length in which the elongation is measured is not given.

St. Etienne shows a 13·4-inch chrome-steel projectile which has pierced a 15·7-inch iron plate obliquely without appreciable deformation, while Holtzer points with pride to the comparative tests of his chrome-steel projectiles with projectiles of Krupp and St. Chamond, given in Table 215.

At Firminy is shown a most instructive wooden model of a 20-inch wrought-iron armor-plate, pierced at an angle of 20°, and apparently like so much butter, by a 14½-inch chrome-steel shell, which seems wholly uninjured. Another of these shells, 16½-inches in diameter, has pierced a 21½-inch Creusot steel plate in direct fire, but here the shell itself was broken.

TABLE 215.—TRIAL OF CHROME-STEEL AND OTHER PROJECTILES.

Number.	Maker.	Penetration, inches.	Condition of projectile after fire.		
			Broken or intact.	Shortening, inches.	Bulging, inches.
1	Holtzer, chrome.	9·37	Intact.	·12 @ ·24	·04 @ ·06
2	" "	9·45	"		
3	" "	9·76	"		
4	Krupp.	8·66	"	·47 @ ·55	·08
5	"	8·78	"		
6	"	8·90	"		
7	St. Chamond.	9·76 and	"	·08	0
8	"	9·84			
9	"	......	Broken.	Fell into the sea.	
10	"	......	"		
11	"	......	"		

Trials at Spezia, September, 1886. 79 to 82-pound projectiles 5·9 inches in diameter were fired with 40-pound charges of powder from a 5·9-inch Armstrong gun with a velocity of 1,870 to 1,900 feet, against a Creusot steel plate 18·9 inches thick, at a distance of 295 feet.

Holtzer also shows chrome-steel which he claims will drill through Mushet's tungsten-steel, and chrome-steel with 12% of chromium and 2% of carbon which can be forged, but which lies at the limit between chrome-steel and chromiferous cast-iron.

Most of the chrome-steel is made in crucibles, but that of St. Etienne and of another maker is made in the basic open-hearth furnace. The procedure at one mill is as follows: The carbon of the bath in the basic open-hearth furnace being brought to the desired point, enough ferrochrome is added to give the desired proportion of chromium, allowing for a loss of 20% of the chromium added. This loss is fairly constant. Neither ferro-silicon nor ferro-manganese is added, the chromium at once preventing blowholes and giving forgeableness. As soon as the ferro-chrome is melted the charge is tapped. Chrome-steel has also been made tentatively in the acid open-hearth furnace, but I am informed that 80% of the chromium charged passed into the slag.

It is now thought that the proportion of chromium in chrome-steel should not exceed 2%, and that for most purposes it should be rather less than 2%.

Brustlein[a] gives us the following information touching ferro-chrome and chrome-steel.

The fracture of ferro-chrome depends more on the proportion of carbon and silicon present than on that of chromium. Ferro-chromes rich in carbon, or in carbon and silicon, are likely to have an acicular structure, and are always hard and brittle. As the carbon diminishes, so does the brittleness. Thus number 26, though with 71·5% of chromium, is less brittle than number 16, which has only 60% of chromium.

Chromium interferes with the magnetism of the metal much less than carbon and silicon. Thus number 26 is strongly magnetic.

Chromium has a strong tendency to oxidize. The oxidized compounds which it forms do not separate readily from the molten steel, and hence are very liable to form in the ingots ineradicable internal flaws, especially if the metal be rich in chromium and poor in carbon. Hence the successful manufacture of soft chrome-steel, say with 0·1 or 0·2% of carbon and 1 or 2% of chromium, is hardly to be looked for. For like reason chrome-steels rich in chromium weld with difficulty if at all. So, too, the employment of ferro-chrome as a recarburizer in the Bessemer and open-hearth processes is likely to cause internal flaws.

Once made, however, chrome-steel according to Brustlein requires in the forge no further precautions than carbon-steel of like hardness, though when hot, as well as when cold, it offers rather more resistance to deformation than carbon-steel. So too it is a little harder to machine than carbon-steel, but if it be well annealed the difference is not very great.

[a] "Le Ferro-Chrome," excerpt Bull. Soc. Indust. Minérale, 2nd Ser. III., 1889.

The effects of quenching penetrate deeper in chrome-steel than in carbon-steel. But the extreme hardness of quenched chrome-steel seems to be coupled with a disproportionate shock-resisting power: hence its special fitness for projectiles and armor-plate already pointed out.

§416. TUNGSTEN-STEEL (Cf. §141, p. 81).—The Paris exhibition indicates that the use of tungsten-steel has increased much, but decidedly less than that of chrome-steel. I found but three exhibits of ferro-tungsten, which in one case contained from 43 to 45% of tungsten. P. E. Martin reports having made ferro-tungsten of 25% in the blast-furnace. One specimen of ferro-tungsten has a smooth conchoidal fracture much like that of "white metal," which is approximately cuprous sulphide, Cu. S., and like that of chalcocite and argentite.

At least six exhibitors display tungsten-steel, at least one of whom has ceased to make it. It is recommended by most of them for cutting extremely hard metals, *e. g* hardened steel and chilled cast-iron, but by one exhibitor for cutting soft and half-hard metals instead. Some of the best makers, who make both chrome- and tungsten-steel, believe that the latter is much the better fitted for tools for cutting hard metal, explaining its limited use by its high price, and by the scarcity of tungsten. St. Chamond recommends tungsten-steel especially for springs, stating that the carrying-power for given size of spring is about one-third greater than that of the best carbon spring-steel, and giving the elastic elongation after quenching and annealing as 0·75 per cent (0·0075). The only analysis of tungsten-steel whose results I saw gave the proportion of tungsten as about 2%. But I understand that some of Holtzer's tungsten-steels contain as much as 8% of tungsten.

TABLE 216.—TUNGSTEN STEEL HOLTZER. (Cf. Table 34, p. 81.)

Number.	Tensile strength, pounds per square inch.			Elastic limit, pounds per square inch.			Elongation, % in 7·9".			Contraction of area, %.		
	Natural state.	Oil-hardened and tempered.	Oil hardened and annealed.	Natural state.	Oil-hardened and tempered.	Oil-hardened and annealed.	Natural state.	Oil-hardened and tempered.	Oil-hardened and annealed.	Natural state.	Oil-hardened and tempered.	Oil-hardened and annealed.
1..	68,553	82,492	76,092	47,504	67,558	52,197	23·7	17·5	19·5	75·5	66	72·3
2..	71,114	71,114	93,017	50,348	48,499		23·5	8·2	15	60	6	59
3..	77,941	179,349	116,769	41,672	135,117	90,172	23·5	2·5	10·2	45·1	2·5	40
4..	93,017	216,186	134,406	47,504		104,538	17	4·5	8·5	33	4	24
5..	106,386	213,342	140,806	62,580		109,230	9	2·8	8·3		1	27

The "natural state" pieces are simply cooled slowly after forging.
The "oil-hardened and tempered" pieces are quenched in oil from a low yellow heat and slightly reheated.
The "oil-hardened and annealed" pieces are similarly quenched, reheated to very dull redness, and cooled slowly.
It is possible that the labels of some of these pieces have been misplaced.

Table 216 gives the properties of tungsten-steel shown by Holtzer at Paris.

§ 417. COPPER-STEEL (Cf. § 142, p. 82).—Three lots of this surprising substance are shown at Paris by Holtzer. Their properties are given in Table 217.

M. Brustlein informs me that the copper in these steels rises to three or four per cent.: that with more than one per cent. they are decidedly redshort: that they have been made only as an experiment: that he believes that copper-steel has no future: that the copper does not appear to be uniformly distributed through the metal: and that it appears to favor the formation of blowholes.

The fracture of bars of Numbers 2 and 3 which have been nicked before breaking is most extraordinary. It consists of flat tables parallel with the surface of the fracture; in Number 3 a single table seems to occupy the whole surface of the fracture, which, indeed, looks as if it had been roughly ground on a grind-stone.

Note the exceedingly high elastic limit of the hardened bars, almost equalling their tensile strength, though the elongation is still considerable. The combination of elastic limit and elongation of bar Number 5 is quite as good as that of any nickel-steel which I have seen described, and of course far better than that of manganese-steel. Indeed, I know but little carbon-steel which excels it in this respect.

It has been thought that the redshortness which usually accompanies the presence of copper is due rather to the formation of sulphide of copper. the copper taking up sulphur from the furnace gases, than to the copper itself. The experiments made with copper-steel at Holtzer's works do not seem to bear out this view.

TABLE 217.—PHYSICAL PROPERTIES OF COPPER-STEEL—HOLTZER. (Cf. § 142, p. 82.)

Number.	% of copper.	Tensile strength, pounds per square inch.			Elastic limit, pounds per square inch.			Elongation, % in 7·9 inches.			Contraction of area, %.		
		Natural state.	Oil-hardened and tempered.	Oil-hardened and annealed.	Natural state.	Oil-hardened and tempered	Oil-hardened and annealed.	Natural state.	Oil-hard-ened and tempered.	Oil-hard-ened and annealed.	Natural state.	Oil-hard-ened and tempered.	Oil-hard-ened and annealed.
1	......	77,941	113,497	110,227	43,664	95,008	99,701	22·5	13·0	17·5	51·	60·	59·
2	......	83,914	173 945	163,989	65,425	142,228	121,605	18·6	6·2	11·	50·	24·	·365
3	3 @ 4	77,941	156,451	121,605	43,664		95,008	22·5	2·	14·5	51·	3·	50·

The "natural state" pieces are simply cooled slowly after forging.
The "oil-hardened and tempered" pieces are quenched in oil from a dull yellow heat and slighly reheated.
The "oil hardened and annealed" pieces are similarly quenched, reheated to very dull redness, and cooled slowly.
It is possible that the labels of some of these pieces have been misplaced.

§ 418. TITANIUM-STEEL (Cf. § 145, p. 85).—St. Chamond shows at Paris ferro-titanium in small irregular lumps, up to say one-inch cube, containing 22% of titanium, and titanium-steel containing 1·30% of carbon and 0·45% of titanium. The lumps of ferro-titanium look as if they had formed as a species of salamander in the crevices of the brickwork in the hearth of a blast-furnace, much as cyano-nitride of titanium often does.

The titanium-steel in its unquenched state looks much like carbon-steel of like percentage of carbon, but when quenched its fracture is unusually satinlike. M. Grobo.[a] informs me that he is certain that the steel actually contains titanium, as he determined it himself, and that he knows of no sure way of making titanium-steel regularly. Note that, in spite of the large proportion of carbon in this titanium-steel, the proportion of titanium is small.

§ 419. NICKEL-STEEL (Cf. § 148, p. 86).[b]—Hardly have we begun to recover from our surprise at Hadfield's discoveries as to manganese-steel when J. Riley startles us with his statements concerning a probably more important and but little less remarkable substance, nickel-steel. Our information is so meagre and contradictory that the following statements are only provisional.

Nickel-steel is made in the open-hearth furnace, without especial difficulty, by the addition of metallic nickel to the bath, practically the whole of the nickel as well as that of any scrap nickel-steel added being recovered. The open-hearth heat lasts about seven hours, and a final addition of ferromanganese is made as usual. No especial care is required either in the open-hearth furnace, in casting, heating or forging, unless the proportion of nickel be very high, say 25%, when the temperature of heating must be kept somewhat lower than in case of carbon-steel of like carbon-content. When molten nickel-steel is thinner, it sets quicker, and pipes deeper than carbon-steel, with apparently little tendency to liquation, yielding ingots whose outside is clean. It forges easily, whether it contain much or little nickel: with 1% of nickel it welds "fairly readily," but with increasing nickel-content the welding-power diminishes, while the hardness and the ductility, whether as measured by elongation or by endurance of twisting, increase, the hardness reaching a maximum with 20% of nickel. The fracture is fibrous, sometimes astonishingly so. The metal takes a high polish, is sometimes highly sonorous, and becomes the whiter the larger the proportion of nickel.

With less than 5% of nickel, nickel-steels can be worked cold readily, provided the proportion of carbon be low. As the proportion of nickel rises higher, cold-working becomes less easy.

Nickel-steel has a lower combination of tensile strength with elongation but (even with only one per cent. of nickel) a higher combination of elastic limit with elongation than manganese-steel. I have met descriptions of but few carbon-steels which excel the best of these nickel-steels in this latter and more important combination.

Even when thus excelling manganese-steel in its combination of elastic limit and elongation, nickel-steel lacks the extreme hardness of the latter material: but it is still so hard that its machining will probably be expensive. I find no data for comparing the combination of hardness and toughness of the harder manganese- and harder nickel-steels.

If we confine our attention to the best specimens, a little nickel (say 1 to 5 %) seems to increase the tensile strength much and the elongation a little: much nickel, say 25%,

[a] Director of the Aciéries d'Assailly, where this remarkable product was made.
[b] Journ. Iron and Steel Inst., 1889, I.; Engineering, XLVII., p. 573, 1889: Pamphlet of "Le Ferro-Nickel" for the jurors of the Paris Exhibition of 1889.

seems to increase the elongation much while sometimes raising sometimes lowering the tensile strength. But almost any theory, except that the effects of nickel are uniform, could be deduced from the scanty and conflicting data. The effects of nickel in nickel-steel seem to vary much more than those of manganese in manganese-steel.

In the single case given annealing does not materially steel. Its electric resistance is great, but less than that of manganese-steel, becoming 6·5 times as great as that of wrought-iron only when the nickel reaches 25%. It is much denser, and even with only 5% of nickel corrodes slightly less than carbon-steel, density and resistance to corrosion increasing with the proportion of nickel. Nickel-steel with 25% of nickel is said to be non-magnetic.

TABLE 218.—TENSILE TESTS OF NICKEL-STEEL—J. RILEY.a

Number.	Composition. Nickel.	Carbon.	Manganese.	Tensile strength, pounds per square inch. As cast.	Cast and annealed.	Rolled.	Rolled and annealed.	Elastic limit, pounds per square inch. As cast.	Cast and annealed.	Rolled.	Rolled and annealed.	Elongation, % in 8 inches. As cast.	Cast and annealed.	Rolled.	Rolled and annealed.	Elongation, % in 4 inches. As cast.	Cast and annealed.	Rolled.	Rolled and annealed.	Contraction of area, %. As cast.	Cast and annealed.	Rolled.	Rolled and annealed.	
1	1·0	·42	·58	b	122,304	129,024	123,424	b	61,152	71,904	67,424	b					1·5	11·0	18·7	b	9·5	24·0	45·0	
2	2·0	·90	·50	Unmachinable.																				c
3	3·0	·35	·57	78,176	78,176	114,240	108,640	44,352	53,760	70,336	62,720					2·5	2·5	20·3	20·3	5·6	9·0	37·0	42·0	
4	3·0	·60	·26			115 360	96,096			65,856	67,872			9·0	7·5			10·1	9·0			9·0	12·0	
5	4·0	·85	·50	Unmachinable.																				
6	4·7	·22	·23			90,720	90,944			56,224	62,720			17·75	20·0			23·4	25·0			42·0	44·8	
7	5·0	·30	·30			103,936	95,424			67,200	62,720			10·0	15·0			12·5	17·5			22·5	18·5	d
8	5·0	·50	·34			116,480	104,832			69,664	72,800			14·0	13·5			15·6	14·0			14·0	17·0	
9	10·0	·50	·50	Unmachinable.																				e
10	25·0	·27	·85			115,136	102,592			85,568	28,560			10·5	29·0			11·7	30·0				28·6	
11	25·0	·82	·52			106,624	94,304			49,280	33,824			43·5	40·0			47·6	45·3			60·0	43·6	
12	49·4	·35	·57			83,776	82,880			45,920	47,040							12·0	20·0			24·0	29·0	
13				214,144 f				120,960								9·37				49·2				
14				219,834 f				116,502				7·8 g				....				52·4				
15				210,246 f				120,780				8·2 g								50·0				

a J. Riley, Engineering, May 17th, 1889, p. 574, a paper read before the Iron and Steel Institute.
b Test-piece defective.
c Too hard to machine with Mushet's steel. Good tools may be made from it by quenching from dull redness in boiling water.
d The average is reduced by the low results given by one test-piece.
e Too hard to machine. Good cutting tools may be made from it by cooling in a blast of cold air.
f We are not told how these pieces have been treated before testing.
g The length in which the elongation is measured is not given.

improve the unforged castings, but forging improves them very greatly, raising the tensile strength and elastic limit by 50%, and increasing the contraction of area and the elongation six- and seven-fold respectively. Like manganese-steel, nickel-steel seems to elongate over its entire length under tensile stress, instead of necking like carbon-steel.

Let us now take up a few of these points in more detail.

The hardness depends on the proportion of nickel and of carbon, jointly, nickel up to a certain percentage increasing the hardness, beyond this lessening it. Thus while steel with 2% of nickel and 0·90% of carbon cannot be machined, steel with 3% of nickel and 0·60% of carbon can. The most striking instances are summed up in Table 220.

TABLE 219.—TORSIONAL TESTS OF NICKEL-STEEL. (J. Riley.)a

Number.	Number in Table 218.	Composition, per cent.			Breaking load, pounds.		Load at elastic limit, pounds.		Number of twists in 8 inches.	
		Nickel.	Carbon.	Manganese.	Hammered.	Hammered and annealed.	Hammered.	Hammered and annealed.	Hammered.	Hammered and annealed.
Nickel-steel.										
I.	1	1·0	0·42	0·58	1,849	1,809	857	697	$1\frac{7}{8}$	$1\frac{7}{8}$
II.	3	3·0	0·35	0·57	1,729		665		$1\frac{3}{4}$	
III.	6	4·7	0·22	0·23	1,493	1,443	621	652	$1\frac{7}{8}$	$2\frac{5}{8}$
IV.	7	5·0	0·30	0·30	1,507	1,485	677	653	$2\frac{1}{8}$	$2\frac{5}{8}$
V.	10	25·0	0·27	0·85	1,950	2,100	510	360	3	5
VI.		50·0	0·35		1,564		553		$2\frac{5}{8}$	
Open-hearth carbon-steel.										
VII.			0·51		1,689		601		$1\frac{15}{16}$	
VIII.			0·51		1,697		601		$1\frac{9}{16}$	
IX.					1,229		445		$3\frac{1}{8}$	

a The pieces tested were one-inch in diameter, and were twisted by means of a lever one-foot long, with the loads above given.
J. Riley, Engineer, May 17th, 1889, p. 574, a paper read before the Iron and Steel Institute.

TABLE 220.—HARDNESS OF NICKEL-STEEL. (J. Riley.)

Nickel %.	Carbon %.	Machinable or not.
2.	0·90	No.
3.	0·60	Yes.
4.	0·85	No.
5.	0·50	Yes.
10.	0·50	No.
25.	0·82	Yes.
	0·27	Yes.
49·4	0·35	Yes.

Density.—Riley reports the following determinations:

% Nickel.	Sp. gr.
100.	8·86
25.	8·08
10.	7·866
5.	7·846
0. (?)	7·84 mean of Riley's results for hammered (carbon ?) steel.
0.	7·85@7·87, usual limits for unhardened carbon steel in Table 149, p. 257.

Corrosion.—Riley states that the rich nickel-steels are practically incorrodible, and that even those with little nickel corrode less than carbon-steels, giving the following results:

TABLE 220 A.—RATES OF CORROSION OF NICKEL AND OTHER STEELS IN ABEL'S CORROSIVE LIQUID.

Metals compared.			Ratio of corrosion of nickel steel to other steel.
Nickel steel.	Other steel.		
5% nickel	Carbon steel 0·18% carbon.		1:1,2
5% nickel		Steel of .40% carbon and 1·60% chromium.	1:1,5
25% nickel	Carbon steel 0·18% carbon.		1:87
25% nickel		Steel of .40% carbon and 1·60% chromium.	1:116

Immersing steel said to contain 25% of nickel in fresh water in contact with carbon-steel rich in carbon, I found that the carbon-steel began to rust within a few hours, at the same time losing its polish: but even after three days the nickel-steel showed no certain sign of rusting. Immersed in fresh water alone for eighteen days the same nickel-steel showed not the least symptom of rusting.

The Fracture of a bar, said to be of nickel-steel and shown me by "Le Ferro-Nickel," nicked on one side and bent away from the nick, was astonishingly fibrous, "barking" like very tough fibrous wrought-iron (Cf. p. 196, 1st column). In another case the sheared fracture of a bar about 1·25 inches square, said to contain 30% of nickel and 1·00% of carbon,[a] was exceedingly silky, and much like that of the softest basic steel, except that its color was very much darker, indeed, almost black.

Ductility.—In the case of nickel- as in that of maganese-steel the elongation, exaggerated by the tendency of the test-piece to stretch over its entire length instead of necking, may be found to give a greatly exaggerated idea of the metal's toughness and value. Thus the contraction of area and the endurance of twisting are less than would be anticipated from the elongation, the percentage of contraction of area being actually less than that of elongation in four out of twenty cases. Number 4 of Table 218 and the rolled and annealed specimen of number 7 in the same table are very fair steels, if judged by their combination of tensile strength and elongation, but not if judged by that of tensile strength and contraction of area. These facts suggest great caution in deciding as to the value and uses of this promising alloy.

Blowholes.—A small broken ingot, about 2·25 inches square, of steel with 30% of nickel and 1% of carbon shown by St. Chamond, has many blowholes besides the central pipe. Its columnar structure is very marked.

Source of Nickel.—It is believed that highly ferruginous nickel, which is quite as suitable as pure nickel for making nickel-steel, can be made at a much lower cost per unit of nickel than the nickel now in the market, which contains relatively little iron. M. Garnier proposes to smelt nickel ores in a common blast-furnace, obtaining thereby a highly sulphurous and ferruginous crude nickel, which he would desulphurize by repeated fusions in a cupola with a very calcareous slag thinned by fluor-spar, (Rollet's process), finally melting the desulphurized product in the basic open-hearth furnace.

Future.—I do not think that we can forecast the future of this remarkable alloy with complete confidence from the data at hand. On the one hand, apparently, even with but short experience, nickel-steels have been made which greatly surpass most of the best carbon-steel in their combinations (1) of tensile strength with elongation, and (2) of elastic limit with elongation, and are but slightly excelled in these combinations by even the very best carbon-steels which I have met: whence we might hope that, with greater experience, nickel-steel would excel the very best carbon-steels decidedly. On the other hand we must bear in mind that our data suggest that the useful ductility of nickel-steel may prove to be much less than would be inferred from its elongation: that its properties appear to vary capriciously: that those interested in it preserve an attitude of reserve, not to say concealment, which, while it is reasonably attributed to other causes, may be due to the discovery of some grave defect: that many another remarkable alloy has been discovered, for which we have anticipated a great future, only to see it play an unimportant rôle: and, finally, that the cost of nickel and the difficulty of machining are likely to be serious obstacles to the extended use of this alloy.

The claim that the properties of nickel-steel are due to the particular mode of introducing the nickel, and not to the mere presence of that element, will be generally received with extreme skepticism. Like claims are made, apparently with no supporting evidence, for most of the patented alloys offered to investors.

a Shown by St. Chamond at the Paris Exhibition of 1889.

APPENDIX II.

ANTI-RUST COATINGS.

§ 420 (Cf. § 168, p. 104).—Finding no data as to the relative protection against rusting afforded by different protective coatings, Mr. R. W. Lodge and the author have carried out a series of experiments with exposures lasting from ten months to a year, with both thin sheet wrought-iron and plates of cast-iron, under four different conditions of exposure and with six protective coatings, specimens of the same irons without protective coating being exposed simultaneously. A fifth series of plates was immersed in sea-water, but, in spite of very considerable precautions to prevent their being carried away by the water or by men, they cannot be found. To facilitate comparison with Table 44, p. 94, the results are reduced to the same standard.

TABLE 221.—LOSS OF WEIGHT OF WROUGHT- AND CAST-IRON WITH DIFFERENT PROTECTIVE COATINGS, IN POUNDS PER SQUARE FOOT OF SURFACE PER ANNUM. (Cf. Table 44, p. 94).

	Exposed to the weather inland.		Immersed.		Average.
	In Canada.	In New York State.	In fresh water.	In sewage.	
WROUGHT-IRON SHEETS.					
Bower-Barffed	0	gain, ·003,0	·006,7	·003,6	·002,5
Tinned	gain, ·002,0	·000,1	·019,4	·007,1	·006,2
Nickel-plated	0	·000,5	·050,4	·003,1	·013,5
Galvanized	gain, ·000,4	... .	·045,9	·080,5	·042,0
Barffed	·001,0	·003,1	·083,9	·117,0	·051,2
Black, *i. e.* unprotected	·001,3	·022,6	·137,0	·169.0	·082,5
Copper-plated	·000,2	·005,0	·179,0	·182,0	·091,6
Average	·000,02	·005,1	·074,6	·080,3	·040
CAST-IRON PLATES.					
Bower-Barffed	gain, ·004,0	gain, ·003,1	gain, ·005.5	·001,4	gain ·002,8
" " and paraffined	·000,6	·001,9	·000,2	·008,4	·002,8
Galvanized	0	0	·049,1	·061,0	·027,5
Tinned	....	gain, ·003,1	·065,5	·061,0	·041,1
Nickel-plated	gain, ·003,4	·002,5	·131,7	·083,3	·053,5
Copper-plated	gain, ·004,0	·005,0	·150,8	·119,2	·067,8
Black, *i. e.* uncoated	gain, ·006,3	·012,0	·148,3	·272,4	·106,6
Average	gain, ·002,9	·002,1	.077,2	·086,7	·041

A single sheet of No. 23 gauge refined wrought-iron was cut into plates 6″ × 12″ and others 6″ × 6″. Of the 6″ × 12″ pieces some were exposed without treatment of any kind, the scale being left on: others were tinned; still others were galvanized by the Rhode Island Tool Company. Of the 6″ × 6″ plates some were Bower-Barffed (Cf. § 167 C, p. 102) by the Yale & Towne Company, others were Barffed by the Pratt & Cady Company, still others were nickel plated and copper-plated, in each case after pickling. The cast iron pieces were skin-bearing plates, 4″ × 3·5″ × 0·187″, presented by Prof. G. W. Maynard. These were subsequently given the coatings indicated, their original skin being retained in all cases.

One set of the pieces thus prepared was exposed on the roof of a dwelling-house in the eastern townships of the Province of Quebec, Canada, by Mr. E. C. Hale, of Sherbrooke, Canada: A second was similarly exposed in a village in Rensselaer County, New York State: A third was immersed in the Chestnut-Hill (Boston) reservoir by Mr. Desmond FitzGerald, of Boston: A fourth was immersed in the Boston main sewer, near the pumping station, by Mr. H. H. Carter, of Boston.

Our thanks are due to these gentlemen and to the companies already named for their kind assistance in preparing or exposing the specimens.

We intend to describe these experiments in more detail in the Transactions of the American Institute of Mining Engineers. Suffice it here to say that in each of the conditions of exposure the wrought-iron pieces were in one open wooden crate, the cast-iron ones in a second, the corners of the pieces (and in case of the 6″ × 12″ wrought-iron pieces a small space in the middle of the long sides) alone being in contact with the crate; and that care was taken that the specimens should not touch each other or any other metallic substance. Though exposed nearly a year, including autumn, winter and spring, at the end of the experiments the gummed labels still adhered to twelve out of the twenty-six specimens exposed in Canada and in New York.

In brief, the Bower-Barffed pieces lost much less and the copper-plated and naked pieces decidedly more than the others: the cast-iron lost about as much as the wrought-iron: the loss was about the same in fresh water as in sewage, and slightly less in Canada than in New York.

Comparing the different conditions of exposure, immersion of course greatly accelerates rusting. Thus in ten out of the fourteen sets of cases the pieces immersed in fresh water lost at least twenty times as much as those exposed to the weather in New York. The loss is slightly but fairly constantly greater in New York than in Canada, which helps to explain the celebrated brightness of the tinned roofs of the Canadian churches. The loss in sewage is slightly greater than in fresh water, but far from constantly, for in seven out of the fourteen cases the loss in fresh water excels or about equals that in sewage, a result most unlooked for, and wholly at variance with Mallet's results with fresh water. It, however, recalls Mallet's results with sea-water, in which sewage on the whole retarded the corrosion of skin-bearing cast-iron (p 97).

Comparing the different protective coatings the Bower-Barffed pieces win easily, undergoing no loss in five out of the eight cases, and with the single exception of the nickel-plated wrought-iron in sewage, losing less than half as much as any of the other irons in the three other cases. The copper-plated and the uncoated iron lose most heavily, copper-plating on the whole accelerating the rusting, especially in case of the wrought-iron sheets. The tinned pieces come in as a good second in case of wrought-iron, the galvanized as a bad second in case of cast-iron. As between nickel-plating and galvanizing in case of wrought-iron, and as between nickel-plating and tinning in case of cast-iron, it is not easy to decide whether the apparent difference is not due to individual peculiarities of the pieces tested.

The most surprising result is the practically identical loss of cast- and of wrought-iron, not only on a general average of the whole, but in at least three out of four of the sets of cases. It harmonizes with the belief expressed in §165, p. 98, that the slower rusting of cast- than of wrought-iron is due chiefly if not wholly to the protection which the skin of the cast-iron affords, rather than to the difference in the nature of the two substances. Just as we there saw that, when wrought- and cast-iron were brought to terms of equality by planing the skin from the latter, it ceased to resist rusting better than wrought-iron, so it does in the experiments of Table 221, in which we may suppose that the protective coatings applied put the materials nearly on equal terms. Still, even when unprotected the wrought-iron here resists rusting about as well as the cast-iron.

APPENDIX III.

LEAD-QUENCHING.

§421. Quenching in lead instead of in oil has been adopted by the Chatillon et Commentry Company of France, especially for forged projectiles for piercing armor-plates. The metal is first heated to the desired temperature (probably the W of Brinnell and b of Chernoff), and then plunged into a bath of molten lead, in which it cools undisturbed. Owing to its density and high conductivity, lead should at first cool the piece more rapidly than oil or water, but later, as the temperature of the piece, sinking below the V of Brinnell, approaches that of the lead bath, the cooling grows slower and slower, ceasing asymptotically. Lead-quenching then should cool the metal more quickly through the higher ranges of temperature and less quickly through the lower ranges than oil-quenching. We may surmise that the fine grain acquired when the metal is heated to W will therefore be preserved better by lead- than by oil-quenching, and we would rather expect that the former operation would induce less powerful internal tension than the latter. Which of the two should the more completely prevent the carbon from passing from the hardening to the cement or non-hardening state it would be hard to judge beforehand.

At the Paris exhibition of 1889 the Chatillon et Commentary Company gives certain results of lead-quenching, which are reproduced in a modified form in Table 222.

Here the influence of lead-quenching is much milder than that of oil-quenching, the lead-quenched piece excelling the oil-quenched in elongation in 9 out of the 12 cases, and being excelled by the oil-quenched piece in tensile strength and in elastic limit in 11 out of the 12 cases. This milder quenching should be desirable for certain cases: but it can hardly be claimed that the effect of lead-quenching is absolutely better than that oil-quenching, for the oil- excel the lead-quenched pieces as much in strength as the lead-excel the oil-quenched ones in elongation. Thus, taking the last eight sets of bars, with carbon from 0·70 to 1·30%, we find that the average elongation of the lead-quenched pieces is 4% greater while their average tensile strength and elastic limit are 10% and 18% less respectively than those of the oil quenched bars. It is not yet clear that the properties acquired by lead-quenching cannot be as readily and more cheaply given by oil-quenching followed by a more complete annealing, nor indeed that this latter combination of operations may not give higher elastic limit for given elongation than lead-quenching does.

Comparing now the lead-quenched with the simply annealed bars, we find that the former invariably excel the latter in tensile strength and elastic limit, but are excelled by the latter in elongation in nine out of twelve cases.

Finally, comparing the simply annealed, the water-quenched and the oil-quenched bars, we find that the water-quenched bars invariably excel the oil-quenched, and these in turn always excel the corresponding simply annealed pieces, in both tensile strength and elastic limit; while as regards elongation the order is as we would expect reversed, the simply annealed excelling the oil-quenched and the oil-quenched excelling the water-quenched, in either case with a single exception, in which the elongations are equal.

These results agree in a rough way with those discussed on pages 19 and 20. The fact that, although the latter indicated that oil-quenching gives high-carbon steel greater strength than water-quenching does, all the water-quenched pieces of Table 222 are stronger than the oil-quenched ones, may be due to the fact that here both have been tempered after quenching, so that some of that intense stress which water-quenching gives, and which probably directly lowers the tensile strength, has been removed.

TABLE 222.—PROPERTIES OF STEEL ANNEALED AFTER DIFFERENT KINDS OF HEAT-TREATMENT—CHATILLON ET COMMENTRY.

Number.	% of carbon, estimated.	Tensile strength, pounds per sq. in., when annealed after				Elastic limit, pounds per square inch, when annealed (?) after				Elongation, % in 8 inches, when annealed after			
		forging.	quenching in water.	quenching in oil.	quenching in lead.	forging.	quenching in water.	quenching in oil.	quenching in lead.	forging.	quenching in water.	quenching in oil.	quenching in lead.
1	0·10	44,090	51,628	....	....	26,170	35,130	....	....	30	20	....	....
2	0·20	43,379	64,429	48,499	44,375	25,601	48,357	36,979	26,738	34	28	30	31
3	0·30	65,567	80,785	71,256	72,251	36,979	52,340	41,815	43,806	24	21	24	22
4	0·40	70,402	88,039	81,496	74,100	39,112	59,024	53,477	45,939	20	18	22	21
5	0·50	77,941	105,391	98,706	86,190	43,806	72,251	65,567	51,486	21	15	19·5	20·5
6	0·60	85,336	112,360	102,404	89,603	46,935	81,070	70,402	53,193	18	13	17	17
7	0·70	91,026	126,583	113,782	99,559	52,624	88,181	73,958	61,158	16	14	14	16
8	0·80	93,870	137,961	119,472	106,671	54,046	92,448	76,803	56,891	17	11	13	14
9	0·90	98,137	140,806	123,739	108,093	54 046	93,870	79,647	64,002	16	10	13	15
10	1.00	106,671	153,606	129,428	115,205	55,469	106,671	81,070	69,691	17	10·5	11	15
11	1·10	113,782	163,562	145,072	129,428	56,891	116,627	92,448	79,647	14	7	9·5	12
12	1·20	122,316	170,674	163,562	150,761	64,002	128,005	115,205	98,137	12	8	9	10
13	1·30	128,005	180,629	163,562	156,451	69,691	125,161	116,627	95,292	10	6	9	10

Thirteen sets of 1½-inch square steel bars, apparently eight inches long between marks, each set being of constant composition, are tested tensilely in four different conditions. These conditions are as follows:
1st, simply annealed, apparently by slow-cooling from dull redness after previous forging.
2d, quenched in cold water from about W. (b of Chernoff), then reheated to 750° F. (400° C.) and cooled slowly.
3d, the same, except that they are quenched in oil instead of water.
4th, the same, except that they are quenched in molten lead instead of water.
The proportion of carbon is approximately that given in the second column, and but little silicon, manganese, etc., is present, *i. e.* the metal is true carbon-steel.

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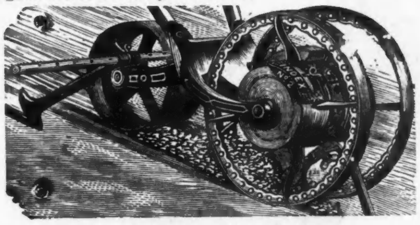

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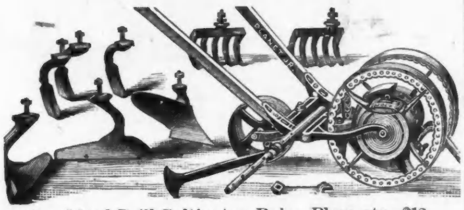

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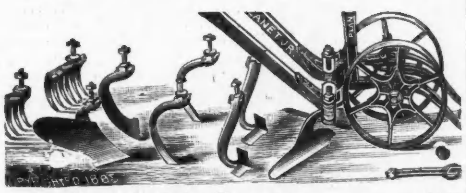

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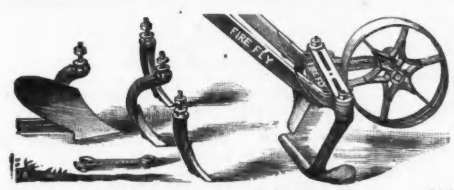

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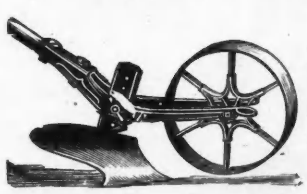

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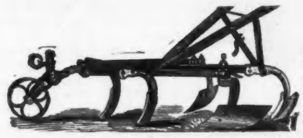

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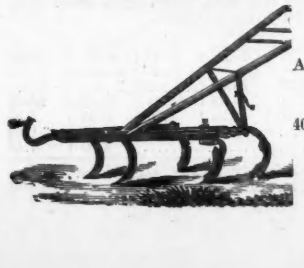

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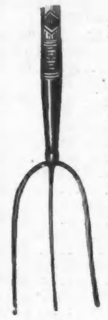

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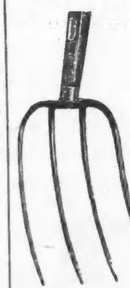
32 B S	12 "	"	Bent & St'pd	11.00
33	12 "	"		9.50
33 S	13 "	"	Strapped	11.00
33 B	13 "	"	Bent	10 00
33 B S	13 "	"	Bent & St'pd	11.50
34	14 "	"		10.25
34 B	14 "	"	Bent	10.75
35	15 "	"		11.25
35 B	15 "	"	Bent	11.75
42 B	12 "	"	Bent	12.50
42 B S	12 "	"	Bent & St'pd	14.00



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Iron wheels, $2 extra. With Pole, Double Tree and Neck Yoke, $2 extra.
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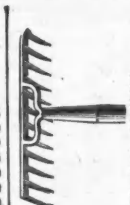

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Best Polished Cast Steel Rakes.

No.	Handles.	Per doz.	No.	Handles.	Per doz.
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Lawn or gravel rakes, price same cast steel garden rakes
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10 doz. case lots, 60, 10 and 5% cased.

Geneva Tool Co.

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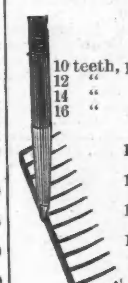
10-Teeth	$5.50	$6.00	$9.00	$10.50
12 "	6.00	6.50	10.00	11.50
14 "	6.50	7.00	11.00	12.50
16 "	7.00	7.50	12.00	13.50

Dis. 70 and 5%.



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"Eagle anvils.

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" 00	4 "	1.70	" 5	50 "	5.05
" 0	10 "	2.20	" 6	60 "	5.50
" 1	15 "	2.75	" 7	70 "	6.00
" 2	20 "	3.00	" 8	80 "	7.00
" 3	30 "	3.75	" 9	90 "	8.00

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American Wood Powder Company.

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A, for large bore; C, for general use; D, fine for small bore and rifles; E, very fine for small bore rifles and gallery shooting	17.00	4.35	.75

			Discount. Per cent.
Bullet Breech Caps	per lb.	1.60	10
Conical Bullet Caps	"	1.75	10

	Discount. Per cent.	
Rim Fire Cartridges	60	10
Military Rim Fire Cartridges	15	10
Central Fire Pistol and Rifle Cartridges	40	10
Central Fire Metallic Cartridges for Target and Sporting Rifles	30	10
Military Cartridges, Central Fire	30	10
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Gatling Cartridges		Special
Primed Shells and Bullets	25	10
Friction Cannon Primers	20	10
Primers		10
Percussion Caps, F. C. per M.	33c.	
U. M. C.	42½c.	
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38, Single Action, 3¼ in., $9.40; 38, Single Action, 4 in., $9.65; 38, Single Action, 5 in., $10.00; 38, Double Action, 3¼ in., $10.40; 38, Double Action, 4 in., $10.65; 38, Double Action, 5 in., $11.00; 38, Safety Hammerless, 3¼ in., $12.00; 38, Safety Hammerless, 4 in., $12.25; 38, Safety Hammerless, 5 in., $12.50; 44, Single Action, 4 in., $11.50; 44, Single Action, 5 in., $11.75; 44, Single Action, 6, 6½ in., $12.00; 44, Double Action, 4 in., $12.50; 44, Double Action, 5 in., $12.75; 44, Double Action, 6½ in., $13.00; 44, Double Action Favorite, 5 in., $12.75.

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" " 22 " half or full plate, 2.10.

Old Model, 22 calibre, by the hundred, half or full plate, $1.50.

Colt Deringer. 41 calibre, per pair half or full plate, $5.50.

American Bull Dog

Double Action 32, 38 and 44 calibre, 2½ inch barrel, $1.60; Double Action 32, 38 and 44 calibre, 4½ inch barrel, $1.85; Double Action 32, 38 and 44 calibre, 6 inch barrel, $2.10.

F. & W. British Bull Dog revolvers, 32 and 38 calibre 2½ inch bbl., $1.80.

F. & W. Automatic revolver, 32 and 38 calibre, 3¼ inch bbl., $5.50.

H. & R. Automatic revolver, 32 and 38 calibre, 3¼ inch bbl., $4.75.

Defender revolvers, Single Action, 22, wood handle, 65.

" " " " 22, rubber " 70.

" " " " 32, wood " 85.

" " " " 32, rubber " 90.

Remington Army revolver, Single Action, 44 cal., frontier cartridge, 5¾ inch barrel, $6.50.

Remington Army revolver, Single Action, 44 cal., frontier cartridge, 7½ inch barrel, $6.00.

Remington Double Deringers, 41 cal., rim fire, $4.05.

National Deringers, 41 calibre, per pair, half or ful plate, $4.00.

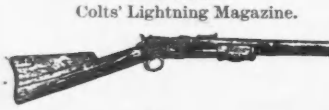
New House, 41 or 38 calibre, blued or nickeled, $5.00.

" Police, 38 calibre, 6 in., " " 7.00.

" " 38 " 4½ in., " " 7.00.

RIFLES.

Colts' Lightning Magazine.



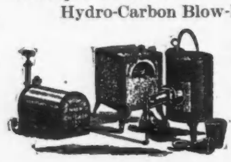
Discount 10 per cent.

40/60 and 45/60 calibre octagon barrel	10 lbs.	$15.38
" " " round	9¾ "	14.25
" " " carbine	9 "	14.25
32, 38, and 44 calibres, octagon	7¼ "	13.50
" " " round	6¾ "	12.38
" " " carbine	6¼ "	12.38
" " " baby carbine	5¼ "	12.38
22 calibre, rim fire, octagon barrel		15.38
" " round		14.25

Remington Light (Baby) carbines, 44 cal., nick., $7.50.

Assay Furnace.

Hydro-Carbon Blow-Pipe Assay Furnace.



No. 2, Muffle Furnace taking C Battersea Muffle 8x4¾x3 in.	$10.00
No. 3, taking F Muffle, 10x6x4 in.	15.00
No. 1, Crucible Furnace, taking Battersea, U or Colorado B Crucible, 4 in. dia. 5½ deep	4.00
No. 2, taking Battersea E, round, 5 in. dia., 6½ deep	5.00
Blow-Pipe No. 1, with half gallon tank, made of plain, strong sheet metal	18.00
Blow-Pipe No. 2, with half gallon tank, made entirely of seamless brass	23.00
Blow-Pipe No. 3, with one gallon tank, otherwise same as No. 2	26.00
Blow-Pipe No. 1, Muffle Furnace No. 2, and Crucible Furnace No. 1	32.00
Blow-Pipe No. 2, Muffle Furnace No. 2, and Crucible Furnace No. 1	37.00

Axes, etc.

Shingling Hatchets.

1. 2. 3.

Collins', $4.75, $5.25, $5.75 doz., dis. 10%.

Peck's, $8.00, $8.50, $9.00 doz. dis. 45%.

Ryder's, $8.00, $8.50, $9.00 doz., dis. 50%.

Claw Hatchets.

1. 2. 3.

Collins', $5.25, $5.75, $6.25 doz., dis. 10%.

Peck's, $9.00, $9.50 $10.00, doz., dis. 45%.

Ryder's, $9.00, $9.50, $10.00 doz., dis. 10%

Hatchets, Broad Single Bevel.

Collins', cut in., 5, $9.50; 5½, $10.00; 6, $10.50; 6½, $11.00; 7½, $11.50; dis. 10%.

Peck's, cut in., 4, $10.50; 4½, $11.50; 5, $13.00; 5½, $14.50; 6, $16.50; 6½, $18.00; 7½, $19.50; 8¼, $22.00; dis. 45%.

Ryder's, cut in., 5, $13.00; 5½, $14.50; 6, $16.50; 6½, $18.00; 7½, $19.50; dis. 50%.

Adzes.

	House. Half flat head. Dozen.	Ship spur poll. Dozen.	Discount. Per cent.
Collins'	$14.00	$13.00	10
Peck's	24.00	25.00	45
Ryder's	24.00	25.00	50

Broad Axes—Pittsburgh Pattern.

5 to 8 pounds, $32.00 dozen.

7 to 9 pounds, $35.00 dozen.

8 to 10 pounds, $38.00 dozen.

9 to 12 pounds, $45.00 dozen.

Western pattern same price.

Spanish Pattern. Detumba round eye, $10.50 per doz.

Spanish Pattern Media labor, $12.25 per dozen.

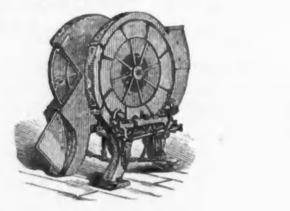
Axle Grease.

Frazer's (2-lb. tins), per gross	$18.00
2-lb. wooden boxes,	12.00

Discount, 25 and 5 %.

Dixon's Everlasting, boxes 1 lb., per doz.	$1.20
" " " 2 lbs. "	2.00

Barrel Machinery.



Stave Jointers.

Single Whee Beer Keg Stavė Jointer, 16 to 22 in.	8	8	$190
Double " " " " " 16 " 22 "	8	8	330
Single Wheel Half Barrel " " 24 " 30 "	8	8	275
Double " " " " " 24 " 30 "	8	8	440
Single " Barrel " " 30 " 36 "	8	8	330
Double " " " " 30 " 36 "	8	8	500
Double Independent Barrel Stave Jointer with Wheels, on separate shafts, but suspended in one frame, 30 to 36 in.	8	8	520
Single Wheel Barrel Stave Jointer, 32 to 38 in.	8	8	350
Double " " " " 32 to 38 "	8	8	550
Double Independent Barrel Stave Jointer, 32 to 38 in.	8	8	575

Bellows.

Miner's Bellows: 24 in., $8.50; 26 in., $9.75; 28 in., $11.00; 30 in., $11.25; 32 in., $13.50.

60 and 5% dis.

Standard, each: 18 to 24 in., $10; 28 in., $12; 32 in., $14; 34 in. $16; 36 in., $18; 38 in., $20; 40 in., $23; 44 in., $32.

60 and 5% dis.

Hand Bellows, per doz.: 6 in., plain, $10; fancy, $20; 7 in., plain, $12; fancy, $24; 8 in., plain, $14; fancy, $28; 9 in., plain, $16; fancy, $32; 10 in., plain, $18; fancy, $36.

50% dis.

Belting.

LEATHER BELTS.

Standard Manufacturers List.

Single belts per foot.

Width.		Width.		Width.	
1 inch	.10	6 inch	.76	20 inch	2.84
1¼ "	.13	7 "	.90	21 "	3.02
1½ "	.17	8 "	1.02	22 "	3.20
1¾ "	.20	9 "	1.15	23 "	3.37
2 "	.23	10 "	1.29	24 "	3.54
2¼ "	.26	11 "	1.42	26 "	3.92
2½ "	.30	12 "	1.55	28 "	4.30
2¾ "	.33	13 "	1.68	30 "	4.64
3 "	.36	14 "	1.82	32 "	5.00
3½ "	.43	15 "	1.98	34 "	5.35
4 "	.50	16 "	2.14	36 "	5.70
4½ "	.56	17 "	2.31	40 "	6.40
5 "	.63	18 "	2.49	44 "	7.10
5½ "	.70	19 "	2.66	48 "	7.80

Double belts twice the price of single.

Discounts of Newark Leather Belting Co.

Dis. single and double belts, cemented, 50 and 5%.

Dis. single and double belts, riveted and cemented, 50 and 5%.

Dis. single belts, cemented and lacesewn, water proofed, 50%.

Dis. double belts, cemented and lacesewn, water proofed, 45%.

Discounts of I. B. Williams & Sons.

Single and double belting, riveted	50 and 10 %.
" " " " cemented	50 and 10 %.
" " " " laced sewed	50 and 5 %.
Electric light belting, single and double cemented only, waterproof	50%.

2% cash f.o.b. New York.

Leather Belt Laces and Leather.

Discounts of I. B. Williams & Sons.

¼-inch per 100 feet	$1.00	½-inch per 100 feet	$2.00
5-16 " " " "	1.25	⅝ " " " "	2.75
⅜ " " " "	1.50	¾ " " " "	3.25

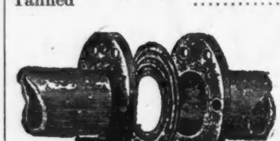
Dis., rawhide, 50 and 10%.

" taned, 60 and 10%.

Rawhide lace sides ......19c. per square foot.

Tanned " " ......14c. " " "

GASKETS.



Corrugated Copper.

Price, 2 cents per square inch, less 30 per cent. discount for home trade.

Less 60% discount for export trade.

Bolts.

Philadelphia Tire Bolt, with forged nuts.

Price per hundred.

Condensed list.

Length	1-8	3-16	7-32	1-4	5-16	3-8
1	$1·50	$1.50	$1.50	....	....	....
2	1·50	1 60	1.85	$2.25	$3.05	$5.00
3	....	1.90	2.25	2.75	3.65	5.80
4	....	....	....	3.25	4.25	6.60
5	....	....	....	....	4.90	7.40

Fractional sizes, intermediate prices.

Discount 80 and 25 %.

Common Carriage Bolts, price per hundred.

Length.	3-16 & 1-4	5-16	3-8	7-16	1-2	9-16 & 5-8	3-4
1 to 1½	$1.35	$1.60	$2.30	$3.10	$3.80	$7.50	
2	1.45	1.75	2.30	3.10	3.80	7.50	
3	1.65	2.05	2.70	3.60	4.44	7.50	$13.50
4	1.85	2.35	3.10	4.10	5.08	8.50	14.90
5	2.05	2.65	3.50	4.60	5.72	9.50	16.30
6	2.25	2.95	3.90	5.10	6.36	10.50	17.70
7	2.45	3.25	4.30	5.60	7.00	11.50	19.10
8	2.65	3.55	4.70	6.10	7.64	12.50	20.50
9	2.85	3.85	5.10	6.60	8.28	13.50	21.90
10	3.05	4.15	5.50	7.10	8.92	14.50	23.30
12	3.45	4.75	6.30	8.10	10.20	16.50	26.10
14	3.85	5.35	7.10	9.10	11.48	18.50	28.90
16	4.25	5.95	7.90	10.10	12.76	20.50	31.70

Fractional sizes, intermediate prices. Dis. 75 and 10%

Philadelphia Carriage Bolt, price per hundred.

Length	1-8, 3-16 & 1-4	5-16	3-8	7-16	1-2
1 inch.	$3.00	$4.00	$5.00	$7.40	$9.00
2 "	3.40	4.10	5.00	7.40	9.00
3 "	3.80	4.70	5.80	8.20	10.00
4 "	4.20	5.30	6.60	9.00	11.00
5 "	4.80	6.00	7.40	9.80	12.00
6 "	5.40	6.60	8.20	10.60	13.00
7 "	....	7.30	9.00	11.40	14.00
8 "	....	7.90	9.80	12.20	15.00
9 "	....	8.50	10.60	13.00	16.00
10 "			11.40	13.80	17.00
11 "				14.60	18.00

Fractional sizes, intermediate prices. Dis. 80 and 5 %.

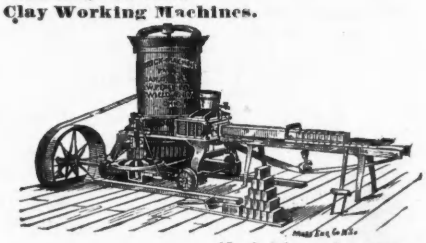
Can Openers.

	Gross.			Doz.	
American	$3.00		Eureka	$2.50	10 % dis.
Duplex	2.70	29 % dis.	Domestic	2.50	45 % dis.

Cigarettes (all tobacco).

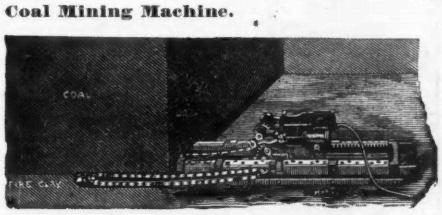
Liberty Bell (small cigars) .... $6.00 per 1000
Golden Giants (regular shape) .... 7.00 " "
Net f. o. b., New York.

Clay Working Machines.



	No. brick per day.	Compl'te.
No. 10 D brick machine	50,000	$1,500
No. 10 S " "	30,000	1,200
No. 4 " "	40,000	1,100
No. 7 S " "	20,000	650
No. 6 S " "	15,000	575
No. 2 E. H. P. "	6,000	3,360

Coal Mining Machine.



Jeffrey.
6 feet undercut........$1500 | 5 feet undercut........$1400
Jeffrey Power Coal Drills.
Air feed drill............$275 | Screw feed drill........$200
Discount. 10%.

Cork Pullers.

The Samson Cork Puller, per dozen, $12 net.

Crucibles. E. H. Sargent & Co.

Battersea Crucibles, Triangular.

No.	Height. Inches.	Width. Inches.	Crucibles. Per doz.	Covers. Per doz.
S	4½	4⅛	$1.00	$0.50
T	4	3¾	0.80	0.50
U	3½	3¼	0.60	0.40
V	3¼	2⅞	0.45	0.40
W	2⅝	2⅝	0.35	0.30
X	2½	2¼	0.30	0.30
Y	2⅛	2⅛	0.25	0.30
Z	1¾	1¾	0.20	0.30

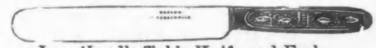
Battersea Muffles, any size, made to order.
See Illustration in advertisement.

No.	Long. Inches.	Wide. Inches.	High. Inches.	Price. Each.
A	7	3⅛	2½	$ .60
B	7½	4⅜	2⅞	.75
C	8	4¾	3	.85
D	8½	5	3¼	1.00
E	9	5½	3⅜	1.15
F	10	6	4	1.25
G	11	4	3⅛	1.00
H	10½	5¼	3⅞	1.00
J	12	6	4	1.25
K	14	8	5	1.75
L	15	9	6	2.00

Export discount 15 %.

Cutlery, Table.

Tommins & Adams.



Iron Handle Table Knife and Fork.
$10.70 per gross pairs.
Dis., 25%.

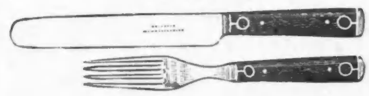


Table Knives and Forks.

Cocobola handles.................... $22.70 per gross pairs.
Ebony " .... 24.00 " " "
Bone " .... 29.30 " " "
Dis., 25%.

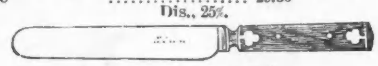
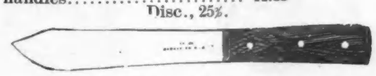


Table Knives and Forks.

Cocobola handles .... $32.00 per gross pairs.
Ebony handles.......................... 33.35 " "
Bone handles.......................... 41.35 " "
Disc., 25%.



Butchers' Knives—Cocobola Handles.
4½ inches... .$1.15 per doz. | 6 inches ... ...$1.20 per doz.
Dis., 25 and 10%.

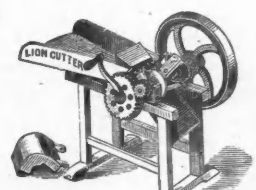
Hunting Knives—Ebony Handles.

5 in.	6 in.	7 in.	8 in.	9 in.	10 in.
$2.10	$2.35	$3.00	$3.60	$4.30	$5.25

Dis., 25 and 10%.

Cutters.

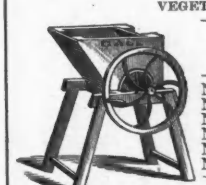
FEED.



No. of cutter.	No. of knives.	Length in inches of knives.	Length in inches of feed cut.	Price.
1	2	6¼	⅛, ¾ and 1⅛	$18 00
2	2	7¼	½, ¾ and 1⅛	21.00
2½	1	7¼	⅝, ⅞, 1¼ and 1¾	21.00
2½	2	7¼	$\frac{7}{16}$, $\frac{9}{16}$, ⅝ and ⅞	23 00
3	1	8½	⅝, ⅞, 1¼ and 1¾	25.00
3	2	8½	$\frac{7}{16}$, $\frac{9}{16}$, ⅝ and ⅞	27.00
4	1	10	⅝, ⅞, 1¼ and 1¾	30.00
4	2	10	$\frac{7}{16}$, $\frac{9}{16}$, ⅝ and ⅞	33.00
5	2	10	$\frac{7}{16}$, ⅝, ⅞ and 1¼	35.00
6	2	11	$\frac{7}{16}$, ¾, 1¼ and 2	45.00
6½	2	11	$\frac{7}{16}$, ¾, 1¼ and 2	45.00
7	2	13	$\frac{7}{16}$, ¾, 1¼ and 2	60.00
7½	2	13	$\frac{7}{16}$, ¾, 1¼ and 2	60.00
10	2	16	$\frac{7}{16}$, ¾, 1¼ and 2	80.00
12	2	20	$\frac{7}{16}$, ¾, 1¼ and 2	100 00
11	2	11	$\frac{7}{16}$, ¾, 1¼ and 2	45.00
13	2.	13	$\frac{7}{16}$, ¾, 1¼ and 2	60.00
16	2	16	$\frac{7}{16}$, ¾, 1¼ and 2	80.00
20	2	20	$\frac{7}{16}$, ¾, 1¼ and 2	100.00

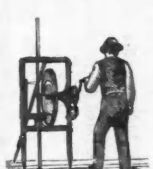
The knife arbors for all sizes are made of machinery steel. 30 per cent. dis.

VEGETABLE—GALE'S.



Size.	Weight of Fly Wheel. Pounds.	Will cut per hour. Pounds.	Price
No. 1½	20	1,500	$12
No. 2½	32	1,700	15
No. 3½	32	1,700	15
No. 4	42	2,000	18
No. 5	50	3,000	25
No. 10	65	8,000	35

30% dis.



Drill—Portable Hand Rock.

Price, $225.

Dis., 20%.

Duck and Twine.

Baltimore T. & N. Co.—22-inch, Hard, Medium and Soft.

No.	Weight per yd.	Cents, per yd.	No.	Weight per yd.	Cents, per yd.
No. 0	19 oz.	35	No. 6	13 oz.	26
1	18 "	33	7	12 "	25
2	17 "	32	8	11 "	23
3	16 "	30	9	10 "	21
4	15 "	28	10	9 "	20
5	14 "	27			

Ravens, 28½-inch.—Eight ounce, 15 cents per yard; Ten ounce, 19 cents per yard; twelve ounce, 22 cents per yard; Fifteen ounce, 27 cents per yard. Dis. 25 and 1%.

Cotton Sail Twine.—Three-fold and upward, 17 to 20 cents per pound. Dis. [illegible].

Electroplate.—Babcock & Co.'s.

CASTERS.

1,200—Dinner

232—Breakfast.

Dinner Casters.

No. 1,200. 17½ in. high, $8.00, quadruple plate.
No. 80. 17 in., $6.00, quadruple plate.
No. 140. 16 in., $7.50, " "
No. 830. 16 in., $5.00, " " Plain, 50 cents less.
No. 25. 16 in., $4.00, double plate.
No. 33. 16 in., $3.75, " "
No. 53. 15 in., $3.00, " "
No. 15½. 14½ in., $2.00, single plate.
No. 19. 14½ in., $1.85, " "
No. 40. 14 in., $1.75, " "

No. 681.

Breakfast Casters.

No. 231. 10 in. high, $4.00, quadruple plate.
No. 232. 12 in. high, $6.00, quadruple plate.
No. 13. 12 in. high, $2.25, double plate.
No. 12. 10½ in. high, $1.75, single plate.

CAKE BASKETS.

Quadruple Plate.

No. 448. 7 in. high-chased, $16; gold lined, $17.
No. 690. 7½ in. high, chased, $7; gold lined, $8.
No. 686. 6½ in. high-chased, $4.50; gold lined, $5.50.
No. 681. 6 in. high, chased, $3; gold lined, $3.50.

BUTTER DISHES.

No. 126. 11 inches high, $5.50.
No. 127. 7 inches high, $5.50.
No. 75. 8 inches high, $1.85.
No. 78. 7½ inches high, $2.00.
Di 60 and 2½ per cent.

CHILD'S SETS.

No. 90.

No. 90. Satin lined case, cup, saucer, knife, fork and spoon, $2.25.

No. 41. Cup, gold-lined, in fancy case, $1.15.

No. 43. Cup and saucer, gold-lined, fancy case, $1.15.

FLAT WARE.

Calla Lily, Empress, Windsor and Olive Patterns, 18 Per Cent Nickel Silver Base.

	Extra plate, per doz.	Double plate, per doz.	Triple plate, per doz.
Tea spoons	$4.75	$6.00	$7.25
Dessert spoons	8.50	10.50	12.50
Table spoons	9.50	12.50	14.50
French coffee spoons	4.75	6.00	7.25
Berry or nut spoons	24.00	30.00	36.00
Bar spoons, small	4.75	6.00	7.25
Dessert forks	8.50	10.50	12.50
Medium forks	9.50	12.00	14.50
Oyster forks	7.00	9.00	11.00
Sugar shells	9.00	11.00	13.00
Sugar tongs	25.50	31.50	37.50
Butter knives, twist or reversed handles	10.50	12.50	14.50
Nut picks	4.75	6.00	7.25
Pie knives, engraved blades	42.00	51.00	60.00
Soup ladles	48.00	60.00	72.00

PICKLE DISHES.

No. 144. 12 in. high, $3.50.

No. 66. 10½ in. high, $2; assorted colored glass.

No. 155. 12 in. high, $4; assorted colored glass.

No. 146. 12½ in. high, $9; hand decorated glass.

No. 156. 12½ in. high, $6; hand decorated glass.

No. 146.

TEA SETS.

No. 255. 6 pieces, $35, quadruple plate.

No. 301. 4 pieces, $23, quadruple plate.

No. 1847. 6 pieces, $42, quadruple plate.

No. 255.

ICE PITCHERS.

No. 754. 21 in. high, double wall, $30, quadruple plate.

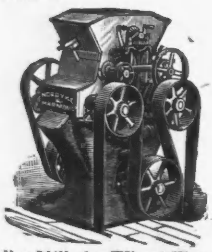
No. 640. 12½ in. high, double wall, $15, quadruple plate.

No. 751. 12½ in. high, single wall, $6, double plate.

No. 754.

Flouring Mill Machinery.

Nordyke & Marmon Co.



Roller Mills for Wheat Flour.
Prices of Double and Single Roller Mills.

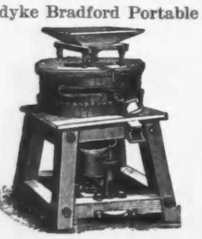
Size.	All smooth.	½ Corrug. ½ smooth.	All corrug.	Single machines. Corrug.	Single machines. Smooth.
6 × 12	$465	$475	$480	......	......
6 × 16	515	525	530	......	......
6 × 20	565	575	580	......	......
7 × 14	515	525	530	......	......
7 × 18	560	570	575	......	......
7 × 24	635	645	650	......	......
9 × 18	625	640	650	$350	$335
9 × 24	700	720	735	390	375
9 × 30	785	810	830	440	420

20-inch New Era Mill for Wheat, Corn, and Middlings.

Size. Inch.	Power. H. P.	Pulley. Inch.	Capacity Bush.
20	4 to 10	14 × 7	12 to 40

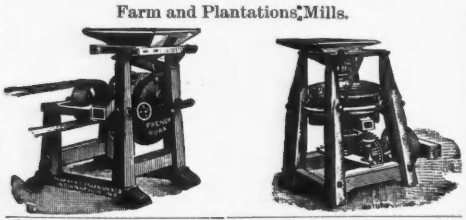
Speed.	Weight. Lbs.	Price.
500 to 800	660	$150

The Nordyke Bradford Portable Mill.



Size of stones, In.	Grinding capacity. Corn, bu. per hour.	Grinding capacity. Wheat bu. per hour.	Horse-power.	Weights. Sing'l gear.	Weights. Double gear.	Pulley mill.	Geared mills. Iron wh'ls.	Geared mills. Mortise wh'ls.
18	8 to 10	....	4	550	625	$130	$165	$180
20	10 to 12	....	5	600	700	140	175	190
22	12 to 15	....	5	700	850	160	190	210
24	15 to 18	....	6	900	1050	175	210	225
26	18 to 20	8 to 10	8	1200	1400	185	225	250
30	20 to 25	10 to 12	10	1500	1700	225	265	290
36	25 to 30	14 to 17	12	1800	2100	315	355	380
42	35 to 40	19 to 21	15	2000	2300	390	435	460

Farm and Plantation Mills.

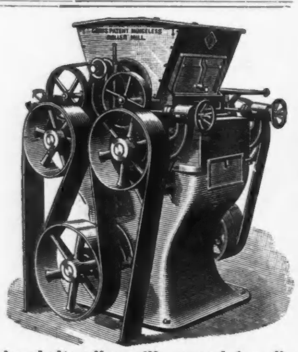


Diameter of burrs.	Power to drive.	Size of pulley.	Capacity per hour.	Revolutions per minute.	Weight.	Price.
	H. P.					
14 in.	2 to 4	9×5½	4 to 14 bushels	600 to 1200	370 lbs.	$100
18 in.	4 to 10	11×6½	8 to 40 bushels	400 to 700	600 lbs.	130

The Dixey Mill—Stiff Spindle Style.

Size.	Power.	Capacity.	Weight. Pulley.	Weight. Geared	Pulley.	Iron gear.	Mortise gear.
18	4 to 6H.P.	8 to 25 bu	560 lbs	650	$130	$165	$180
22	6 to 8 "	12 to 30 "	800 "	1000	165	200	225
26	8 to12 "	16 to 40 "	1100 "	1500	185	220	245
30	10 to15 "	25 to 60 "	1300 "	1700	215	255	280

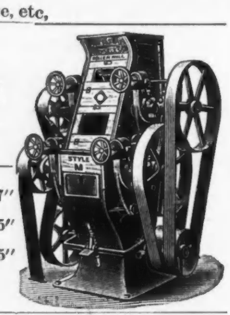
Flour Mills.
E. P. Allis & Co.



Gray's pat. noiseless belt roller-mills, porcelain rolls.

Size of Rolls.	Height.	Length.	Width.	Driving pulley.	Revolutions per minute.	Approximate power required.	Length of driving belt above floor.	Approximate shipping weight.	Price
14'' × 16'' single....	5' 7''	3' 2''	4' 5''	20'' × 6¼''	200 to 300	1¾ to 2½ H. P.	16' 3''	2,700 lbs.	$600.00
14'' × 16'' double....	5' 10''	5' 6''	4' 10''	20'' × 6¼''	200 " 300	3 " 4½ H. P.	19' 3''	4,000 "	800.00
9'' × 14''..........	5' 1½''	3' 10''	3' 10''	12'' × 5¼''	300 " 400	1½ " 2½ H. P.	16' 6''	2,700 "	580.00
With corrugated chilled iron rolls.									
9'' × 14''..........	5' 1½''	3' 10'	3' 10''	12'' × 5¼''	300 to 400	1½ to 2½ H. P.	16' 6''	2,700 lbs.	$600.00
With Wegmann's patent porcelain rolls.									
9'' × 14 '..........	5' 1½''	3' 10''	3' 10	12'' × 5¼''	300 to 400	1½ to 2½ H. P.	16' 6''	2,700 lbs.	$650.00
Divided four roller machines.									
9'' × 14''.......... 1-pr. cor. 1-pr. sm.	5' 1½''	3' 10''	3' 10''	12'' × 5¼''	300 to 400	1½ to 2½ H. P.	16' 6''	2,700 lbs.	$590.00
9'' × 14''.......... 1-pr. sm. 1-pr. por.	5' 1½''	3' 10''	3 10''	12'' × 5¼''	300 to 400	1½ to 2½ H. P.	16 6''	2,700 lbs.	615.00
9'' × 14''.......... 1-pr. cor. 1-pr. por.	5' 1½''	3' 10''	3 10''	12'' × 5¼''	300 to 400	1½ to 2½ H. P.	16' 6''	2,700 lbs.	625.00

For grinding corn, feed, rye, etc,



Size.	Height.	Width.	Length.
6'' × 12''...	4' 6''	3' 5''	2' 7''
9'' × 14''...	5' 8''	3' 10''	3' 5''
9'' × 18''...	5' 8''	4' 9''	3' 5''
9'' × 24''...	5' 8''	5' 6''	3'

Driving pulley.	Revolutions per minute.	Length of belt above floor.	Approximate shipping weight	Price.
10'' × 5¼''	400 to 500	14'	....	$500.00
14'' × 6¼''	350 to 450	18'	2600 lb.	600.00
14'' × 7¼''	350 to 450	18'	3050 lb.	650.00
14'' × 8¼''	350 to 450	18'	3350 lb.	735.00

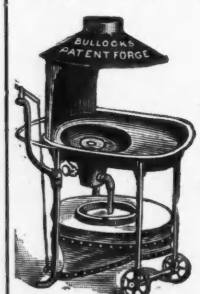
Flue Cleaner.
Hurley's Automatic Steam Flue Cleaner.

No.	Outside diam. of tubes.	With hose clamps.	Globe Valves.		Best 4-ply steam hose.	Per foot.
1	1½ to 2	$5.00	½,	95 cents	¾,	67 cents.
2	2 to 2½	6.25	½,	95 cents	¾,	67 cents.
3	2½ to 3	7.50	¾,	$1.30	¾,	67 cents.
4	3 to 3½	8.75	1,	1.75	1¾,	83 cents.
5	3½ to 4½	10.00	1¼	2.90	1¼,	$1.04

Dis. on flue cleaners, 60 and 70%.
Dis. on steam hose, 50%, good to 90 lbs steam.

Forges (Portable).
Fairbanks.

No. 2c, weight, 155 lbs. 21 × 27 hearth..............$42.00
" 3a, " 80 " 18 in. diam. hearth.......... 27.00
" 3b, " 75 " 18 " " " 24.00
" 3c, " 85 " 18 " " " 30.00
" 6a, " 45 " 14 " " " 18.00
" 6B, " 45 " 14 " " " 16.00
Dis. 60%.

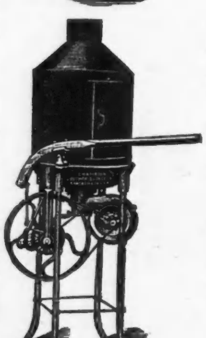


No. 1, 18 in. bellows, $20; No. 2, 20 in. bellows, 25; No. 3, 22 in. bellows, $30.
20% dis.
Stationary.
27 in. bellows, $21; 30 in. bellows, $25; 33 in. bellows, $33; 36 in. bellows, $45.
20% dis.

Riveting Forges.

Bellows, 18 in., 20 in., 22 in., 24 in., $8.00. $10.00. $13.00. $17.00.

20% dis.



Light work, 12 × 17; height, 15 in., $16.00.

Same, with Hood, 12 × 17; height, 28 in., $20.00.

Bridge, Boiler or Railroad work, Pan, 17 × 19; height, 29 in.; Fan, 8 in., $27.00.

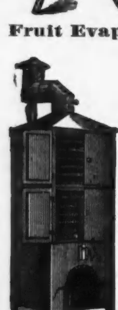
Same, with Hood, $30.00.

Water Tank, $4.00 extra.

Iron Fire Ring Round Tuyere $1.00 extra.

50% dis., f.o.b. at Cohoes.

Fruit Evaporator.

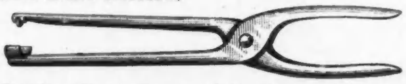


No. 1. Evaporator.................... $30
No. 2. Fruit Drier and Baker, with Bleacher attachment. Weight, 225 lbs. Capacity, 5 to 7 bushels apples per day; 24 in. deep, 26 in. wide, 5½ ft. high; 12 trays, 22 × 22; 40 square feet drying surface. Complete.................... $50
No. 3. Capacity, 15 to 20 bushels per day.................... 100
No. 4. Capacity, 20 to 30 bushels per day.................... 16
Dis., No. 1, 3 and 4 = 20%.
" 2 = 30%
Boxing, extra:
No. 1, $3.00; No. 2, $5.00; No. 3, $7.50; No. 4, $12.50.
Freight to New York:
No. 1, $4.00; No. 2, $6.00; No. 3, $12.00; No. 4, $18.00.

Fruit Presses.

P., D. & Co. ....per doz., $4.50

Glass Tube Cutters.

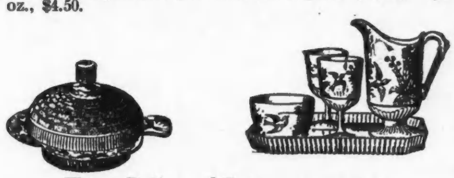


One Arm Carries Rotary Cutter Price, $2.50 each.

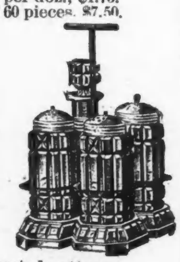
Glassware.

6-in. bowl and cover, per doz..........$3.25
7-in. " " " 4.50
8-in. " " " 6.00
9-in. " " " 8.00
10-in. " " " 10.50
Net.

Nappy, 4½-inch., per doz., 50c.; 6-inch., per doz., $2; 7-inch., per doz., $3; 8-inch., per doz., $4.
Cream Pitcher, 1 pint, per doz., $1.25; one quart, per doz., $3.50; 3 pints, per doz., $4.50.
Pint Pitcher, per doz., $1.50; quart pitcher, per doz., $2; ½ gallon pitcher, per doz., $3; 3 quart pitcher per oz., $4.50.



Flange Butter and Cover, per doz., $1.75.
Water Set, per doz., sets of 60 pieces, $7.50.

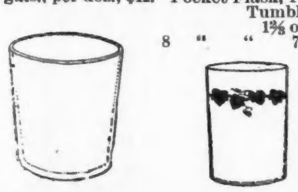


Cheese Dish and Cover, 8 in., per doz., $4.50.
Quart Water Bottle, per doz., $4.50.
Ind. Salts; per gross, $2.00. Assorted patterns.
4 Bottle Castors, per doz., $7.50; 3 bottle, per doz., $4.50.

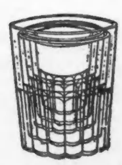
Berry Dish, 4½-inch , per doz., 50c.; 10-inch, per doz., $4.
Butter Dish and Cover, per doz., $1.25.
Butter Dish and Cover, per doz., 75c.

Candlesticks, per doz., $2.00. Glass Slipper for Flowers, per doz., 50 cents; slipper and tray, per doz., $1. Jam Jar and Cover, 1 qt., per doz., $2.50; ½ gal., per doz., $3.25; ¾ gal., per doz., $4; 1 gal., per doz., $5; 1½ gals., $9; 2 gals., per doz., $12. Pocket Flask, 1 pint, $1.

Tumblers.
1⅝ oz., per doz., 50 cents.
8 " " 75



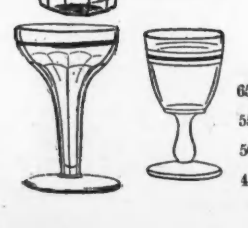
9 oz., per doz., $2.75.



11 oz., assorted patterns, per doz., 30 cts.

9½ oz., assorted patterns, per doz., 25 cts.

1 oz. to 12 oz., nested for shipping, per doz. nest, $2.



Goblets, banded, per doz., 65 cents.
Claret to match, per doz., 55 cents.
Wines, to match, per doz., 50 cents.
Cordials, to match, per 45 cents.

Goblets, per doz., 50 cts.
Claret, " 50 "
Wine, " 35 "

Banded, open, hollow stem.

Champagne, per doz., $1.25.

½ Pt. tumbler, per doz. ..55 cts.
½ Pt. mug to match, " ..65 "
Goblet, " ..50 "
Spoon holder, cream pitcher, sugar, butter dish to match.
Sets of 4 pieces, per doz. sets, 48 pieces, $3.75.

Hammers.

H. Cheney Hammer Co.

Adz-eye Hammers.—Per Dozen.

No.	Weight.		No.	Weight.	
5. Round.	1 lb., 4 oz	$9.00	7½. Round.	13 oz ..	$8.00
7. "	1 lb........	8.50	8 "	7 oz....	7.50

Adz-eye Hammers.—Per Dozen.

No. 17. Octagon. weight, 1 lb., 4 oz..............$9.00

Adz-eye Hammers.—Patent Nail Holder.—Per Dozen.

No.	Weight.		No.	Weight.	
33. Bell-face.	1 lb., 4 oz	$9.50	35. Round h.	1 lb., 4 oz	$9.50
34. "	1 lb.	9.00	36. "	1 lb......	9.00

Adz-eye Hammers.—Bell Face.—Per Dozen.

No.	Weight.		No.	Weight.	
37.	1 lb., 4 oz......	$9.00	38½.	13 oz...........	$8.00
38.	1 lb.............	8.50	39½.	7 oz	7.50

Farriers' Hammers.—Per Dozen.

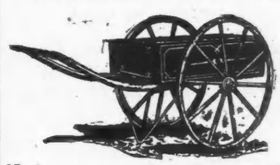
No.		Weight.	
55.	Adz-eye. Octagon.	9 oz......	$7.75
56.	" "	7 oz......	7.50
57.	Plain. "	7 oz......	6 25
58.	Plain Brad.	4 oz......	5 50
60.	Adz-eye, Round Head.	7 oz......	7 50
61.	" Octagon. Boston pattern	10 oz......	8.00
62.	" " "	7 oz......	7.50

Machinists' Ball Pein Hammers.—Octagon.—Per Dozen.

No.	Weight.		No.	Weight.	
90.	3 lbs............	$22.00	94.	1 lb., 4 oz......	$13.50
90½.	3 lbs., 8 oz......	19.00	95.	1 lb............	12.50
91.	4 lbs., 4 oz	17.50	96.	12 oz............	12.00
92.	2 lbs....	16.50	97.	8 oz............	12.00
92½.	1 lb., 12 oz......	15.50	98.	6 oz............	12.00
93.	1 lb., 8 oz ...	14.50			

Discount, 35 and 5 per cent. Net Cash, 30 days. 10 per cent. Cash, 10 days. Cases at Cost.

Hand Carts No. 0 42 wheel, 1 in. tread, 1 in. axle box 48x28x10 deep, $10.50.



No. 1, 36 wheel, 1 in. tread, ⅞ in. axle, box 40x23x10 deep, $9.00.
No. 2, 30 wheel, ¾ in tread, ¾ in. axle, box 32x20x9 deep, $8.25.

With Wagon-Seat Spring.

No. 6, same sizes as No 0..$12.00
" 7, same sizes as No. 1.. 10.50
" 8, " " " No. 2.. 9.75

With Third Wheel, Without Springs.

No. 3, same sizes as No. 0..$12.00
" 4, " " " No. 1.. 10.50
" 5, " " " No. 2.. 9.5

Handles. Doz.

Extra, Axe 36-inch..$1.90
No. 1.................$1.50 | No 2.......................... 1.10
Extra, Axe, Boys, 26 and 28 inch.......................... 1.25
No. 1.................$1.15 | No. 2.......................... 85
Extra, Axe, Broad or Squaring.......................... 2.00
No. 1.................$1.50 | No. 2.......................... 1.25
Extra, Adz Colonial, Ship and R. R., 34 and 32-inch. 2.00
No. 1.................$1.60 | No. 2.......................... 1.25
Extra, Pick R. R., 36-inch.......................... 2.00
No. 1.................$1.40 | No. 2.......................... 1.10
Extra, Pick Square Eye Miners' 34, 33 and 32-inch. } 2.00
Extra, Square Eye Driving 34, 33 and 32-inch....... }
No. 1.................$1.50 | No. 2.......................... 1.25
Extra, Pick Square or Oval Eye Miners' or Drifting Pick, 34 and 32-inch.......................... 2.00
No. 1. ....$1.45 | No. 2.......................... 1.20

Sledge Hammer, Tool, Maul, Straight Taper.

			Extra.				Extra.
24-in......	No. 1,	$ 65;	$ 80	34-in......	No. 1,	$ 95;	$1.10
26-in......	No. 1	75;	90	36-in......	No. 1,	1.05;	1.20
28-in......	No. 1,	80;	95	38-in......	No. 1,	1.15;	1.30
30-in......	No. 1,	85;	1.00	40-in......	No. 1,	1.35;	1.40
32-in......	No. 1,	90;	1.05	42-in......	No. 1,	1.60;	1.75

Blacksmith Hammer, Machinist Hammer, Hand Hammer.

	Per. doz.	Extra.		Per doz.	Extra.
14-in.......	No. 1, 35c.;	45c.	20-in.......	No. 1, 65c.;	75c.
16-in.......	No. 1, 45c.;	55c.	22-in.......	No. 1, 70c.;	80c.
18-in.......	No. 1, 55c.;	65c.	24-in.......	No. 1, 75c.;	85c.

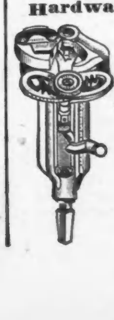
Adze Eye and Round Eye Hammer, 12, 13, 14, 15 in., per doz.......................... 30c.
Shingling and Lath Hatchet, 12, 13, 14, 15 in., per doz. 30c.

Broad Hatchet.

	Per doz.		Per doz.
16-in....................	50c.	18-in....................	55c.
17-in....................	50c.	19-in....................	55c.

Dis., 10.10 and 2 %.

Hardware Specialties.

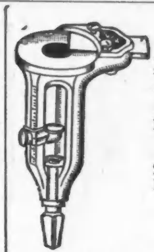


AUGERS.

Patent Adjustable Hollow.

Cuts from ¼ to 1¼, pivoted jaws, graduated scale to 1-16ths, per doz., $60.00.

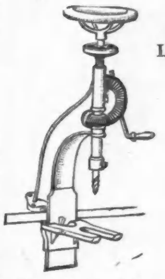
Discount, 15 and 10%.



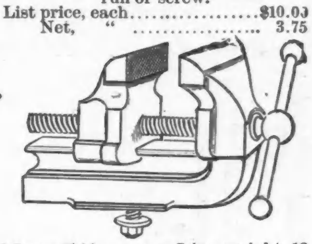
Patent Hollow Auger.

Inch.........	5-16	⅜	7-16	½	
With bits....	12.00	12.00	12.00	12.00	
Without bits	8.00	8.00	8.00	8.00	
9-16	⅝	¾	⅞	1	1⅛
14.00	14.00	14.00	16.00	16.00	20.00
9.00	9.00	9.00	13.00	13.00	14.00
1¼	1⅜	1½			
20.00	24.00	24.00			
14.00	16.00	15.00			

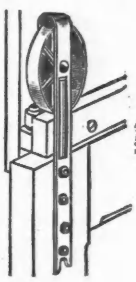
Discount, 15 and 10%.



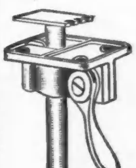
BENCH DRILL.
Adjustable bed plate.
26½ high drills to ½ in. hole, 3½ run of screw.
List price, each......................$10.00
Net, " 3.75



Bench Vise, Steel Jaws, 3½ in., opens 3 in.; weight, 12 lbs.; list price, each, $4.00.; net price, each, $1.60.

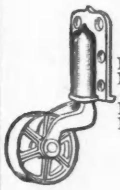


BARN DOOR HANGER.
4 in., per doz. pairs..................$12.00
5 " " " 14.40
Track, per foot.......................... .08
One dozen pairs in case.
Dis., 50%.

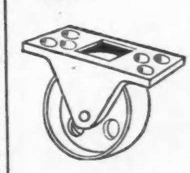


BENCH HOOK.
Patent, adjustable and reversible
List $9 dozen, ½ dozen in box.
Discount, 20 and 10%.

BLACKSMITH'S TONGS.
Swivel Jaw.
No. 1, 16 in., per doz..........................$10.00
" 2, 18 " " 10.00
Dis. 20%.



CASTERS.
Swivel Store Truck.
No. 20, japanned, 4 in. wheel, each..... .55
No. 25, " 5 " " " ..... .75
Noiseless turned wheel.
No. 30, japanned, 4 in. wheel, each..... 1.30
No. 35, " 5 " " " 1.60
Discount, 25%.



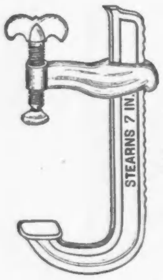
Store Truck, stationary.
No. 50, 5-inch wheel, 1½ inch wide, each, $1.05.
No. 60, 5-inch, extra heavy, 1½ inch wide, each $1.50.
Discount, 25%.

CLOTHES REEL.
Extra heavy, gray iron, japanned.
List per doz..........................$15.00
Net 7.00

JACK SCREWS.
New pattern wrought iron screw.

No.	Rise of screw.	High.	Diameter screw.	Price.
20	4½ in.	10 in.	2 in.	$4.50
25	6½ "	12 "	2 "	5.25
30	8½ "	14 "	2 "	5.75
3	11½ "	16 "	2 "	6.50

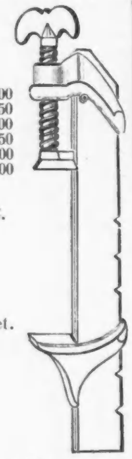
Discount, 40%.



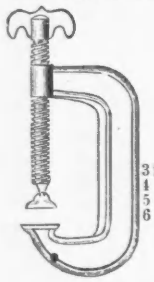
SCREW CLAMPS.
Adjustable.

3 in., per doz.	$4.00
5 " "	6.50
7 " "	9.00
9 " "	10.50
12 " "	15.00
16 " "	20.00

½ doz. in box.
Discount, 20 and 10%.



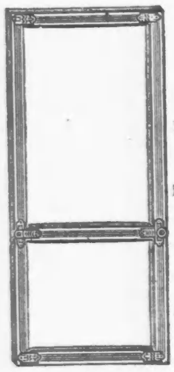
CLAMPS.
New Door Frame.
3 ft. long, per doz., $8 list; $5 per doz. net.



Malleable Iron Screw Clamps.

	Per Doz.		Per Doz.
3 in.	$7.00	7 in.	$20.00
4 "	10.00	8 "	25.00
5 "	12.00	9 "	27.50
6 "	16.00	10 "	30.00

3, 4, 5, 6 in., ½ doz. in box.
Dis., 70%.



DOOR SCREEN FRAMES.

Patent Corners.

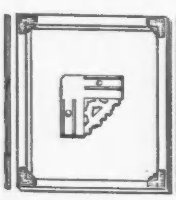
No. 22, 3 by 7 ft. sticks, ⅞ by 2, per doz. sets, $11.

No. 24, 3½ by 8 ft. sticks, ⅞ by 2, per doz. sets, $12.

No. 26, 3 by 7 ft. sticks, ⅞ by 2½, per doz. sets, $12.50.

No. 28, 3½ by 8 ft. sticks, ⅞ by 2½, per doz. sets, $14.50.

Dis., 20%.



WINDOW SCREEN FRAMES.
Patent Japanned Corners.
No.25, 36 by 36 corners and screws, without bead, per doz., $2.50.
No.25, 36 by 36 corners and screws, with bead, per doz., $2.90.
No.35, 42 by 42 corners and screws, without bead, per doz., $2.90.
No.35, 42 by 42 corners and screws, with bead, per doz., $3.30.
Black satin stain, sticks ⅞ by 1 in.
Dis., 20%.

PULLEYS.
Side, No. 45, Japanned.

Inches...	1	1¼	2	2½	3	4	5
Per doz..	.90	1.00	1.60	2.40	3.50	9.00	15.00

2 inch and under, 2 dozen in box: 2½, 3 and 4, 1 dozen in box; 5 inch, ½ dozen in box.

Discount, 50%.

PULLEY HOOK (New Floor.)
Deep cut thread, forged point.

Per doz.
¾ in. wrought iron, 8 in. long, list....... $1.90
net........ 1.00

WELL WHEEL.
New pattern.
Japanned.

In.	8	10	12	14	16
Pr.d.	7.00	9.50	12.50	20.00	30.00

Discount, 70%.

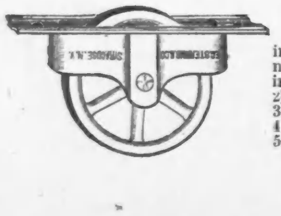
HAY FORK PULLEY.

New pattern.

No. 15, 5 in. iron wheel	per doz.	$4.50
25, 5 in. wood "	"	4.50
66, 6 in. "	"	6.00

4 dozen in case, 8 dozen in barrel.

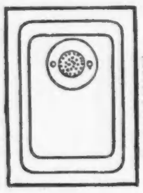
No. 15, per dozen, $2 net.



SHEAVES.
Patent Common
Turned and polished iron wheels, round corners, brass pin, one set in box.

2½ inch	$1.50
3 "	1.60
4 "	2.00
5 "	2.60

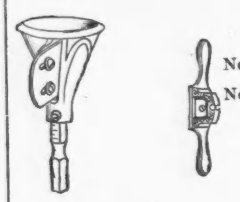
Discount, 50%.



SINKS.
All 6 inch deep.

14 × 20 in.	$1.50	18 × 30 in.	$2.50
15 × 25 in.	1.75	18 × 32 in.	3.00
15 × 27 in.	2.00	18 × 36 in.	3.00
16 × 24 in.	1.80	20 × 30 in.	3.00
16 × 28 in.	2.10	20 × 36 in.	3.70
17 × 30 in.	2.25	20 × 40 in.	4.00
18 × 24 in.	2.10		

Discount, 60%.



SPOKE POINTERS.

Per doz.
No. 1, points 1¾ in. diameter, $9.00
No. 2, points 2⅜ in. diameter, $15.00

Discount, 15 and 10%.

½ dozen in box.

VISE.
(Bench Vise, Steel Jaws.)
3½ in. opens 5 in., weight 12 lbs.
List price, each. $4.00
Net " " .. 1.60

Silent Saw Vise.
No. 10., 10 in. jaw, per doz....$15.00
Dis., 33⅓%.

Moore & Barnet Mfg. Co.

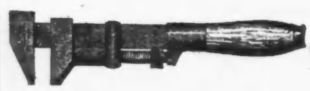
No.	per dz.	gr., lbs.	No. Clamp.	per dz.	gr., lbs.
1 Amateur vise	$2.25	70	1½	3.00	80
Anvil.			2½	5.00	220
2	3.75	200	3½	14.25	700
3	11.25	615	4½	21.00	1,425
4	18.00	1,350	Combination hand	5.25	85
10	24.00	1,675			

Spot cash discount, 33, 20 and 2, f.o.b.

Nos. 1, 1½, 2 and 2½ are packed in dozens; Nos. 3 and 3½ in half dozens; Nos. 4, 4½ and 10 in quarter dozens, and No. 20 singly. Each hand vise is put up in neat box and packed in half dozen lots.

1 Hinge pipe vise, 0 to 2 in. pipe	Each $10.00
2 " " " 0 to 4 in. pipe	20.00
1 Malleable pipe vise, 0 to 2 in. pipe	8.00
1 Combination pipe and bench vise, 0 to 2 in. pipe	16.00

Discount, 50%.



WRENCHES.

Coes' Knife Handle Wrenches.

BLACK.

Size.	℔ doz.	Size.	℔ doz.
6 inch	$9.00	15 inch	$24.00
8 "	10.00	18 "	30.00
10 "	12.00	21 "	36.00
12 "	14.00		

BRIGHT.

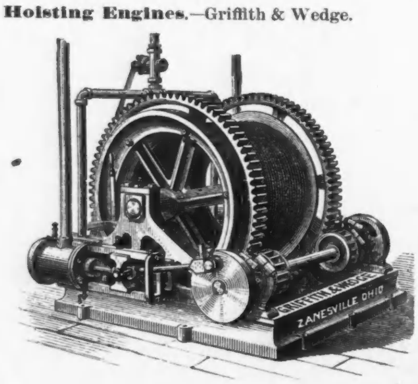
4 inch	$10.00	12 inch	$16.00
6 "	10.00	15 "	26.00
8 "	11.00	18 "	32.00
10 "	14.00	21 "	38.00

Discount, 55, 10, 7½ and 3%.

Coes Mechanics' Screw Wrenches, same list, less 55, 10, 10, 7½ and 3%.

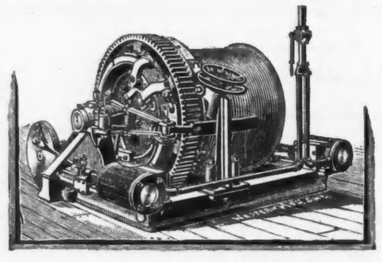
A. G. Coes & Co. Pat. Screw Wrenches, same list as above. Discount, 55, 10, 7½ and 3%.

Hoisting Engines.—Griffith & Wedge.



	Weight.	$
Hoisting Engines, Miner's Prospecting	4,500	750
Hoisting Engines, No. 1 Double Cylinder	4,500	800
Discount, 20%.		
" " No. 2 Double Cylinder	6,000	1,000
" " No. 3 " "	11,000	1,550
" " No. 4 " "	15,500	1,800
" " No. 5 " "	17,000	2,100
" " No. 6 " "	13,600	1,750
" " No. 7 " "	17,000	2,100
" " No. 8 " "	19,000	2,400
" " No. 9 " "	48,000	4,500

Discount, 25%.



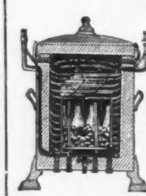
Webster, Camp & Lane Machine Co.

Single drum.	No.	Average Load. Pounds	Approx. weight, complete. Pounds.	Double drum.
$825.00 =	5	1,950	6,000 =	....
918.50 =	6	1,650	6,500 =	....
1,177.00 =	7	2,200	8,000 =	$1,661.00
1,331.00 =	8	3,000	8,500 =	1,815.00
1,694.00 =	9	3,500	14,000 =	2,722.50
1,914.00 =	16½	3,700	16,000 =	3,124.00
2,343.00 =	17½	5,500	19,000 =	3,333.00
2,475.00 =	18	5,500	22,000 =	3,872.00

See also advertising pages ENG. AND MINING JOURNAL.

Ice Machines (Family).

L. DERMINGNY & Co.



No. 1, Ice machine, ice and ice cream molds, 1 lb. ice, $15.00.

No. 2, Ice machine, ice and ice cream molds, 1½ lbs. ice, $20.00.

No. 3, Ice machine, ice and ice cream molds, 1 carafe 1 bottle holder, 2 lbs. ice, $26.50.

No. 4, Ice machine, ice and ice cream molds, 2 carafe 1 bottle holder, 4 lbs. ice, $33.00.

No. 5, Ice machine, ice and ice cream molds, 3 carafe 1 bottle holder, 6 lbs. ice, $40.00.

No. 6, Ice machine, ice and ice cream molds, 4 carafe 1 bottle holder, 9 lbs. ice, $46.50.

India Rubber Goods.

MECHANICAL.
Commonwealth Rubber Co.

RUBBER BELTING.

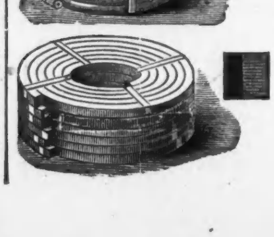
Inches.	2 ply per foot.	3 ply per foot.	4 ply per foot.	5 ply per foot.	6 ply per foot.
1	$0.07	....	....	....	....
1¼	0.09	....	....	....	....
1½	0.11	....	....	....	....
2	0.15	$0.17	$0.21	....	....
2½	0.18	0.22	0.26	....	....
3	0.22	0.26	0.31	....	....
3½	0.26	0.30	0.37	....	....
4	0.30	0.34	0.42	....	....
4½	0.33	0.39	0.47	....	....
5	0.36	0.43	0.52	....	....
6	0.43	0.52	0.62	....	....
7	0.51	0.60	0.73	....	....
8	0.59	0.70	0.84	$1.05	$1.25
9	0.67	0.80	0.95	1.18	1.42
10	0.75	0.90	1.07	1.33	1.60
11	0.83	1.00	1.18	1.47	1.77
12	0.91	1.08	1.30	1.62	1.95
13	1.00	1.18	1.42	1.77	2.13
14	1.08	1.28	1.54	1.92	2.31
15	1.16	1.38	1.66	2.07	2.49
16	1.25	1.50	1.78	2.22	2.67
18	1.41	1.70	2.02	2.52	3.03
20	1.58	1.99	2.26	2.82	3.39
22	1.76	2.12	2.52	3.15	3.74
24	1.96	2.36	2.80	3.50	4.20
26	2.18	2.60	3.08	3.85	4.62
28	2.42	2.84	3.36	4.20	5.04
30	....	....	3.64	4.55	5.46
32	....	....	3.92	4.90	5.88
34	....	....	4.20	5.25	6.30
36	....	....	4.48	5.60	6.72
38	....	....	4.76	5.95	7.14
40	....	....	5.04	6.30	7.56
42	....	....	5.32	6.65	7.98
44	....	....	5.60	7.00	8.40
46	....	....	5.88	7.35	8.82
48	....	....	6.16	7.70	9.24
50	....	....	6.44	8.05	9.66
52	....	....	6.72	8.40	10.08

Dis. Reliance, 60 and 5. Dis. Royal, 60, 10 and 10. Dis Manhattan, 70 and 5. See Link Belting, page 9.

PACKING.

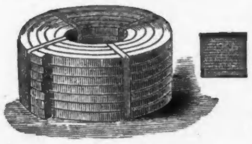
Piston Packing.

Round Piston Packing
Per lb. 85c.
Discount, 60, 10 and 5 per cent.



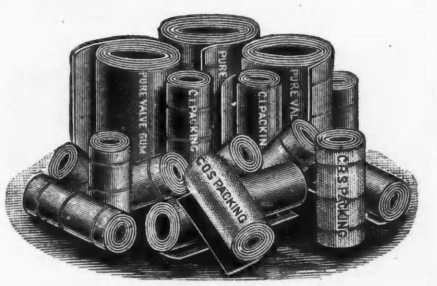
Square Piston Packing.

Price same as above.
Round and square piston packing is made in lengths of twelve or twenty-four feet.



Square Piston Packing. Rubber back, per pound $1. Discount 60 der cent. Best only.

Square piston packing, rubber back is made in lengths of twenty feet.



Steam Packing.
Cloth Insertion, Rubber Outside.
Cloth Insertion, Cloth on one or both sides.

Thickness.	1-Ply.	2-Ply.	3-Ply.	4-Ply.
1-64 inch	70 cts.	....	....	....
1-32 "	65 cts.	....	....	....
1-16 "	60 cts.	63 cts.	66 cts.	....
3-32 "	55 cts.	58 cts.	61 cts.	....
1-8 "	55 cts.	55 cts.	58 cts.	61 cts.
3-16 "	55 cts.	55 cts.	55 cts.	58 cts.
1-4 "	55 cts.	55 cts.	55 cts.	55 cts.

One-ply of cloth to every 1-16 inch thickness.

Three cents per pound additional will be charged for each extra ply of cloth. Each cloth, whether insertion or on outside, to count as one ply.

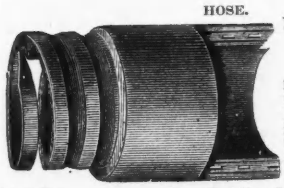
All cloth insertion or plain packing is one yard wide, and any length desired.

Wire insertion packing, all thicknesses, per ℔, 50 cents.

Discounts: Reliance, 70 & 10; Royal, 60, 10 & 10; Manhattan, 60 per cent.

See "Link" Packing, page 9.

HOSE.



Improved "Smooth Bore" Rubber Suction Hose.

On spiral flat or round tinned steel wire.

Int. Diam.	Per ft.
2 inch	$2.60
2½ "	3.50
3 "	4.00
3½ "	5.50

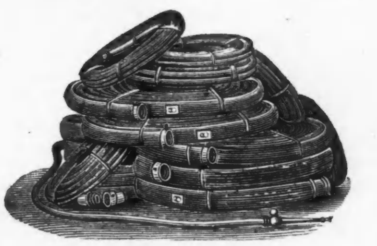
In. Diam.	Per ft.	Per. Diam.	Per ft.
4 inch	6.50	7 inch	$13.50
4½ "	7.50	7½ "	15.00
5 "	8.50	8 "	16.50
5½ "	9.50	9 "	19.50
6 "	10.50	10 "	22.50
6½ "	12.00	12 "	27.50

Suction hose discount: Reliance, 50 and 10%; Royal, 60, 10 and 5%; Manhattan, 70 and 5%.

SUCTION HOSE.

On spiral brass or iron wire

Int. Diam.	Per. ft.
¾-inch	$ .77
1 "	1.00
1¼ "	1.25
1½ "	1.65
1¾ "	2.10
2 "	2,50



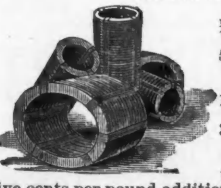
RUBBER HOSE.

Conducting Hose—Two-ply.

Int. diam.	Per ft.	Int. diam.	Per ft.	Int. diam.	Per ft.
½ in.	$0.20	2 in.	$0.66	5 in.	$1.65
¾ in.	25	2¼ in.	75	6 in.	1.98
1 in.	33	2½ in.	83	7 in.	2.31
1¼ in.	42	2¾ in.	92	8 in.	2.64
1½ in.	50	3 in.	99	9 in.	2.97
1¾ in.	58	4 in.	1.32	10 in.	3.33
HYDRANT HOSE—THREE-PLY.					
½ in.	$0.25	1½ in.	$0.60	2½ in.	$1.00
¾ in.	30	1¾ in.	70	2¾ in.	1.10
1 in.	40	2 in.	80	3 in.	1.20
1¼ in.	60	2¼ in.	90	3½ in.	1.40
				4 in.	1.60

Discount—Reliance, 60; Royal, 70; Manhattan, 70 and 10 per cent.

GASKETS AND RINGS.



Fibrous.

⅛ inch thich, or less, per lb. $0.90

5-32 inch thick, and upwards, per lb. $0.80

Cloth Insertion.

1-16 inch thick, or less, per lb. $1.25

3-32 inch thick, and upwards, per lb. $1.00

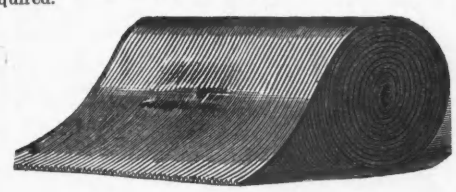
There is one ply of cloth to every 1-16 in. thickness.

Five cents per pound additional for each extra ply of cloth.

Dis., 60, 10 and 5%.

CORRUGATED RUBBER MATTING.

Rolls 1 yard wide, 30 yards long, cut to any size required.

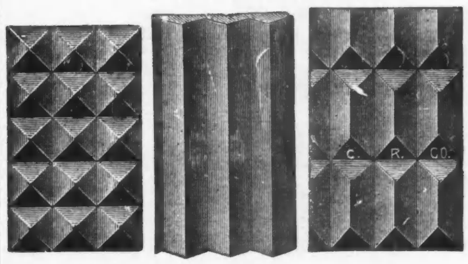


3-32 in. thick, per sq. ft.	$0.33
⅛ " " "	0.40
3-16 " " "	0.56
¼ " " "	0.73
⅜ " " "	1.03
½ " " "	1.30

Dis., 25 and 5%.

TENNIS SHOE SOLING.

Cuts show full size of pattern.



Diamond Point. Corrugated. Oblong.

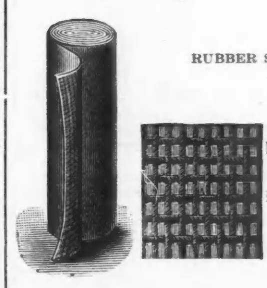
Price, $1 per lb.

Rubber cement to attach soles furnished.

STAIR TREADS.

No.	Inches.	Thick.	Per doz.	Thick.	Per doz
1.	6 x18	⅛	$4.00	3/32	$3.30
2.	7 x24	⅛	6.00	3/32	5.00
3.	4 x39	⅛	5.50	3/32	4 70
4.	7 x40	⅛	10.00	3/32	8.30
5.	7½x42	⅛	11.00	3/32	9.10
6.	7½x48	⅛	12.50	3/32	10 40
7.	9 x40	⅛	12.50	3/32	10.40
8	9 x48	⅛	15.00	3/32	12.50
9.	9 x36	⅛	11.25	3/32	9.40
10.	6 x48	⅛	10.20	3/32	8.70
11.	7 x28	⅛	7.00	3/32	5 85
12.	9 x54	⅛	16 80	3/32	14 00
13.	8 x52	⅛	14.60	3/32	12.15
14.	10 x24	⅛	8.40	3/32	7.00

RUBBER SOLING FOR BOOTS.



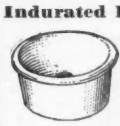
Rough finish, 1-16 to 3-16 thick.

Smooth finish. 1-32 to 1-16 thick.

85 cents per lb.

Indurated Fibre Ware.

SPITTOONS.



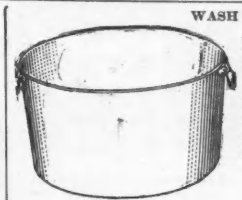
	Doz.
16 in. dia., 8 in. high	$24.00
12½ in. dia., 5½ in. high	10.80
9 in. dia., 5 in. high	7.80

Dis. on all 25 and 20%.

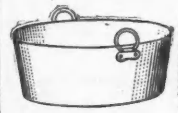
CORDLEY & HAYES.

Pails.	No. doz. in crate.	Cubic feet.	Price per doz.
Ladies' or Weaver's pails, 6 qt.	1	2¾	$5.35
Half or buggy pails, 6 qt.	1	3	4.80
Star pails (standard plain), 12 qt., stenciled "for fire only" without extra charge	1	3½	6.00
Deck or Mason's pails (same size as Star, but heavier, with heavy wire bail)	1	4	6.60
Railroad or fire pails, 14 qt. (also stenciled "fire" without extra charge)	½	3½	7.80
Fire pails, round bottoms	1	4	7.80
Milk pails, 14 qt.	1	4	7.80
Stable pails, flush bottom, heavy wire bail, 14 qt	1	4	7.80
Stable pails, 16 qt., same as above	½	3½	8.40
" 18 " "	½	3¾	10.70
" 20 " "	½	4	12.00
Covers for fire or star pails		1	3.35

WASH TUBS.



No. 0, 23 in.	½	12	27.00
Nos. 0, 1, 2 and 3, nested	1 n.	3½	22.50
No. 1, 21 in.	½	10½	24.00
No. 2, 19½ in.	½	9	21.00
No. 3, 18½ in.	½	9	18.00
Nos. 1, 2, and 3, nested	½	9¾	21.00



KEELERS.

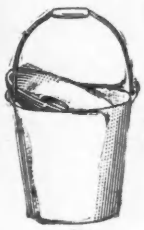
		Doz.
A—20 in.	7 in. deep	16.20
B—19 "	" "	15.00
C—18½ "	" "	14.00
1—17½ "	" "	13.20
2—15½ "	6 in. "	12.00
3—13½ "	5 in. "	10.20
4—12 "	4 in. "	9.00

MILK OR VEGETABLE PANS.

13½ in. dia., 3¼ in. deep, 6 quarts, $3.60 per doz.

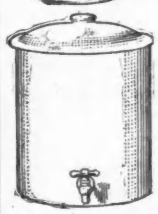
WASH BASINS.

	Doz.
12½ in.	$4.80
12½ in.	4.20
11½ in.	3.60



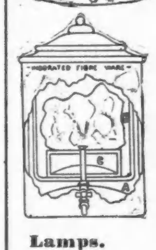
CHAMBER PAILS.

12 in. dia., 9 in. deep, 3 gal, 16.00



WATER COOLERS.

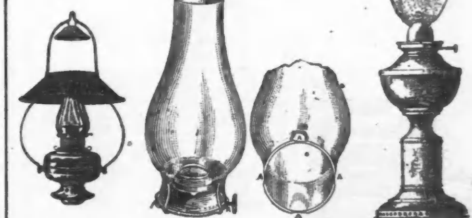
	Doz.
3 gal	$32.00
4 "	40.00
5 "	44.00
6 "	48.00
8 "	64.00
10 "	80.00
12 "	96.00
15 "	120.00



WATER COOLERS AND FILTERS.

	Doz.
4 gal	$96.00
5 "	108.00
6 "	120.00
8 "	144.00
10 "	192.00
15 "	288.00

Lamps. F. H. Lovell & Co.



Miners'.

Brass, Collar and Breast in one piece, Spout and Body in one piece.

Price, $9 per gross net.

Drummond Electric Hanging Lamp, 300 candle power, complete, each $3.50.

The electric lamp, 60 candle-power.

With decorated shades, nickel, per doz. $22.00

With opal plain shades, nickel, per doz. 18.00.

With decorated shades, brass, per doz. 21.00.

With opal plain shades, brass, per doz. 17.00.

Lamp chimney patent for Sun burners. Per doz. No. 0, 50 cents. No. 1, 60c. No. 2, 75c.

Hitchcock nickel table lamp	(No. 654),	each	$3.75
" " hanging "	656	"	7.25
" " bracket "	651	"	4.00
" " " with reflector	653	"	4.00

" French bronze bracket, with reflector, No. 653, each $3.75.

Harp, complete, with square tin shade, per doz., $9.50.

Complete, with Burner and chimney, per doz., $1.50.

Hurricane lanterns 25 cents extra with guards.

875, ⅜ wick, without guards, per doz., $5.00.

876, square safety lifting globe, per doz., $5.50.

877, ⅝ wick, safety lifting globe, per doz., $6.75.

Nickel plated diamond reflector reading lamp, 30 candle-power, $13.50 per doz.

Net.

Illuminated night clock, per doz., $27.

PAPER LAMPS.

Lined with oil proof composition.

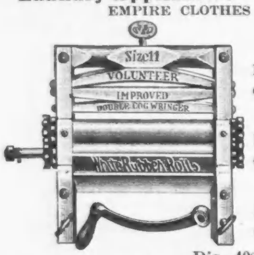
	No. 0.	No. 1.	No. 2.
Height	2½ in.	3 in.	3¾ in.
Diameter	3½ in.	2½ in.	2½ in
Weight, ₩ doz.	3¾ lbs.	1¾ lbs.	2 lbs
Price	$2.75 per doz.	$2.25	$2.75

	No. 0.	No. 3.	No. 4.
Height	2½ in.	5 in.	6½ in.
Diameter	3½ in.	3½ in.	4 in.
Weight, ₩ doz.	3¾ lbs.	3½ lbs.	7 lbs.
Price	$2.75 per doz.	$3.25	$4.50

Dis., 20%.

Laundry Appliances.

EMPIRE CLOTHES WRINGERS.



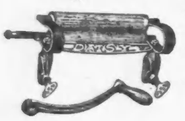
Rolls.

"Volunteer." Length, 10 in.x1¾ in. dia. $40 per doz.

"Volunteer." Length, 11 in.x1¾ in. dia. $50 per doz.

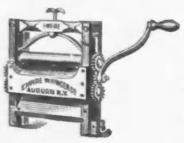
"Volunteer." Length 12 in.x1¾ in. dia. $50 per doz.

Dis., 40%.



"Daisy." Length, 10 in.x1¾ in. dia. $30 per doz.

"Daisy." Length, 12 in.x1¾ in. dia. $48 per doz. Dis., 40%.



"Empire." Length, 10 in.x1¾ in. dia. $63 per doz.

"Empire." Length, 11 in.x1¾ in dia. $74 per doz.

"Empire." Length, 12 in.x1⅞ in. dia. $84 per doz.

"Empire." Length, 12 in.x1⅞ in. dia. $87 per doz.

"Empire." Length, 14 in.x2¼ in. dia. $156 per doz.

"Empire." Length, 14 in.x2¼, with pulleys. $220 per doz.

"Empire." Length, 16 in.x2½, with pulleys. $350 per doz.

Dis., 40%.

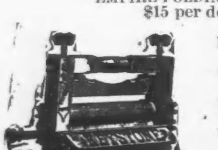
EMPIRE CLOTHES DRYING BARS.
$10 per doz.
Dis., 40%.

Closed.

Open for use.

EMPIRE FOLDING WASH BENCHES

$15 per doz. Dis., 40%.



Royal Keystone cog wheel, 10 by 1¾ rolls, $36 per doz.

No. 10, wood frame cog wheel, 10 by 1¾ rolls, $24.50.

No. 16, wood frame cog wheel, 11 by 1¾ rolls, $29.

No. 18, wood frame cog wheel, 11 by 1⅞ rolls, $33.50.

No. 20, wood frame cog wheel, 11 by 2 rolls, $39.50.

No. 22, wood frame cog wheel, 12 by 1⅞ rolls $39.50.

No. 24, wood frame cog wheel, 12 by 2 rolls, $48.50.

No. 11, iron frame cog wheel, 10 by 1⅝ rolls, $20.

No. 2, iron frame cog wheel, 10 by 1¾ rolls, $24.

Solance iron frame (Eureka Pat.), 10 by 1¾ rolls, $20.

Solance iron frame (Eureka Pat.), 11 by 1¾ rolls, $24.50

F.o.b.cars at works; 60 cents doz entra f.o.b. New York.

Keystone Double Bench Wringer.

Rolls, 10 by 1¾, $36.50 per doz. Made to fold.

Folding Double Folding Wash Bench, packed 6 in crate per doz., $14.

Adams Ironing Table, per doz	$15.00
Keystone Washing Machines, per doz	24.00
Complete " " "	13.50
People's " " "	13.50
Lovell " " "	13.50

Net prices.

Cabinet Clothes Driers, per doz., $21.00 net,

Excelsior Clothes Horse, per doz., $6.00 net.

Reversible Clothes Horse.

	High.	Per doz.	
A	3 ft	$14.00	Dis., ash, 50 and 10%.
B	3 ft. 10 in.	16.00	
C	4 ft. 10 in.	18.00	
D	5 ft. 10 in.	20.00	Basswood, 60 and 10%.

Nursery Reversible Clothes Horse.

2 section, 3 ft. high, per doz	$9.00
" " "	12.00
" " "	16.00

Black Walnut Bronze Tips and Hinges. Dis., 30%.

WASHBOARDS.

The following prices are on orders of not less than 25 dozen of one kind or an assortment.

Wilson, one rubbing surface, per doz., $1.40.

Saginaw, one rubbing surface, per doz., $1.25.

Exchange, one rubbing surface, per doz., $1.10.

Wilson, two rubbing surface, per doz., $2.

Saginaw, one rubbing surface, per doz., $1.75.

Crescent, one rubbing surface, per doz., $2.25.

Shamrock, one rubbing surface, per doz., $2.

Rubbing surface of the two latter is solid sheet of zinc, without wood backs.

Lawn Mowers.

Forward Cut Mowers.

In.		Lbs.		In.		Lbs.	
10	Weight,	30¾	$13.00	16	Weight,	38	$19.00
12	"	31½	15.00	18	"	41	21.00
14	"	36	17.00	21			31.00

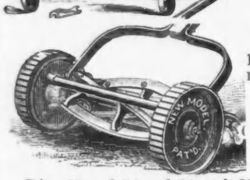
Dis. 60 and 5%.

10 in.	12 in.	14 in.
$13.00	$15.00	$17.00
16 in.	18 in.	20 in.
$19.00	$21.00	$23.00

24 in., $30.00.

Geared at both ends.

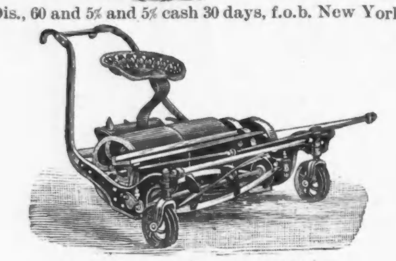
Dis. 60 and 5 and 5%.



Chadborn & Caldwell Mfg. Co.

10 in. Croquet, 18 pound, mower	$11.00
10 in.	13.00
12 in.	15.00
14 in.	17.00
16 in.	19.00
18 in.	21.00
20 in.	23.0

Dis., 60 and 5% and 5% cash 30 days, f.o.b. New York.



New Excelsior Horse Lawn Mower.

25 in. cut, without shafts or seat	$65.00
30 " with shaft and seat	110.00
35 " " " " "	135.00
40 " " " " "	170.00
Horse boots, per set	12.00

Dis. 50%.

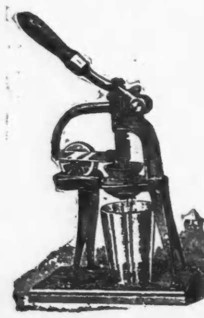
Excelsior Three-Blade Mower and Roller.

8 in., $11.00; 10 in., $13.00; 12 in., $15.00; 14 in., $17.00; 16 in., $19.00; 18 in., $21.00; 20 in., $23.00.

Dis. 60% and 5% cash 30 days f.o.b. New York.

Lemon Squeezers.

THE SAMSON



THE ACME.

The Acme Lemon Squeezers, knife and squeezer, per dozen, $15.00.

The Samson, per dozen, $3.00.

Porcelain lined, No. 1, per doz $6.00

25 and 30 % discount.

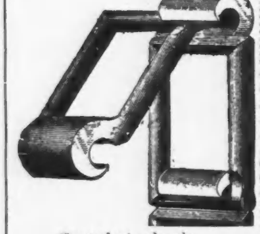
Wood, No. 2, per doz $3.00

30 % discount.

Wood, common, per doz $1.70

Link Belting.

Link-Belt Machinery Co.'s. Price per running foot net.

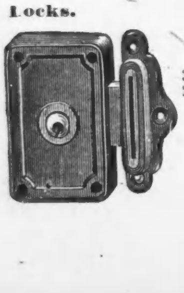


No.	Price.	No.	Price.
25	$0.13	78	$0.40
32	.13	83	.45
33	.12	85	.50
34	.13	88	.50
35	.14	95	.60
42	.16	103	.75
45	.16	105	.70
51	.20	106	.90
52	.25	107	.80
55	.22	108	.80
57	.24	109	.90
62	.30	114	1.10
66	.30	122	1.50
67	.30	124	1.30
75	.35	146	1.40
77	.35		

Sprocket wheels 25%

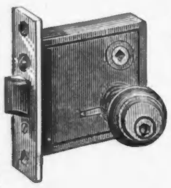
(Rubber belting, see page 6.)

Locks.



YALE PATENT.
RIM STORE LATCH.

	Per doz.
3 × 5 in., 4 keys	$48.00
2½ × 4 in., 3 keys	39.00

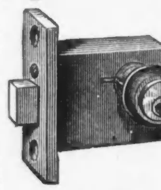


RIM NIGHT LATCH.

Spring lock, 3 keys	18.00
Dead lock, 3 keys	25.00

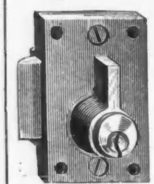
NIGHT LATCH.

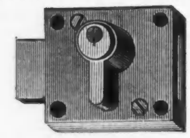
Escutcheon	39.00
"	36.00



MORTISE DEAD LOCK.

4⅝ × 3½	45.00
2⅜ × 3½	24.00



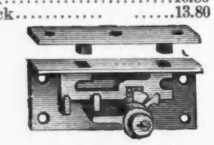


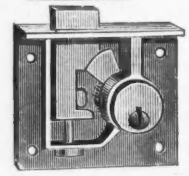
CUPBOARD LOCKS.

Plated Nose	13.20
Brass Nose	12.00

CUPBOARD

Dead Lock	10.80
Spring Lock	13.80





CHEST LOCKS.

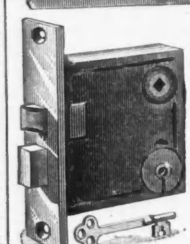
Plated nose	19.20
Brass "	18.00

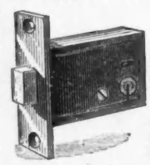
DRAWER LOCK.

Plated nose	10.20
Brass "	9.00

KNOB LOCKS.

5 × 3⅜	22.50
5 × 3⅜	20.00
4¼ × 3⅜	13.25
3½ × 3⅜	10.50





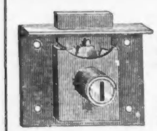
STANDARD LATCHES.

Dead locks.

3¾ × 2¾	24.00
2½ × 3⅜	14.00
1¾ × 2⅜	12.00

NIGHT LATCHES.

3¼ × 3⅜	20.00
2½ × 3¾	18.00



DRAWER LOCKS.

2 × 1⅝, two tumblers.

Plated nose	7.50
Brass "	6.00

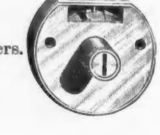
Three tumblers.

Plated nose	9.00
Brass "	7.50

RIM FLUSH DRAWER LOCK.

2 in. diameter.

	2 tumblers.	3 tumblers.
Plated nose	7.50	9.00
Brass "	6.00	7.50

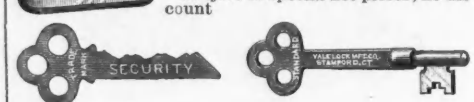


BRONZE SPRING PADLOCK.

2 flat steel keys.

In.	
1	11.00
1¼	12.00
1½	13.50
1¾	14.50
2	16.00
2¼	17.50

Subject to special net prices; no discount

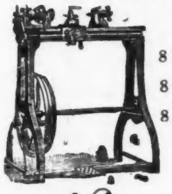


YALE KEYS.

Lumber.—Soft.

Per 1000 ft.	New York.	Boston.	Per 1000 ft.	New York.	Boston.
Flooring—			Bevel siding—		
4-4 No. 1	$24.00	$26.00	No. 1	15.00	16.00
4-4 " 2	20.00	22.00	No. 2	13.00	14.00
4-4 " 3	17.50	19.50	Base Boards, D. 4 S—		
5-4 " 1	26.50	28.50			
5-4 " 2	21.00	23.00	4-4 No. 1	26.00	28.00
5-4 " 3	18.50	20.50	4-4 " 1	22.00	24.00
Ceiling—			Stk. Boards, D 2 S—		
4-4 No. 1	25.00	27.00			
4-4 " 2	20.50	22.50	4-4 No. 1	26.50	28.50
5-8 " 1	19.50	20,50	5-4 " 1	28.50	30.50
1-2 " 1	15.75	16.75	6-4 " 1	29.50	31.50
5-8 " 2	15.75	16.75	8-4 " 1	30.50	32.50
1-2 " 2	12.25	13.25	Edge Boards, D 2 S—		
Partition—					
4-4 No. 1	25.50	27.50	4-4 No. 1	24.50	26.50
4-4 " 2	21.00	23.00	Edge wide, D 2 S—		
Ger. siding—					
4-4 No. 2	25.00	27.00	4-4 No. 1	26.50	28.50
4-4 " 2	21.00	23.00			

Machinery—Foot Power.

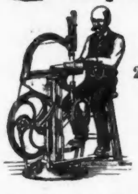


S., M. & Co.'s Screw-Cutting Engine Lathes.

8 in. swing, 20 in. bet. centers, 36 in. bed, 240 lbs. weight, $60.
8 in. swing, 30 in. bet. centers, 46 in. bed, 260 lbs. weight, $70.
8 in. swing, 36 in. bet. centers, 52 in. bed, 280 lbs. weight, $75.

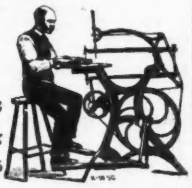
Boxing for export, $2.50 extra; f.o.b. at Cincinnati, 25 % dis.

SAWS AND LATHES.

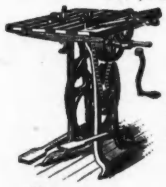


Victor Scroll Saw, Cuts to 3 Inches.

24-inch swing, with 12 saw blades $40
Dis., 20%.

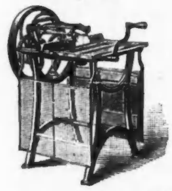


Empire Scroll Saw, Cuts to 3 Inches.
24-in. swing, drill and tilting table.
Price, boxed.................. $25
Dis., 20%



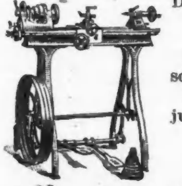
The Acme Combination Saw.

Hand or steam power.
Adjustable table and gauges.
Price, boxed.................... $40
Scroll saw attachment............ 7
Boring attachment................ 10
Moulding attachment.............. 10
Dis., 20%.

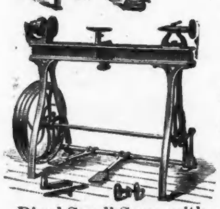


Paragon Self Feed Rip Saw.
Two changes of speed; three changes of feed.
Price, with one 10 in. saw, $50.00.
Dis., 20%.

Diamond Mortising Machine.
With mortise ¼ to 1 in. wide, 3 in. deep.
" cut tenons ¼ to ¾ thick, 3 in. wide.
Price, with 3 chisels.................. $25.00
Dis., 20%



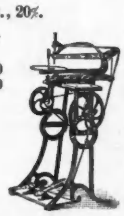
The "Star" Lathe.
Swings 9 × 25 in., back geared, screw cutting.
Feeds in or out, right or left. Adjustable Tail Stock for Tapers.
Price.................. $75.00
Dis., 15%.



The Crown Lathe.

Swings 10 × 36 in.

Price, boxed........... $45.00
Compound slide rest . 15.00
Countershaft 10.00
Dis., 20%.



Rival Scroll Saw, with six extra saw blades, twist drill and wrench.
Price........................ ...$10.00
Lathe attachment............. ....$3.00
Dis., 25%.

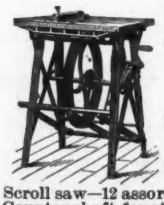
The Challenge Scroll Saw, for shell, bone wood, or metal.
Nickel Plated, with six extra saws twist drill and wrench.
Boxed........................ $20.00
With lathe attachment......... $5.00
Dis., 25%.

Hand Circular Rip Saw.

Cuts 3¾ thick, 19 in. wide.

Price $50.00.

Dis., 35%.



Scroll and Circular saw Combined.
Combined Machines.
Combined circular scroll saw and boring attachment—2 circular saws, 12 assorted scroll saws, boring attachment, and self-centering drill chuck..... $50.00
Combined circular and scroll saw—2 circular and 12 scroll saws..... 40.00
Circular saw—1 extra rip and 1 cross-cut saw..... 35.00
Scroll saw—12 assorted scroll saws..... 32.00
Counter shaft for steam power..... 10.00
Dis., 35%.

Foot Power Former.
$20.00; Knives extra, $1.00 each.
Dis., 35%.

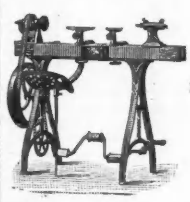
Mortising Machine.
$22.00; Chisels, $1.00 each.
Dis., 35%.
Blind Slat Chisels, 3 set bits, $5.00.
Dis., 20%.

Tenoning Machine,

Price, $25.

Dis., 35%.

Velocipede Scroll Saw,
Without boring attachment...... $20.00
With " " 23.00
1 doz. saw blades, 1 3-16 bit. } Included.
Dis., 35%.



Lathe.

3 centres, 1 spur, 2 tool rests and sockets, 1 turned face-plate, $35.

Dis., 30%.

Lathe.

One turned face-plate, two pointed and one spur center, two rests, with sockets and plate for hand tools, slide rest-wrench, belting, etc., $40.

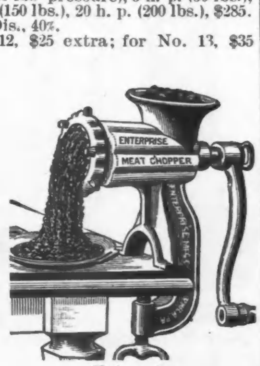
Dis., 25%.

Motors Water).

Size No 8, for Sewing Machines, etc , $18 each.

No. 9, ⅛ horse-power (30 lbs. pressure), ¼ h. p. (50 lbs.), ½ h. p. 100 lbs.), ¾ h. p. (150 lbs.), 1 h. p. (200 lbs.), $30.
No. 10, ¼ horse-power (30 lbs. pressure), ½ h. p. (50 lbs.), 1 h. p. (100 lbs.), 1½ h. p. (150 lbs.), 2 h. p. (200 lbs.), $50.
No. 10½, ½ horse-power (30 lbs. pressure), 1 h. p. (50 lbs), 2 h. p. (100 lbs.), 3 h. p. (150 lbs.), 4 h. p. (200 lbs.), $75.
No. 11, 1 horse-power (30 lbs. pressure), 1½ h. p. (50 lbs.), 3 h. p. (100 lbs.), 4½ h. p. (150 lbs.). 6 h. p. (200 lbs.), $100.
No. 12, 2 horse-power (30 lbs. pressure), 3 h. p. (50 lbs.), 6 h. p. (100 lbs.), 9 h. p. (150 lbs.), 12 h. p. (200 lbs.), $175.
No. 13, 3 horse-power (30 lbs pressure), 5 h. p. (50 lbs.), 10 h. p. (100 lbs.), 15 h. p. (150 lbs.), 20 h. p. (200 lbs.), $285.
Dis., 40%.
Governors for 11 and 12, $25 extra; for No. 13, $35 extra.

Meat Cutters.



American.
1 2 3 4
each, $5.00 7.00 10.00 25.00
Dis., — —.

Enterprise.
10 12 22 32 52
each, $3.00 2.50 4.00 6.00 15.00
Dis., 30%.

Mining Machinery.

N. B.—Special attention is invited to the goods advertised and illustrated in the advertising pages of the ENGINEERING AND MINING JOURNAL, quotations and discounts upon which would only mislead buyers.
Price-lists and other information may be obtained by addressing the advertisers direct, or by writing to the ENGINEERING AND MINING JOURNAL.

Mouse Traps.

The Cyclone Mouse Trap, per gross, $4.05.

The Ideal Mouse Trap per gross, $8.25.

Slayer Rat Traps, per gross, $10. Net prices

Nails and Tacks.

Swedes. Tacks.
Per doz. ½ ¾ 1 1½ 2 2½ 3
½ wt.. 35 40 46 50 55 60 65 75
6 8 10 12 14 16 18 20 24 oz.
85 1.00 1.20 1.40 1.60 1.75 1.85 2.15 2.55
Doz. full ½ ¾ 1 1½ 2 2½ 3 4
weight 60 70 80 90 1.00 1.10 1.20 1.40
6 8 10 12 14 16 18 20 24 oz.
1.60 1.90 2.30 2.70 3.10 3.40 3.80 4.20 5.00
lb., bulk ½ ¾ 1 1½ 2 2½ 3 4
or paper 1.60 1.25 1.00 80 66 58 52 46
6 8 10 12 14 16 18 20 24
36 32 31 30 29 28 28 28 28
Discount, 67½, 10 and 2%.

O. H. Swedes.
Price, same as Swedes.
Swedes steel tacks same list price as iron.
Discounts, 72½, 10 and 2%.

Upholsterers.
Price, same as Swedes.

Cut Tacks. Price per dozen ounces.

1 1½ 2 2½ 3 4 6 8 10
¼ wt..... .. .. 35 40 45 50 55
12 14 16 18 20
60 70 80 90 1.00
½ wt..... 1 1½ 2 2½ 3 4 6 8 10
45 50 50 55 60 65 70 80 95
12 14 16 18 20
1.10 1.25 1.40 1.55 1.70
Full wt .. 1 1½ 2 2½ 3 4 6 8
80 90 90 1.00 1.10 1.20 1.30 1.50
10 12 14 16 18 20
1.80 2.10 2.40 2.70 3.00 3.30
Discount, 70, 10 and 2%.

Carpet Tacks, flat and oval heads.

Blued, doz. oz. 4 6 8 10 12 14 16 18 20
¼ wt. 35 40 45 50 55 65 75 85 95
22 24
1.05 1.15
" ½ wt. 4 6 8 10 12 14 16
65 70 80 95 1.10 1.25 1.40
18 20 22 24
1.55 1.70 1.85 2.00
Tinned, doz. ¼ wt. 4 6 8 10 12 14 16
50 55 60 75 85 1.00 1.10
18 20 22 24
1.20 1.35 1.45 1.60
Tinned, doz. ½ wt. 4 6 8 10 12 14
95 1.05 1.15 1.40 1.60 1.85
16 18 20 22 24
2.10 2.35 2.60 2.85 3.10
Discount, 72½, 10 and 2%.

Finishing Nails.
Inch....⅜ 3½-8 4-8 4½-8 ⅝ 5½-8 6-8 7-8 1
Per lb...48 40 32 28 26 24 22 20 18
1⅛ and larger.
16
Discount, 60, 10 and 2%.
Chair Nails.
Doz. ½ wt.; doz. full wt.; pound B. or P.
Inch..⅜ 3½-8 4-8 4½-8 ⅝ 5½-8 6-8 7-8
Per lb.51 43 35 31 29 27 25 23
1 1⅛
21 19
Discount, 60, 10 and 2%.

Common and patent brads.

inch.	Price per doz. ½ wt.	Price per doz. full wt.	Price per lb. in papers or bulk.
2-8.........	.50	1.00	1.25
3-8.........	.60	1.20	.80
4-8.........	.65	1.30	.58
5-8.........	.72	1.44	.48
6-8.........	.80	1.60	.36
7-8.........	.90	1.80	.30
1..........	1.00	2.00	.26
1⅛.........	1.12	2.24	.25
1¼.........	1.26	2.52	.24
1½.........	1.82	3.64	.22
1¾.........	2.25	4.50	.20
2..........	2.43	4.86	.18

Dis. 60, 10 and 2%.

Oars. Best quality selected White Ash.

	Cents.		Cents.
6 to 12 ft., per sq. ft....	7	22 ft., per sq. ft..........	14
13 " 16 " " " ...	8	24 " " "	18
17 " 18 " " " ...	8½	25 " " "	20
19 " " " ...	10	5 and 2½ cash.	
20 " " " ...	11		

Oils.

LUBRICATING.—Fiske Bros.
Lubroleine A cylinder oil 50 in. barrels.
Lubroleine D cylinder oil 40 in. barrels.
Lubroleine A machine oil 45 in. barrels.
Lubroleine B machine oil 35 in. barrels.
Lubroleine A engine oil 50 in. barrels.
Lubroleine B engine oil 40 in. barrels.
In cases 5c gal. extra.
Crescent Axle Grease.—Barrels, 3c per lb; 100-lb. kegs, 3½c lb.; 2-lb. decorated tins, $12, gross less 5 per cent.
Texas Star Axle Grease.—Barrel, 2¼c per lb.; 100-lb. kegs, 3c per lb.

Oil Stones.

Best White Washita.

Green Paper Brand, 8 × 2 × 1⅛ inches.......per lb.	.32
Oil stone, No. 1, " " .... "	.22½
" Extra, " " .... "	.30
High rounds, " " .... "	.30
Round edge slips, Nos. 1, 3½ to 5, in boxes 10 lbs. upwards.......... "	.40
Round edge slips, extra, in boxes 10 lbs. upwards.......... "	.50
Pen knife pieces, ass't 3 to 5 × 1 × 1⅝, in boxes 10 lbs. upwards.......... "	.50
Needle pieces......................per hundred.	$5.00
Wheels, 1⅛ to 5¾ in. thick............per inch.	.40

Good Washita,

Oil Stone No. 1, 8x2x1⅛	per lb.	.15
" " 2, "	"	.12
Axe Stone, assorted sizes	"	.10
Round Edge Slips, assorted sizes	"	.25

Arkansas.

Oil Stone No. 1, 4 to 6 in. long x2x¾ to 1 in.	per lb.	$1.35
Oil Stone No. 1, 6 to 9 in. long x2x¾ to 1 in.	"	1.75
Oil Stone No. 2, 4 to 9 in. long x2x¾ to 1 in.	"	.75
Round Edged Slips, assorted sizes	"	2.00
Square File Slips, 3 to 4 inches long	per doz.	1.75
Diamonds, 3½ to 4 inches long	"	3.00
Triangulars, 3½ to 4 inches long	"	3.00
Flat Files, 3 to 4 inches long	"	2.00
Beveled Files, 3½ to 4 inches long	"	2.50
Knife Blades, 3 to 4 inches long	"	3.00
Points, extra long, 3 to 3½ inches	"	2.00
Points	"	1.50
Pen Knife Pieces, assorted sizes	per lb.	2.00
Needle Pieces	per hund.	8.00
Wheels, 2 to 4 inches ½ inch thick	per inch	1.25
Oil Stone Powder	per lb.	15

10, 10 and 2½ dis.

Oil Stoves.

Burns 8 hours; holds 1 quart oil.

Nickel plated crown plate, per doz. $12.

Packings. (See also India Rubber Goods, page 6.)

SELDEN'S PATENT.

For Steam, Air, Water and Ammonia.
With Rubber Core, 60 cents per lb.
Dis., 25 and 5%.
With canvas core, 50 cents per lb.
Dis., 30 and 5%.

Paints.

For Assorted Cans of 1, 2, 3 and 5 pounds. 100-lb. cases.

No.		lb. c.	No.		lb. c.
533.	Scotch yellow	18	583.	Black	18
534.	Lead color	18	584.	Dark blue	25
536.	Brown	18	585.	Chrome yellow	30
537.	Light drab	18	586.	Vermilion	30
539.	Buff	18	587.	Indian red	25
542.	Warm drab	18	588.	Bronze green	25
544.	Dark green	25	589.	Quaker green	25
581.	Light green	25	546.	Inside white	15
582.	Norway red	18	547.	Outside white	18

Discount 50 per cent.

Ordinary shades. Per gal.	Per gal.
One to 5 gallon cans.. $1.90	Half gallon cans...... $2.00

Tuscan Red, Green and Yellow.

Per gal.	Per gal.
One to 5 gallon cans.. $3.10	Half gallon cans...... $3.30

Vermilion.

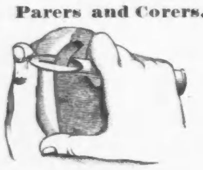
Per gal.	Per gal.
One to 5 gallon cans.. $5.00	Half gallon cans...... $5.20

Discount 40 per cent.

The list in barrels, half-barrels and kegs (of 5 gallons or larger) will be 10c. a gallon less than in gallon cans. Kegs of less than 5 gallons will be charged at gallon price. One-quarter gallon cans not put up. Special shades made to order.

Special cash discount for large orders.

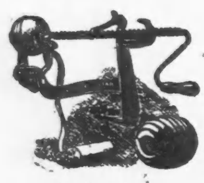
Parers and Corers.



SAML. LEES & Co.

List, $9 per gross.

APPLE.

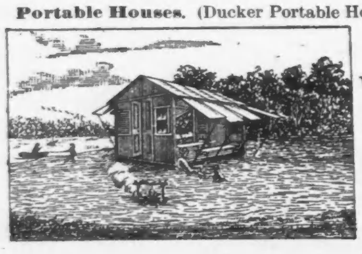


Little Gem.

Rocking Table.

	Per doz.
Advance	$4.75
Baldwin	5.25
Champion	7.25
Hudson's '88	3.75
Improved Bay State	30.
Monarch	31.50
Oriole	4.00
Turntable	4.50
Victor	13.50
White Mountain	4.50
Rocking Table	4.25
Little Gem Corer and Slicer	3.70

Portable Houses. (Ducker Portable House.

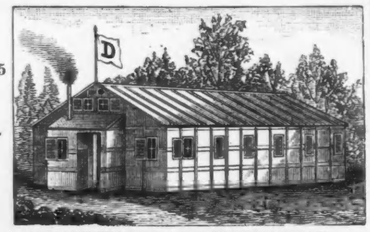


Weight, 450 lbs.

Price, $150.

Closes securely.

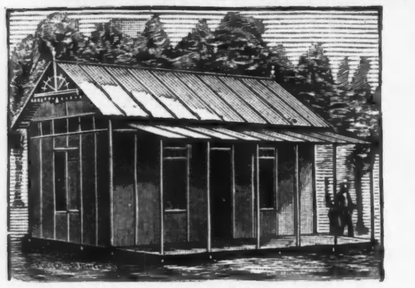
Dis., 10%.



Weight, 85 lbs. per section.

Price, $220.

Dis., 10%.



Weight, complete, 5600 pounds.

No. 10.—26 × 33 ft., including veranda and rear extension. Main part, 19 × 26 ft. $500.00

	No. 1. Veranda on side.	No. 2. Veranda on end.	No. 3. without veranda.
12 × 12, 1 door, 3 windows,	$120.00	$120.00	$105.00
12 × 14, 1 " 3 "	135.00	130.00	120.00
12 × 17, 1 " 3 "	155.00	150.00	135.00
12 × 19, 2 " 4 "	175.00	165.00	150.00
12 × 21, 3 " 5 "	190.00	180.00	165.00
12 × 23, 3 " 5 "	200.00	190.00	175.00
12 × 26, 3 " 5 "	220.00	205.00	190.00
14 × 21, 3 " 5 "	205.00	195.00	180.00
10 × 12, 1 " 3 "		100.00	90.00
10 × 14, 1 " 3 "		105.00	95.00
7 × 10, 1 " 2 "			65.00
7 × 12, 1 " 2 "			75.00
7 × 14, 1 " 2 "			85.00

Hunter's Cabins.

7 × 12, with 4 berths	$80.00
7 × 14, " 4 "	90.00

Discount, 20%.

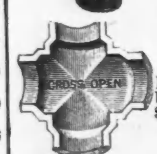
Pipe Covering.

Magnesia Sectional Covering.

For Wrought Iron Pipe. In Canvas Jacketed Sections, 36 inches in length.

Inside dia. of pipe.	Weight of cover per lineal ft.	Price per lineal foot canvas jacketed.
½ in.	8 ozs.	$0.25
¾ "	9 "	0.25
1 "	10 "	0.25
1¼ "	12 "	0.25
1½ "	15 "	0.25
2 "	18 "	0.27
2½ "	20 "	0.31
3 "	24 "	0.36
3½ "	26 "	0.40
4 "	30 "	0.44
4½ "	38 "	0.47
5 "	40 "	0.50
6 "	48 "	0.60
7 "	55 "	0.65
8 "	65 "	0.75
9 "	75 "	0.80
10 "	85 "	0.90

Elb'ws.	Tees.	G Valv's.	Crosses.	Unions.
$0.20	$0.30	$0.25	$0.35	$0.30
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.27	0.36	0.27	0.48	0.33
0.31	0.41	0.41	0.53	0.41
0.36	0.48	0.48	0.60	0.48
0.40	0.53	0.53	0.68	0.53
0.44	0.59	0.59	0.75	0.59
0.50	0.65	0.65	0.80	0.63
0.58	0.75	0.75	0.90	0.67
0.65	0.90	0.90	1.00	0.77
0.83	1.20	1.20	1.10	0.90
1.00	1.35	1.35	1.20	1.00
1.10	1.50	1.50	1.35	1.10
1.25	1.75	1.75	1.50	1.25



Magnesia Plastic Covering (dry)—Prepared Carbonate Magnesia and Fiber, for Trowel Work per barrel, $8.00

Dis. 25%.

Post Hole Diggers.

Little Giant	$36.00	doz 11 cu ft.
Hercules	30.00	" " " "
New Champion	20.00	" " " "
Scheidler	36.00	" " " "

Dis. 40% f.o.b. New York or Boston.

Press.

Combined press for cutting, forming, horning and seaming.

Particulars of flat front presses, including beds, slides, bolsters, plates, etc.

Prices are net, delivered on steamers in New York, including insurance, etc.

Nominal size of press	41	42	43	44	45
Price, including et ceteras	$130	$200	$260	$420	$660
Weight, about ....lbs	600	1050	1900	3600	7200
Greatest diameter that can be wired ....ins	5	7	10	14	20
Greatest depth that can be wired ....ins	8	10	13	16½	20
Hole through bed—circle intersecting ....ins	4½	6	8½	12	17
Hole through back—width ....ins	8	9½	12	15½	20½
Width between die clamps—clear ....ins	8	11	15	20	27
Distance back from center of slide bar ....ins	4½	5½	7	9	12
Height to slide-bar, when up..ins	5¼	6½	7½	8½	9
Stroke of slide-bar ....ins	1	1¼	1½	1¾	2
Adjustment of slide-bar ....ins	1	1¼	1½	1¾	2
Diameter of fly-wheel ....ins	20	26	32	38	44
Width of fly-wheel ....ins	3	4	5	6	7
Weight of fly-wheel, about....lbs	125	250	420	725	1100
Speed per minute, about ....rev	120	110	100	90	80
Cubic feet boxed, about	30	40	50	60	70

Printers' Sundries.

Vanderburgh, Wells & Co.

Wood rules, 12 cents per yard.
Wood rules, on end wood, 15 cents per foot.

EUREKA STAND.
12 full cases.

Price without cases	$12.00
Boxing and cartage	1.25

CASE RACKS.

	In. High.	Plain.	Inclosed sides and back.
Single, to hold 12 cases,	41¼	$6.00	$8.50
" " 16 "	50¾	7.00	9.50
" " 20 "	60¼	8.00	11.00
" " 24 "	69¾	9.00	12.00
" " 30 "	84	10.00	13.50
Double, to hold 32 "	50¾	12.50	16.00
" " 40 "	60¼	14.00	17.50
" " 60 "	84	18.00	23.00

When required we make inclosed case racks trimmed with moldings, and painted or grained. Locking bars, to prevent cases from being removed, furnished to order.

GALLEY RACKS.

8 n., 5 t. high	$3.00
10 ". 5 t. 8½ in. high	3.50
12 " 6 f.. 7 in. high	4.25
15 " 8 ft. high	5.25
20 " 9 ft. 8 in. high	7.00

Arms, per pair, 35 cents.

SHOOTING STICKS.

Each.
No. 1, 75c.
No. 2, $1.
No. 4, 45c., black.
No. 4, 60c., bright.
No. 5, 60c., black.
No. 5, 75c., bright.

GAUGE PINS.

Improved brass gauge pins, 40c. doz., all sizes.
Improved wire gauge pins, 25. doz., all sizes.
Improved steel gauge pins, 60c. doz., all sizes.
Improved golden gauge pins, 40c. doz., all sizes.

MITRE BOXES.

Regular size, 2 in., 50c. each.
Extra size, 3½ in., 75c. each.

LEAD CUTTER.

Curtis' Lead Cutter	$2.00

PROOF PRESS, "OUR OWN."

9 × 32, complete, with Brayer	$28.00

TYPE CASES.
Full Size.

No.			Strong slat.
	1—Pairs (News)	per pair,	$1.75
	3—German	"	1.75
	4—Music	"	3.50
	4½—Music	"	3.50
	5—Greek	"	3.50
	6—Hebrew	"	3.50
	7—Job (Italic)	each	1.00
	7½—New York Job	"	1.00
	8—Triple	"	1.00
	8½—Paterson Job	"	1.00
	9—Yankee Job	"	1.00
	10—Lead, No. 1	"	1.00
	11—Lead, No. 2	"	1.00
	12—Lead, No. 3	"	1.00
	13—Quad, No. 1	"	1.00
	13½—Quad, No. 2	"	1.25
	14—Labor Saving Rule, No. 1	"	1.20
	15—Labor Saving Rule, No. 2	"	1.20
	16—Labor Saying Rule, No. 3	"	1.20
	17—Slug	"	1.00
	18—Border	"	1.00
	19—Blank or Cut	"	
	19½—Improved Wood Type	"	
	20—Sort, No. 1, extra deep	"	1.50
	41—Sort, No. 2, extra deep	"	1.50

PROOF GALLEYS.

All Wood.

Single column, 4⅛ × 25 inches inside	$0.80
Double " 7 × 25 " "	90

Brass Bottom.

Single column, 3⅝ × 23¼ inches inside	$1.25
Double " 6¾ × 23¼ " "	1.50

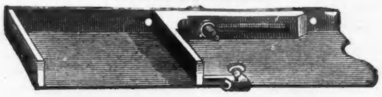
Half Lined.

Single column, 3⅝ × 23¼ inches inside	$1.76
Double " 6¼ × 23¼ " "	2.25

All Brass.

Single column, 3¾ × 23¾	$2.50
Double " 6¼ × 23½	3.00

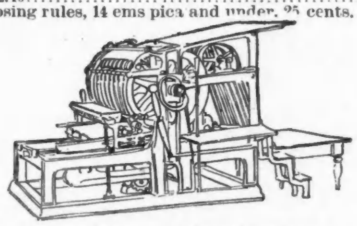
COMPOSING STICKS.



GROVER'S PATENT AND UNION.

	Screw or News.
6 in., 1.10	$ .90
8 " 1.20	1.10
10 " 1.40	1.20
12 " 1.60	1.40
14 " 1.80	1.60
16 " 2.00	1.80
18 " 2.20	2.00
20 " 2.40	2.20

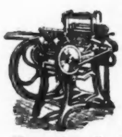
Composing rules, 14 ems pica and under, 25 cents.



THE "LIBERTY" CYLINDER PRESS.
For Newspaper and Job Printing.

Bed.	Form.	
No. 5—29 × 42	24 × 40	$1,200
6—33 × 47	28½ × 45	1,300
7—37 × 51	33 × 49	1,600

Dis., 20 and 5%.



THE "LIBERTY" JOB PRINTING PRESS.
Size of chase.

No. 2 — 7	× 11	$200
2a— 9	× 13	250
3 —10	× 15	300
3a—11	× 17	350
4 —13	× 19	400
5 —14½	× 22	500

Dis., 12% and 5%.

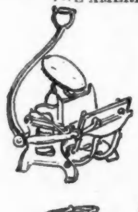
Two sizes built extra strong for boxmakers, embossing, etc.

No. 3a—11 × 17 .... $375
4 —13 × 19 425

Dis., 12 and 5%.

Fountains, either size, $25 extra, if ordered with press. Steam fixtures, either size, $15 extra.

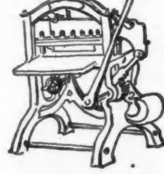
THE AMERICAN CARD AND BILL HEAD PRESS.



No. 5—4 × 6 .... $16
7—6 × 9 36
8—8 × 12 60

Dis., 20% and 5%.

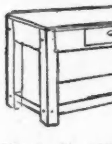
THE "LIBERTY" PAPER CUTTER.



Cuts 30 inches $140.00
Extra knife 18.80

Dis., 12% and 5%.

THE "LIBERTY" IMPOSING TABLES



Marble top.

No. 1—24 × 36 .... $24
2—32 × 48 38
3—26 × 74 44
4—36 × 48 48

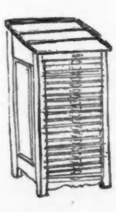
Dis., 12% and 5%.

Slate Top.

No. 1—24 × 36 .... $18
2—32 × 48 25
3—26 × 74 32

Dis., 12 % and 5%.

THE "LIBERTY" TYPE CABINETS.

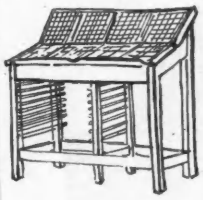


Number of cases.	Stained. Flat. $	Stained. Galley.* $	Grained. Flat. $	Grained. Galley.* $
12⅔	12.00	14.50	14.00	17.00
16⅔	15.00	17.50	17.00	20.00
18⅔	16.50	19.00	18.50	21.50
20⅔	18.00	20.50	20.00	23.00
12¾	15.00	17.50	17.00	20.00
16¾	18.00	20.50	20.00	23.00
18¾	19.50	22.00	21.50	24.50
20¾	22.00	24.50	23.00	26.00
12 full	18.00	20.50	20.00	23.00
16 "	22.00	24.50	24.00	27.00
18 "	24.00	26.50	26.00	29.00
20 "	26.00	28.50	28.00	31.00

Number of cases.	Pine. Flat. $	Pine. Galley.* $	Cherry. Flat. $	Cherry. Galley.* $	Napanoch. Flat. $	Napanoch. Galley.* $	Walnut. Flat. $	Walnut. Galley.* $
12⅔	18.00	21.00	20.00	23.00	22.00	25.00	23.00	26.00
16⅔	22.00	25.00	24.00	27.00	26.00	29.00	27.00	30.00
18⅔	24.00	27.00	.....	.....	.....	.....	.....	.....
20⅔	26.00	29.00	28.00	31.00	30.00	33.00	31.00	34.00
12¾	21.00	24.00	23.00	26.00	25.00	28.00	26.00	29.00
16¾	25.00	28.00	27.00	30.00	29.00	32.00	30.00	33.00
18¾	27.00	30.00	.....	.....	.....	.....	.....	.....
20¾	29.00	32.00	31.00	34.00	33.00	36.00	34.00	37.00
12 full	24.00	27.00	26.00	29.00	28.00	31.00	29.00	32.00
16 "	28.00	31.00	30.00	33.00	32.00	35.00	33.00	36.00
18 "	30.00	33.00	.....	.....	.....	.....	.....	.....
20 "	32.00	35.00	34.00	37.50	36.00	39.00	37.00	40.00

*Furnished with galley top and extra drawer for copy.
Dis., 20 and 5%.

THE "LIBERTY" CASE STANDS AND RACKS.



Stands.

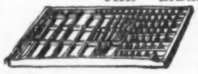
Single, without racks $3.75
" with racks for 8 full cases 4.00
Single, with racks for 10 full cases 4.25
Single, with racks for 12 full cases 4.50
Single, with racks for 14 full cases 4.75
Double, without racks 4.25
" with racks for 8 full cases 4.50
Double, with racks for 16 full cases, and gal. rest 6.25
Double, with racks for 20 full cases and gal. rest 6.50
" " " " 24 " " " " " 6.75
" " " " 24 ⅔ cases 5.25
" " " " 8 full and 8 ⅔ cases 5.00
" " " " 8 " " 8 ¾ " 5.25
" " " " 10 " " 12 ⅔ " 5.50
" " " " 12 " " 16 ⅔ " 5.75
" " " " 12 " " 16 ¾ " 6.00
Stands with closed ends, extra 2.00
Extra slides for stands, each .... .05

Case Racks.

Cases.	Inches High.	Price.	Inclosed Back and Sides.	Cases.	Inches High.	Price.	Inclosed Back and Sides.
12	41	$6.00	$8.50	30	84	$10.00	$13.50
16	50	7.00	9.50	32	51	12.50	16.00
20	60	8.00	11.00	40	60	14.00	17.50
24	70	9.00	12.00	60	84	18.00	23.00

Dis., 20 and 5%.

THE "LIBERTY" TYPE CASES.



Name.	Outside Measurements.
Full size	32¼x16½x1 9-16
Rooker size	28½x14¼x1 9-16
¾ size	26x16½x1⅜
⅔ size	22⅜x16½x1⅜
Enlarged size	32¼x23x2 3-16
Wood type "	32¼x23x1 9-16
Mammoth "	44x23x1 9-16

Cabinet case sides extend 1½ to 3 inches. In ordering cabinet cases, state whether high or low fonts are wanted.

	Without Pat. Clasps.	With Pat. Clasps.
News, full, per pair	$1 60	$1.75
" Rocker, "	1.60	1.75
" ¾ "	1.50	1.60
" ⅔ "	1.40	1.50
German, full, "	1 60	1.75
Music " "	2 00	2.20
Job " "	.90	1.00
Job, full size, California	.90	1.00
" Rooker	.90	1.00
" full, Yankee	.90	1.00
" ¾ Regular	.80	.90
" ⅔ Yankee	.75	.85
" " Boston	.75	.85
" " California	.75	.85
" " improved	.90	1.00
" full size, Middletown	1.20	....
" " Paterson	.90	....
" " New York	.90	1.00
Quadruple, full size	1.20	....
Double lower, "	1.20	....

Name.	Without pat. clasps.	With pat. clasps.
Galley lower, full size	$1.10	
Enlarged Yankee job	2.20	
Enlarged German	2.20	
Founder's sort case	2.20	
Half-cap	.50	
L. S. lead, full-size	1.00	
" rule "	1.15	$1.25
" " ¾ size	.95	1.05
" " ⅔ "	.80	.90
Improved, ⅔ "	90	1.00
Space and quad, full-size	1.00	
Slug "	1.00	
Figure "	.90	
Triple "	.90	1.00
Improved triple "	.90	1.00
Triple, ¾ size	.80	.90
Blank, full-size	.65	
" ¾ size	.55	
" ⅔ size	.50	
Script, full-size	.90	
" ¾ size	.80	
" ⅔ size	.75	
Wood type, 23x32¼	1.10	
Mammoth, 23x44	1.30	
Metal furniture, full-size	1.25	
Border "	1.25	
" ⅔ size	1.00	
Leader, ⅔ size, per pair	1.40	
Butler jobs, full-size, per pair	3.00	

For pulls on cabinet cases add per case .... .10
For rollers " " " .... .30

Dis., 25 and 5%.

THE "LIBERTY" GALLEYS.
All brass "indestructible."

Single, 3¾ x 23¾ inside $2.50
" 3¾ x 15¾ " 2.00
" 3¾ x 11¾ " 1.75
Medium, 5 x 23¾ inside 2.75
Double, 6¼ x 23¾ inside 3.00

Dis., 33⅓%.

SMOOTH LINED NEWS GALLEYS.

	Half-lined.	Full-lined.		Half-lined.	Full-lined.
Single col.	$1.75	$2.00	Double col.	$2.00.	$2.50

Dis., 20% and 5%.

SCREW GALLEYS.

	Unlined.	Half-lined.	Full-lined.
Single column	$1.25	$1.50	$1.75
Double column	1.50	1.75	2.00

Dis., 20% and 5%.

SMOOTH LINED JOB GALLEYS.

Size.	Unlined.	Full-lined.	Size.	Unlined.	Full-lined.
6 × 10	$1.25	$2.00	12 × 18	$2.50	$3.50
8½ × 13	1.50	2.50	14 × 20	3.00	4.00
9 × 14	1.75	2.75	15 × 22	3.50	5.00
10 × 16	2.00	3.00	18 × 25	4.00	5.50

Dis., 20% and 5%.

RULED GALLEYS.

These have a rule laid out on one of the rims, divided into quarter inches, by which to set advertisements. Cost of ruling extra, 25 cents.

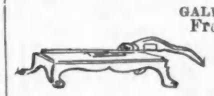
Dis., 20% and 5%.

MAILING GALLEYS.

Zinc bottom, 50 cents; brass bottom, 90 cents. Brass closed both ends, $3.

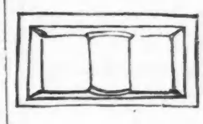
Dis., 20% and 5%.

GALLEY RACKS.
From $3 up.



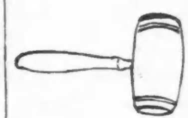
LEAD CUTTERS,
From $2 up.
Dis., 20% and 5%.

THE "LIBERTY" STEEL SHOOTING STICKS.
Bright, $1 each.
Nickelplated, $1.25 each.
Dis., 40%.



STANDARD METAL FURNITURE
25c. a pound.
In fonts of 25, 50, 75 and 100 lbs.
Dis., 15%.

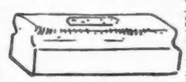
THE "LIBERTY" MALLETS.



Hickory, small .... $ .20
" medium .... .25
" large .... .30
" iron bound 1.00
Lignum Vitæ, No. 4 .... .30
" " No. 3 .... .40
" " No. 2 .... .50
" " No. 1 .... .70

Dis., 20 and 5%.

THE "LIBERTY" PLANERS AND PROOF PLANERS.



Midget planer .... 10c.
Small Maple .... 20c.
Large " .... 25c.
" b'ked with leather .... 30c.
Midget " " " .... 12c.
Proof planer, faced with cloth, 50c.
Dis., 40%.

THE "LIBERTY" COMPOSING STICKS.

Grover.

6 in., Steel	$ .90	16 in., Steel	$1.80
8 "	1.00	18 "	2.00
10 "	1.20	20 "	2.20
12 "	1.40	Extra Clasp	.10
14 "	1.60	Extra Knee	.40

Screw.

6 in., Steel	$ .75	16 in., Steel	$1.45
8 "	.80	18 "	1.60
10 "	1.00	20 "	1.75
12 "	1.15	Extra Knee	.30
14 "	1.30	" Screw and Nut.	.10

Dis., 40%.

Yankee.

6-in., Steel	$ .75	12 in., Steel	$1.15
8 "	.80	Extra Knee	.30
10 "	1.00	" Clamp and Screw	.15

Other Sizes to Order.
Dis., 40%.

Albion.

6-in., Steel	$1.00	6-in, German Silver	$1.50
8 "	1.10	8 " " "	1.75
Extra Knee	.40	Extra Screw and Nut.	.10

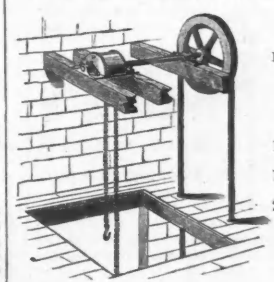
Pulley Blocks.

WESTON DIRECT.

	Each.
⅛ ton	$10
¼ ton	13
½ ton	15
1 ton	20
1½ tons	25
2 tons	30
3 tons	40

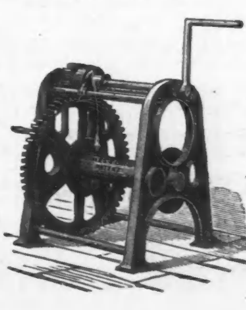
Geared.

1 ton	35
2 tons	45
3 tons	60
4 tons	80
5 tons	110
6 tons	150
8 tons	210
10 tons	275



DOUBLE LIFT HOISTS FOR HATCHWAYS, ETC.

500 lbs $25.00
1000 " 50.00
1500 " 65.00
2000 " 80.00
500 " 30.00



WESTON CRAB SAFETY BRAKE, HANDLES CANNOT FLY BACK.

	Each.
21	$35.00
22	45.00
23	65.00
25	100.00

Pumps.

Rumsey & Co.
Prices on all pumps include cylinders.

No.	Dia. Cyl.	Suction.	Cap. stroke.	Price — Iron.	Price — Brass cyl.
0	2 in.	1 in.	1-15 gal.	$3.50	......
1	2¼ "	1 "	1-12 "	4.00	$6.00
2	2⅜ "	1¼ "	1-11 "	4.50	7.00
3	2½ "	1¼ "	1-10 "	5.00	8.00
4	3 "	1¼ "	1-6 "	5.50	10.00
5	3¼ "	2 "	1-5 "	6.50	14.00
6	3½ "	2 "	1-4 "	8.00	18.00
7	4 "	2½ "	1-3 "	12.00	20.00

Dis., 65%.

1	2½ in.	1¼ in.	1-10 gal.	4.25	.....
2	3 "	1¼ "	1-7 "	4.75	.....
3	3½ "	1¼ "	1-5 "	5.25	.....
4	4 "	1½ "	1-4 "	5.75	.....
5	4½ "	1½ "	1-3 "	6.25	.....

Dis., 70%.

Standard and Cylinder for 1½ in. Iron Pipe, $16.00.

Dis., 55%

No. 6½, standard and cylinder, 1¼ in. pipe, $13.00.

No. 7½, standard and cylinder, 1¼ in. pipe, $15.00.

No. 8½, standard and cylinder, 1½ in. pipe, $18.00.

With hose and discharge pipe, add $3.00 to list price.

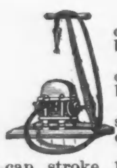
Dis. 55%.

No. 1, diam. cyl., 2½ in.; cap. stroke, 1-8 gal.; size pipe, 1¼ in. Price, iron, $12.50; brass cyl., $17.50.

No. 2, diam. cyl., 3 in.; cap. stroke, 1-6 gal.; size pipe, 1¼ or 1½ in. Price, iron, $14.50; brass cyl., $18.50.

No. 3, diam. cyl., 4 in.; cap. stroke, 2-5 gal.; size pipe, 1½ or 2 in. Price, iron, $23.50; brass cyl., $34.50.

Dis., 55%.



No. 1, diam. cyl., 3 in.; suction, 1¼ in.; cap. stroke, 3-10 gal. Price, iron, $28.00; brass cyl., $58.00.

No. 2, diam. cyl., 4 in.; suction, 1½ in.; cap. stroke, 1-2 gal. Price, iron, $32.00; brass cyl., $60.00.

No. 3, diam. cyl., 5 in.; suction, 2 in.; cap. stroke, 6-7 gal. Price, iron, $35.00; brass cyl., $90.00.

No. 4, diam. cyl., 6 in.; suction, 2½ in.; cap. stroke, 1 1-5 gal. Price, iron, $45.00; brass cyl., $120.00.

Dis., 45%.

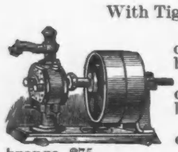
No.	Diam. cyl.	Cap. stroke.	Stroke.	Pipe.	Price.
0	2 in.	1-11 gal.	7 in.	1 in.	$21.50
00	2½ "	1-7 "	7 "	1¼ "	23.00
1	3 "	1-5 "	7 "	1½ "	25.25
2	3½ "	1-3 "	7 "	1½ "	27.25
3	4 "	4-10 "	7 "	2 "	30.50
3½	4½ "	1-2 "	7 "	2 "	37.50
4	5 "	8-10 "	10 "	2½ "	44.00
4½	5½ " 1	"	10 "	2½ "	47.00
5	6 " 1	1-5 "	10 "	3 "	50.00

Dis., 40%.

No.	Diam. cyl.	Cap. stroke.	Diam. pipe.	Price — Iron.	Price — Br's cyl.
1	2 in.	1-5 gal.	1 in.	$39	$51
2	2½ "	1-3 "	1¼ "	41	56
3	3 "	1-2 "	1½ "	45	62
4	3½ "	6-7 "	2 "	51	81
5	4 "	7-8 "	2 "	63	114
6	4½ "	1 "	2 "	80	155

Dis., 40%.

With Tight and Loose Pulleys.



No. 1, cap. per rev., 1-6 gal.; size of pipe, 1¼ in.; price, iron, $26; bronze, $45.

No. 2, cap. per rev., 1-5 gal.; size of pipe, 1½ in.; price, iron, $31; bronze, $55.

No. 4, cap. per rev., 1-3 gal.; size of pipe, 2 in.; price, iron, $48; bronze, $75.

Pulleys on Nos. 1 and 2 are 8 in. diam., 2½ in. face; on No. 4, 12 in. diam., 3½ in face.

Balance wheels for above pumps. $1, $2, and $3, according to size.

Dis., 45%.

No. 2, ½ to 2 gal. per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, ¾ in.; discharge, ⅜ in.; price, $9.

No. 3, 1 to 4 gal. per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, 1 in.; discharge, ⅜ in.; price, $11.

No. 4, 2 to 8 gal. per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, 1½ in.; discharge, ½ in.; price, $14.

No. 5, 3 to 14 gal, per min.; length of drive pipe, 25 to 40 ft.; calabre of pipes, drive, 2 in.; discharge, 1 in.; price, $22.

No. 6, 4 to 25 gal. per min.; length of drive pipe, 30 to 40 ft.; calibre of pipes, drive, 2½ in.; discharge, 1¼ in.; price, $40.

No. 7, 8 to 60 gals. per min.; length of drive pipe, 30 to 40 ft.; calibre of pipes, drive, 4 in.; discharge, 2 in.; price, $75.

No. 8, 12 to 120 gal. per min.; length of drive pipe, 30 to 50 ft.; calibre of pipes, drive, 6 in.; discharge, 2½ in.; price, $125.

Dis., 45%.

Railroad Dumping Cars and Carts.

A. C. McEwen.

Cars.	Gauge.	Capacity.	Price.	Capacity.	Price.	Capacity.	Price.
Side Dumping	24"	1 c. y.	$55	2 c. y.	$65	3 c. y.	$75*
End "	"	"	55	"	65	"	75*
Revolving "	"	"	70	"	80	"	90*
Bottom "	"	"	80	"	90	"	100*
Tunnel	"	"	55	"	65	"	75*
Mine	"	"	50	"	60	"	70*
Plantation	30"		43				
Logging	36"		170				
"	4' 8½"		185				
Hand	36"		45				
"	4' 8½"		50				
Push	36"		40				
"	4' 8½"		45				
R.R. Construction	36"		60				
"	4' 8½"		65				
Carts. Plantation and Railroad			45 to 75				
Wagons. McEwen Patent Dumping	....	1 "	175	1½ "	200		

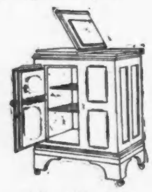
*These cars built of any gauge from 18" to 56½" and of any capacity from ½ to 6 cu. yd.

Refrigerators.

Indurated Fibre and Stoneware-Lined.

Cordley & Hayes.

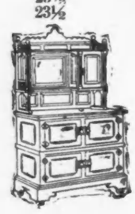
No. 35.



Nos. 75, 85.

No.	High.	Wide.	Deep.	Price.
35	46¼	28¾	20¼	$20.00
75	44¼	33¼	23½	28.00
85	47¾	38	23½	34.00

No. 2.



No. 6.

No.	High.	Wide.	Deep.	Price.
2	41	46	26	$36.00
6	84	46	26	60.00

Mirror 16 by 18 in. Dis., 30 and 5%.

Rules.

"Lufkin." Steel Rules, per doz.

	Rules only.	In leather cases.
No. 31, 1 ft. folding pocket	$4.00	$5.50
" 31, 2 " " "	8.00	10.00
" 41, 1 " " "	4.00	5.50
" 41, 2 " " "	7.50	9.50
" 41, 3 " " "	11.00	13.50
" 41, 4 " " "	14.50	17.00

	1 ft.	2 ft.	3 ft.
No. 60, ¾ × 21 gauge	$4.00	$8.00	......
No. 62, 1¼ × 16 "	8.00	15.00	$22.00

Discount, 60 and 10%.

Tinner's Rules.

No. 95, 3 ft. circumference rules ....each $2.50
No 95, 4 ft. " " .... " 3.00

Discount, in dozen lots, 50%.

	₩ doz.
No. 51, 3½ ft steel board rules	$42.00
No. 52, 3 " " "	36.00
No. 52½, 2½ ft. " "	33.00

Discount, 50%.

Sad Irons. (Mrs. Potts' Patent).

With detachable wood handles, in sets of 3 irons, 1 handler, 1 stand (1 each Nos. 1, 2 and 3 iron weighing 4, 5 and 6 pounds respectively.)

	D'ble Pointed. Nickel Plated	D'ble Pointed. Plain P'l'sh'd	Square Back. Nickel Plated	Square Back. Plain P'l'sh'd
No.	150	155	160	165
Price per doz. sets	$30.00	$24.00	$30.00	$24.00
Irons not in sets, either in Nos. 1, 2 or 3, with handles, per doz	12.50	10.50	12.50	10.50
Without handles, per doz	8.50	6.50	.50	6.50
No. 4 iron, extra heavy, weight 7 lbs., with handles, per doz	......	......	15.00	15.00
Without handles, per doz	......	......	11.00	8.00

Polishing irons with handles.
(Double point.)

	Large size, weight 4½ lbs. each. Nickel Plated	Large size. Plain P'l'sh'd	Small size, weight 3 lbs. each. Nickel Plated	Small size. Plaid P'l'sh'd
No.	180	185	182	187
Price per doz.	$15.00	$3.00	$11.00	$9.00

Girls' irons with handles.

Same as No. 1 iron in set, but smaller size. Weight, 2 lbs each.

(Double point.)

Nickel plated No. 190, per doz $7.50
Plain polished, No. 195, per doz 6.00
Extra handles for any size, per doz 4.00
Extra stands for any size, per doz .... .60

Star Irons,

With Perforated Iron Handle. Not detachable. Assorted either No. 1, 2 or 3 sizes, correspond to the detachable handle irons in sets.

	D'ble pointed. Nickel Plated	D'ble pointed. Plain Plish'd	Square back. Nickel Plated	Square back. Plain Plsh'd
No.	70	75	71	76
Price per doz.	$7.25	$5.50	$7.25	$5.50

Polishing Irons.

Small Size. 3 lbs each. Doubled Pointed.

Nickel Plated. No. 72, per doz .... $7.25 | Plain Polished. No. 77, per doz........ $5.50

Girls' Irons.

Double-pointed, 2 lbs. each; similar to detatchable handle irons.

Nickel-plated, No. 100 .... $5 per doz
Plain polished, No. 105 .... $3.75 "

Toy Irons.

Weight, 14 ounces each, nickel-plated (No. 110), $3.25 per dozen; plain polished (No. 115), $2.50 per dozen.

Weight, 5 ounces each, nickel-plated (No. 120), $2 per dozen; plain polished (No. 125), $1.05.

Discount on all Sad Irons 50 and 5%.

Sash Chains.

No. A. "Giant" metal, 15c. pr. ft., wts. not over 125 lbs.

No. 1. "Giant" metal, 12c. pr. ft., wts. not over 75 lbs.

No. 2. "Giant" metal, 10c. pr. ft., wts. not over 40 lbs.

No. 0. "Giant" metal, 8c. pr. ft., wts. not over 25 lbs.

No. 1. Red metal, 10c. pr. ft., wts. not over 40 lbs.

No. 2. Red metal, 8c. pr. ft., wts. not over 30 lbs.

No. 0. Red metal, 6c. pr. ft., wts. not over 15 lbs.

No. 1. Steel, 8c. pr. ft., wts. not over 75 lbs.

No. 2. Steel, 6c. pr. ft., wts. not over 30 lbs.

No. 0. Steel, 4c. pr. ft., wts. not over 15 lbs.

No. 1. Steel, black enameled, 9c. pr. ft., wts. not over 75 lbs.

No. 2. Steel, black enameled, 7c. pr. ft., wts. not over 30 lbs.

No. 0. Steel, black enameled, 5c. pr. ft., wts. not over 15 lbs.

Fastenings for hanging a window of 2 sashes for Nos. 1 and 2 chains, consisting of 4 hooks, 4 rings, 4 sash irons, a set, 18c. per set.

Fastenings for hanging a window of 2 sashes for No. 0 chains, 14c. per set.

Dis. on "Giant" metal chain	40	10	10%	
" " Red metal chain	40	10	10	10%
" " Steel " "	40	10	10	10%
" " Fastenings	40	10	10%	

Scales.—Discount on all scales 50 per cent.

Postal scales.

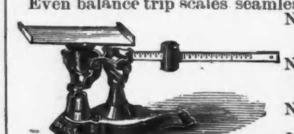
No 1, capacity ½ to 9 oz. $3.00.

No. 2, capacity ½ to 12 oz., $4.00.

No. 3, capacity ½ to 34 oz. $6.00

No. 4, capacity ½ oz. to 4 lbs., $8.00

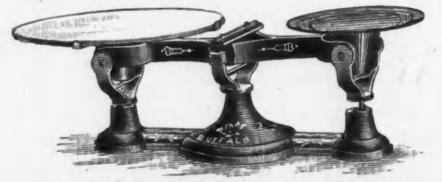
Even balance trip scales seamless scoop, with weights.



No. 1, capacity ½ oz. to 2 lbs., tin scoop, $5.50 brass scoop, $6.50.

No. 2, capacity ½ oz. to 4 lbs., tin scoop, $6.50; brass scoop, $7.50.

No. 2½, capacity ½ oz. to 18 lbs, tin scoop, $11; brass scoop, $12.50.



Butter Trip Scales, slab, weights and scoop.

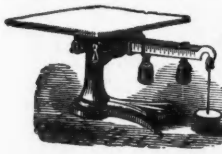
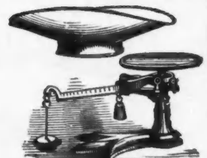
No. 7, ¼ oz. to 10 lbs., 10 in. slab, without side beam	$10.50
" " " " " " with "	11.50
" 8 " " 20 lbs., 12 in. " without "	12.50
" " " " " " with "	13.50

Tea Scales—All Seamless Scoops.

Capacity.	Scoop.		Capacity.	Scoop.	
¼ oz. to 10 lbs.	Tin	$8.00	¼ oz. to 10 lbs.	Brass	9.00

Druggists.

Capacity. Scoop. | Capacity. Scoop.
1-16 oz. to 8 lbs. Tin ..$10.00 | 1-16 oz. to 8 lbs. Brass..$11.00

Counter.

Capacity. Scoop. | Capacity. Scoop.
½ oz. to 36 lbs. Tin ..$10.00 | ½ oz. to 36 lbs. Brass..$12.00

Grocer.

Capacity. Scoop. | Capacity. Scoop.
½ oz. to 62 lbs. Tin... $12.00 | ½ oz. to 62 lbs. Brass..$14.00

Meat or Butter Scales, with Slab.

½ oz. to 62 lbs., with Single Beam..........................$14.00
" " " " Double " 15.00

Patent Boston platform, 13½ in. long by 10 in. wide.

Pillar, 18 in. high, double beam, marked both sides.

With large seamless tin scoop, $25.00
" " " brass " 27.00

Platform scales.—Without Wheels.

No.	Capacity.	Platform.	Price.
1	400 lbs.	21½ by 15 inches.	$23.00
2	600 lbs.	25 by 16 "	30.00
3	800 lbs.	25 by 17 "	34.00
4	1,000 lbs.	26 by 17 "	39.00
5	1,200 lbs.	28 by 20 "	45.00
6	1,600 lbs.	29 by 21 "	55.00
7	2,000 lbs.	32 by 23 "	70.00

With Wheels.

No.	Capacity.	Platform.	Price.
1	400 lbs.	21½ by 15 inches.	$26.00
2	600 lbs.	25 by 16 "	33.00
3	800 lbs.	25 by 17 "	38.00
4	1,000 lbs.	26 by 17 "	43.00
5	1,200 lbs.	28 by 20 "	49.00
6	1,600 lbs.	29 by 21 "	60.00
7	2,000 lbs.	32 by 23 "	75.00

Brass sliding poise at same price if so specified in order.

With Wheels and Drop Lever.

No.	Capacity.	Platform.	Price.
4	1,000 lbs.	26 by 17 inches.	$51.00
5	1,200 lbs.	28 by 20 "	59.00
6	1,600 lbs,	29 by 21 "	70.00
7	2,000 lbs.	32 by 23 "	82.00
8	2,500 lbs.	33¼ by 24¾ "	94.00
9	3 000 lbs.	38 by 30 "	125.00

School Slates.

Noiseless School Slates.

Winsboro Cord Bound.

Size.	Doz. in case.	Price per case.
5 by 7	18	$18.00
6 by 9	12	15.00
7 by 11	10	14.40
8 by 12	8	14.00
9 by 13	6	12.00

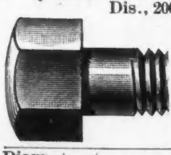
Dis., 50 and 2½%.

"D" School Slates.

Winsboro Oval Round Corner

Size.	Doz. in case.	Price per case.
4 by 6	24	$10.80
5 by 7	18	9.00
6 by 8	12	8.20
6 by 9	12	8.64
6½ by 10	12	9.00
7 by 10	10	7.70
7 by 11	10	8.00
8 by 12	8	8.00
9 by 13	6	7.20

Dis., 200 case lots, 50 and 2½%.



Screws.

STEEL SCREWS ADD 50% TO LIST.

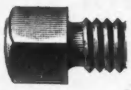
Prices are per 100.

Hexagon Cap Screws.

Heads on Steam-tight Screws not polished, unless so ordered. Can make these 12 inches long.

Diam. head.	7-16	½	9-16	⅝	¾	13-16	⅞	1	1⅛	1¼	1⅜
Length head.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
Diam. screw.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞		1⅛
L'gth under head. ¾	3.00	3.25	3.75	4.40	5.50	7.00					
1	3.25	3.50	4.00	4.70	5.70	7.00	9.50				
1¼	3.50	3.75	4.25	5.00	6.00	7.50	9.50	12.20			
1½	3.75	4.00	4.50	5.30	6.30	8.00	10.00	12.20	16.00		
1¾	4.00	4.25	4.75	5.60	6.60	8.50	10.60	12.80	16.60	21.20	
2	4.25	4.60	5.05	5.95	7.00	9.10	11.20	13.40	17.20	22.30	29.00
2¼		5.00	5.40	6.35	7.50	9.70	11.90	14.10	17.90	23.60	30.50
2½			5.80	6.80	8.00	10.40	12.70	14.90	18.80	25.10	32.30
2¾				7.30	8.60	11.20	13.60	15.90	20.00	26.90	34.40
3					9.30	12.10	14.70	17.00	21.80	29.00	37.00
Thread to in.	20	18	16	14	12	12	11	10	9	8	7
Add for each ¼ in.	30	40	50	60	80	1.00	1.30	1.60	2.00	2.40	3.00

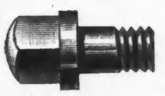
Dis., heads ground, 60%; dis., heads black, 60 and 5%; dis., heads extra finish, 50%; dis., heads case-hardened, 5%; dis., heads polished after hardening, 45%.



SQUARE CAP SCREWS.

Diam. head.	⅜	7-16	½	9-16	⅝	11/16	¾	⅞	1⅛	1¼	1⅜
Length head.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
Diam screw.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
L'gth under head. ¾	2.40	2.75	3.20	3.80	4.40	5.75					
1	2.60	2.95	3.40	4.00	4.70	5.75	7.70				
1¼	2.75	3.10	3.65	4.20	4.95	6.05	7.70	10.50			
1½	2.90	3.30	3.85	4.45	5.25	6.35	8.25	10.50	14.00		
1¾	3.05	3.50	4.10	4.70	5.55	6.65	8.80	11.10	14.80	18.00	
2	3.25	3.70	4.35	4.95	5.90	7.05	9.40	11.80	15.70	19.00	22.50
2¼		4.00	4.65	5.25	6.30	7.55	10.10	12.60	16.70	20.20	24.00
2½			5.00	5.60	6.75	8.15	10.90	13.50	17.80	21.50	25.80
2¾				6.00	7.25	8.85	11.80	14.60	19.10	23.10	27.90
3					7.80	9.65	12.80	15.90	20.60	25.00	30.50
Thread to in.	20	18	16	14	12	12	11	10	9	8	7
Add for each ¼ in.	25	35	45	55	65	90	1.20	1.50	1.80	2.30	3.00

Dis., heads ground, 65%; dis., heads black, 65 and 5%; dis., heads extra finish, 55%; dis., heads case harden ed, 60%; dis., heads polished-hardened, 50%.

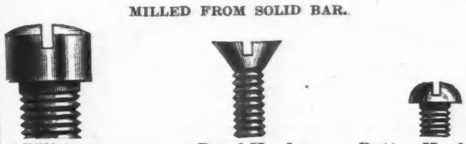


MILLED HEADS, COLLAR SCREWS.

Diameter of Collar.	¼	11/32	7/16	½	⅝	11/16	13/16	15/16	1	1¼
Diameter of Screw.	⅛	3/16	¼	5/16	⅜	7/16	½	9/16	⅝	¾
Length under Head to Point. ¾	2.50	2.[illegible]	3.10	3.75	4.40	5.00	6.25			
1	2.80	3.10	3.40	4.05	4.70	5.30	6.60	8.25		
1¼	3.10	3.40	3.70	4.35	5.00	5.60	7.00	8.60	11.25	
1½	3.45	3.70	4.00	4.70	5.30	5.95	7.40	9.00	11.90	15.00
1¾		4.05	4.35	5.05	5.65	6.35	7.80	9.45	12.60	15.60
2			4.70	5.45	6.25	6.85	8.40	10.00	13.35	16.25
2¼				5.95	6.85	7.40	9.00	10.60	14.15	17.10
2½					7.50	8.10	9.60	11.25	15.00	18.00
2¾						8.75	10.30	11.90	15.90	19.00
3							11.00	12.60	16.85	20.00
Threads to inch	40	30	20	18	16	14	12 or 13	12	11	10
Add for each ¼ inch	30	40	50	60	80	1.00	1.30	1.60	2.00	2.40

Dis., 25%.

MILLED FROM SOLID BAR.



Fillister. Bevel Head. Button Herd

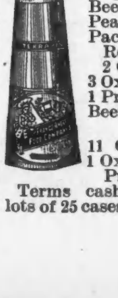
Diam. Head	3-16	¼	⅜	7-16	9-16	⅝	¾	13-16	⅞	1
Length Head	⅛	3-16	¼	5-16	⅜	7-16	½	9-16	⅝	¾
Diam. Screw	⅛	3-16	¼	5-16	⅜	7-16	½	9-16	⅝	¾
Length under Head. ¾	2.00	2.25	2.50	3.00	3.50	4.00	5.00			
1	2.25	2.50	2.75	3.25	3.75	4.25	5.30	6.60		
1¼	2.50	2.75	3.00	3.50	4.00	4.50	5.60	6.90	9.00	
1½	2.75	3.00	3.25	3.75	4.25	4.75	5.90	7.20	9.50	12.00
1¾		3.25	3.50	4.00	4.50	5.00	6.20	7.50	10.00	12.50
2			3.75	4.35	5.00	5.50	6.75	8.00	10.75	13.00
2¼				4.75	5.50	6.00	7.25	8.50	11.50	13.75
2½					6.00	6.50	7.75	9.00	12.00	14.50
2¾						7.00	8.25	9.50	12.75	15 25
3							8.75	10.00	13.50	16.00
Threads to inch.	40	30	20	18	16	14	12	12	11	10

Head on Bevel and Button Head Screws, 1-16 larger in diameter than above specifications.

Price, according to size of head.

Discount, 50%; case hardened, 45%; case hardened and polished, 35%.

Soups (French). Franco-American Brand



Per dozen.	In Cans Quarts.	In Cans Pints.	In Glass. 1½ pt.
Green turtle.... } Terrapin..........	$8.00	$4.32	$9.00
Chicken .... } Mulligatawny. ..	3.75	2.25 }	
Mock turtle......			
Ox tail........			
Consommé.......			4.50
Tomato........			
Julienne........			
Printanier.......	3.50	2.10	
French bouillon.........			
Mutton broth........			None in glass.
Vegetable........			
Beef........			
Pea........			
Packed in cases of......	2 doz.	4 doz.	1 doz.

Regular Assorted Cases. In Cans—Quarts.

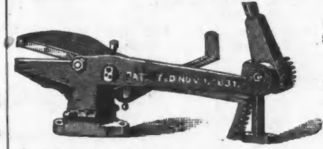
2 Chicken, 1 Mulligatawny, 3 Mock Turtle, 3 Ox Tail, 2 Consommé, 2 Tomato, 3 Julienne, 1 Printanier, 1 Mutton Broth, 1 Vegetable, 1 Beef, 2 French Bouillon, 2 Pea. Per doz., $3.55.

In Glass.

11 Chicken, 1 Mulligatawny, 2 Mock Turtle, 1 Ox Tail, 2 Consommé, 2 Tomato, 1 Julienne, Printanier, 1 Mutton Broth.

Terms cash Discounts: 5% for lots of 10 cases, 10% for lots of 25 cases. 15% for lots of 50 cases.

Shears. The Patent "Eureka



No. 1 cuts round metal up to ¼ in. steel to ⅛, $12.

No. 2 cuts round metal up to ½ in., steel to 3-16, $20.

Discount, 25%.

Slate Roofing.

F. o. b. New York. Stowage allowed.

Purple and Green, per 100 feet sq...... ....$4.50
Dark blue, per 100 feet sq.............................. 4.1[illegible]

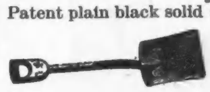
Sizes, 24 × 12 = 115 to sq., 650 lbs. weight.
Sizes, 20 × 10 = 170 to sq., 650 lbs. weight.

Spades and Shovels.

The D. F. Jones Mfg. Co., of Gananoque (Ld.).

JONES'

Patent plain black solid cast-steel shovels and spades.



Meyer's patent steel shovel.

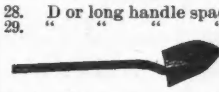
No.		No.	Per Doz. Black.	Per Doz. Pol's'd
20.	D. or long handle sq.-point shovels.	2	$15.50	$16.50
21.	" " " " "	3	16.25	17.25
22.	" " " " "	4	17.00	18.50
23.	" " " " "	6	17.50	19.00
24.	" " " " charcoal.	8	20.50.	22.00

Pt. plain back solid cast steel shovel.

25.	D or long handle round-point shovels.	3	16.25	17.25

Patent steel spade.

28.	D or long handle spades..........	2	16.00	17.00
29.	" " " "	3	16.50	18.00



Patent plait back solid cast steel.

26.	Long round joint shovel No. 2...........	15.50	16.50
27.	" square " " No. 2...........	15.50	16.50
32.	D. handle square-point molders' shovels...........2	.....	17.00
33.	D. handle square point railroad, extra heavy...........2	15.75	
34.	D. handle round point railroad, extra heavy...........3	16.50	
35.	L. handle round point shovel, with foot cap...........2	16.00	17.00

GRAY'S

Patent plain back solid-steel shovels and spades.

50.	D. or long handle sq.-point shovels.	2	$12.00	$13.00
51.	" " " " "	3	12.75	14.00
52.	" " " round point "	3	12.75	14.00
55.	D. handle spades....................	2	12.25	13.25
56.	" " "	3	13.00	14.25

Patent solid corrugated scoop

SCOOPS.

Jones' patent plain back solid corrugated scoops.

90.	D. or long handle solid cast steel...	2	$13.50	$14.50
91.	" " " " " ...	4	14.50	15.50
91½.	" " " " " ...	6	16.50	17.50

Jones' riveted scoops.

92.	Cast steel D. or long handle...	2	13.50	14.50
93.	" " " "	4	14.50	15.50
94.	" " " "	6	16.50	17.50
				Half polished.
95.	" " "	8		$20.00
96.	" " "	10		22.50
97.	" " " Locomotive or coal (heavy)...........	6	17.50	
98.	" Long or D. handle for salt (heavy)...........	6	17.50	
99.	" D. handle flour and house furnace...........		10.50	
100.	" D. handle r'd-pt. for coal (extra heavy)...........	6	20.00	
				Polished.
101.	" ash pit, furnace L. handle...........	2		13.00
102.	" " " 32 in. D..	2		13.50
103.	" " " 42 " iron D. handle...........	2		14.00

Ditching spade.

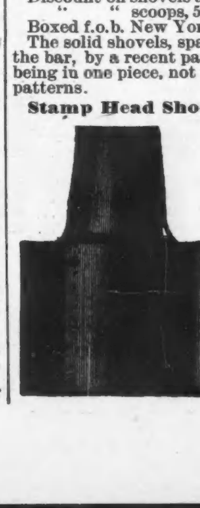
124.	D handle ditching (flat)...................	18.00	19.50
125.	D handle post hole (concave)............	18.00	19.50
126.	D handle Alcock (for clay and brick)....	16.00	17.00

Discount on shovels and spades, 50 and 10.
" " scoops, 50.

Boxed f.o.b. New York, Boston on Montreal.

The solid shovels, spades and scoops are made from the bar, by a recent patent process, the blade and strap being in one piece, not welded. All goods are American patterns.

Stamp Head Shoes and Dies.




Shoe & Die (Adamantine), showing even wear from end to end.

Chrome Steel Works.

8 cents per lb f.o.b. New York.

Stencil Inks.

S. H. QUINT & SON.

Black.

No.	Per can.	Per cake.	No.	Per can.	Per cake.
1	7 cents	3 cents	3	20 cents.	12 cents
2	10 "	5 "	4	30 "	20 "
Blue.					
1	10 cents.	6 cents	3	30 cents.	22 cents
2	15 "	9 "	4	50 "	40 "
Red and Green.					
1	12 cents	8 cents	3	50 cents.	42 cents
2	20 "	15 "	4	90 "	80 "

Per doz. cans or cakes, net, per gross, 10% less.

Indelible Ink.

Small bottles per 100	$2.75
" " 500	12.00
" " 1,000	20.00

STENCIL COMBINATIONS.

Contains Alphabet, Figures, Brush, and Ink.

½ inch, per doz	$5.00
¾ " "	5.40
1 " "	5.75
1¼ " "	7.50
1½ " "	8.40
2 " "	10.00
2½ " "	15.00

Dis., 10%.

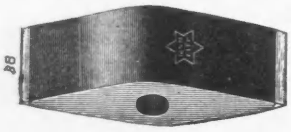
Tools.

ARTISANS.

Chisel (Mason).

Stone, 5 and 8c. lb., net.

Mill Picks.
Cast steel. 2 to 3 lbs., $22 per doz.
Dis., 60 and 5%.



Stone Axes, Cast Steel.

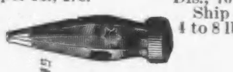
All sizes, 50c. per lb.

Dis., 70 and 10%.

Five lbs. and over, 40c.; with teeth, 45c.; 3 to 5 lbs., 45c.; with teeth, 50c.; under 3 lbs., 50c.; with teeth, 55c.

Nos. 40 and 41, spalling or stone hammer, 5 lbs. and ver, 36c.; 3 to 5 lbs., 40c.; under 3 lbs., 45c. per lb.

Nos. 40 and 41, spalling hammers, 9 to 20 lbs., steel face, per lb., 17c. Dis., 70 and 10%



Ship or Top Mauls, Steel Face. 4 to 8 lbs., 28c. per lb.

Dis., 50, 10 and 5%..

Steel Wedges, wood, 1st qual., 5c. lb.

Cooper Froes.

8 in.. ₩ doz.	$13.00
10 in.. ₩ doz.	13.50
12 in.. ₩ doz.	14.00
14 in.. ₩ doz.	14.50
16 in.. ₩ doz.	15.00

Discount, 60%.

60 days, 2% 10 days. Vise.

No 1. Solid Box Vises.

		Each.
No. 25, 3¾	in. Jaw	$12.00
" 30, 3½	"	11.00
" 55, 3⅞	"	10.00
" 40, 4	"	10.50
" 45, 4¼	"	11.00
" 50, 4¼	"	11.50
" 55, 4½	"	12.00
" 60, 4½	"	13.00
" 65, 4¾	"	14.00
" 70, 5	"	15.00
" 75, 5	"	16.00
" 80, 5¼	"	17.50
" 85, 5¼	"	18.50
" 90, 5½	"	20.00
" 95, 5¾	"	21.00
" 100, 6	"	22.00
" 105, 6	"	23.00
" 110, 6¼	"	24.00
" 115, 6¼	"	25.00
" 120, 6½	"	26.00
" 125, 6½	"	27.50
" 130, 6¾	"	29.00

		Each.			Each.
No. 135, 6¾	in. Jaw	$31.50	No. 170, 7¼	in. Jaw	$44.50
" 140, 7	"	33.00	" 180, 8	"	47.00
" 145, 7	"	35.00	" 190, 8	"	53.00
" 150, 7	"	36.00	" 200, 8	"	56.00
" 160, 7¼	"	41.50			

Dis., 60 and 10%.

MINERS.

Adze Eye Coal Picks.
Same list and dis. as No. 16.

Anthracite Coal Picks.
Same list and dis. as No. 16.

Stone Picks, per doz.

No. 18, 6 to 7 lbs.	$16.50.
No. 18, 7 to 8 lbs.	17.50.
No. 18, 8 to 9 lbs.	18.50.

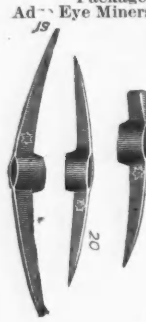
Dis., 60 and 5%.

Coal Picks.

No.		Per doz.
16, Weight, 2	lbs.	$8.50
16, " 2½	"	9.00
16, " 3	"	9.50
16, " 3½	"	10.00
16, " 4	"	10.50
16, " 4½	"	11.00
16, " 5	"	11.50
16, " 5½	"	12.00
16, " 6	"	12.50
16, " 6½	"	13.00
16, " 7	"	14.00

Packages charged at cost. Dis., 60%.

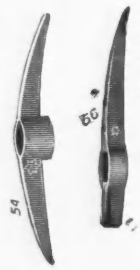
Ad-- Eye Miners Picks—Surface, Drifting and Poll.



No.			per doz.
19, Surface.	No. 1, 4	lbs.	$14.00
19, "	No. 2, 4½	"	15.00
19, "	No. 3, 5	"	16.00
19, "	No. 4, 5½	"	17.00
19, "	No. 5, 6	"	18.00
19, "	No. 6, 6½	"	19.00
19, "	No. 7, 7	"	20.00
20, Drifting,	No. 1, 3	"	12.50
20, "	No. 2, 4	"	14.00
20, "	No. 3, 4½	"	15.00
20, "	No. 4, 5	"	16.00
20, "	No. 5, 6	"	17.50
21, Poll,	No. 1, 3½	"	15.00
21, "	No. 2, 4	"	16.00
21, "	No. 3, 4½	"	17.00
21, "	No. 4, 5	"	18.50
21, "	No. 5, 6	"	20.00
21, "	No. 6, 6¾	"	21.50

Dis., 60, 10 and 5%.

No. Ore Picks.



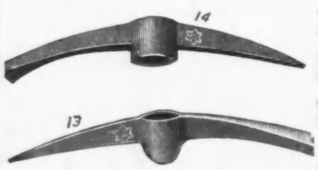
54, Adze Eye,	5 to 6 lbs.	₩ doz.	$12.00
54, "	6 to 7 "	"	$13.00
54, "	to 8 "	"	$14.00

56, Steel Lake Superior Mining Pick*

(Special Price and Quality.)

Dis, 60 and 10

Tamping Picks.



Adze eye, 6 to 7 lbs., per doz., $17.
Adze eye, 7 to 8 lbs., per doz., $18.
Adze eye, 8 o 9 lbs., per doz., $19.
Hunt eye, 6 tc 7 lbs., per doz., $17.

Hunt eye, 7 to 8 lbs., per doz., $18.
Hunt eye, 8 to 9 lbs., per doz., $19.
Dis., 60 and 10%.

Steel Face Hammers.

No. 43, hand drilling hammers, 2 to 5 lbs.; No. 45, napping hammers, 2 to 5 lbs.; No. 39, mason hammers, 3 to 8 lbs.; No. 42, smiths' hand hammers, 2 to 5 lbs.; No. 44, smiths' striking hammers, 2 to 5 lbs., all steel face, per b., 26c. Dis., 70 and 10%.

Steel Face Sledges.

No. 34. Smiths' sledges, 6 to 30 lbs., steel face, 17c. per lb.

No. 35. Stone sledges, 6 to 30 lbs., steel face, 17c. per lb.

No. 36. Striking sledges, 6 to 30 lbs., steel face, 17c. per lb.

No. 37. Coal sledges, 5 to 10 lbs., steel face, 18c. per lb.

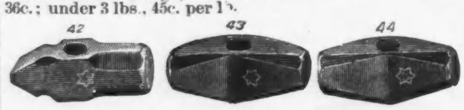
Cast Steel Sledges.

No. 34. Blacksmiths' sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.

No. 35. Stone sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.

No. 36. Striking sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.

No. 37. Coal sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.



No. 43, hand drilling hammer, 5 lbs. and over, 36c.; 3 to 5 lbs., 40c.; under 3 lbs., 45c. per lb.

Dis., 70 and 10%.

Cast Steel.

No. 42, blacksmiths' hand hammer, 5 lbs. and over, 30c.; 3 to 5 lbs., 34c.; under 3 lbs., 45c. per lb.

No. 44, drilling or striking hammer, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.

No. 45, napping hammer, 5 lbs. and over, 30c.; 3 to 5 bs., 35c., under 3 lbs., 45c. per lb.

Dis., 70 and 10%.

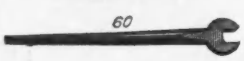
RAILROADS.

Railway Track Punch

Round Point.

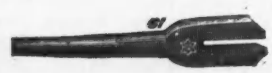
15c. lb., net.

Track Wrench.



7¾c. lb., net.

Rail Fork.



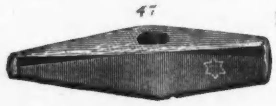
9c. lb., net.

Crow Bars.
Wedge Points,
3½c. lb., net.
Pinch Point,
3½c. lb., net.

65 Tamping Bar,
6c. lb., net.

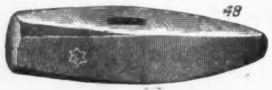
66 Claw Bar,

7c. lb., net.



Railroad Spike Mauls
6 to 16 lbs., Steel Face
18c. lb.

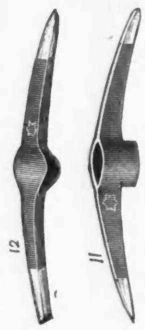
Dis., 50, 10, and 5%.



Steel Track Chisel,

15c. per lb., net.

Railroad or Clay Picks.

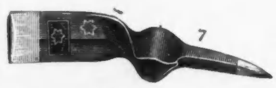


No.		Per doz.
11, Adze eye,	4 to 5 lbs.	$11.00
11, "	5 to 6 "	12.00
11, "	6 to 7 "	13.00
11, "	7 to 8 "	14.00
11, "	8 to 9 "	16.00
11, "	9 to 10 "	18.00
12, Hunt eye,	4 to 5 "	11.00
12, "	5 to 6 "	12.00
12, "	6 to 7 "	13.00
12, "	7 to 8 "	14.00

Dis., 60 and 10%.

Mattocks—Price per doz.

2, Adze Eye, Long Cutter, 6 lbs., $16.00.
3, Adze Eye, Short Cutter, 5½ lbs., $15.50.
2, Adze Eye, Long Cutter, Light, $15.00.
3, Adze Eye, Short Cutter, Light, $15.00.
4, Hunt Eye, Long Cutter, 6 lbs., $16.00.
5, Hunt Eye, Short Cutter, 5½ lbs., $15.50.



Adze Eye Pick Mattocks..........$16.

Hunt Eye Pick Mattocks.........$16

Dis., 60 and 10%.

Grub Hoes.

Western Pattern, No. 0, 3 lbs., ₩ doz., $10.50.
Western Pattern, No. 1, 3½ lbs., ₩ doz., $11.
Western Pattern, No. 2, 4 lbs., ₩ doz., $11.50.
Western Pattern, No. 3, 4½ lbs., ₩ doz., $12.
Baltimore Pattern, No. 1, 3½ lbs., ₩ doz., $11.
Baltimore Pattern, No. 2, 4½ lbs., ₩ doz., $11.75
Baltimore Pattern, No. 3, 5 lbs., ₩ doz., $12.75.
Baltimore Pattern, No. 4, 5¾ lbs., ₩ doz., $13.75.

Dis., 60 and 10%.

Shovels. C. S., long handle, round point.

Ames'.	Hobart's	Day's.
No. 1... 11.50	8.00	8.00
2... 11.50	8.00	8.00
3... 12.25	8.50	8.50
D. Handles round point.		
2... 12.00	8.50	8.50
3... 12.50	9.00	9.00

Dis., 20, 10 and 5%.

Tools, Carpenters'.

BOXWOOD RULES.

Two feet, four-fold, 1 inch wide.

Plate.	Middle.	Edge.	Bound.
Round joint	$4	...	...
Square "	5	$7	$15
Arch "	6	8	16

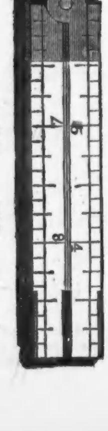
Two feet, four-fold, 1⅜ inches wide.

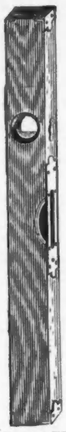
Plate.	Middle.	Edge.	Bound.
Square joint	$7	$9	$18
Arch "	9	11	20

Two feet, two-fold, 1½ inches wide.

Square joint.	Arch.	Arch Bound.
$5	$7	$16
12	14	24
		Gunter's Slide.

Dis. 80, 10 and 10%.





LEVELS.

	10 to 16 in.	18 to 24 in.
Arch top plate, 2 side views..	$9.00	$12.00

PLUMBS AND LEVELS.

Arch top plate, 2 side views.

	12 to 18 in.	18 to 24 in.	24 to 30 in.
Polished	$14.00	$16.00	$18.00
Mahogany	....	16.50	22.50
Mahogany tp'd and lp'd	27.00	.....	.....
Polished and l pped	.....	.....	24.00
Polished and tipped	.....	.....	28.00
Polished, lip'd and tip'd	.....	.....	35.00

	in.	
Mason's level, 2 plumbs, polished,	36,	$30.00
Mason's level, 2 plumbs, p'd and t'd,	36,	36.00
Mason's level, 2 plumbs, polished,	42,	36.00

PATENT ADJUSTABLE PLUMBS AND LEVEL.

Arch Top plate, 2 side views	26 to 30 in.
Polished and lipped	$27.00
Polished and tipped	30.00
Polished, lipped and tipped	39.00
Mahogany	27.00
Mahogany, lipped	33.00
Mahogany, lipped and tipped	48.00
Polished, triple stock, lipped and tipped	48.00
Mahogany " " " " "	60.00
Rosewood, lipped and tipped	90.00

Dis., 70, 10, 10%.

POCKET LEVELS.

Iron top, Japanned	2 50
Brass top	3.00

Dis., 70, 10, 10%.

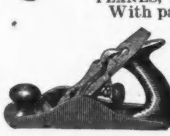
SCREWDRIVERS.

Varnished handles, pat. metallic fastening. Size 1½, $1 per dozen; 2, $1.50; 3, $2; 4, $2.50; 5, $3; 6, $3.50; 7, $4; 8, $4.75; 10, $3; 12, $8.

Dis., 75 %.

PLANES, BAILEY'S PATENT IRON.

With pat. lateral adjustment.



Smooth, 8 in. × 1¾ in., $3; 9 in. × 2 in., $3.25; 10 in. × 2⅜ in., $3.75 each.

Jack, 14 in. × 2 in., $3.75.

Fore, 18 in. × 2⅜ in., $4.75

Jointer, 24 in. × 2⅝ in., $6.50 each.

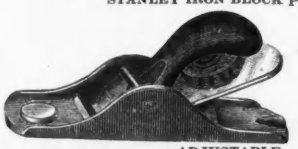
Dis., 40, 10 and 10 %.

BAILEY'S PATENT WOOD PLANES.

Smooth.		Handle smooth.
9 × 8¾ in.	8 × 2 in.	9 × 2 in.
$2	$2	$2.50 each
Jack.	Fore.	Jointer.
15 × 2⅛ in.	20 × 2⅜ in.	26 × 2⅝ in.
$2.50	$2.75.	$3.25 each

Dis., 40, 10 and 10%.

STANLEY IRON BLOCK PLANES.

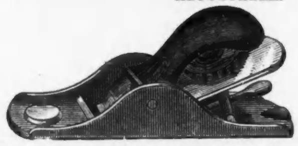


3½ × 1 in. 20c.

5½ × 1¼ in. 40c.

7½ × 1¾ in. 60c. each.

ADJUSTABLE.



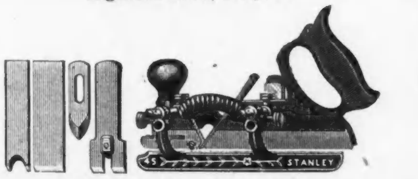
5½ × 1¼ in. 60c.

7½ × 1¾ in. 85c. each.

Dis., 40, 10 and 10%.

STANLEY'S BEADING, RABBET, SLITTING AND MATCHING PLANE.

Eighteen Tools, Bits, etc.



$8 each. Dis., 20, 10 and 10%.

STANLEY "ODD JOBS."

Embraces in combination with ordinary Carpenters' Rule:

010 Try square.
020 Mitre square.
030 T– – – square.
040 Marking gauge.
050 Mortise gauge.
060 Depth gauge.
070 Mitre level.
080 Spirit level and plumb.
090 Beam compass.
0100 Inside square for making boxes and frames.

Price 75 cents.
Dis., 20, 10 and 10%.

TACK HAMMERS.

	Doz.
Magnetic, small	$1.25
Medium	1.50
Large	1.75

Discount, 30, 10, 10%.

MALLEABLE IRON.

Inlaid Handle.

Per Doz $2.50

Discount, 30, 10, 10%.

STEAK HAMMERS.

Japanned	$2.25
X Plated	3.00

Discount, 30, 10, 10%.

BOSTON PATTERN.

Trucks.

New York Pattern.

Size.	Length of hdles. Ft.	In.	Width at nose. Inches.	Width at upper bar. Inches.	Size of wheel. Inches.	Price.
No. 0	3	6½	12	13¼	6½ × 1¾	$4.50
No. 1	4	1	13⅞	15⅝	6½ × 1¾	4.85
No. 2	4	5	15	16½	7¾ × 1⅞	6.00
No. 3	4	8	16	17¾	8¾ × 2¼	7.00
No. 4	5	0	16¼	17¾	9¾ × 2¼	8.00
No. 5	5	4	17¼	18⅞	10¾ × 2¾	9.50

Discount 50%.
Special net prices on quantity orders.

Tuyeres.

No. 2.	No. 4.
$25.00	$35.00 per doz.

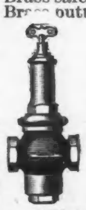
20 % dis.

Valves. Brass Globe and Angle Valves.

Size, inches	⅛	¼	⅜	½	¾	1
Star globe and angle valves	$0.80	$0.85	$0.90	$1.20	$1.55	$2.00
Star globe and angle valves, heavy patterns	...	...	...	1.50	1,95	2.80
Extra heavy Star and Lion patterns	...	...	...	2.00	2.60	3.60
All brass, yoke top	...	...	...	....	....	3.75
Cross valves	...	1.15	1.25	1.50	2.00	2.50
Star check valves	.70	.70	.75	.95	1.20	1.65
do. heavy pattern	..	...	...	1.15	1.50	2.00
Crescent globe and angle valves	.60	.60	.75	1.00	1.35	1.80
Crescent hose valves	..	...	...	...	...	...
check valves	.	.50	.60	.85	1.15	1.55
Vertical check v'lv's	.	.50	.60	.85	1.15	1.55
Jenkins globe and angle valves	.	1.10	1.25	1.60	2.20	2.80
Jenkins check valv's	..	1.10	1.20	1.30	1.90	2.60
Gate valves, Chapman	..	...	...	1.30	1.75	2.25
Gate valves, other makes	..	...	1.00	1.20	1.75	2.50
Brass safety valves	..	2.00	2.25	2.75	3.50	5.00
Brass butterfly v'lv's	..	...	...	...	...	3.50

Size, inches	1¼	1½	2	2½	3
Star globe and angle valves.	$3.00	$4.00	$6.50	$12.50	$19.00
do. heavy pattern.	3.95	5.30	8.35	14.00	22.00
Extra heavy Star and Lion patterns	5.40	7.20	10.80	18.20	28.60
All brass, yoke top	5.00	7.00	10.00	18.00	30.00
Cross valves	3.50	5.00	8.00	16.00	24.00
Star check valves	2.50	3.25	5.00	11.00	15.00
do heavy pattern	3.00	4.00	6.50	12.50	17.00
Crescent globe and angle valves	2.80	3.90	5.90	11.25	16.00
Crescent hose valves	4.00	5.50	7.00	10.00	....
" check valves	2.30	3.25	5.20	10.00	14.00
Vertical check valves	2.30	3.25	5.20	10.00	14.00
Jenkins globe and angle valves	4.00	5.50	8.00	15.75	22.00
Jenkins check valves	3.60	5.00	7.50	13.50	20.50
Gate valves, Chapman	3.25	4.25	6.25	11.50	16.00
" " other makes	3.50	5.00	7.50	15.00	22.00
Brass safety valves	7 00	8.50	12.00	20.00	30.00
Brass butterfly valves	4.50	5.50	8.00	11.00	16.00

Pressure Regulating.



Mason Regulator Co.

Size pipe.	Price.	Size pipe.	Price.	Size pipe.	Price
1 inch,	$22.	1¼ inch,	$28.	1½ inch,	$35.
2 "	44.	2½ "	57.	3 "	72.

Ludlow Valve Co.
Double Gate Brass Valves.
Gland in packing box.

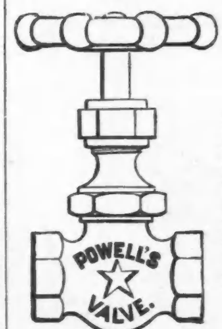
Size.	Screw socket.	Flange.	Diameter of Standard Flange.	Face to face of Screw socket	Face to face of Flanges.	Extra for slide stem and lever subject to discount.
In.	$	$	In.	In.	In.	
½	1.25	.....	....	2¼	....	$1.00
¾	1.65	.....	....	2½	....	1.00
1	2.15	.....	....	2⅞	....	1.00
1¼	3.15	.....	....	3⅜	....	1.00
1½	4.25	.....	....	3¾	....	1.00
2	6.25	11.50	6	4⅛	4⅝	1.00
2½	11.50	18.00	6½	4 13-16	5⅜	1.25
3	16.00	22.00	7	5	6¼	1.25
3½	21.00	31.00	7½	....	....	1.25
4	35.00	43.00	9	....	7 1-16	1.25
5	52.00	64.00	10	....	....	1.25
6	78.00	90.00	11	....	9	1.25
8	.....	.....	....	....	....	....
10	.....	.....	....	....	....	....
12	.....	.....	....	....	....	....

Rubber-Faced Slide Gate Fire Hydrant.
See cuts on pages 19 and 20.

Diameter of pipe connection.	Diameter of stand pipe.	Diameter of seat ring.	One 2½ nozzle.	Two 2½ nozzles.	Three 2½ nozzles.
Inches.	Inches.	Inches.			
3 or 4	4⅝	3	$28	....	....
3–4–6	5¾	4	31	$33.00	$35.00
4 or 6	7	5	....	38.50	40.50
6 or 8	8	6	....	49.00	51.00
8 or 10	10	8	....	....	....

Four 2½ nozzles	Six 2½ nozzles.	One steamer nozzle.	One steamer and one 2½ nozzle.	One steamer and two 2½ nozzles.	Frost case, standard length.
......	......	....	....	....	$4.50
......	......	$33.00	$35.00	$37.00	5.00
......	......	38.50	40 50	42.50	6.50
$53.00	......	49.00	51.00	53.00	7.50

For each 6 inches more or less than standard length of stand pipe, add or deduct from list.	For each 6 inches more or less than standard length of frost case, add or deduct from list.	Extra charge for hub.	Independe't nozzle gates each.
$0.60	$0.44	....	....
.75	.50	6 in. $0.50	$3.50
.85	70	No ch'ge	3.75
1.00	.90	8 in. $1.25	3.75
....	....	....	4.50



Star Radiator Valves, with Brass T Handles or Wood Wheels.

Size, inches	½	¾	1
Plain brass	$1.60	$2.00	$2.50
Plated trim'gs.	1.80	2.25	2.80
Rough & Plat'd	2.00	2.45	3.05
Finish'd & P'l't.	2.50	3.00	3.65

Size, inches	1¼	1½	2
Plain brass	$3.60	$4.80	$7.50
Plated trim'gs.	3.95	5.20	8.00
Rough & Plat'd	4.20	5.50	8.50
Finish'd & P'l't.	4.95	6.50	9.75

Dis., 40, 10 and 5%.

Varnish.

E.S. 1827 & Co.

Edward Smith & Co.

For Finishing Coats.

	gal.
Wearing body varnish	$5.50
Medium drying body	5.50
One coat coach varnish	4.50
Wearing carriage	4.50
Heavy gear varnish	4.00
Coach body "	4.05
No. 1 coach "	2.2

For Under Coats.

Hard drying body	$4.50	Black rubbing varnish	$4.00
Rubbing body varnish.	4.00	Priming (1st coat)	2.50
Quick rubbing "	3.50	Filling (2d coat)	2.50
		Rough stuff	2.50

For Inside Work.

Best flowing varnish	$4.50	Hard oil finish light	$2.75
Best polishing "	4.50	" dark	2.25
Cabinet "	3.00	White copal	4.00

Dryers.

Japan gold size	$3.50	Brown japan	$1.25
Coach japan	1.75	Liquid dryer	1.25

Discount, 40 per cent. f.o.b. N. Y.

Preservative Coatings.

Spar coatings	$4.00	Exterior car coating	$4.00
I. X. L. No. 1	2.50	Interior car coating	3.25
I. X. L. No. 2	4.00	Locomotive coating	4.00
Floor finish	2.50		

Discount, 35 per cent, f.o.b. N. Y.

Watches.—Trenton Watch Co.

Open Face, Stem Wind and Set.

No. 51. Nickel Silver, Snap Back and Bezel $3.50

No. 55. Nickel Silver, Jointed Back and Bezel 3.7

No. 60. Nickel Silver, Bassine style, (Smooth Edges), Double Joints 4.25

No. 65. Dueber Silverine Bassine... 4.50

No. 92. Silver, Engine Turned..... 6.37

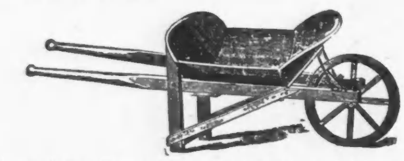
No. 90. Silver, Engraved.......... 6.50

No. 101. 14-karat Gold, Filled, Cases made of two plates of 14-karat gold rolled on base metal, and warranted to wear for 15 years, Engine Turned 11.00

No. 102. Same, Engraved.......... 13.00

Dis., 15 and 6% cash.

Wheelbarrows.

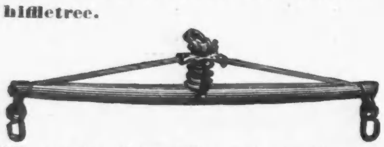


Climax Bolted Barrow, with Wood Wheel per doz. $22.50. 1½ tire of iron,
Common Nailed Barrow per doz. $18.50.
" Bolted " " " 18.75.
Lansing's Patent Iron-Bolted Barrow, per doz., $25.50
Capital Patent Bolted Dirt " " " 30.00
Red oak or Government " " " 40.50
Wharf " " " 72.50
Mortar " " " 30.00
Bent Handle Stone " " " 48.00
Coal or Ore " " " 31.50
Pig Metal or Casting " " " 40.50
Brick Yard 20 inch Iron Wheel " each 10.50
Globe Patent Bolted Garden Barrow Box 30 by 24 by 12 deep, wood wheel } per doz., 42.50.

Capita Patent Barrows
With Iron Tray, A, per doz. $39.00
" " " B, " " 42.00

The Leader Iron and Steel Barrows.
Gas-pipe Legs and Handles in one price.
No. 1 Tray of 16 iron, capacity 3 cu. ft. of earth, each $12.
No. 2 " " 14 " " 5 " " " "
or 250 lbs. of coal .... " 15
3 Galvanized 18 iron, capacity same as No. 2 ..... " 1

Whiffletree.

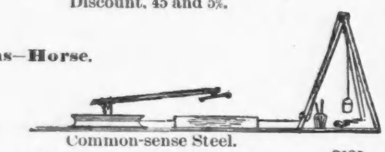


Willson spring (Jeffery Manufacturing Company).

	Single.	Double.
No. 1, 34 or 36 inches long	$1.25	$2.50
No. 2, " " "	1.40	2.75
No. 3, " " "	1.50	3.00
No. 4, " " "	1.65	3.25

Including either steel hooks or rings
Discount, 45 and 5%.

Whims—Horse.



Common-sense Steel.
F. O. B. $125
Dis., 25%.

Wick.

Baltimore Twine & Net Co.
Braided, all kinds, from .... 60c. to $1.00

LAMP.

0, or E	per gross..$0.40
1, or A	" .60
2, or B	" .75
3, or D	" 1.30
Brilliant, Argand and Crystal light	" 1.60
Deitz	" .70
B Double Thick	" 2.00
Pet Circular	" .33
German Pet	" .55
Moehring	" 3.00
Mann's Monarch	" 2.00
Dual	" 2.00
Duplex and Oxford	" 3.00
Wide Awake and Nutmeg	" .40
Tom Thumb, Round and Flat	" .25
Nos. 1 and 2 German Student	" 1.10
BB, or Bonanza	" 2.00
AA	" 1.50
Above, in 32-yard pieces	as per gross
Round Fluid	per doz..$ .30
Wick in Boxes	3 cents extra

Dis., 60, 10, 5 and 3%.

CANDLE.

13 to 20 cents.

Windmills.

A. J. CORCORAN.
Patent Storm Defying Pumping Mills.

Wheel.	Weight, boxed.	Cubic feet.	Price.
8½ ft.	650 lbs.	55	95.00
10 "	700 "	75	120.00
12 "	900 "	95	150.00
14 "	1,350 "	135	250.00
16 "	1,850 "	195	375.00
18 "	2,150 "	250	450.00
20 "	3,500 "	335	600.00
Dis., 25%.			
25 "	5,400 lbs.	450	775.00
Dis., 20%.			
30 "	9,500 lbs.	795	975.00

Boxing for export extra.

Corcoran Storm Defying Geared Wind mills for Driving Machinery.

Price includes upper set of Bessemer steel gears, one length of shaft.

Dia.	H. P.	Weight.	Cu. ft.	Price.
16 ft.	2½	1,900 lbs.	200	$400.00
20 "	5	3,600 "	340	650.00
25 "	6½	5,400 "	355	850.00
30 "	8	9,600 "	816	1 150.00
36 "	10	12,000 "	855	1 500.00
40 "	12	14,500 "	896	2 000.00
50 "	30	16,500 "	956	3 500.00
60 "	40	20,000 "	1,015	4 500.00

Dis., 25%.

10 ft. pumping	.... $75	Plus cost of packing.
12 ft. "	 95	
14 ft. "	 140	
16 ft. "	 225	

Dis., 50 per cent.

Wire Cloth.

Brass and Copper Wire Cloth.

No. Mesh.		Price per foot.	No. Mesh.		Price per foot.
2 from	No. 10 wire	....$2 50	20 from	No. 26 wire	.... $.80
3 "	11 "	.... 2.50	22 "	27 "	.... .80
4 "	12 "	.... 2.50	24 "	28 "	.... .80
5 "	13 "	.... 2.50	30 "	30 "	.... .65
6 "	14 "	.... 2.50	40 "	32 "	.... .70
8 "	16 "	.... 2.50	50 "	34 "	.... .75
10 "	18 "	.... 2.00	60 "	35 "	.... .78
12 "	19 "	.... 2.00	70 "	37 "	.... .70
14 "	22 "	.... 1.10	80 "	38 "	.... .90
16 "	24 "	.... .80	90 "	39 "	.... 1.10
18 "	25 "	.... .80			

Dis., 60%.

Wire Goods.

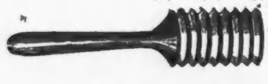
Fly Traps. Per gross.
Paragon.......$18.00
Balloon......... 15.00

Dis., 10%.

Woodenware.

MASHERS.

Beefsteak.



Price, 70c. per dozen; barrels contain about 12 dozen.
Made out of Sugar Maple

Potato

Small size, 50c. per dozen; barrels contain about 30 dozen.
Medium size, 60c. per dozen; barrels contain about 15 dozen
Large size, 70c. per dozen; barrels contain about 11 dozen.
Made out of Hard Sugar Maple and Wax Polished.

MALLETS.

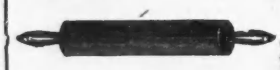
Round Hickory.

	Per doz.	Barrels contain about.
No. 1, 2 to 2½ in.	$1.25	10 dozen.
" 2, 2½ to 3 "	1.75	8 "
" 3, 3 to 3½ "	2.25	5 "
" 4, 4	2.50	4 "

Round Lignumvitæ.

	Per doz.	Barrels contain about.
No. 1, 3 inches	...$3.00	6 dozen.
" 2, 3½ "	... 4.00	5 "
" 3, 4 "	... 5.00	4 "
" 4, 5 "	... 6.00	3 "

ROLLING PINS.



Packed in crates of one gross, and in boxes of one dozen. Solid and Loose or Revolving handles. Per dozen, $1.00.

SHOVELS.

Grain Scoops or Shovels (Wood).

Small size, price per dozen, $7.
Medium size, price per dozen, $8.
Large size, price per dozen, $9.
Made out of selected Hardwood, Maple, Beach and Birch.
Small, Medium and Large Sizes; used for Grain, Malt, Potatoes, Fruit, etc.
Long Handle Scoops, 4 feet long, $12 per dozen.

TABLE CONVERTING AMERICAN INTO ENGLISH MONEY.

American cents	1	2	3	4	5	6	7	8		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
English money	d. ½	d. 1	d. 1½	d. 2	d. 2½	d. 3	d. 3½	d. 4	d. 4½	d. 5	d. 5½	d. 6	d. 6½	d. 7	d. 7½	d. 8	d. 8½	d. 9	d. 9½	d. 10	d. 10½	d. 11	d. 11½	s. d. 1	s. d. 1 ½	s. d. 1 1	s. d. 1 1½	s. d. 1 2	s. d. 1 2½	s. d. 1 3	s. d. 1 3½	s. d. 1 4	s. d. 1 4½
American cents	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
English money	s. d. 1 5	s. d. 1 5½	s. d. 1 6	s. d. 1 6½	s. d. 1 7	s. d. 1 7½	s. d. 1 8	s. d. 1 8½	s. d 1 9	s. d. 1 9½	s. d. 1 10	s. d. 1 10½	s. d. 1 11	s. d. 1 11½	s. d. 2	s. d. 2 ½	s. d. 2 1	s. d. 2 1½	s. d. 2 2	s. d. 2 2½	s. d. 2 3	s. d. 2 3½	s. d. 2 4	s. d. 2 4½	s. d. 2 5	s. d. 2 5½	s. d. 2 6	s. d. 2 6½	s. d. 2 7	s. d. 2 7½	s. d. 2 8	s. d. 2 8½	s. d. 2 9
American cents	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
English money	s. d. 2 9½	s. d. 2 10	s. d. 2 10½	s. d. 2 11	s. d. 2 11½	s. d. 3	s. d. 3 ½	s. d. 3 1	s. d. 3 1½	s. d. 3 2	s. d. 3 2½	s. d. 3 3	s. d. 3 3½	s. d. 3 4	s. d. 3 4½	s. d. 3 5	s. d. 3 5½	s. d. 3 6	s. d. 3 6½	s. d. 3 7	s. d. 3 7½	s. d. 3 8	s. d. 3 8½	s. d. 3 9	s. d. 3 9½	s. d. 3 10	s. d. 3 10½	s. d. 3 11	s. d. 3 11½	s. d. 4	s. d. 4 ½	s. d. 4 1	s. d. 4 1½

American dollars	1	2	3	4	5	6	7	8	9	10	20	30	40	50	60	70	80	90	100
English £ s. d.	£0 4 2	£0 8 4	£0 12 6	£0 16 8	£1 10	£1 5 0	£1 9 2	£1 13 4	£1 17 6	£2 1 8	£4 3 4	£6 5 0	£8 6 8	£10 8 4	£12 10 0	£14 11 8	£16 13 4	£18 15 0	£20 16 8

EXAMPLE.—If you want to convert $94.62, table shows that $90 equals £18 15s.; $4 equals 16s. 8d.; 62 cents equals 2s. 7d.; total, £19 14s. 3d.

NEW YORK PRICES CURRENT.
SEPTEMBER 7, 1889.

Discounts are for Export Only.

In the interest of the extension of the markets for American manufactures the ENGINEERING AND MINING JOURNAL has secured the services of gentlemen thoroughly acquainted with the export trade and with foreign markets, and it offers its services to foreign buyers who may desire information concerning any article whatever of American manufacture. No charge will be made for these services, either directly or indirectly through commissions on goods purchased. The proprietors of the ENGINEERING AND MINING JOURNAL are neither commission merchants nor exporters, but they have many sources of information, both at home and in foreign countries, and place these at the service of manufacturers and exporters here and of importers and consumers in other countries.

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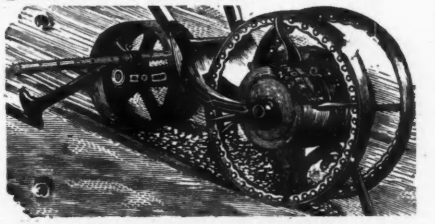
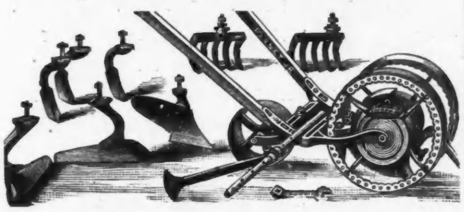
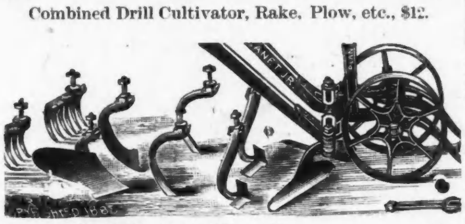
Agricultural Implements.



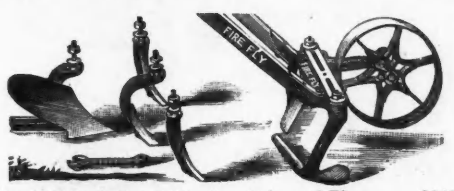
"Planet, Jr." No. 2 Seed Drill, $9.



Combined Drill Cultivator, Rake, Plow, etc., $12.



Double-Wheel Hoe Rake, Plow, etc	$8.00
Double-Wheel Hoe, plain (Hoe's only)	4.50

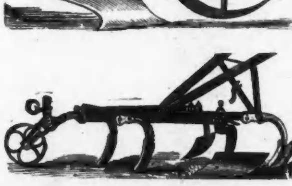


Single Wheel Hoe Cultivator, Rake and Plow...... $6.00

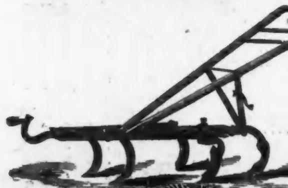
"Fire Fly" single-wheel Hoe, Cultivator and Plow, $5.

"Fire Fly" Hand Plow, $2.50.

30% discount, f.o.b. New York.



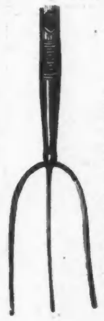
All Steel Horse Hoe and Cultivator combined, with wheel, $11.



All Steel Plain Cultivator, $6.00.

40% discount, f.o.b., New York.

HAY FORKS.



Ely Hoe & Fork Co.—Gold Finish, Patent Overcaps.

Three Tine Forks.

No.	Tine.	Handles.		Per doz.
30	10 in.	4½ ft.	Boy's	$7.75
32	12 "	4 to 6 ft.		9.00
32 S	12 "	"	Strapped	10.50
32 B	12 "	"	Bent	9.50
32 B S	12 "	"	Bent & St'pd	11.00
33	12 "	"		9.50
33 S	13 "	"	Strapped	11.00
33 B	13 "	"	Bent	10 00
33 B S	13 "	"	Bent & St'pd	11.50
34	14 "	"		10.25
34 B	14 "	"	Bent	10.75
35	15 "	"		11.25
35 B	15 "	"	Bent	11.75
42 B	12 "	"	Bent	12.50
42 B S	12 "	"	Bent & St'pd	14.00

Manure Forks, Solid Steel Shanks, Gold Bronze Finish, Patent Overcaps.

No. 44, oval, 4 tine, 12 in. tine, 4 ft. handle, plain ferrules, $12.50 per doz.

No. 44 S, oval, 4 tine, 12 in. tine, 4 ft. handle, strapped ferrules, $14.

No. 44½, oval, 4 tine, 12 in. tine, 4½ ft. handle, plain ferrules, $12.50.

No. 44½ S, oval, 4 tine, 12 ft. tine, 4½ ft. handle, strapped ferrules, $14.

No. 54, oval, 5 tine, 13 in. tine, 4 ft. handle, plain ferrules, $19.50.

No. 54 S, oval, 5 tine, 13 in. tine, 4 ft. handle, strapped ferrules, $21.

No 64, oval, 6 tine, 13 in. tire, 4. ft. handle, plain ferrules, $22.50.

No. 64 S, oval, 6 tine 13 in. tine, 4 ft. handle, strapped ferrules, $24.

HOES.

Ely Standard Socket, all Gold Bronze Neck, full Pol'd, C. S. Blade.

Field, 7 × 5 in., selected handles	$9.00
" 7½ × 4½ " " "	9.00
" 8 × 4¾ " " "	9.00
" 8½ × 4½ " " "	9.00
" 8 × 5 " " "	9.00
Washington County Pattern, spring handles	10.00
Rhode Island, 7 to 9 in., spr'g handles	9.00
" " 9½ in. " "	9.25
" " 10 " " "	9.50
Meadow, 9 × 4 in., poplar handles	9.00
Meadow, 9½ × 3½ in., poplar handles	9.25
Meadow, 10 × 3½ in., poplar handles	9.50
Broom Corn, 7½ × 4½ in., poplar handles	9.00

Popular Handles in Meadow Socket Hoes, unless otherwise ordered.

PLOWS.

Reversible Oneonta Clipper.

16. Oneonta Clipper, Reversible, Iron beam Cutter	$14
" Oneonta Clipper, Reversible, Iron Wheel and Cutter	15
18. Oneonta Clipper, Reversible, Iron Beam Cutter	15
" Oneonta Clipper, Reversible, Iron Beam, Wheel and Cutter	16
17. Hard Metal, Reversible, Iron Beam Cutter	17
17. Hard Metal, Reversible, Iron Beam, Wheel and Jointer	17
19. Hard Metal, Reversible, Wood Beam Cutter	16
" " " " " " Wheel and Jointer	17
20. Steel Mould Board, Reversible, Wood Beam Cutter	15
" " " " " " " Wheel and Cutter	16

Iron Beam Plows.

Two-horse Sod and Stony Land	8.50 plain.
Curtis's Sod Two horse	11.50 "
" " " "	13.00 cutter.
" " " "	14.25 wheel & cutter.

Subsoil Plows.

Two-horse 9.50 Draft Rod.
" " 11.00 Wheel and Draft Rod.

Hitchcock's Potato Digger and Shovel Plow.

Improved adjustable handle shovel plow	7.00
Hitchcock's Potato Digger	8.00
" " " and shovel plow	10.50

Dis. 30%.

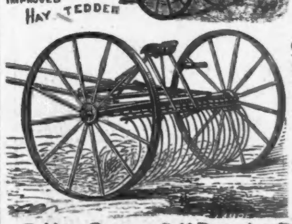
RAKES.

The S. R. Nye Improved.

22 Teeth Rake, $32.00

26 " " 34.00

25% dis.



Chieftain Lock Lever

No. 1	$30.00
No. 2	30.00
No. 5	29.00

Iron wheels, $2 extra. With Pole, Double Tree and Neck Yoke, $2 extra.

22 cubic feet packed, 400 lbs. gro., 225 lbs. net.

Golden Farmer Self-Dumping Rake, $37.00; 22 cu. ft., 430 lbs. gro., 250 lbs. net.

Chieftain Hay Tedders, $59.00; 700 lbs. gro., 450 lbs. net.

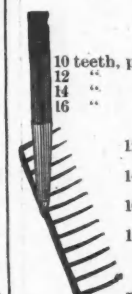
Potato Diggers, $7.00; 100 lbs. gro., 60 lbs. net; dis., 40% f.o.b. ship New York or Boston.

RAKES (GARDEN).

Braced steel garden rakes.	Per doz.
8 teeth	$8.00
10 "	9.00
12 "	10.00
14 "	11.00
16 "	12.00
Braced malleable garden rakes.	
10 teeth	$5.50
12 "	6.00
14 "	6.50
16 "	7.00

	Ten-Teeth Malleable Garden. Plain.	Braced.	Steel Garden. Plain.	Braced.
10-Teeth	$5.50	$6.00	$9.00	$10.50
12 "	6.00	6.50	10.00	11.50
14 "	6.50	7.00	11.00	12.50
16 "	7.00	7.50	12.00	13.50

Dis. 70 and 5%.



Cast steel garden rakes.

	Per doz.
10 teeth, polished, tapering bar, tempered rake	$9.00
12 " " " " " "	10.00
14 " " " " " "	11.00
16 " " " " " "	12.00

Cast steel lawn rakes.

12 teeth, polished, tapering bar, tempered rake	$10.00
14 teeth polished tapering bar, tempered rake	11.00
16 teeth polished tapering bar, tempered rake	12.00
18 teeth polished tapering bar, tempered rake	13.00

Dis. 70% from Standard Association list.

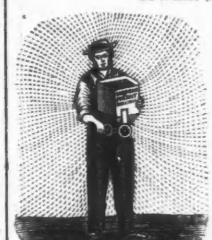
Prices made where XX handles, etc., are required.

SCYTHES (GRASS).

Waldron's pattern, oiled	$8.50
Silver steel, painted	8.50
Western dutchman, bronzed and painted	9.00
Clipper, polished web	9.00
Fine cutlery steel, full polished	10.00
All steel, full polished	11.00
Grain Scythes.	
Waldron's pattern, oiled	11.25
Silver steel, painted	11.25
Clover, oiled	11.25
Clipper, bronzed and painted	11.50
Lawn Scythes.	
Clipper, bronzed and painted	9.00

Dis., 40 and 10%.

SOWER, BROADCAST SEED.



Per dozen.............. $36 f.o.b.

Gross wt., 110 pounds per dozen

Net wt., 75 pounds per dozen.

Anvils.

"Eagle anvils.

No.	Weight about		No.	Weight about	
No. 000	½ lb.	$1 00	No. 4	40 lbs.	$4.25
" 00	4 "	1.70	" 5	50 "	5.05
" 0	10 "	2.20	" 6	60 "	5.50
" 1	15 "	2.75	" 7	70 "	6.00
" 2	20 "	3.00	" 8	80 "	7.00
" 3	30 "	3.75	" 9	90 "	8.00

Anvils weighing 100 to 800 lbs., 10 cts. per lb. Discount 20 and 10%.

Arms and Ammunition.

Wood Powder.

American Wood Powder Company.

	Kegs, 25 lbs.	¼ kegs. 6¼ lbs.	1 lb. cans.
Trap for first quality arms only	$19.50	5.00	.85
A, for large bore; C, for general use; D, fine for small bore and rifles; E, very fine for small bore rifles and gallery shooting	17.00	4.35	.75

		Discount. Per cent.
Bullet Breech Caps......per lb.	1.60	10
Conical Bullet Caps...... "	1.75	10

		Discount. Per cent.
Rim Fire Cartridges	60	10
Military Rim Fire Cartridges	15	10
Central Fire Pistol and Rifle Cartridges	40	10
Central Fire Metallic Cartridges for Target and Sporting Rifles	30	10
Military Cartridges, Central Fire	30	10
Lefaucheux Cartridges		60

Gatling Cartridges		Special
Primed Shells and Bullets	25	10
Friction Cannon Primers	20	10
Primers		10
Percussion Caps, F. C......per M.	33c.	
U. M. C...... "	42½c.	
Musket...... "	45c.	
Brass Shot Shells, U. M. C., 1st qual	60	10
Club brand	65	10

Paper Shot Shells.

14, 16 and 20 ga. First quality, 30, 10 and 10 per cent; 4, 8, 10 and 12 ga., First quality, 25, 10 and 10 per cent.

14, 16 and 20 ga. Club brand, 30, 10 and 10 per cent.
10 and 12 ga. Club brand, 33⅛, 10 and 10 per cent.
Gun Wads, 20 and 5 per cent.

RIFLES.

Colts' Lightning Magazine.

Discount 10 per cent.

40/60 and 45/60 calibre octagon barrel...	10	lbs.	$15.38
" " " " round " ...	9¾	"	14.25
" " " " carbine " ...	9	"	14.25
32, 38, and 44 calibres, octagon " ...	7¼	"	13.50
" " " " round " ...	6¾	"	12.38
" " " " carbine " ...	6¼	"	12.38
" " " " baby carbine.......	5¼	"	12.38
22 calibre, rim fire, octagon barrel.............			15.38
" " round......................			14.25

Remington Light (Baby) carbines, 44 cal., nick., $7.50.

MARTIN RIFLE. MODEL, 1888.

The best in the market, embodying all latest improvements.

32, 38 and 44 calibres, using the same cartridges as Winchester rifles of the respective sizes.

Octagon barrel,	24	inch,	6½	lbs.	$19.50
" "	26	"	6¾	"	21.50
" "	28	"	7	"	23.50
Round "	24	"	6½	"	18.50
Carbine	20	"	5½	"	17.50

Discount, 25, 10 and 10%.

REVOLVERS.

Smith & Weston

32, Single Action, 3, 3½ in., $8.00.
32, Double Action, 3, 3½ in., $9.35.
32, Safety Hammerless, 3, 3½ in., $11.00.

38, Single Action, 3¼ in., $9.40; 38, Single Action, 4 in., $9.65; 38, Single Action, 5 in., $10.00; 38, Double Action, 3¼ in., $10.40; 38, Double Action, 4 in., $10.65; 38, Double Action, 5 in., $11.00; 38, Safety Hammerless, 3¼ in., $12.00; 38, Safety Hammerless, 4 in., $12.25; 38, Safety Hammerless, 5 in., $12.50; 44, Single Action, 4 in., $11.50; 44, Single Action, 5 in., $11.75; 44, Single Action, 6, 6½ in., $12.00; 44, Double Action, 4 in., $12.50; 44, Double Action, 5 in., $12.75; 44, Double Action, 6½ in., $13.00; 44, Double Action Favorite, 5 in., $12.75.

Colts.

Discount, 10 per cent from following prices.

Double Action Army, 44 and 45 calibre, 4¾, 5½, 7½ inch bbl., $13.00.
Double Action, 41 calibre, 2½ to 6 inch bbl., $11.20.
" " 38 " 2½ to 6 " " $10.00.
Single " Army, 45 calibre, 4¾, 5½, and 7½ inch bbl., $12.00.
Single Action Army, 44 calibre, "Frontier," 4¾, 5½, and 7½ inch bbl., $12.00.
New Line, 41 calibre, blued or nickeled, $4.00.
" " 32 " " " 4.00.
" " 30 " " " 2.00.
" " 22 " half or full plate, 2.10.
Old Model, 22 calibre, by the hundred, half or full plate, $1.50.
Colt Deringer. 41 calibre, per pair half or full plate, $5.50.

American Bull Dog

Double Action 32, 38 and 44 calibre, 2½ inch barrel, $1.60; Double Action 32, 38 and 44 calibre, 4½ inch barrel, $1.85; Double Action 32, 38 and 44 calibre, 6 inch barrel, $2.10.

F. & W. British Bull Dog revolvers, 32 and 38 calibre 2½ inch bbl., $1.80.
F. & W. Automatic revolver, 32 and 38 calibre, 3¼ inch bbl .. $5.50.
H. & R. Automatic revolver, 32 and 38 calibre, 3¼ inch bbl., $4.75.
Defender revolvers, Single Action, 22, wood handle, 65.
" " " " 22, rubber " 70.
" " " " 32, wood " 85.
" " " " 32, rubber " 90.

Remington Army revolver, Single Action, 44 cal., frontier cartridge, 5¾ inch barrel, $6.50.
Remington Army revolver, Single Action, 44 cal., frontier cartridge, 7½ inch barrel, $6.00.
Remin gton Double Deringers, 41 cal., rim fire, $4.05.
National Deringers, 41 calibre, per pair, half or ful plate, $4.00.
New House, 41 or 38 calibre, blued or nickeled, $5.00.
" Police, 38 calibre, 6 in., " " 7.00.
" " 38 " 4½ in., " " 7.00.

MARTIN AUTOMATIC DOUBLE ACTION REVOLVERS.

32 and 38 cal., 3¼ bbl., $10; 25 and 10%.

This revolver is made in the best manner, and is equal to any in the market. Uses Smith & Wesson cartridges.

H. & R. AUTOMATIC DOUBLE ACTION REVOLVERS.

32 and 38 cal., 3¼-in. barrel, 4.75 net.

H. & R. EJECTING DOUBLE ACTION REVOLVERS.

32 and 38 cal., 3¼-in. barrel, 4.00 net.

AMERICAN DOUBLE-ACTION REVOLVERS.

32 cal., $1.75, net, 2½ in. bl.

38 cal., $2, net, 4½ in. bl.

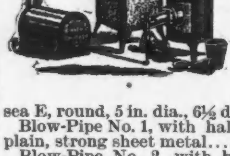
44 cal. $2.30, net, 6 in. bl.

AMERICAN BULLDOG REVOLVERS.

32, 38, 44 cal., 2½ in. bl., $1.60, net.

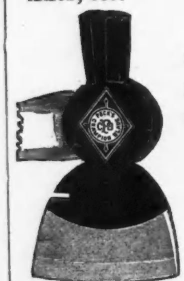
Assay Furnace.

Hydro-Carbon Blow-Pipe Assay Furnace.



No. 2, Muffle Furnace taking C Battersea Muffle 8x4¾x3 in.............$10.00
No. 3, taking F Muffle, 10x6x4 in........... 15.00
No. 1, Crucible Furnace, taking Battersea, U or Colorado B Crucible, 4 in. dia. 5½ deep.. 4.00
No. 2, taking Battersea E, round, 5 in. dia., 6½ deep..................... 5.00
Blow-Pipe No. 1, with half gallon tank, made of plain, strong sheet metal........................ 18.00
Blow-Pipe No. 2, with half gallon tank, made entirely of seamless brass........................ 23.00
Blow-Pipe No. 3, with one gallon tank, otherwise same as No. 2.................................. 26.00
Blow-Pipe No. 1, Muffle Furnace No. 2, and Crucible Furnace No. 1................................ 32.00
Blow-Pipe No. 2, Muffle Furnace No. 2, and Crucible Furnace No. 1................................ 37.00

Axes, etc.



Shingling Hatchets.

1. 2. 3.
Collins', $4.75, $5.25, $5.75 doz., dis. 10%.
Peck's, $8.00, $8.50, $9.00 doz. dis. 45%.
Ryder's, $8.00, $8.50. $9.00 doz., dis. 50%.

Claw Hatchets.

1. 2. 3.
Collins', $5.25, $5.75, $6.25 doz., dis. 10%.
Peck's, $9.00, $9.50 $10.00, doz., dis. 45%.
Ryder's, $9.00, $9.50, $10.00 doz., dis. 10%

Hatchets, Broad Single Bevel.

Collins', cut in., 5, $9.50; 5½., $10.00; 6, $10.50; 6½, $11.00; 7½. $11.50; dis. 10%.

Peck's, cut in., 4, $10.50; 4½, $11.50; 5, $13.00; 5½, $14.50; 6, $16.50; 6½, $18.00; 7½, $19.50; 8¼, $22.00; dis. 45%.

Ryder's, cut in., 5, $13.00; 5½, $14.50; 6, $16.50; 6½, $18.00; 7½, $19.50; dis. 50%.

Adzes.

	House. Half flat head. Dozen.	Ship spur poll. Dozen.	Discount. Per cent.
Collins'...	$14.00	$13.00	10
Peck's....	24.00	25.00	45
Ryder's...	24.00	25.00	50

Broad Axes—Pittsburgh Pattern.

5 to 8 pounds, $32.00 dozen.
7 to 9 pounds, $35.00 dozen.
8 to 10 pounds, $38.00 dozen.
9 to 12 pounds, $45.00 dozen.
Western pattern same price.

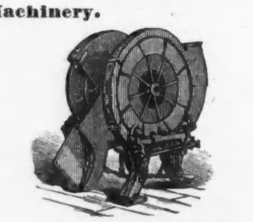
Spanish Pattern. Detumba round eye, $10.50 per doz.

Spanish Pattern Media labor, $12.25 per dozen.

Axle Grease.

Frazer's (2-lb. tins), per gross........................$18.00
2-lb. wooden boxes, " 12.00
Discount, 25 and 5 %.
Dixon's Everlasting, boxes 1 lb., per doz............ $1.20
" " " 2 lbs., " 2.00

Barrel Machinery.



Stave Jointers.

Single Whee Beer Keg Stave Jointer, 16 to 22 in.	8	8	$190
Double " " " " 16 " 22 "	8	8	330
Single Wheel Half Barrel " " 24 " 30 "	8	8	275
Double " " " " 24 " 30 "	8	8	440
Single " Barrel " " 30 " 36 "	8	8	330
Double " " " " 30 " 36 "	8	8	500
Double Independent Barrel Stave Jointer with Wheels, on separate shafts, but suspended in one frame, 30 to 36 in...........................	8	8	520
Single Wheel Barrel Stave Jointer, 32 to 38 in.	8	8	350
Double " " " " 32 to 38 ".	8	8	550
Double Independent Barrel Stave Jointer, 32 to 38 in....................................	8	8	575

Bellows.

Miner's Bellows: 24 in., $8.50; 26 in., $9.75; 28 in., $11.00; 30 in., $11.25; 32 in., $13.50.
60 and 5% dis.

Standard, each: 18 to 24 in., $10; 28 in., $12; 32 in., $14; 34 in. $16; 36 in., $18; 38 in., $20; 40 in., $23; 44 in., $32.
60 and 5% dis.

Hand Bellows, per doz.: 6 in., plain, $10; fancy, $20; 7 in., plain, $12; fancy, $24; 8 in., plain, $14; fancy, $28; 9 in., plain, $16; fancy, $32; 10 in., plain, $18; fancy, $36.
50% dis.

Belting. LEATHER BELTS.

Standard Manufacturers List.
Single belts per foot.

Width.		Width.		Width.	
1 inch	10	6 inch	.76	20 inch	2.84
1¼ "	13	7 "	.90	21 "	3.02
1½ "	17	8 "	1.02	22 "	3.20
1¾ "	20	9 "	1.15	23 "	3.37
2 "	23	10 "	1.29	24 "	3.54
2¼ "	26	11 "	1.42	26 "	3.92
2½ "	30	12 "	1.55	28 "	4.30
2¾ "	33	13 "	1.68	30 "	4.64
3 "	36	14 "	1.82	32 "	5.00
3½ "	43	15 "	1.98	34 "	5.35
4 "	50	16 "	2.14	36 "	5.70
4½ "	56	17 "	2.31	40 "	6.40
5 "	63	18 "	2.49	44 "	7.10
5½ "	70	19 "	2.66	48 "	7.80

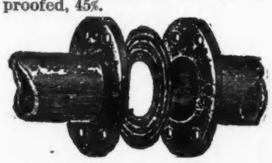
Double belts twice the price of single.
Discounts of Newark Leather Belting Co.

Dis. single and double belts, cemented, 50 and 5%.

Dis. single and double belts, riveted and cemented, 50 and 5%.

Dis. single belts, cemented and lacesewn, water proofed, 50%.

Dis. double belts, cemented and lacesewn, water proofed, 45%.



GASKETS.

Corrugated Copper.

Price, 2 cents per square inch, less 30 per cent. discount for home trade.

Less 60% discount for export trade.

Bolts.

Philadelphia Tire Bolt, with forged nuts.
Price per hundred.
Condensed list.

Length	1-8	3-16	7-32	1-4	5-16	3-8
1	$1·50	$1.50	$1.50	....	....	....
2	1·50	1.60	1.85	$2.25	$3.05	$5.00
3	....	1.90	2.25	2.75	3.65	5.80
4	....	....	....	3.25	4.25	6.60
5	....	....	....	....	4.90	7.40

Fractional sizes, intermediate prices.
Discount 80 and 25 %.

Common Carriage Bolts, price per hundred.

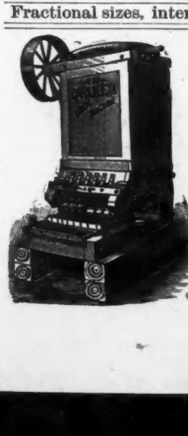
Length.	3-16 & 1-4	5-16	3-8	7-16	1-2	9-16 & 5-8	3-4
1 to 1½	$1.35	$1.60	$2.30	$3.10	$3.80	$7.50	
2	1.45	1.75	2.30	3.10	3.80	7.50	
3	1.65	2.05	2.70	3.60	4.44	7.50	$13.50
4	1.85	2.35	3.10	4.10	5.08	8.50	14.90
5	2.05	2.65	3.50	4.60	5.72	9.50	16.30
6	2.25	2.95	3.90	5.10	6.36	10.50	17.70
7	2.45	3.25	4.30	5.60	7.00	11.50	19.10
8	2.65	3.55	4.70	6.10	7.64	12.50	20.50
9	2.85	3.85	5.10	6.60	8.28	13.50	21.90
10	3.05	4.15	5.50	7.10	8.92	14.50	23.30
12	3.45	4.75	6.30	8.10	10.20	16.50	26.10
14	3.85	5.35	7.10	9.10	11.48	18.50	28.90
16	4.25	5.95	7.90	10.10	12.76	20.50	31.70

Fractional sizes, intermediate prices. Dis. 75 and 10%

Philadelphia Carriage Bolt, price per hundred.

Length	1-8, 3-16 & 1-4	5-16	3-8	7-16	1-2
1 inch.	$3.00	$4.00	$5.00	$7.40	$9.00
2 "	3.40	4.10	5.00	7.40	9.00
3 "	3.80	4.70	5.80	8.20	10.00
4 "	4.20	5.30	6.60	9.00	11.00
5 "	4.80	6.00	7.40	9.80	12.00
6 "	5.40	6.60	8.20	10.60	13.00
7 "	....	7.30	9.00	11.40	14.00
8 "	....	7.90	9.80	12.20	15.00
9 "	....	8.50	10.60	13.00	16.00
10 "	....	....	11.40	13.80	17.00
11 "	....	....	....	14.60	18.00

Fractional sizes, intermediate prices. Dis. 80 and 5 %.

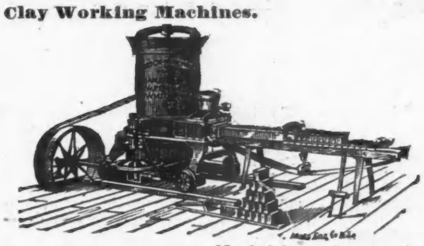


Brick Machinery.

BENNETT BROS. & CO.

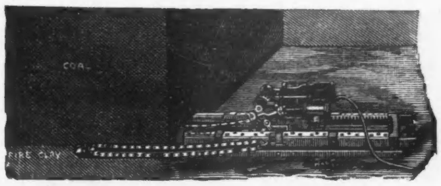
Heavy Steam Power Machine $525.00
Horse-Power Machines 300.00
Additional Horizontal Pugmill 225.00
Brick Moulds .... $2.50 to $3.00
Brick Trucks .... 5.00 to 13.50
Brick Barrows 7.25
Brick Barrows with Springs 8.25
Sand Barrows, steel tray 6.50

Clay Working Machines.



	No. brick per day.	Compl'te.
No. 10 D brick machine	50,000	$1,500
No. 10 S " "	30,000	1,200
No. 4 " "	40,000	1,100
No. 7 S " "	20,000	650
No. 6 S " "	15,000	575
No. 2 E. H. P. "	6,000	3,360

Coal Mining Machine.



Jeffrey.
6 feet undercut .... $1500 | 5 feet undercut $1400
Jeffrey Power Coal Drills.
Air feed drill .... $275 | Screw feed drill $200
Discount, 10%.

Cork Pullers.

The Samson Cork Puller, per dozen, $12 net.

Crucibles. E. H. Sargent & Co.

Battersea Crucibles, Triangular.

No.	Height. Inches.	Width. Inches.	Crucibles. Per doz.	Covers. Per doz.
S	4½	4⅛	$1.00	$0.50
T	4	3¾	0.80	0.50
U	3½	3¼	0.60	0.40
V	3¼	2⅞	0.45	0.40
W	2⅝	2⅝	0.35	0.30
X	2½	2¼	0.30	0.30
Y	2⅛	2⅛	0.25	0.30
Z	1¾	1¾	0.20	0.30

Battersea Muffles, any size, made to order.
See Illustration in advertisement.

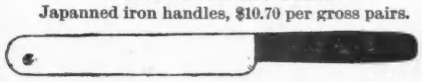
No.	Long. Inches.	Wide. Inches.	High. Inches.	Price. Each.
A	7	3½	2½	$ .60
B	7½	4⅜	2⅞	.75
C	8	4¾	3	.85
D	8½	5	3¼	1.00
E	9	5½	3⅝	1.15
F	10	6	4	1.25
G	11	4	3⅛	1.00
H	10½	5¼	3⅞	1.00
J	12	6	4	1.25
K	14	8	5	1.75
L	15	9	6	2.00

Export discount 15 %.

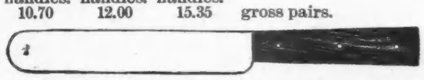
Cutlery.

(Tommins & Adams.)
TABLE KNIVES AND FORKS.

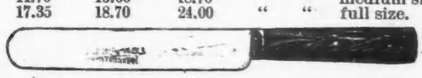
Japanned iron handles, $10.70 per gross pairs.



Cocobola handles.	Ebony handles.	Bone handles.	
10.70	12.00	15.35	gross pairs.



14.70	16.00	18.70	" " medium size.
17.35	18.70	24.00	" " full size.



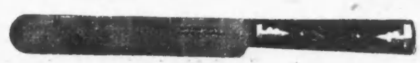
17.35	18.70	21.35	" " medium size.
20.00	21 35	26.70	" " full size.

22.70 24.00 29.35 " "

27.35 28.70 36.00 " "

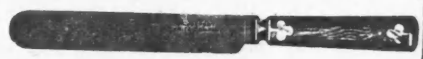
Cocobola handles.	Ebony handles.	Bone handles.	
28.00	29.35	38.00	" " gross pairs.

28.65 30.00 38.00 " "

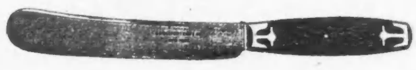


28.65 30.00 38.00 " "

32.00 33.35 41.35 " "



34.70 36.00 48.00 " "



33.35 34.70 46.70 " "

37.35 38.70 50.70 " "

40.00 41.35 53.35 " "

Hard rubber handles, 5.75 per dozen pairs.

Solid bone handles, 4.80 per dozen pairs.

Celluloid handles, 7.35 per dozen pairs.

Forks are made to match all above patterns, with either three or four prongs.

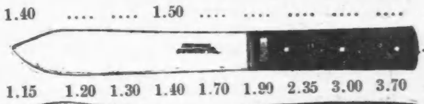
Discount 25 %.

BUTCHERS' KNIVES—COCOBOLA HANDLES.

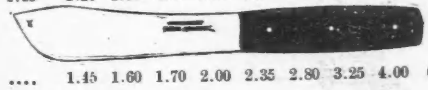
Per dozen.

4 and 4½ in.	5 in.	5½ in.	6 in.	6½ in.	7 in.	8 in.	9 in.	10 in.	12 in.
1.15	....	....	1.20	....	....	....	....	....	....

1.40	....	....	1.50	....	....	....	....	....	....

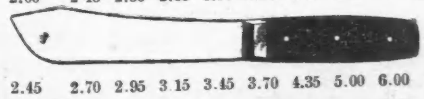


1.15	1.20	1.30	1.40	1.70	1.90	2.35	3.00	3.70	5.35

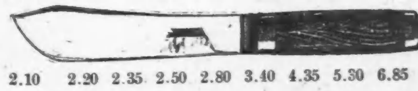


....	1.45	1.60	1.70	2.00	2.35	2.80	3.25	4.00	6.00

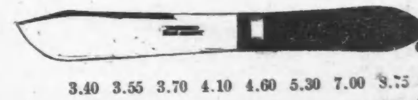
2.00	2.15	2.30	2.35	2.70	3.00	3.50	4.25	5.00	7.50



2.45	2.70	2.95	3.15	3.45	3.70	4.35	5.00	6.00	8.25



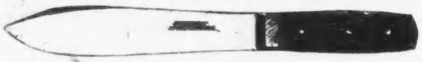
2.10	2.20	2.35	2.50	2.80	3.40	4.35	5.30	6.85	....



	3.40	3.55	3.70	4.10	4.60	5.30	7.00	8.75	11.75

.... 4.10 4.25 4.40 4.80 5.30 6.00 7.75 9.50 12.50

2.00 2.15 2.30 2.35 2.70 3.00 3.50 ....

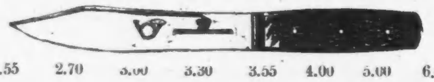


Discount 25 and 10 %.

HUNTING KNIVES—EBONY HANDLES.

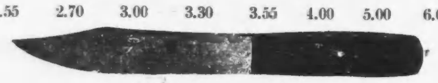
5 in. 5½ in. 6 in. 6½ in. 7 in. 8 in. 9 in. 10 in.
Per Dozen.
2.10 2.20 2.35 2.75 3.00 3.60 4.30 5.25

2.10 2.20 2.35 2.75 3.00 3.60 4.30 5.25



2.55 2.70 3.00 3.30 3.55 4.00 5.00 6.00

2.55 2.70 3.00 3.30 3.55 4.00 5.00 6.00

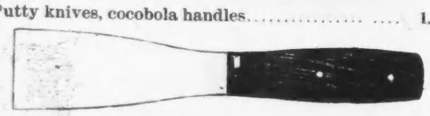


Discount, 25 and 10 %.

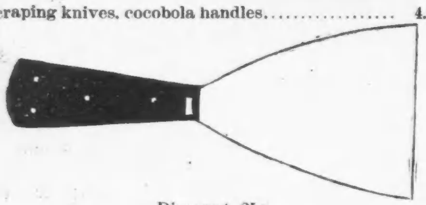
Per Dozen.

Putty knives, cocobola handles.................... $1.30

Putty knives, cocobola handles.................... 1.50



Scraping knives, cocobola handles.................... 4.00



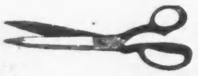
Discount, 25 %.

TAILORS' SHEARS—JAPANNED OR NICKEL HANDLES.

Per pair.
12 in.............. 6.00
12½ in.............. 7.00
13 in.............. 8.00
13½ in.............. 9.00
14 in.............. 10.00
14½ in.............. 11.00
in.............. 12.00 | 1... .... 14.00

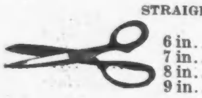
Discount, japanned, 60 %; nickle, 45 %.

BENT TRIMMERS.



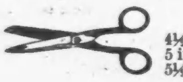
Per dozen.
6 in...... 13.00 | 10 n...... 27.00
7 in .. .. 15.00 | 11 in...... 30.00
8 in .. .. 17.00 | 12 in...... 33.00
9 in .. .. 22.00 |

STRAIGHT TRIMMERS.



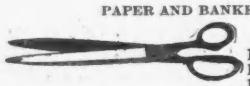
Per dozen,
6 in.......... 12.00 | 10 in.......... 25.00
7 in.......... 14.00 | 11 in.......... 30.00
8 in.......... 16.00 | 12 in.......... 33.00
9 in.......... 19.00 |

LADIES' SCISSORS.



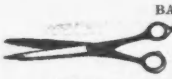
Per dozen.
4½ in....... 10.00 | 6 in....... 11.00
5 in....... 10.00 | 6½ in....... 12.00
5½ in....... 10.50 | 7 in....... 13.00

PAPER AND BANKERS' SHEARS.



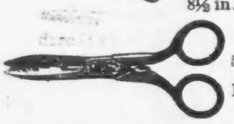
Per dozen.
9 in...18.00 | 13 in... 36.00
10 in...25.00 | 14 in... 42.00
11 in...27.00 | 16 in... 54.00
12 in...32.00 | 18 in... 20.00

BARBERS' SHEARS.



Per dozen.
7½ in....... 15.00 | 9 in....... 18.00
8 in....... 16.00 | 9½ in....... 20.00
8½ in....... 17.00

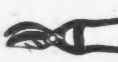
BUTTON-HOLE SCISSORS.



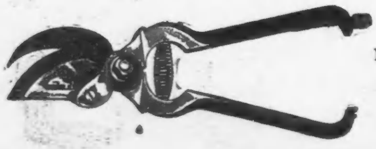
5 and 5½ in., 14.00 per dozen.

Discount, japanned, 70 and 10 % nickel, 60 and 10 %.

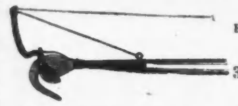
PRUNING SHEARS.



1 B., 9 in., 24 per dozen; 2 B., 8½ in., 21; 3 B., 7¾ in., 9.80.



No. 110, 10, $30.

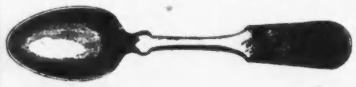


PRUNING SHEARS FOR LONG HANDLES.

No. 1, 36 per dozen; No. 2, 30.

Discount, 35%.

SPOONS, FORKS, ETC., BEST PLATE ON HARD WHITE METAL.



Tipped Tea Spoon.

Oval Tea Spoon.

Perfect Tea Spoon.

Leader Tea Spoon.

	——5 oz. or extra plate——		
	Tipd.	Oval.	Perfect leader.
Tea spoons	4.25	4.50	4.75 per doz.
Dessert spoons	7.50	8.00	8.50 " "
Table spoons	8.50	9.00	9.50 " "
Coffee spoons	4.25	4.50	4.75 " "
Dessert forks	7.50	8.00	8.50 " "
Medium forks	8.50	9.00	9.50 " "

Discount, 60 and 5%.

Spoons and forks, German silver, tipped pattern.

Tea spoons.	Table spoons.	Medium forks.
22..0	45.00	45.00 per gross.

Discount, 60 %.

Spoons and forks, made from brass, and silver plated on a coating of hard, white nickel.

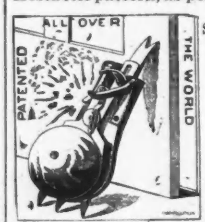
Aesthetic medium fork.

Tea spoons.	Table spoons.	Medium forks.
7.50	15.00	15.00 per gross.

Discount, 30 and 5 %.

Children's sets *on cards*.

	3 pcs.	4 pcs.	
Leader pattern, as per cut	21.00	24.00 doz.	60 and 5 %
Aesthetic pattern, as per cut	5.75	7.25 doz.	30 and 5 %



SAFETY AUTOMATIC BURGLAR ALARM AND DOOR FASTENER.

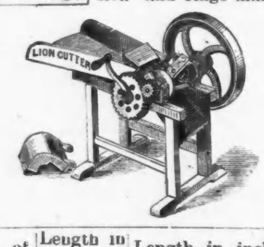
REQUIRES NO WINDING UP.

Per doz., $24. Dis., 40%.

The slightest push on the door explodes two caps in succession and rings alarm bell.

Cutters.

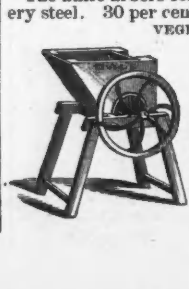
FEED.



No. of cutter.	No. of knives.	Length in inches of knives.	Length in inches of feed cut.	Price.
1	2	6¼	½, ¾ and 1⅛	$18.00
2	2	7¼	½, ¾ and 1⅛	21.00
2½	1	7¼	⅝, ⅞, 1¼ and 1¾	21.00
2½	2	7¼	5/16, 7/16, ⅝ and ⅞	23.00
3	1	8½	⅝, ⅞, 1¼ and 1¾	25.00
3	2	8½	5/16, 7/16, ⅝ and ⅞	27.00
4	1	10	⅝, ⅞, 1¼ and 1¾	30.00
4	2	10	5/16, 7/16, ⅝ and ⅞	33.00
5	2	10	7/16, ⅝, ⅞ and 1¼	35.00
6	2	11	7/16, ¾, 1¼ and 2	45.00
6½	2	11	7/16, ¾, 1¼ and 2	45.00
7	2	13	7/16, ¾, 1¼ and 2	60.00
7½	2	13	7/16, ¾, 1¼ and 2	60.00
10	2	16	7/16, ¾, 1¼ and 2	80.00
12	2	20	7/16, ¾, 1¼ and 2	100.00
11	2	11	7/16, ¾, 1¼ and 2	45.00
13	2	13	7/16, ¾, 1¼ and 2	60.00
16	2	16	7/16, ¾, 1¼ and 2	80.00
20	2	20	7/16, ¾, 1¼ and 2	100.00

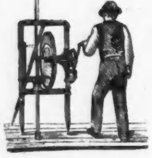
The knife arbors for all sizes are made of machinery steel. 30 per cent. dis.

VEGETABLE—GALE'S.



Size.	Weight of Fly Wheel. Pounds.	Will cut per hour. Pounds.	Price
No. 1½	20	1,500	$12
No. 2½	32	1,700	15
No. 3½	32	1,700	15
No. 4	42	2,000	18
No. 5	50	3,000	25
No. 10	65	8,000	35

30% dis.



Drill—Portable Hand Rock.

Price, $225.

Dis., 20%.

Duck and Twine.

Baltimore T. & N. Co.—22-inch, Hard, Medium and Soft.

No.	Weight per yd.	Cents, per yd.	No.	Weight per yd.	Cents, per yd.
0...	19 oz.	35	6...	13 oz.	26
1...	18 "	33	7...	12 "	25
2...	17 "	32	8...	11 "	23
3...	16 "	30	9...	10 "	21
4...	15 "	28	10...	9 "	20
5...	14 "	27			

Ravens, 28½-inch.—Eight ounce, 15 cents per yard Ten ounce, 19 cents per yard; twelve ounce, 22 cents per yard; Fifteen ounce, 27 cents per yard. Dis. 25 and 1%.

Cotton Sail Twine.—Three-fold and upward, 17 to 20 cents per pound. Dis. 3%.

Electroplate.—Babcock & Co.'s.

Dis. 60 and 2%.

CASTERS.

1,200—Dinner

232—Breakfast.

Dinner Casters.

No. 1,200. 17½ in. high, $8.00, quadruple plate.
No. 80. 17 in., $6.00, quadruple plate.
No. 140. 16 in., $7.50, " "
No. 830. 16 in., $5.00, " " Plain, 50 cents less.
No. 25. 16 in., $4.00, double plate.
No. 33. 16 in., $3.75, " "
No. 53. 15 in., $3.00, " "
No. 15½. 14½ in., $2.00, single plate.
No. 19. 14½ in., $1.85, " "
No. 40. 14 in., $1.75, " "

No. 681.

Breakfast Casters.

No. 231. 10 in. high, $4.00, quadruple plate.
No. 232. 12 in. high, $6.00, quadruple plate.
No. 13. 12 in. high, $2.25, double plate.
No. 12. 10½ in. high, $1.75, single plate.

CAKE BASKETS.

Quadruple Plate.

No. 448. 7 in. high-chased, $16; gold lined, $17.
No. 690. 7½ in. high, chased, $7; gold lined, $8.
No. 686. 6½ in. high-chased, $4.50; gold lined, $5.50.
No. 681. 6 in. high, chased, $3; gold lined, $3.50.

BUTTER DISHES.

No. 126. 11 inches high, $5.50.
No. 127. 7 inches high, $5.50.
No. 75. 8 inches high, $1.85.
No. 78. 7½ inches high, $2.00.

Discount.

No. 90.

CHILD'S SETS.

No. 90. Satin lined case, cup, saucer, knife, fork and spoon, $2.25.

No. 41. Cup, gold-lined, in fancy case, $1.15.

No. 43. Cup and saucer, gold-lined, fancy case, $1.15.

FLAT WARE.

Calla Lily, Empress, Windsor and Olive Patterns, 18 Per Cent Nickel Silver Base.

	Extra plate, per doz.	Double plate, per doz.	Triple plate, per doz.
Tea spoons	$4.75	$6.00	$7.25
Dessert spoons	8.50	10.50	12.50
Table spoons	9.50	12.50	14.50
French coffee spoons	4.75	6.00	7.25
Berry or nut spoons	24.00	30.00	36.00
Bar spoons, small	4.75	6.00	7.25
Dessert forks	8.50	10.50	12.50
Medium forks	9.50	12.00	14.50
Oyster forks	7.00	9.00	11.00
Sugar shells	9.00	11.00	13.00
Sugar tongs	25.50	31.50	37.50
Butter knives, twist or reversed handles	10.50	12.50	14.50
Nut picks	4.75	6.00	7.25
Pie knives, engraved blades	42.00	51.00	60.00
Soup ladles	48.00	60.00	72.00

PICKLE DISHES.

No. 144. 12 in. high, $3.50

No. 66. 10½ in. high, $2; assorted colored glass.

No. 155. 12 in. high, $4; assorted colored glass.

No. 146. 12½ in. high, $9; hand decorated glass.

No. 156. 12½ in. high, $6; hand decorated glass.

No. 146.

No. 255.

TEA SETS.

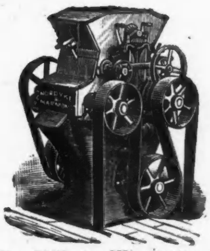
No. 255. 6 pieces, $35, quadruple plate.

No. 391. 4 pieces, $23, quadruple plate.

No. 1847. 6 pieces, $42, quadruple plate.

Flouring Mill Machinery.

Nordyke & Marmon Co.



Roller Mills for Wheat r'lour.
Prices of Double and Single Roller Mills.

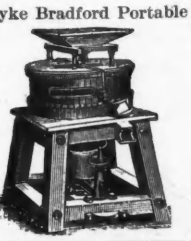
Size.	All smooth.	½ Corrug. ½ smooth.	All corrug.	Single machines. Corrug.	Single machines. Smooth.
6 × 12	$465	$475	$480	......	......
6 × 16	515	525	530	......	......
6 × 20	565	575	580	......	......
7 × 14	515	525	530	......	......
7 × 18	560	570	575	......	......
7 × 24	635	645	650	......	......
9 × 18	625	640	650	$350	$335
9 × 24	700	720	735	390	375
9 × 30	785	810	830	440	420

20-inch New Era Mill for Wheat, Corn, and Middlings.

Size. Inch.	Power. H. P.	Pulley. Inch.	Capacity Bush.
20	4 to 10	14 × 7	12 to 40

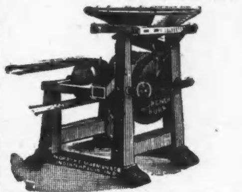
Speed.	Weight. Lbs.	Price.
500 to 800	660	$150

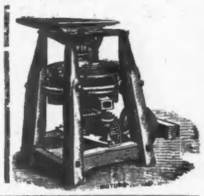
The Nordyke Bradford Portable Mill.



Size of stones, In.	Grinding capacity. Corn, bu. per hour.	Grinding capacity. Wheat bu. per hour.	Horse-power.	Weights. Sing'l gear.	Weights. Double gear.	Pulley mill.	Geared mills. Iron wh'ls.	Geared mills. Mortise wh'ls.
18	8 to 10	....	4	550	625	$130	$165	$180
20	10 to 12	....	5	600	700	140	175	190
22	12 to 15	....	5	700	850	160	190	210
24	15 to 18	....	6	900	1050	175	210	225
26	18 to 20	8 to 10	8	1200	1400	185	225	250
30	20 to 25	10 to 12	10	1500	1700	225	265	290
36	25 to 30	14 to 17	12	1800	2100	315	355	380
42	35 to 40	19 to 21	15	2000	2300	390	435	460

Farm and Plantations Mills.





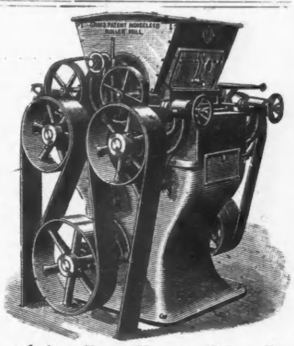
Diameter of burrs.	Power to drive.	Size of pulley.	Capacity per hour.	Revolutions per minute.	Weight.	Price.
	H. P.					
14 in.	2 to 4	9×5½	4 to 14 bushels	600 to 1200	370 lbs.	$100
18 in.	4 to 10	11×6½	8 to 40 bushels	400 to 700	600 lbs.	130

The Dixey Mill—Stiff Spindle Style.

Size.	Power.	Capacity.	Weight. Pulley.	Weight. Geared	Pulley.	Iron gear.	Mortise gear.
18	4 to 6 H.P.	8 to 25 bu	560 lbs	650	$130	$165	$180
22	6 to 8 "	12 to 30 "	800 "	1000	165	200	225
26	8 to 12 "	16 to 40 "	1100 "	1500	185	220	245
30	10 to 15 "	25 to 60 "	1300 "	1700	215	255	280

Flour Mills.

E. P. Allis & Co.

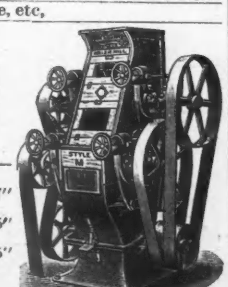


Gray's pat. noiseless belt roller-mills, porcelain rolls.

Size of Rolls.	Height.	Length.	Width.	Driving pulley.	Revolutions per minute.	Approximate power required.	Length of driving belt above floor.	Approximate shipping weight.	Price
14″ × 16″ single...	5′ 7″	3′ 2″	4′ 5″	20″ × 6¼″	200 to 300	1¾ to 2½ H. P.	16′ 3″	2,700 lbs.	$600.00
14″ × 16″ double...	5′ 10″	3′ 6″	5′ 10″	20″ × 6¼″	200 " 300	3 " 4 H. P.	19′ 3″	4,000 "	800.00
9″ × 14″	5′ 1½″	3′ 10″	3′ 10″	12″ × 5¼″	300 " 400	1½ " 2½ H. P.	16′ 6″	2,700 "	580.00
With corrugated chilled iron rolls.									
9″ × 14″	5′ 1½″	3′ 10″	3′ 10″	12″ × 5¼″	300 to 400	1½ to 2½ H. P.	16′ 6″	2,700 lbs.	$600.00
With Wegmann's patent porcelain rolls.									
9″ × 14″	5′ 1½″	3′ 10″	3′ 10″	12″ × 5¼″	300 to 400	1½ to 2½ H. P.	16′ 6″	2,700 lbs.	$650.00
Divided four roller machines.									
9″ × 14″ .... 1-pr. cor. 1-pr. sm.	5′ 1½″	3′ 10″	3′ 10″	12″ × 5¼″	300 to 400	1½ to 2½ H. P.	16′ 6″	2,700 lbs.	$590.00
9″ × 14″ .... 1-pr. sm. 1-pr. por.	5′ 1½″	3′ 10″	3′ 10″	12″ × 5¼″	300 to 400	1½ to 2½ H. P.	16′ 6″	2,700 lbs.	615.00
9″ × 14″ .... 1-pr. cor. 1-pr. por.	5′ 1½″	3′ 10″	3′ 10″	12″ × 5¼″	300 to 400	1½ to 2½ H. P.	16′ 6″	2,700 lbs.	625.00

For grinding corn, feed, rye, etc,

Size.	Height.	Width.	Length.
6″ × 12″...	4′ 6″	3′ 5″	2′ 7″
9″ × 14″...	5′ 8″	3′ 10″	3′ 5″
9″ × 18″...	5′ 8″	4′ 9″	3′ 5″
9″ × 24″...	5′ 8″	5′ 6″	3′



Driving pulley.	Revolutions per minute.	Length of belt above floor.	Approximate shipping weight.	Price.
10″ × 5¼″	400 to 500	14′	....	$500.00
14″ × 6¼″	350 to 450	18′	2600 lb.	600.00
14″ × 7¼″	350 to 450	18′	3050 lb.	650.00
14″ × 8¼″	350 to 450	18′	3350 lb.	735.00

Flue Cleaner.

Hurley's Automatic Steam Flue Cleaner.

No.	Outside diam. of tubes.	With hose clamps.	Globe Valves.	Best 4-ply steam hose. Per foot.
1	1½ to 2	$5.00	½, 95 cents	¾, 67 cents.
2	2 to 2½	6.25	½, 95 cents	¾, 67 cents.
3	2½ to 3	7.50	¾, $1.30	¾, 67 cents.
4	3 to 3½	8.75	1, 1.75	1¼, 83 cents.
5	3½ to 4½	10.00	1¼ 2.90	1¼, $1.04½

Dis. on flue cleaners, 60 and 70%.

Dis. on steam hose, 50%, good to 90 lbs steam.

Forges (Portable).

Fairbanks.

No. 2c, weight, 155 lbs. 21 × 27 hearth........ $42.00
" 3a, " 80 " 18 in. diam. hearth.......... 27.00
" 3b, " 75 " 18 " " " 24.00
" 3c, " 85 " 18 " " " 30.00
" 6a, " 45 " 14 " " " 18.00
" 6B, " 45 " 14 " " " 16.00

Dis. 60%.

No. 1, 18 in. bellows, $20; No. 2, 20 in. bellows, 25; No. 3, 22 in. bellows, $30.

20% dis.

Stationary.

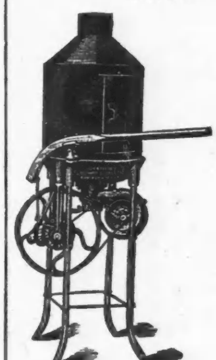
27 in. bellows, $21; 30 in. bellows, $25; 33 in. bellows, $33; 36 in. bellows, $45.

20% dis.

Riveting F...ges.

Bellows, 18 in., 20 in., 22 in., 24 in., $8.00. $10.00. $13.00. $17.00.

20% dis.



Light work, 12 × 17; height, 15 in., $16.00.

Same, with Hood, 12 × 17; height, 28 in., $20.00.

Bridge, Boiler or Railroad work, Pan, 17 × 19; height, 29 in.; Fan, 8 in., $27.00.

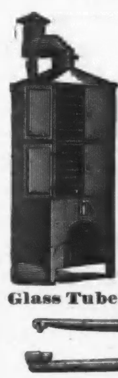
Same, with Hood, $30.00.

Water Tank, $4.00 extra.

Iron Fire Ring Round Tuyere $1.00 extra.

50% dis.

Fruit Evaporator.



No. 1. Evaporator........................ $30

No. 2. Fruit Drier and Baker, with Bleacher attachment. Weight, 225 lbs. Capacity, 5 to 7 bushels apples per day; 24 in. deep, 26 in. wide, 5½ ft. high; 12 tiays, 22 22; 40 square feet drying surface. Complete $50

No. 3. Capacity, 15 to 20 bushels per day.......................... 100

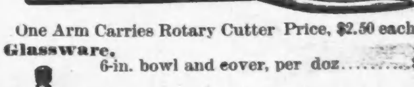
No. 4. Capacity, 20 to 30 bushels per day.......................... 16

Dis., No. 1, 3 and 4 = 20%.
" 2 = 30%

Boxing, extra:
No. 1, $3.00; No. 2, $5.00; No. 3, $7.50; No. 4, $12.50.

Freight to New York:
No. 1, $4.00; No. 2, $6.00; No. 3, $12.00; No. 4, $18.00.

Glass Tube Cutters.



One Arm Carries Rotary Cutter Price, $2.50 each.

Glassware.

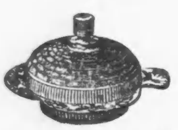
6-in. bowl and cover, per doz.......... $3.25
7-in. " " " 4.50
8-in. " " " 6.00
9-in. " " " 8.00
10-in. " " " 10.50

Net.

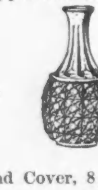
Nappy, 4½-inch., per doz., 50c.; 6-inch., per doz., $2; 7-inch., per doz., $3; 8-inch., per doz., $4.

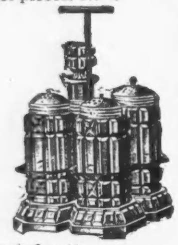
Cream Pitcher, 1 pint, per doz., $1.25; one quart, per doz., $3.50; 3 pints, per doz., $4.50.

Pint Pitcher, per doz., $1.50; quart pitcher, per doz., $2; ½ gallon pitcher, per doz., $3; 3 quart pitcher per oz., $4.50.



Flange Butter and Cover, per doz., $1.75.
Water Set, per doz., sets of 60 pieces, $7.50.





Cheese Dish and Cover, 8 in., per doz., $4.50.

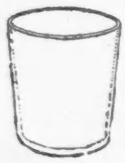
Quart Water Bottle, per doz., $4.50.

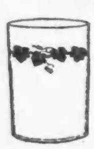
Ind. Salts; per gross, $2.00. Assorted patterns.
4 Bottle Castors, per doz., $7.50; 3 bottle, per doz., $4.50.

Berry Dish, 4½-inch, per doz., 50c.; 10-inch, per doz., $4.
Butter Dish and Cover, per doz., $1.25.
Butter Dish and Cover, per doz., 75c.

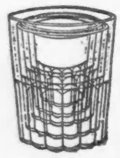
Candlesticks, per doz., $2.00. Glass Slipper for Flowers, per doz., 50 cents; slipper and tray, per doz., $1. Jam Jar and Cover, 1 qt., per doz., $2.50; ½ gal., per doz., $3.25; ¾ gal., per doz., $4; 1 gal., per doz., $5; 1½ gals., $9; 2 gals., per doz., $12. Pocket Flask, 1 pint, $1.

Tumblers.
1⅜ oz., per doz., 50 cents.
8 " " 75



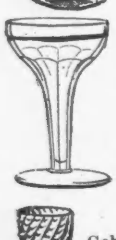


9 oz., per doz., $2.75.



11 oz., assorted patterns, per doz., 30 cts.

9½ oz., assorted patterns, per doz., 25 cts.



1 oz. to 12 oz., nested for shipping, per doz. nest, $2.

Goblets, banded, per doz., 65 cents.

Claret to match, per doz., 55 cents.

Wines, to match, per doz., 50 cents.

Cordials, to match, per 45 cents.

Goblets, per doz., 50 cts.
Claret, " 50 "
Wine, " 35 "

Banded, open, hollow stem.

Champagne, per doz., $1.25.

½ Pt. tumbler, per doz. 55 cts.

½ Pt. mug to match, " 65 "

Goblet, " 50 "

Spoon holder, cream pitcher, sugar, butter dish to match.

Sets of 4 pieces, per doz. sets, 48 pieces, $3.75.

Hammers.

H. Cheney Hammer Co.

Adz-eye Hammers.—Per Dozen.

No.	Weight.		No.	Weight.	
5. Round.	1 lb., 4 oz.	$9.00	7½. Round.	13 oz...	$8.00
7. "	1 lb.......	8.50	8 "	7 oz....	7.50

Adz-eye Hammers.—Per Dozen.

No. 17. Octagon. weight, 1 lb., 4 oz............$9.00

Adz-eye Hammers.—Patent Nail Holder.—Per Dozen.

No.	Weight.		No.	Weight.	
33. Bell-face.	1 lb., 4 oz.	$9.50	35. Round h.	1 lb., 4 oz	$9.50
34. "	1 lb.	9.00	36. "	1 lb.......	9.00

Adz-eye Hammers.—Bell Face.—Per Dozen.

No.	Weight.		No.	Weight.	
37.	1 lb., 4 oz......	$9.00	38½.	13 oz..........	$8.00
38.	1 lb.............	8.50	39½.	7 oz..........	7.50

Farriers' Hammers.—Per Dozen.

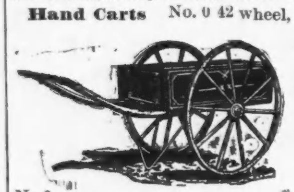
No.		Weight.	
55.	Adz-eye. Octagon.	9 oz.....	$7.75
56.	" "	7 oz.....	7.50
57.	Plain. "	7 oz.....	6 25
58.	Plain Brad.	4 oz.....	5 50
60.	Adz-eye, Round Head.	7 oz.....	7 50
61.	" Octagon. Boston pattern	10 oz.....	8.00
62.	" " "	7 oz.....	7 50

Machinists' Ball Pein Hammers.—Octagon.—Per Dozen.

No.	Weight.		No.	Weight.	
90.	3 lbs............	$22.00	94.	1 lb., 4 oz......	$13 50
90½.	3 lbs., 8 oz.....	19.00	95.	1 lb............	12.50
91.	4 lbs., 4 oz	17.50	96.	12 oz............	12.00
92.	2 lbs....	16.50	97.	8 oz............	12.00
92½.	1 lb., 12 oz.....	15.50	98.	6 oz............	12.00
93.	1 lb., 8 oz ...	14.50			

Discount, 35 and 5 per cent. Net Cash, 30 days. 10 per cent. Cash, 10 days. Cases at Cost.

Hand Carts No. 0 42 wheel, 1 in. tread, 1 in. axle box 48x28x10 deep, $10.50.



No. 1, 36 wheel, 1 in. tread, ⅞ in. axle, box 40x23x10 deep, $9.00.

No. 2, 30 wheel, ¾ in tread, ¾ in. axle, box 32x20x9 deep, $8.25.

With Wagon-Seat Spring.

No. 6, same sizes as No 0.........................$12.00
" 7, same sizes as No. 1......................... 10.50
" 8, " " " No. 2......................... 9.75

With Third Wheel, Without Springs.

No. 3, same sizes as No. 0.........................$12.00
" 4, " " " No. 1......................... 10.50
" 5, " " " No. 2......................... 9.5

Handles. Doz.

Extra, Axe 36-inch.........................$1.90
No. 1..........$1.50 | No 2.......... 1.10
Extra, Axe, Boys, 26 and 28 inch.......... 1.25
No. 1..........$1.15 | No. 2.......... 85
Extra, Axe, Broad or Squaring.......... 2.00
No. 1..........$1.50 | No. 2.......... 1.25
Extra, Adz Colonial, Ship and R. R., 34 and 32-inch. 2.00
No. 1..........$1.60 | No. 2.......... 1.25
Extra, Pick R. R., 36-inch.......... 2.00
No. 1..........$1.40 | No. 2.......... 1.10
Extra, Pick Square Eye Miners' 34, 33 and 32-inch. } 2.00
Extra, Square Eye Driving 34, 33 and 32-inch....... }
No. 1..........$1.50 | No. 2.......... 1.25
Extra, Pick Square or Oval Eye Miners' or Drifting Pick, 34 and 32-inch.......... 2.00
No. 1..........$1.45 | No. 2.......... 1.20

Sledge Hammer, Tool, Maul, Straight Taper.

			Extra.				Extra.
24-in......	No. 1,	$ 65;	$ 80	34-in......	No. 1,	$ 95;	$1.10
26-in......	No. 1	75;	90	36-in......	No. 1,	1.05;	1.20
28-in......	No. 1,	80;	95	38-in......	No. 1,	1.15;	1.30
30-in......	No. 1,	85;	1.00	40-in......	No. 1,	1.35;	1.40
32-in......	No. 1,	90;	1.05	42-in......	No. 1,	1.60;	1.75

Blacksmith Hammer, Machinist Hammer, Hand Hammer.

	Per. doz.	Extra.		Per doz.	Extra.
14-in........	No. 1, 35c.;	45c.	20-in........	No. 1, 65c.;	75c.
16-in........	No. 1, 45c.;	55c.	22-in........	No. 1, 70c.;	80c.
18-in........	No. 1, 55c.;	65c.	24-in........	No. 1, 75c.;	85c.

Adze Eye and Round Eye Hammer, 12, 13, 14, 15 in., per doz.......... 30c.
Shingling and Lath Hatchet, 12, 13, 14, 15 in., per doz. 30c.

Broad Hatchet.

	Per doz.		Per doz.
16-in..................	50c.	18-in..................	55c.
17-in..................	50c.	19-in..................	55c.

Dis., 10.10 and 2 %.

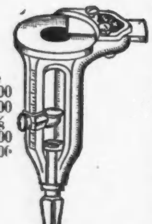
Hardware Specialties.

AUGERS.

Patent Adjustable Hollow.

Cuts from ¼ to 1¼, pivoted jaws, graduated scale to 1-16ths, per doz., $60.00.

Discount, 15 and 10%.



Patent Hollow Auger.

Inch..........	5–16	⅜	7–16	½
With bits....	12.00	12.00	12.00	12.00
Without bits	8.00	8.00	8.00	8.00

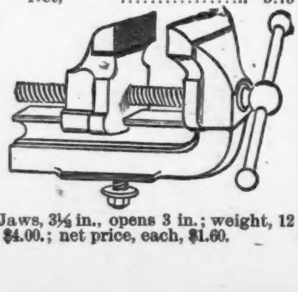
9–16	⅝	¾	⅞	1	1⅛
14.00	14.00	14.00	16.00	16.00	20.00
9.00	9.00	9.00	13.00	13.00	14.00

1¼	1⅜	1½
20.00	24.00	24.00
14.00	16.00	15.00

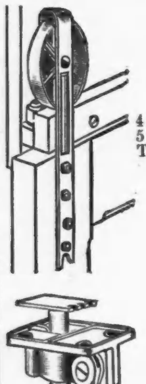
Discount, 15 and 10%.

BENCH DRILL.

Adjustable bed plate.
26½ high drills to ½ in. hole, 3½ run of screw.
List price, each..................$10.00
Net, " 3.75



Bench Vise, Steel Jaws, 3½ in., opens 3 in.; weight, 12 lbs.; list price, each, $4.00.; net price, each, $1.60.

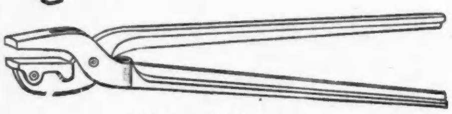


BARN DOOR HANGER.

4 in., per doz. pairs..................$12.00
5 " " " 14.40
Track, per foot.................. .08
One dozen pairs in case.
Dis., 50%.

BENCH HOOK.

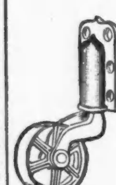
Patent, adjustable and reversible
List $9 dozen, ½ dozen in box.
Discount, 20 and 10%.



BLACKSMITH'S TONGS.

Swivel Jaw.

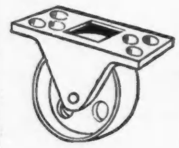
No. 1, 16 in., per doz..................$10.00
" 2, 18 " " 10.00
Dis. 20%.



CASTERS.

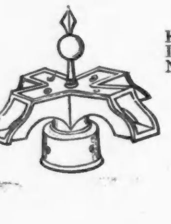
Swivel Store Truck.

No. 20, japanned, 4 in. wheel, each..... .55
No. 25, " 5 " " " ..... .75
Noiseless turned wheel.
No. 30, japanned, 4 in. wheel, each..... 1.30
No. 35, " 5 " " " 1.60
Discount, 25%.



Store Truck, stationary.

No. 50, 5-inch wheel, 1½ inch wide, each, $1.05.
No. 60, 5-inch, extra heavy, 1½ inch wide, each $1.50.
Discount, 25%.



CLOTHES REEL.

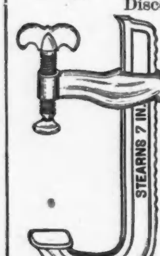
Extra heavy, gray iron, japanned.
List per doz..................$15.00
Net " 7.00

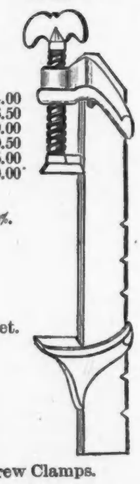
JACK SCREWS.

New pattern wrought iron screw.

No.	Rise of screw.	High.	Diameter screw.	Price.
20	4½ in.	10 in.	2 in.	$4.50
25	6½ "	12 "	2 "	5.25
30	8½ "	14 "	2 "	5.75
3	11½ "	16 "	2 "	6.50

Discount, 40%.





SCREW CLAMPS.

Adjustable.

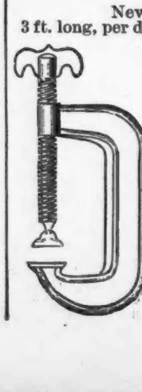
3 in., per doz.....$4.00
5 " " 6.50
7 " " 9.00
9 " " 10.50
12 " " 15.00
16 " " 20.00

½ doz. in box.
Discount, 20 and 10%.

CLAMPS.

New Door Frame.

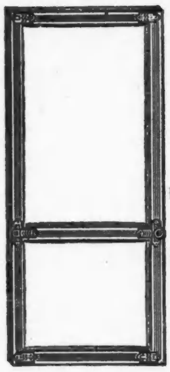
3 ft. long, per doz., $8 list; $5 per doz. net.



Malleable Iron Screw Clamps.

	Per Doz.		Per Doz.
3 in............	$7.00	7 in............	$20.00
4 "	10.00	8 "	25.00
5 "	12.00	9 "	27.50
6 "	16.00	10 "	30.00

3, 4, 5, 6 in., ½ doz. in box.
Dis., 70%.



DOOR SCREEN FRAMES.

Patent Corners.

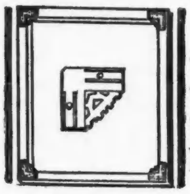
No. 22, 3 by 7 ft. sticks, ⅞ by 2, per loz. sets, $11.

No. 24, 3½ by 8 ft. sticks, ⅞ by 2, per doz. sets, $12.

No. 26, 3 by 7 ft. sticks, ⅞ by 2½, per doz. sets, $12.50.

No. 28, 3½ by 8 ft. sticks, ⅞ by 2½, per doz. sets, $14.50.

Dis., 20%.



WINDOW SCREEN FRAMES.

Patent Japanned Corners.

No.25, 36 by 36 corners and screws, without bead, per doz., $2.50.

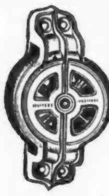
No.25, 36 by 36 corners and screws, with bead, per doz., $2.90.

No.35, 42 by 42 corners and screws, without bead, per doz., $2.90.

No.35, 42 by 42 corners and screws, with bead, per doz., $3.30.

Black satin stain, sticks ⅞ by 1 in.

Dis., 20 %.



PULLEYS.

Side, No. 45, Japanned.

Inches...	1	1¼	2	2½	3	4	5
Per doz..	.90	1.00	1.60	2.40	3.50	9.00	15.00

2 inch and under, 2 dozen in box: 2½, 3 and 4, 1 dozen in box; 5 inch, ½ dozen in box.

Discount, 50%.

PULLEY HOOK (New Floor.)

Deep cut thread, forged point.

Per doz.

¾ in. wrought iron, 8 in. long, list........ $1.90
net........ 1.00

WELL WHEEL.

New pattern.

Japanned.

In.	8	10	12	14	16
Pr.d.	7.00	9.50	12.50	20.00	30.00

Discount, 70%.

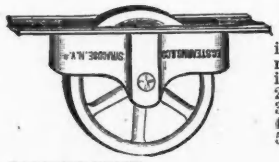
HAY FORK PULLEY.

New pattern.

No. 15, 5 in. iron wheel..........per doz. $4.50
25, 5 in. wood " .... " 4.50
66, 6 in. " .... " 6.00

4 dozen in case, 8 dozen in barrel.

No. 15, per dozen, $2 net.



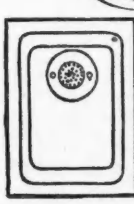
SHEAVES.

Patent Common

Turned and polished iron wheels, round corners, brass pin, one set in box.

2½ inch.......... $1.50
3 " 1.60
4 " 2.00
5 " 2.60

Discount, 50%.



SINKS.

All 6 inch deep.

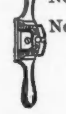
14 × 20 in....	$1.50	18 × 30 in....	$2.50
15 × 25 in....	1.75	18 × 32 in....	3.00
15 × 27 in....	2.00	18 × 36 in....	3.00
16 × 24 in....	1.80	20 × 30 in....	3.00
16 × 28 in....	2.10	20 × 36 in....	3.70
17 × 30 in....	2.25	20 × 40 in....	4.00
18 × 24 in....	2.10		

Discount, 60%.

SPOKE POINTERS.

Per doz.

No. 1, points 1⅞ in. diameter, $9.00



No. 2, points 2⅜ in. diameter, $15.00

Discount, 15 and 10%.

½ dozen in box.

VISE.

(Bench Vise, Steel Jaws.)

3½ in. opens 5 in., weight 12 lbs.

List price, each. $4.00
Net " " .. 1.60

Silent Saw Vise.

No. 10., 10 in. jaw, per doz.... $15.00

Dis., 33⅓%.

Moore & Barnet Mfg. Co.

No.		per dz.	per gr., lbs.	No.	per dz.	gr., lbs.
1	Amateur vise......	$2.25	70	Clamp.		
Anvil.				1½..............	3.00	80
2	....	3.75	200	2½..............	5.00	220
3	....	11.25	615	3½..............	11.25	700
4	....	18.00	1,350	4½..............	21.00	1,425
10	....	24.00	1,675	Combination hand.........	5.25	85

Spot cash discount, 33, 20 and 2, f.o.b.

Nos. 1, 1½, 2 and 2½ are packed in dozens; Nos. 3 and 3½ in half dozens; Nos. 4, 4½ and 10 in quarter dozens, and No. 20 singly. Each hand vise is put up in neat box and packed in half dozen lots.

1 Hinge pipe vise, 0 to 2 in. pipe................Each $10.00
2 " " " 0 to 4 in. pipe.................... 20.00
1 Malleable pipe vise, 0 to 2 in. pipe.................. 8.00
1 Combination pipe and bench vise, 0 to 2 in. pipe... 16.00

Discount, 50%.

WRENCHES.

Coes' Knife Handle Wrenches.

BLACK.

Size.	₩ doz.	Size.	₩ doz.
6 inch...............	$9.00	15 inch..............	$24.00
8 "	10.00	18 "	30.00
10 "	12.00	21 "	36.00
12 "	14.00		

BRIGHT.

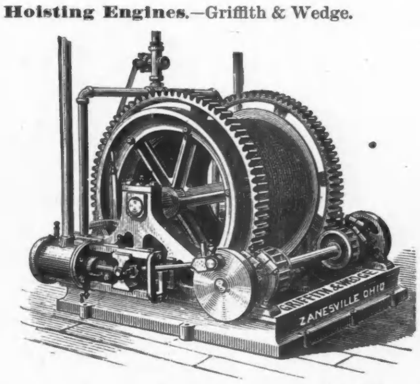
4 inch..............	$10.00	12 inch..............	$16.00
6 "	10.00	15 "	26.00
8 "	11.00	18 "	32.00
10 "	14.00	21 "	38.00

Discount, 55, 10, 7½ and 3 %.

Coes Mechanics' Screw Wrenches, same list, less 55, 10, 10, 7½ and 3 %.

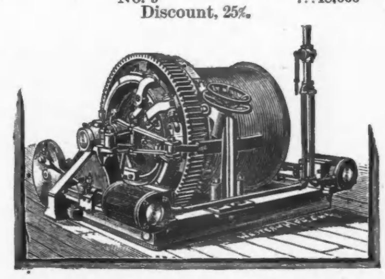
A. G. Coes & Co. Pat. Screw Wrenches, same list as above. Discount, 55, 10, 7½ and 3%.

Hoisting Engines.—Griffith & Wedge.



	Weight.	$
Hoisting Engines, Miner's Prospecting.....	4,500	750
Hoisting Engines, No. 1 Double Cylinder...	4,500	800
Discount, 20%.		
" " No. 2 Double Cylinder...	6,000	1,000
" " No. 3 " " ...	11,000	1,550
" " No. 4 " " ...	15,500	1,800
" " No. 5 " " ...	17,000	2,100
" " No. 6 " " ...	13,600	1,750
" " No. 7 " " ...	17,000	2,100
" " No. 8 " " ...	19,000	2,400
" " No. 9 " " ...	48,000	4,500

Discount, 25%.



Webster, Camp & Lane Machine Co.

Single drum.	No.	Average Load. Pounds.	Approx. weight, complete. Pounds.	Double drum.
$825.00 =	5	1,950	6,000 =	....
918.50 =	6	1,650	6,500 =	....
1,177.00 =	7	2,200	8,000 =	$1,661.00
1,331.00 =	8	3,000	8,500 =	1,815.00
1,694.00 =	9	3,500	14,000 =	2,722 50
1,914.00 =	16½	3,700	16,000 =	3,124 00
2,343.00 =	17½	5,500	19,000 =	3,333.00
2,475.00 =	18	5,500	22,000 =	3,872.00

Ice Machines (Family).

L. Dermingny & Co.

No. 1, Ice machine, ice and ice cream molds, 1 lb. ice, $15.00.

No. 2, Ice machine, ice and ice cream molds, 1½ lbs. ice, $20.00.

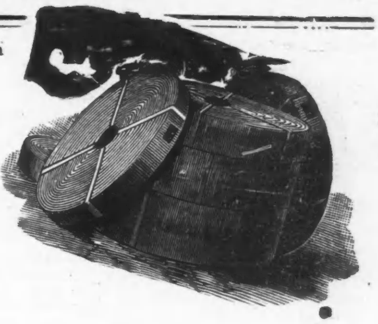
No. 3, Ice machine, ice and ice cream molds, 1 carafe 1 bottle holder, 2 lbs. ice, $26.50.

No. 4, Ice machine, ice and ice cream molds, 2 carafe 1 bottle holder, 4 lbs. ice, $33.00.

No. 5, Ice machine, ice and ice cream molds, 3 carafe 1 bottle holder, 6 lbs. ice, $40.00.

No. 6, Ice machine, ice and ice cream molds, 4 carafe 1 bottle holder, 9 lbs. ice, $46.50.

India

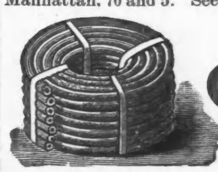


RUBBER BELTING.

Inches.	2 ply per foot.	3 ply per foot.	4 ply per foot.	5 ply per foot.	6 ply per foot.
1	$0.07	....	....	....	....
1¼	0.09	....	....	....	....
1½	0.11	....	....	....	....
2	0.15	$0.17	$0.21	....	....
2½	0.18	0.22	0.26	....	....
3	0.22	0.26	0.31	....	....
3½	0.26	0.30	0.37	....	....
4	0.30	0.34	0.42	....	....
4½	0.33	0.39	0.47	....	....
5	0.36	0.43	0.52	....	....
6	0.43	0.52	0.62	....	....
7	0.51	0.60	0.73	....	....
8	0.59	0.70	0.84	$1.05	$1.25
9	0.67	0.80	0.95	1.18	1.42
10	0.75	0.90	1.07	1.33	1.60
11	0.83	1.00	1.18	1.47	1.77
12	0.91	1.08	1.30	1.62	1.95
13	1.00	1.18	1.42	1.77	2.13
14	1.08	1.28	1.54	1.92	2.31
15	1.16	1.38	1.66	2.07	2.49
16	1.25	1.50	1.78	2.22	2.67
18	1.41	1.70	2.02	2.52	3.03
20	1.58	1.90	2.26	2.82	3.39
22	1.76	2.12	2.52	3.15	3.74
24	1.96	2.36	2.80	3.50	4.20
26	2.18	2.60	3.08	3.85	4.62
28	2.42	2.84	3.36	4.20	5.04
30	....	....	3.64	4.55	5.46
32	....	....	3.92	4.90	5.88
34	....	....	4.20	5.25	6.30
36	....	....	4.48	5.60	6.72
38	....	....	4.76	5.95	7.14
40	....	....	5.04	6.30	7.56
42	....	....	5.32	6.65	7.98
44	....	....	5.60	7.00	8.40
46	....	....	5.88	7.35	8.82
48	....	....	6.16	7.70	9.24
50	....	....	6.44	8.05	9.66
52	....	....	6.72	8.40	10.08

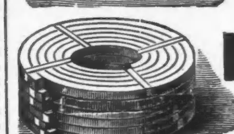
Dis. Reliance, 60 and 5. Dis. Royal, 60, 10 and 10. Dis Manhattan, 70 and 5. See Link Belting, page 9.

PACKING.



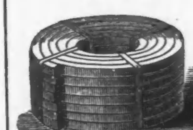
Piston Packing.

Round Piston Packing Per lb. 85c. Discount, 60, 10 and 5 per cent.



Square Piston Packing.

Price same as above. Round and square piston packing is made in lengths of twelve or twenty-four feet.



Square Piston Packing. Rubber back, per pound $1. Discount 60 der cent. Best only.

Square piston packing, rubber back is made in lengths of twenty feet.

Steam Packing.

Cloth Insertion, Rubber Outside.

Cloth Insertion, Cloth on one or both sides.

Thickness.	1-Ply.	2-Ply.	3-Ply.	4-Ply.
1-64 inch..............	70 cts.	....	....	....
1-32 "	65 cts.	....	....	....
1-16 "	60 cts.	63 cts.	66 cts.	....
3-32 "	55 cts.	58 cts.	61 cts.	....
1-8 "	55 cts.	55 cts.	58 cts.	61 cts.
3-16 "	55 cts.	55 cts.	55 cts.	58 cts.
1-4 "	55 cts.	55 cts.	55 cts.	55 cts.

One-ply of cloth to every 1-16 inch thickness.

Three cents per pound additional will be charged for each extra ply of cloth. Each cloth, whether insertion or on outside, to count as one ply.

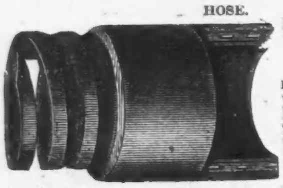
All cloth insertion or plain packing is one yard wide, and any length desired.

Wire insertion packing, all thicknesses, per lb, 50 cents.

Discounts: Reliance, 70 & 10; Royal, 60, 10 & 10; Manhattan, 60 per cent.

See "Link" Packing, page 9.

HOSE.



Improved "Smooth Bore" Rubber Suction Hose.

On spiral flat or round tinned steel wire.

Int. Diam.	Per ft.
2 inch	$2.60
2½ "	3.50
3 "	4.00
3½ "	5.50

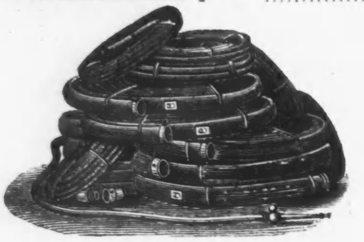
In. Diam.	Per ft.	Per. Diam.	Per ft.
4 inch	6.50	7 inch	$13.56
4½ "	7.50	7½ "	15.00
5 "	8.50	8 "	16.5(
5½ "	9.50	9 "	19.50
6 "	10.50	10 "	22.50
6½ "	12.00	12 "	27.50

Suction hose discount: Reliance, 50 and 10%; Royal, 60, 10 and 5%; Manhattan, 70 and 5%.

SUCTION HOSE.

On spiral brass or iron wire

Int. Diam.	Per. ft.
¾-inch	$ .77
1 "	1.00
1¼ "	1.25
1½ "	1.65
1¾ "	2.10
2 "	2.50



RUBBER HOSE.

Conducting Hose—Two-ply.

Int. diam.	Per ft.	Int. diam.	Per ft.	Int. diam.	Per ft.
½ in	$0.20	2 in	$0.66	5 in	$1.65
¾ in	25	2¼ in	75	6 in	1.98
1 in	33	2½ in	83	7 in	2.31
1¼ in	42	2¾ in	92	8 in	2.64
1½ in	50	3 in	99	9 in	2.97
1¾ in	58	4 in	1.32	10 in	3.33
HYDRANT HOSE—THREE-PLY.					
½ in	$0.25	1½ in	$0.60	2½ in	$1.00
¾ in	30	1¾ in	70	2¾ in	1.10
1 in	40	2 in	80	3 in	1.20
1¼ in	60	2¼ in	90	3½ in	1.40
				4 in	1.60

Discount—Reliance, 60; Royal, 70; Manhattan, 70 and 10 per cent.

GASKETS AND RINGS.

Fibrous.

⅛ inch thich, or less, per lb. $0.90

5-32 inch thick, and upwards, per lb. $0.80

Cloth Insertion.

1-16 inch thick, or less, per lb. $1.25

3-32 inch thick, and upwards, per lb. $1.00

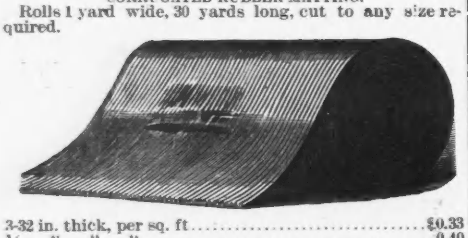
There is one ply of cloth to every 1-16 in thickness.

Five cents per pound additional for each extra ply of cloth.

Dis., 60, 10 and 5%.

CORRUGATED RUBBER MATTING.

Rolls 1 yard wide, 30 yards long, cut to any size required.

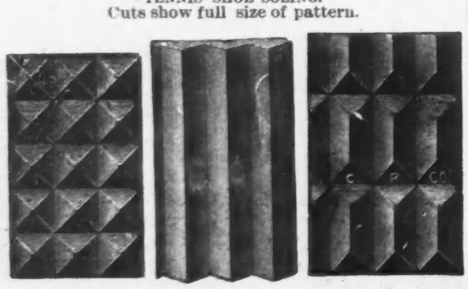


3-32 in. thick, per sq. ft	$0.33
⅛ " " "	0.40
3-16 " " "	0.56
¼ " " "	0.73
⅜ " " "	1.03
½ " " "	1.30

Dis., 25 and 5%.

TENNIS SHOE SOLING.

Cuts show full size of pattern.

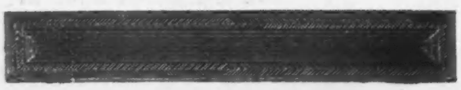


Diamond Point. Corrugated. Oblong.

Price, $1 per lb.

Rubber cement to attach soles furnished.

STAIR TREADS.



No.	Inches.	Thick.	Per doz.	Thick.	Per doz.
1.	6 x18	⅛	$4.00	3/32	$3.30
2.	7 x24	⅛	6.00	3/32	5.00
3.	4 x39	⅛	5.50	3/32	4.70
4.	7 x40	⅛	10.00	3/32	8.30
5.	7½x42	⅛	11.00	3/32	9.10
6.	7½x48	⅛	12.50	3/32	10.40
7.	9 x40	⅛	12.50	3/32	10.40
8.	9 x48	⅛	15.00	3/32	12.50
9.	9 x36	⅛	11.25	3/32	9.40
10.	6 x48	⅛	10.20	3/32	8.50
11.	7 x28	⅛	7.00	3/32	5.85
12.	9 x54	⅛	16.80	3/32	14.00
13.	8 x52	⅛	14.60	3/32	12.15
14.	10 x24	⅛	8.40	3/32	7.00

RUBBER SOLING FOR BOOTS.

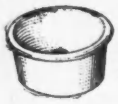
Rough finish, 1-16 to 3-16 thick.

Smooth finish, 1-32 to 1-16 thick.

85 cents per lb.

Indurated Fibre Ware.

SPITTOONS.



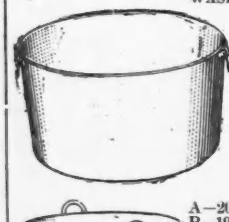
	Doz.
16 in. dia., 8 in. high	$24.00
12½ in. dia., 5½ in. high	10.80
9 in. dia., 5 in. high	7.80

Dis. on all 25 and 20%.

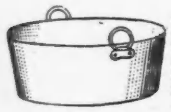
CORDLEY & HAYES.

Pails.	No. doz. in crate.	Cubic feet.	Price per doz.
Ladies' or Weaver's pails, 6 qt	1	2¾	$5.35
Half or buggy pails, 6 qt	1	3	4.80
Star pails (standard plain), 12 qt., stenciled "for fire only" without extra charge	1	3½	6.00
Deck or Mason's pails (same size as Star, but heavier, with heavy wire bail)	1	4	6.60
Railroad or fire pails, 14 qt. (also stenciled "fire" without extra charge)	½	3½	7.80
Fire pails, round bottoms	1	4	7.80
Milk pails, 14 qt	1	4	7.80
Stable pails, flush bottom, heavy wire bail, 14 qt	1	4	7.80
Stable pails, 16 qt., same as above	½	3½	8.40
" 18 " "	½	3¾	10.70
" 20 " "	½	4	12.00
Covers for fire or star pails		1	3.35

WASH TUBS.



No. 0, 23 in	½	12	27.00
Nos. 0, 1, 2 and 3, nested	1 n.	3½	22.50
No. 1, 21 in	½	10½	24.00
No. 2, 19½ in	½	9	21.00
No. 3, 18½ in	½	9	18.00
Nos. 1, 2, and 3, nested	½	9¾	21.00



KEELERS.		Doz.
A—20 in.	7 in. deep	16.20
B—19 "	" "	15.00
C—18½ "	" "	14.00
1—17½ "	" "	13.20
2—15½ "	6 in. "	12.00
3—13½ "	5 in. "	10.20
4—12 "	4 in. "	9.00

MILK OR VEGETABLE PANS.

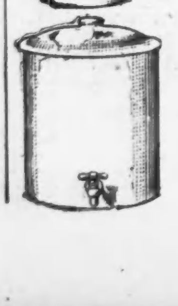
13½ in. dia., 3¼ in. deep, 6 quarts,

$3.60 per doz.

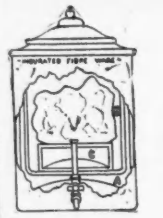
WASH BASINS.	Doz.
12½ in	$4.80
12½ in	4.20
11½ in	3.60

CHAMBER PAILS.

12 in. dia., 9 in. deep, 3 gal, ... 16.00

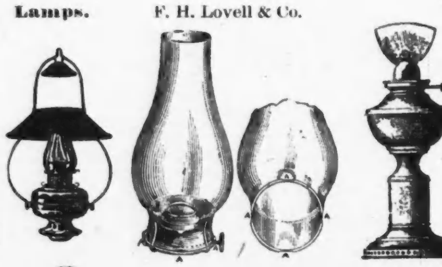


WATER COOLERS.	Doz.
3 gal	$32.00
4 "	40.00
5 "	44.00
6 "	48.00
8 "	64.00
10 "	80.00
12 "	96.00
15 "	120.00



WATER COOLERS AND FILTERS.	Doz.
4 gal	$96.00
5 "	108.00
6 "	120.00
8 "	144.00
10 "	192.00
15 "	288.00

Lamps. F. H. Lovell & Co.



Drummond Electric Hanging Lamp, 300 candle power, complete, each $3.50.

The electric lamp, 60 candle-power.

With decorated shades, nickel, per doz. $22.00

With opal plain shades, nickel, per doz. 18.00.

With decorated shades, brass, per doz. 21.00.

With opal plain shades, brass, per doz. 17.00.

Lamp chimney patent for Sun burners. Per doz. No. 0, 50 cents. No. 1, 60c. No. 2, 75c.

Hitchcock nickel table lamp	(No. 654),	each	$3.75
" " hanging "	656	"	7.25
" " bracket "	651	"	4.00
" " " with reflector	653	"	4.00

" French bronze bracket, with reflector, No. 653, each $3.75.

Harp, complete, with square tin shade, per doz., $9.50.

Complete, with Burner and chimney, per doz., $1.50.

Hurricane lanterns 25 cents extra with guards.

875, ⅜ wick, without guards, per doz., $5.00.

876, square safety lifting globe, per doz., $5.50.

877, ⅝ wick, safety lifting globe, per doz., $6.75.

Nickel plated diamond reflector reading lamp, 30 candle-power, $13.50 per doz.

Net.

Illuminated night clock, per doz., $27.

PAPER LAMPS.

Lined with oil proof composition.

	No. 0.	No. 1.	No. 2.
Height,	2½ in	3 in.	3¾ in.
Diameter,	3½ in	2½ in.	2½ in.
Weight, ℔ doz.,	3¾ lbs.	1¾ lbs.	2 lbs.
Price,	$2.75 per doz	$2.25	$2.75
	No. 0.	No. 3.	No. 4.
Height,	2½ in	5 in.	6½ in.
Diameter,	3½ in	3½ in.	4 in.
Weight, ℔ doz.,	3¾ lbs.	3½ lbs.	7 lbs.
Price,	$2.75 per doz	$3.25	$4.50

Dis., 20%.

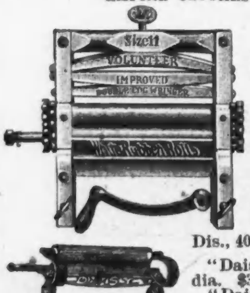
Miners'.

Brass, Collar and Breast in one piece, Spout and Body in one piece.

Price, $9 per gross net.

Laundry Appliances.

EMPIRE CLOTHES WRINGERS.



Rolls.

"Volunteer." Length 10 in. x1¾ in. dia. $40 per doz.

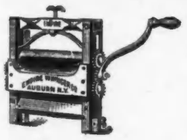
"Volunteer." Length, 11 in. x1¾ in. dia. $50 per doz.

"Volunteer." Length 12 in. x1¾ in. dia. $50 per doz.

Dis., 40%.

"Daisy." Length, 10 in. x1¾ in. dia. $30 per doz.

"Daisy." Length, 12 in. x1¾ in. dia. $48 per doz. Dis., 40%.



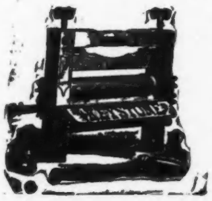
"Empire." Length, 10 in.x1¾ in. dia. $63 per doz.
"Empire." Length, 11 in.x1¾ in dia. $74 per doz.
"Empire." Length, 12 in.x1⅞ in. dia. $84 per doz.
"Empire." Length, 12 in.x1⅞ in. dia. $87 per doz.
"Empire." Length, 14 in.x2¼ in. dia. $156 per doz.
"Empire." Length, 14 in.x2¼, with pulleys. $220 per doz.
"Empire." Length, 16 in.x2½, with pulleys. $360 per doz.
Dis., 40%.

EMPIRE CLOTHES DRYING BARS.
$10 per doz.
Dis., 40%.

Closed.

Open for use.

EMPIRE FOLDING WASH BENCHES
$15 per doz. Dis., 40%.



Royal Keystone cog wheel, 10 by 1¾ rolls, $36 per doz.
No. 10, wood frame cog wheel, 10 by 1¾ rolls, $24.50.
No. 16, wood frame cog wheel, 11 by 1¾ rolls, $29.
No. 18, wood frame cog wheel, 11 by 1⅞ rolls, $33.50.
No. 20, wood frame cog wheel, 11 by 2 rolls, $39.50.
No. 22, wood frame cog wheel, 12 by 1⅞ rolls $39.50.
No. 24, wood frame cog wheel, 12 by 2 rolls, $48.50.
No. 11, iron frame cog wheel, 10 by 1⅝ rolls, $20.
No. 2, iron frame cog wheel, 10 by 1¾ rolls, $24.
Solance iron frame (Eureka Pat.), 10 by 1¾ rolls, $20.
Solance iron frame (Eureka Pat.), 11 by 1¾ rolls, $24.50
F.o.b.cars at works; 60 cents doz entra f.o.b. New York.
Keystone Double Bench Wringer.
Rolls, 10 by 1¾, $36.50 per doz. Made to fold.
Folding Double Folding Wash Bench, packed 6 in crate per doz., $14.

Adams Ironing Table, per doz	$15.00
Keystone Washing Machines, per doz	24.00
Complete " " "	13.50
People's " " "	13.50
Lovell " " "	13.50

Net prices.
Cabinet Clothes Driers, per doz., $21.00 net.
Excelsior Clothes Horse, per doz., $6.00 net.
Reversible Clothes Horse.

	High.	Per doz.	
A	3 ft	$14.00	Dis., ash, 50 and 10%.
B	3 ft. 10 in.	16.00	
C	4 ft. 10 in.	18.00	
D	5 ft. 10 in.	20.00	Basswood, 60 and 10%.

Nursery Reversible Clothes Horse.

2 section, 3 ft. high, per doz	$9.00
" " "	12.00
" " "	16.00

Black Walnut Bronze Tips and Hinges. Dis., 30%.

WASHBOARDS.

The following prices are on orders of not less than 25 dozen of one kind or an assortment.
Wilson, one rubbing surface, per doz., $1.40.
Saginaw, one rubbing surface, per doz., $1.25.
Exchange, one rubbing surface, per doz., $1.10.
Wilson, two rubbing surface, per doz., $2.
Saginaw, one rubbing surface, per doz., $1.75.
Crescent, one rubbing surface, per doz., $2.25.
Shamrock, one rubbing surface, per doz., $2.
Rubbing surface of the two latter is solid sheet of zinc, without wood backs.

Lawn Mowers.

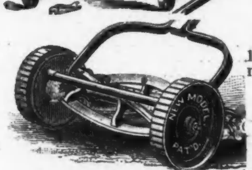
Forward Cut Mowers.

In.		Lbs.		In.		Lbs.	
10	Weight,	30¾	$13.00	16	Weight,	38	$19.00
12	"	31½	15.00	18	"	41	21.00
14	"	36	17.00	21			31.00

Dis. 60 and 5%.

10 in.	12 in.	14 in.
$13.00	$15.00	$17.00
16 in.	18 in.	20 in.
$19.00	$21.00	$23.00

24 in., $30.00.
Geared at both ends.
Dis. 60 and 5 and 5%.



Chadborn & Caldwell Mfg. Co.

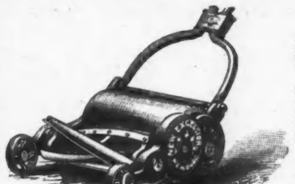
10 in. Croquet, 18 pound, mower	$11.00
10 in.	13.00
12 in.	15.00
14 in.	17.00
16 in.	19.00
18 in.	21.00
20 in.	23.0

Dis., 60 and 5% and 5% cash 30 days, f.o.b. New York.

New Excelsior Horse Lawn Mower.

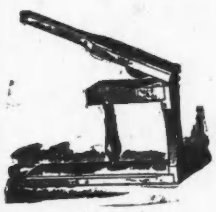
25 in. cut, without shafts or seat	$65.00
30 " with shaft and seat	110.00
35 " " " "	135.00
40 " " " "	170.00
Horse boots, per set	12.00

Dis. 50%.



Excelsior Three-Blade Mower and Roller.
8 in., $11.00; 10 in., $13.00; 12 in., $15.00; 14 in., $17.00; 16 in., $19.00; 18 in., $21.00; 20 in., $23.00.
Dis. 60% and 5% cash 30 days f.o.b. New York.

Lemon Squeezers.



THE SAMSON

THE ACME.

The Acme Lemon Squeezers, knife and squeezer, per dozen, $15.00.
The Samson, per dozen, $3.00.

Porcelain lined, No. 1, per doz	$6.00
25 and 30 % discount.	
Wood, No. 2, per doz	$3.00
30 % discount.	
Wood, common, per doz	$1.70

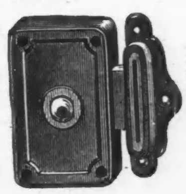
Link Belting.

Link-Belt Machinery Co.'s. Price per running foot net.

No.	Price.	No	Price.
25	$0.13	78	$0.40
32	.13	83	.45
33	.12	[illegible]	[illegible]
34	.13	88	.50
35	.14	95	.60
42	.16	103	.75
5	.16	105	.70
51	.20	106	.90
52	.25	107	.80
55	.22	108	.80
57	.24	109	.90
62	.30	114	1.10
66	.30	122	1.50
67	.30	124	[illegible]
75	.35	146	1.40
77	.35		

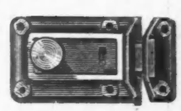
Sprocket wheels 25%
(Rubber belting, see page 6.)

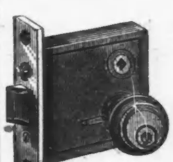
Locks.



YALE PATENT.
RIM STOLE LATCH.

	Per doz.
3 × 5 in., 4 keys	$48.00
2½ × 4 in., 3 keys	39.00





RIM NIGHT LATCH.

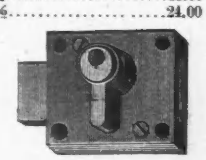
Spring lock, 3 keys	18.00
Dead lock, 3 keys	25.00

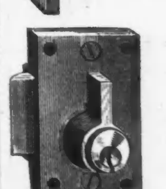
NIGHT LATCH.

Escutcheon	39.00
"	36.00

MORTISE DEAD LOCK.

4⅝ × 3½	45.00
2⅝ × 3½	24.00



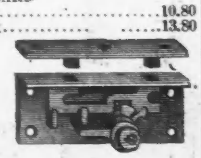


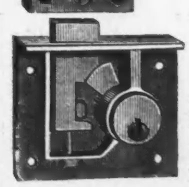
CUPBOARD LOCKS.

Plated Nose	13.20
Brass Nose	12.00

CUPBOARD

Dead Lock	10.80
Spring Lock	13.80



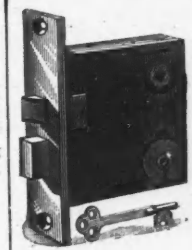


CHEST LOCKS.

Plated nose	19.20
Brass	18.00

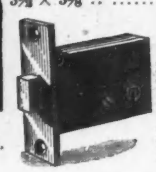
DRAWER LOCK.

Plated nose	10.20
Brass "	9.00



KNOB LOCKS.

5 × 3⅝	22.50
5 × 3⅝	20.00
4¼ × 3⅝	13.25
3½ × 3⅝	10.50



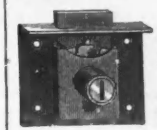
STANDARD LATCHES.

Dead locks.

3¾ × 2¾	24.00
2½ × 3⅝	14.00
1¾ × 2⅝	12.00

NIGHT LATCHES.

3¼ × 3⅝	20.00
2½ × 3¾	18.00



DRAWER LOCKS.
2 × 1⅝, two tumblers.

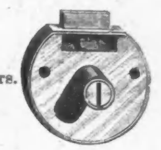
Plated nose	7.50
Brass "	6.00

Three tumblers.

Plated nose	9.00
Brass "	7.50

RIM FLUSH DRAWER LOCK.
2 in. diameter.

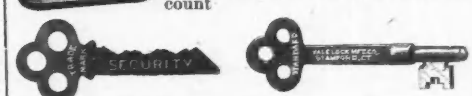
	2 tumblers.	3 tumblers.
Plated nose	7.50	9.00
Brass "	6.00	7.50



BRONZE SPRING PADLOCK.
2 flat steel keys.

In.	
1	11.00
1¼	12.00
1½	13.50
1¾	14.50
2	16.00
2¼	17.50

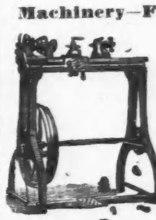
Subject to special net prices; no discount



YALE KEYS.

Machinery—Foot Power.

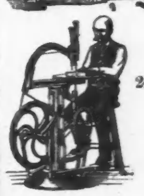
S., M. & Co.'s Screw-Cutting Engine Lathes.



8 in. swing, 20 in. bet. centers, 36 in. bed, 240 lbs. weight, $60.
8 in. swing, 30 in. bet. centers, 46 in. bed, 260 lbs. weight, $70.
8 in. swing, 36 in. bet. centers, 52 in. bed, 280 lbs. weight, $75.

Boxing for export, $2.50 extra ; f.o.b. at Cincinnati, 25 % dis.

SAWS AND LATHES.



Victor Scroll Saw, Cuts to 3 Inches.
24-inch swing, with 12 saw blades $40
Dis., 20%.

Empire Scroll Saw, Cuts to 3 Inches.
24-in. swing, drill and tilting table.
Price, boxed $25
Dis., 20%

The Acme Combination Saw.
Hand or steam power.
Adjustable table and gauges.

Price, boxed	$40
Scroll saw attachment	7
Boring attachment	10
Moulding attachment	10

Dis., 20%.

Paragon Self Feed Rip Saw.
Two changes of speed; three changes of feed.
Price, with one 10 in. saw, $50.00.
Dis., 20%.

Diamond Mortising Machine.
With mortise ¼ to 1 in. wide, 3 in. deep.
" cut tenons ¼ to ¾ thick, 3 in. wide.
Price, with 3 chisels $25.00
Dis., 20%.

The "Star" Lathe.
Swings 9 × 25 in., back geared, screw cutting.
Feeds in or out, right or left. Adjustable Tail Stock for Tapers.
Price $75.00
Dis., 15%.

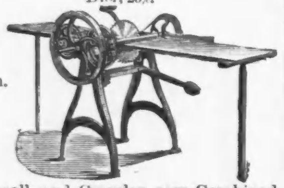
The Crown Lathe.

Swings 10 × 36 in.

Price, boxed............ $45.00
Compound slide rest... 15.00
Countershaft 10.00
Dis., 20%.

Rival Scroll Saw, with six extra saw blades, twist drill and wrench.
Price.............................. ...$10.00
Lathe attachment............. ....$3.00
Dis., 25%.

The Challenge Scroll Saw, for shell, bone wood, or metal.
Nickel Plated, with six extra saws, twist drill and wrench.
Boxed.............................$20.00
With lathe attachment........$5.00
Dis., 25%.

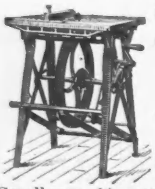


Hand Circular Rip Saw.

Cuts 3¾ thick, 19 in. wide.

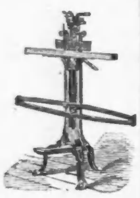
Price $50.00.

Dis., 35%.



Scroll and Circular saw Combined.
Combined Machines.
Combined circular scroll saw and boring attachment—2 circular saws, 12 assorted scroll saws, boring attachment, and self-centering drill chuck.....$50.00
Combined circular and scroll saw—2 circular and 12 scroll saws.......................... 40.00
Circular saw—1 extra rip and 1 cross-cut saw.................. 35.00
Scroll saw—12 assorted scroll saws.................... 32.00
Counter shaft for steam power........................ 10.00
Dis., 35%.

Foot Power Former.
$20.00; Knives extra, $1.00 each.
Dis., 35%.

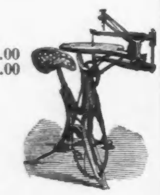


Mortising Machine.
$22.00; Chisels, $1.00 each.
Dis., 35%.
Blind Slat Chisels, 3 set bits, $5.00.
Dis., 20%.

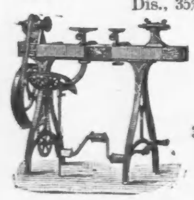
Tenoning Machine,

Price, $25.

Dis., 35%.



Velocipede Scroll Saw,
Without boring attachment...... $20.00
With " " 23.00
1 doz. saw blades, } Included.
1 3-16 bit.
Dis., 35%.



Lathe.

3 centres, 1 spur, 2 tool rests and sockets, 1 turned face-plate, $35.

Dis., 30%.

Lathe.

One turned face-plate, two pointed and one spur center, two rests, with sockets and plate for hand tools, slide rest-wrench, belting, etc., $40.

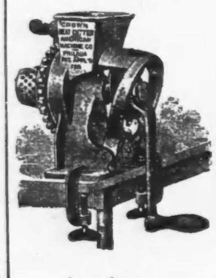
Dis., 25%.

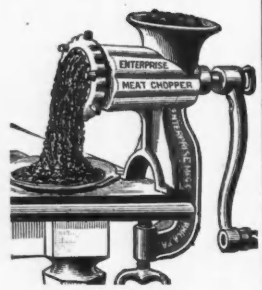
Motors (Water).
Size No 8, for Sewing Machines, etc , $18 each.

No. 9, ⅛ horse-power (30 lbs. pressure), ¼ h. p. (50 lbs.), ½ h. p. 100 lbs.), ¾ h. p. (150 lbs.), 1 h. p. (200 lbs.), $30.
No. 10, ¼ horse-power (30 lbs. pressure), ½ h. p. (50 lbs.), 1 h. p. (100 lbs.), 1½ h. p. (150 lbs.), 2 h. p. (200 lbs.), $50.
No. 10½, ½ horse-power (30 lbs. pressure), 1 h. p. (50 lbs), 2 h. p. (100 lbs.), 3 h. p. (150 lbs.), 4 h. p. (200 lbs.), $75.

No. 11, 1 horse-power (30 lbs. pressure), 1½ h. p. (50 lbs.), 3 h. p. (100 lbs.), 4½ h. p. (150 lbs.), 6 h. p. (200 lbs.), $100.
No. 12, 2 horse-power (30 lbs. pressure), 3 h. p. (50 lbs.), 6 h. p. (100 lbs.), 9 h. p. (150 lbs.), 12 h. p. (200 lbs.), $175.
No. 13, 3 horse-power (30 lbs. pressure), 5 h. p. (50 lbs.), 10 h. p. (100 lbs.), 15 h. p. (150 lbs.), 20 h. p. (200 lbs.), $285.
Dis., 40%.
Governors for 11 and 12, $25 extra; for No. 13, $35 extra.

Meat Cutters.



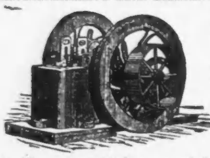


American.
1 2 3 4
each, $5.00 7.00 10.00 25.00
Dis., — —.

Enterprise.
10 12 22 32 42
each, $3.00 2.50 4.00 6.00 15.00
Dis., 30%.

Mining Machinery.

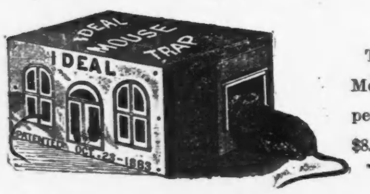
N. B.—Special attention is invited to the goods advertised and illustrated in the advertising pages of the Engineering and Mining Journal, quotations and discounts upon which would only mislead buyers.
Price-lists and other information may be obtained by addressing the advertisers direct, or by writing to the Engineering and Mining Journal.



Concentrating Machinery.
Fort Scott Foundry & Machine Works Co.
Blake Improved Crusher: 10x7, weight 7,500; $410.00.
Blake Improved Crusher: 15x9, weight 9,000; $580.00.
Discount 25%.
Cornish Crushing Rollers: 20 diameter, 10 face, weight 5,400; $450.00.
Cornish Crushing Rollers: 20 diameter, 14 face, weight 6,000; $500.00.
Cornish Crushing Rollers: 22 diameter, 14 face, weight 9,500; $625.00.
Cornish Crushing Rollers: 27 diameter, 14 face, weight 13,000; $750.00.
Cornish Crushing Rollers: 30 diameter, 14 face, weight 15,000, $850.00.
Discount 25%.
Complete Sizing Arrangement, consisting of Revolving Screens of Steel Sheet and Hydraulic Classifier.
For Concentrator, 25 tons capacity, $250; 50 tons capacity, $350; 75 tons capacity, $450; 100 tons capacity, $800. Discount, 10 per cent.
Automatic working Jig Machines, all complete, woodword included, with slidemotion: 2 sieves, $310; 3 sieves, $360: 4 sieves, $450.
With Eccentric Motion, all complete, woodwork included: 1 sieves, $200; 2 sieves, $270; 3 sieves, $320; 4 sieves, $330.
Automatic working Double Jig Machines, all complete, woodwork included: 4 sieves, $210; 6 sieves, $335; 8 sieves, $425. Discount, 25 per cent.
Single Rittinger Percussion Tables, all the iron parts, $350; Double Rittinger Percussion Tables, all the iron parts, $500. Discount, 10 per cent.
Improved Rotary Tables, all the iron parts and pipes, $250. Discount, 25 per cent.

Mouse Traps.

The Cyclone Mouse Trap, per gross, $4.05.



The Idea Mouse Trap per gross, $8.25.

Slayer Rat Traps, per gross, $10. Net prices

Nails and Tacks.

Swedes. Tacks.
Per doz. ½ ¾ 1 1½ 2 2½ 3
½ wt.. 35 40 46 50 55 60 65 75
6 8 10 12 14 16 18 20 24 oz.
85 1.00 1.20 1.40 1.60 1.75 1.85 2.15 2.55
Doz.full ½ ¾ 1 1½ 2 2½ 3 4
weight 60 70 80 90 1.00 1.10 1.20 1.40
6 8 10 12 14 16 18 20 24 oz.
1.60 1.90 2.30 2.70 3.10 3.40 3.80 4.20 5.00
lb.,bulk ½ ¾ 1 1½ 2 2½ 3 4
or paper 1.60 1.25 1.00 80 66 58 52 46
6 8 10 12 14 16 18 20 24
36 32 31 30 29 28 28 28 28
Discount, 67½, 10 and 2%.

O. H. Swedes.
Price, same as Swedes.
Swedes steel tacks same list price as iron.
Discounts, 72½, 10 and 2%.

Upholsterers.

Price, same as Swedes.

Cut Tacks. Price per dozen ounces.

1 1½ 2 2½ 3 4 6 8 10
¼ wt..... .. .. 35 40 45 50 55
12 14 16 18 20
60 70 80 90 1.00
½ wt. 1 1½ 2 2½ 3 4 6 8 10
45 50 50 55 60 65 70 80 95
12 14 16 18 20
1.10 1.25 1.40 1.55 1.70
Full wt.... 1 1½ 2 2½ 3 4 6 8
80 90 90 1.00 1.10 1.20 1.30 1.50
10 12 14 16 18 20
1.80 2.10 2.40 2.70 3.00 3.30
Discount, 70, 10 and 2%.

Carpet Tacks, flat and oval heads.

Blued, doz. oz. 4 6 8 10 12 14 16 18 20
¼ wt. 35 40 45 50 55 65 75 85 95
22 24
1.05 1.15
" ½ wt. 4 6 8 10 12 14 16
65 70 80 95 1.10 1.25 1.40
18 20 22 24
1.55 1.70 1.85 2.00
Tinned, doz. ¼ wt. 4 6 8 10 12 14 16
50 55 60 75 85 1.00 1.10
18 20 22 24
1.20 1.35 1.45 1.60
Tinned, doz. ½ wt. 4 6 8 10 12 14
95 1.05 1.15 1.40 1.60 1.85
16 18 20 22 24
2.10 2.35 2.60 2.85 3.10
Discount, 72½, 10 and 2%.

Finishing Nails.
Inch....⅜ 3½-8 4-8 4½-8 ⅝ 5½-8 6-8 7-8 1
Per lb...48 40 32 28 26 24 22 20 18
1⅛ and larger.
16
Discount, 60, 10 and 2%.

Chair Nails.
Doz. ½ wt. ; doz. full wt.; pound B. or P.
Inch..⅜ 3½-8 4-8 4½-8 ⅝ 5½-8 6-8 7-8
Per lb.51 43 35 31 29 27 25 23
1 1⅛
21 19
Discount, 60, 10 and 2%.

Common and patent brads.

inch.	Price per doz. ½ wt.	Price per doz. full wt.	Price per lb. in papers or bulk.
2-8.........	.50	1.00	1.25
3-8.........	.60	1.20	.80
4-8.........	.65	1.30	.58
5-8.........	.72	1.44	.48
6-8.........	.80	1.60	.36
7-8.........	.90	1.80	.30
1...........	1.00	2.00	.26
1⅛.........	1.12	2.24	.25
1¼.........	1.26	2.52	.24
1½.	1.82	3.64	.22
1¾.........	2.25	4.50	.20
2...........	2.43	4.86	.18

Dis. 60, 10 and 2%.

Oars. Best quality selected White Ash.

	Cents.
6 to 12 ft., per sq. ft...	7
13 " 16 " " " ...	8
17 " 18 " " " ...	8½
19 " " " ...	10
20 " " " ...	11
22 ft., per sq. ft..........	14
24 " " "	18
25 " " "	20

5 and 2½ cash.

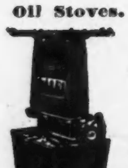
Oils.

Lubricating.—Fiske Bros.
Lubroleine A cylinder oil 50 in. barrels.
Lubroleine D cylinder oil 40 in. barrels.
Lubroleine A machine oil 45 in. barrels.
Lubroleine B machine oil 35 in. barrels.
Lubroleine A engine oil 50 in. barrels.
Lubroleine B engine oil 40 in. barrels.
In cases 5c gal. extra.
Crescent Axle Grease.—Barrels, 3c per lb; 100-lb. kegs 3½c lb.; 2-lb. decorated tins, $12, gross less 5 per cent.
Texas Star Axle Grease.—Barrels, 2½c per lb.; 100-lb. kegs, 3c per lb.

Oil Stones.

Best White Washita.
Green Paper Brand, 8 × 2 × 1⅛ inches.......per lb. .32
Oil stone, No. 1, " " .... " .22½
" Extra, " " .... " .30
High rounds, " " .... " .30
Round edge slips, Nos. 1, 3½ to 5, in boxes 10 lbs. upwards.................................... " .40
Round edge slips, extra, in boxes 10 lbs. upwards.. " .50
Pen knife pieces, ass't 3 to 5 × 1 × 1⅝, in boxes 10 lbs. upwards........................... " .50
Needle pieces...........................per hundred. $5.00
Wheels, 1½ to 5¾ in. thick.......... .....per inch. .40
Good Washita,
Oil Stone No. 1, 8x2x1⅛.........................per lb. .15
" " 2, " .... " .12
Axe Stone, assorted sizes........... .... " .10
Round Edge Slips, assorted sizes........... .. " .25
Arkansas.
Oil Stone No. 1, 4 to 6 in. long x2x¾ to 1 in. per lb. $1.35
Oil Stone No. 1, 6 to 9 in. long x2x¾ to 1 in. " 1.75
Oil Stone No. 2, 4 to 9 in. long x2x¾ to 1 in. " .75
Round Edged Slips, assorted sizes .... " 2.00
Square File Slips, 3 to 4 inches long........per doz. 1.75
Diamonds, 3½ to 4 inches long............... " 3.00
Triangulars, 3½ to 4 inches long............ " 3.00
Flat Files, 3 to 4 inches long.......... ...... " 2.00
Beveled Files, 3½ to 4 inches long.......... " 2.50
Knife Blades, 3 to 4 inches long............. " 3.00
Points, extra long, 3 to 3½ inches........... " 2.00
Points... " 1.50
Pen Knife Pieces, assorted sizes............per lb. 2.00
Needle Pieces..............................per hund. 8.00
Wheels, 2 to 4 inches, ½ inch thick.........per inch 1.25
Oil Stone Powder...........................per lb. 15
10, 10 and 2½ dis.

Oil Stoves.



Burns 8 hours; holds 1 quart oil.

Nickel plated crown plate, per doz., $12.

Packings.

SELDEN'S PATENT.
For Steam, Air, Water and Ammonia.
With Rubber Core, 60 cents per lb.
Dis., 25 and 5%.
With canvas core, 50 cents per lb.
Dis., 30 and 5%.

Paints.

For Assorted Cans of 1, 2, 3 and 5 pounds. 100-lb. cases.

No.		lb. c.	No.		lb. c.
533.	Scotch yellow	18	583.	Black	18
534.	Lead color	18	584.	Dark blue	25
536.	Brown	18	585.	Chrome yellow	30
537.	Light drab	18	586.	Vermilion	30
539.	Buff	18	587.	Indian red	25
542.	Warm drab	18	588.	Bronze green	25
544.	Dark green	25	589.	Quaker green	25
581.	Light green	25	546.	Inside white	18
582.	Norway red	18	547.	Outside white	18

Discount 50 per cent.

Ordinary shades. Per gal. One to 5 gallon cans.. $1.90 | Per gal. Half gallon cans...... $2.00

Tuscan Red, Green and Yellow.

Per gal. One to 5 gallon cans.. $3.10 | Per gal. Half gallon cans...... $3.30

Vermilion.

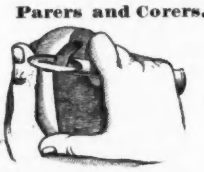
Per gal. One to 5 gallon cans.. $5.00 | Per gal. Half gallon cans...... $5.20

Discount 40 per cent.

The list in barrels, half-barrels and kegs (of 5 gallons or larger) will be 10c. a gallon less than in gallon cans. Kegs of less than 5 gallons will be charged at gallon price. One-quarter gallon cans not put up. Special shades made to order.

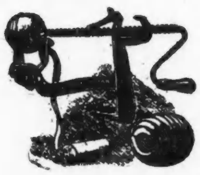
Special cash discount for large orders.

Parers and Corers.



SAML. LEES & CO.

List, $9 per gross.



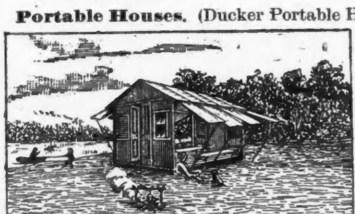
Little Gem.

Rocking Table.

APPLE.

	Per doz.
Advance	$4.75
Baldwin	5.25
Champion	7.25
Hudson's '88	3.75
Improved Bay State	30.
Monarch	31.50
Oriole	4.00
Turntable	4.50
Victor	13.50
White Mountain	4.50
Rocking Table	4.25
Little Gem Corer and Slicer	3.70

Portable Houses. (Ducker Portable House.



Weight, 450 lbs.

Price, $150.

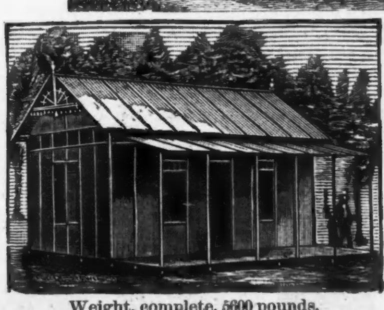
Closes securely.

Dis., 10%.

Weight, 85 lbs. per section.

Price, $220.

Dis., 10%.



Weight, complete, 5600 pounds.

No. 10.—26 × 33 ft.. including veranda and rear extension. Main part, 19 × 26 ft.......$500.00

	No. 1. Veranda on side.	No. 2. Veranda on end.	No. 3. without veranda.
12 × 12, 1 door, 3 windows,	$120.00	$120.00	$105.00
12 × 14, 1 " 3 "	135.00	130.00	120.00
12 × 17, 1 " 3 "	155.00	150.00	135.00
12 × 19, 2 " 4 "	175.00	165.00	150.00
12 × 21, 3 " 5 "	190.00	180.00	165.00
12 × 23, 3 " 5 "	200.00	190.00	175.00
12 × 26, 3 " 5 "	220.00	205.00	190.00
14 × 21, 3 " 5 "	205.00	195.00	180.00
10 × 12, 1 " 3 "		100.00	90.00
10 × 14, 1 " 3 "		105.00	95.00
7 × 10, 1 " 2 "			65.00
7 × 12, 1 " 2 "			75.00
7 × 14, 1 " 2 "			85.00

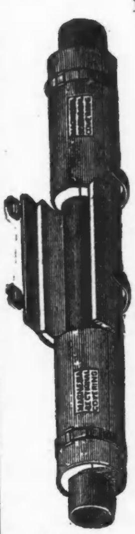
Hunter's Cabins.

7 × 12, with 4 berths.......$80.00
7 × 14, " 4 " 90.00

Discount, 20%.

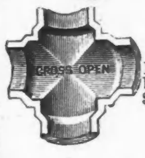
Pipe Covering.

Magnesia Sectional Covering.
For Wrought Iron Pipe. In Canvas Jacketed Sections, 36 inches in length.



Inside dia. of pipe.	Weight of cover per lineal ft.	Price per lineal foot canvas jacketed.
½ in.	8 ozs.	$0.25
¾ "	9 "	0.25
1 "	10 "	0.25
1¼ "	12 "	0.25
1½ "	15 "	0.25
2 "	18 "	0.27
2½ "	20 "	0.31
3 "	24 "	0.36
3½ "	26 "	0.40
4 "	30 "	0.44
4½ "	38 "	0.47
5 "	40 "	0.50
6 "	48 "	0.60
7 "	55 "	0.65
8 "	65 "	0.75
9 "	75 "	0.80
10 "	85 "	0.90

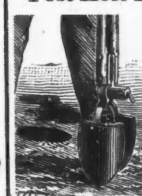
Elb'ws.	Tees.	G Valv's.	Crosses.	Unions.
$0.20	$0.30	$0.25	$0.35	$0.30
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.27	0.36	[illegible]	0.48	0.33
0.31	0.41	0.41	0.53	0.41
0.36	0.48	0.48	0.60	0.48
0.40	0.53	0.53	0.68	0.53
0.44	0.59	0.59	0.75	0.59
0.50	0.65	0.65	0.80	0.63
0.58	0.75	0.75	0.90	0.67
0.65	0.90	0.90	1.00	0.77
0.83	1.20	1.20	1.10	0.90
1.00	1.35	1.35	1.20	1.00
1.10	1.50	1.50	1.35	1.10
1.25	1.75	1.75	1.50	1.25



Magnesia Plastic Covering (dry)—Prepared Carbonate Magnesia and Fiber, for Trowel Work per barrel, $8.00

Dis. 25%.

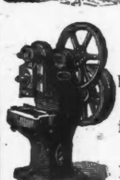
Post Hole Diggers.



Little Giant	$36.00	doz 11 cu ft.
Hercules	30.00	" " " "
New Champion	20.00	" " " "
Scheidler	36.00	" " " "

Dis. 40% f.o.b. New York or Boston.

Press.



Combined press for cutting, forming, horning and seaming.

Particulars of flat front presses, including beds, slides, bolsters, plates, etc.

Prices are net, delivered on steamers in New York, including insurance, etc.

Nominal size of press	41	42	43	44	450
Price, including et ceteras	$130	$200	$260	$420	$660
Weight, about...lbs	600	1050	1900	3600	7200
Greatest diameter that can be wired...ins	5	7	10	14	20
Greatest depth that can be wired...ins	8	10	13	16½	20
Hole through bed—circle intersecting...ins	4½	6	8½	12	17
Hole through back—width...ins	8	9½	12	15½	20½
Width between die clamps—clear...ins	8	11	15	20	27
Distance back from center of slide bar...ins	4½	5½	7	9	12
Height to slide-bar, when up..ins	5¼	6½	7½	8½	9
Stroke of slide-bar...ins	1	1¼	1½	1¾	2
Adjustment of slide-bar...ins	1	1¼	1½	1¾	2
Diameter of fly-wheel...ins	20	26	32	38	44
Width of fly-wheel...ins	3	4	5	6	7
Weight of fly-wheel, about...lbs	125	250	420	725	1100
Speed per minute, about...rev	120	110	100	90	80
Cubic feet boxed, about	30	40	50	60	70

Printers' Sundries.

Vanderburgh, Wells & Co.
And Liberty Machine Works.
Wood rules, 12 cents per yard.
Wood rules, on end wood, 15 cents per foot.

EUREKA STAND.
12 full cases.

Price without cases.......$12.00
Boxing and cartage.......1.25

SHOOTING STICKS.

Each.
No. 1, 75c.
No. 2, $1.
No. 4, 45c., black.
No. 4, 60c., bright.
No. 5, 60c., black.
No. 5, 75c., bright.

GAUGE PINS—ALL SIZES.

Brass, 40c. doz.
Wire, 25c. doz.
Steel, 60c. doz.
Golden, 40c. doz.

MITRE BOXES.

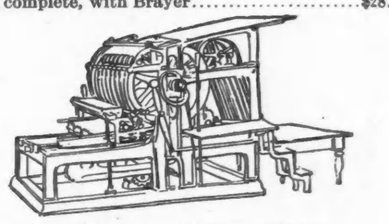
Regular size, 2 in., 50c. each.
Extra size, 3½ in., 75c. each.

LEAD CUTTER.

Curtis' Lead Cutter.......$2.00

PROOF PRESS, "OUR OWN."

9 × 32, complete, with Brayer.......$28.00

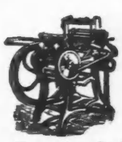


THE "LIBERTY" CYLINDER PRESS.
For Newspaper and Job Printing.

Bed.	Form.	
No. 5—29 × 42	24 × 40	$1,200
6—33 × 47	28½ × 45	1,300
7—37 × 51	33 × 49	1,600

Dis., 20 and 5%.

THE "LIBERTY" JOB PRINTING PRESS.



Size of chase.

No. 2 — 7 × 11	$200
2a— 9 × 13	250
3 —10 × 15	300
3a—11 × 17	350
4 —13 × 19	400
5 —14½ × 22	500

Dis., 12% and 5%.

Two sizes built extra strong for boxmakers, embossing, etc.

No. 3a—11 × 17.......$375
4 —13 × 19.......425

Dis., 12 and 5%.

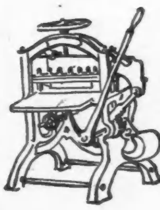
Fountains, either size, $25 extra, if ordered with press.
Steam fixtures, either size, $15 extra.

THE AMERICAN CARD AND BILL HEAD PRESS.

No. 5—4 × 6.......$16
7—6 × 9.......36
8—8 × 12.......60

Dis., 20% and 5%.

THE "LIBERTY" PAPER CUTTER.



Cuts 30 inches.......$140.00
Extra knife.......18.80

Dis., 12% and 5%.

THE "LIBERTY" IMPOSING TABLES

Marble top.

No. 1—24 × 36.......$24
2—32 × 48.......38
3—26 × 74.......44
4—36 × 48.......48

Dis., 12% and 5%.

Slate Top.

No. 1—24 × 36.......$18
2—32 × 48.......25
3—26 × 74.......32

Dis., 12% and 5%.

THE "LIBERTY" TYPE CABINETS.

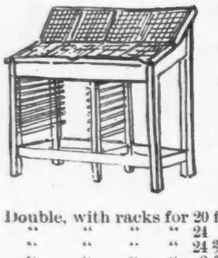
Number of cases.	Stained. Flat. $	Stained. Galley.* $	Grained. Flat. $	Grained. Galley.* $
12⅔	12.00	14.50	14.00	17.00
16⅔	15.00	17.50	17.00	20.00
18⅔	16.50	19.00	18.50	21.50
20⅔	18.00	20.50	20.00	23.00
12¾	15.00	17.50	17.00	20.00
16¾	18.00	20.50	20.00	23.00
18¾	19.50	22.00	21.50	24.50
20¾	22.00	24.50	23.00	26.00
12 full	18.00	20.50	20.00	23.00
16 "	22.00	24.50	24.00	27.00
18 "	24.00	26.50	26.00	29.00
20 "	26.00	28.50	28.00	31.00

Number of cases.	Pine. Flat. $	Pine. Galley.* $	Cherry. Flat. $	Cherry. Galley.* $	Napanoch. Flat. $	Napanoch. Galley.* $	Walnut. Flat. $	Walnut. Galley.* $
12⅔	18.00	21.00	20.00	23.00	22.00	25.00	23.00	26.00
16⅔	22.00	25.00	24.00	27.00	26.00	29.00	27.00	30.00
18⅔	24.00	27.00	.....	.....	.....	.....	.....	.....
20⅔	26.00	29.00	28.00	31.00	30.00	33.00	31.00	34.00
12¾	21.00	24.00	23.00	26.00	25.00	28.00	26.00	29.00
16¾	25.00	28.00	27.00	30.00	29.00	32.00	30.00	33.00
18¾	27.00	30.00	.....	.....	.....	.....	.....	.....
20¾	29.00	32.00	31.00	34.00	33.00	36.00	34.00	37.00
12 full	24.00	27.00	26.00	29.00	28.00	31.00	29.00	32.00
16 "	28.00	31.00	30.00	33.00	32.00	35.00	33.00	36.00
18 "	30.00	33.00	.....	.....	.....	.....	.....	.....
20 "	32.00	35.00	34.00	37.50	36.00	39.00	37.00	40.00

*Furnished with galley top and extra drawer for copy.
Dis., 20 and 5%.

THE "LIBERTY" CASE STANDS AND RACKS.

Stands.



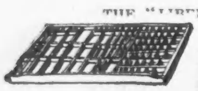
Single, without racks	$3.75
" with racks for 8 full cases	4.00
Single, with racks for 10 full cases	4.25
Single, with racks for 12 full cases	4.50
Single, with racks for 14 full cases	4.75
Double, without racks	4.25
" with racks for 8 full cases	4.50
Double, with racks for 16 full cases, and gal. rest	6.25
Double, with racks for 20 full cases and gal. rest	6.50
" " " " 24 " " " " "	6.75
" " " " 24 ⅔ cases	5.25
" " " " 8 full and 8 ⅔ cases	5.00
" " " " 8 " " 8 ¾ "	5.25
" " " " 10 " " 12 ⅔ "	5.50
" " " " 12 " " 16 ⅔ "	5.75
" " " " 12 " " 16 ¾ "	6.00
Stands with closed ends, extra	2.00
Extra slides for stands, each	.05

Case Racks.

Cases.	Inches High.	Price.	Inclosed Back and Sides.	Cases.	Inches High.	Price.	Inclosed Back and Sides.
12	41	$6.00	$8.50	30	84	$10.00	$13.50
16	50	7.00	9.50	32	51	12.50	16.00
20	60	8.00	11.00	40	60	14.00	17.50
24	70	9.00	12.00	60	84	18.00	23.00

Dis., 20 and 5%.

THE "LIBERTY" TYPE CASES.



Name.	Outside Measurements.
Full size	32¼x16½x1 9-16
Rooker size	28½x14¼x1 9-16
¾ size	26x16½x1⅜
⅔ size	22⅜x16½x1⅜
Enlarged size	32¼x23x2 3-16
Wood type "	32¼x23x1 9-16
Mammoth "	44x23x1 9-16

Cabinet case sides extend 1½ to 3 inches. In ordering cabinet cases, state whether high or low fonts are wanted.

	Without Pat. Clasps.	With Pat. Clasps.
News, full, per pair	$1.60	$1.75
" Rocker, "	1.60	1.75
" ¾ "	1.50	1.60
" ⅔ "	1.40	1.50
German, full, "	1 60	1.75
Music " "	2 00	2.20
Job " "	.90	1.00
Job, full size, California	.90	1.00
" Rooker	.90	1.00
" full, Yankee	.90	1.00
" ¾ Regular	.80	.90
" ⅔ Yankee	.75	.85
" " Boston	.75	.85
" " California	.75	.85
" " improved	.90	1.00
" full size, Middletown	1.20	....
" " Paterson	.90	....
" " New York	.90	1.00
Quadruple, full size	1.20	....
Double lower, "	1.20	....

Name.	Without pat. clasps.	With pat. clasps.
Galley lower, full size	$1.10	
Enlarged Yankee job	2.20	
Enlarged German	2.20	
Founder's sort case	2.20	
Half-cap	.50	
L. S. lead, full-size	1.00	
" rule "	1.15	$1.25
" " ¾ size	.95	1.05
" " ⅔ "	.80	.90
Improved, ⅔ "	90	1.00
Space and quad, full-size	1.00	
Slug "	1.00	
Figure "	.90	
Triple "	.90	1.00
Improved triple "	.90	1.00
Triple, ¾ size	.80	.90
Blank, full-size	.65	
" ¾ size	.55	
" ⅔ size	.50	
Script, full-size	.90	
" ¾ size	.80	
" ⅔ size	.75	
Wood type, 23x32¼	1.10	
Mammoth, 23x44	1.30	
Metal furniture, full-size	1.25	
Border "	1.25	
" ⅔ size	1.00	
Leader, ⅔ size, per pair	1.40	
Butler jobs, full-size, per pair	3.00	
For pulls on cabinet cases add per case		.10
For rollers " " "		.30

Dis., 25 and 5%.

THE "LIBERTY" GALLEYS.

All brass "indestructible."

Single, 3¾ x 23¾ inside	$2.50
" 3¾ x 1-¾ "	2.00
" 3¾ x 11¾ "	1 75
Medium, 5 x 23¾ inside	2.75
Double, 6¼ x 23¾ inside	3.00

Dis., 33⅓%.

SMOOTH LINED NEWS GALLEYS.

	Half-lined.	Full-lined.		Half-lined.	Full-lined
Single col.	$1.75	$2.00	Double col.	$2.00.	$2.50

Dis., 20% and 5%.

SCREW GALLEYS.

	Unlined.	Half-lined.	Full-lined.
Single column	$1.25	$1.50	$1.75
Double column	1.50	1.75	2.00

Dis., 20% and 5%.

SMOOTH LINED JOB GALLEYS.

Size.	Unlined.	Full-lined.	Size.	Unlined.	Full-lined.
6 × 10	$1.25	$2.00	12 × 18	$2.50	$3.50
8¼ × 13	1.50	2.50	14 × 20	3.00	4.00
9 × 14	1.75	2.75	15 × 22	3.50	5.00
10 × 16	2.00	3.00	18 × 25	4.00	5.50

Dis., 20% and 5%.

RULED GALLEYS.

These have a rule laid out on one of the rims, divided into quarter inches, by which to set advertisements. Cost of ruling extra, 25 cents.

Dis., 20% and 5%.

MAILING GALLEYS.

Zinc bottom, 50 cents; brass bottom, 90 cents. Brass closed both ends, $3.

Dis., 20% and 5%.

GALLEY RACKS.

From $3 up.

LEAD CUTTERS.

From $2 up.

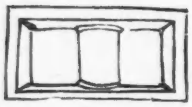
Dis., 20% and 5%.

THE "LIBERTY" STEEL SHOOTING STICKS.

Bright, $1 each.

Nickelplated, $1.25 each.

Dis., 40%.



STANDARD METAL FURNITURE

25c. a pound.

In fonts of 25, 50, 75 and 100 lbs.

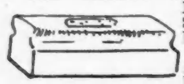
Dis., 15%.

THE "LIBERTY" MALLETS.

Hickory, small	$ .20
" medium	.25
" large	.30
" iron bound	1.00
Lignum Vitæ, No. 4	.30
" " No. 3	.40
" " No. 2	.50
" " No. 1	.70

Dis., 20 and 5%.

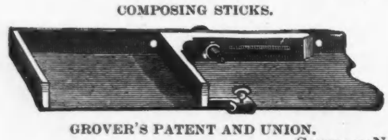
THE "LIBERTY" PLANERS AND PROOF PLANERS.



Midget planer	10c.
Small Maple	20c.
Large "	25c.
" b'ked with leather	30c.
Midget " " "	12c.
Proof planer, faced with cloth,	50c.

Dis., 40%.

COMPOSING STICKS.



GROVER'S PATENT AND UNION.

	Screw or News.
6 in., 1.10	$ .90
8 " 1.20	1.10
10 " 1.40	1.20
12 " 1.60	1.40
14 " 1.80	1.60
16 " 2.00	1.80
18 " 2.20	2.00
20 " 2.40	2.20

Composing rules, 14 ems pica and under, 25 cents.

THE "LIBERTY" COMPOSING STICKS.

Grover.

6 in., Steel	$ .90	16 in., Steel	$1.80
8 "	1.00	18 "	2.00
10 "	1.20	20 "	2.20
12 "	1.40	Extra Clasp	.10
14 "	1.60	Extra Knee	.40

Screw.

6 in., Steel	$ .75	16 in., Steel	$1.45
8 "	.80	18 "	1.60
10 "	1.00	20 "	1.75
12 "	1.15	Extra Knee	.30
14 "	1.30	" Screw and Nut.	.10

Dis., 40%.

Yankee.

6-in., Steel	$ .75	12 in., Steel	$1.15
8 "	.80	Extra Knee	.30
10 "	1.00	" Clamp and Screw	.15

Other Sizes to Order.

Dis., 40%.

Albion.

6-in., Steel	$1.00	6-in, German Silver	$1.50
8 "	1.10	8 " " "	1.75
Extra Knee	.40	Extra Screw and Nut.	.10

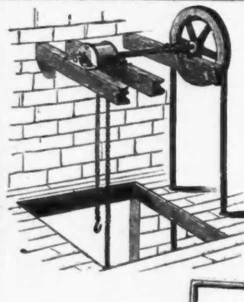
Pulley Blocks.

WESTON DIRECT.

	Each.
⅛ ton	$10
¼ ton	13
½ ton	15
1 ton	20
1½ tons	25
2 tons	30
3 tons	40

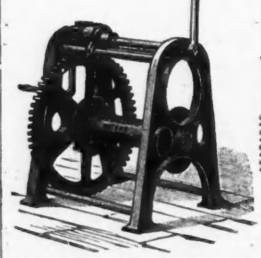
Geared.

1 ton	35
2 tons	45
3 tons	60
4 tons	80
5 tons	110
6 tons	150
8 tons	210
10 tons	275



DOUBLE LIFT HOISTS FOR HATCHWAYS, ETC.

500 lbs	$25.00
1000 "	50.00
1500 "	65.00
2000 "	80.00
500 "	30.00



WESTON CRAB SAFETY BRAKE, HANDLES CANNOT FLY BACK.

	Each.
21	$35.00
22	45.00
23	65.00
25	100.00

Pumps. Rumsey & Co.

Prices on all pumps include cylinders.

No.	Dia. Cyl.	Suction.	Cap. stroke.	Price Iron.	Price Brass cyl.
0	2 in.	1 in.	1-15 gal.	$3.50	......
1	2¼ "	1 "	1-12 "	4.00	$6.00
2	2⅜ "	1¼ "	1-11 "	4.50	7.00
3	2½ "	1¼ "	1-10 "	5.00	8.00
4	3 "	1¼ "	1-6 "	5.50	10.00
5	3¼ "	2 "	1-5 "	6.50	14.00
6	3½ "	2 "	1-4 "	8.00	18.00
7	4 "	2½ "	1-3 "	12.00	20.00

Dis., 65%.

No.	Dia. Cyl.	Suction.	Cap. stroke.	Price Iron.	Price Brass cyl.
1	2½ in.	1¼ in.	1-10 gal.	4.25	.....
2	3 "	1¼ "	1-7 "	4.75	.....
3	3½ "	1¼ "	1-5 "	5.25	.....
4	4 "	1½ "	1-4 "	5.75	.....
5	4½ "	1½ "	1-3 "	6.25	.....

Dis., 70%.

Standard and Cylinder for 1½ in. Iron Pipe, $16.00.

Dis., 55%

No. 6½, standard and cylinder, 1¼ in. pipe, $13.00.

No. 7½, standard and cylinder, 1¼ in. pipe, $15.00.

No. 8½, standard and cylinder, 1½ in. pipe, $18.00.

With hose and discharge pipe, add $3.00 to list price.

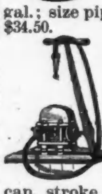
Dis. 55%.

No. 1, diam. cyl., 2½ in.; cap. stroke. 1-8 gal.; size pipe, 1¼ in. Price, iron, $12.50; brass cyl., $17.50.

No. 2, diam. cyl., 3 in.; cap. stroke, 1-6 gal.; size pipe, 1¼ or 1½ in. Price, iron, $14.50; brass cyl., $18.50.

No. 3, diam. cyl., 4 in.; cap. stroke, 2-5 gal.; size pipe, 1½ or 2 in. Price, iron, $23.50; brass cyl., $34.50.

Dis., 55%.



No. 1, diam. cyl., 3 in.; suction, 1¼ in.; cap. stroke, 3-10 gal. Price, iron, $28.00; brass cyl., $58.00.

No. 2, diam. cyl., 4 in.; suction, 1½ in.; cap. stroke, 1-2 gal. Price, iron, $32.00; brass cyl., $60.00.

No. 3, diam. cyl., 5 in.; suction, 2 in.; cap. stroke, 6-7 gal. Price, iron, $35.00; brass cyl., $90.00.

No. 4, diam. cyl., 6 in.; suction, 2½ in.; cap. stroke, 1 1-5 gal. Price, iron, $45.00; brass cyl., $120.00.

Dis., 45%.

No.	Diam. cyl.	Cap. stroke.	Stroke.	Pipe.	Price.
0	2 in.	1-11 gal.	7 in.	1 in.	$21.50
00	2½ "	1-7 "	7 "	1¼ "	23.00
1	3 "	1-5 "	7 "	1½ "	25.25
2	3½ "	1-3 "	7 "	1½ "	27.25
3	4 "	4-10 "	7 "	2 "	30.50
3½	4½ "	1-2 "	7 "	2 "	37.50
4	5 "	8-10 "	10 "	2½ "	44.00
4½	5½ "	1 "	10 "	2½ "	47.00
5	6 "	1 1-5 "	10 "	3 "	50.00

Dis., 40%.

No.	Diam. cyl.	Cap. stroke.	Diam. pipe.	Price Iron.	Price Br's cyl.
1	2 in.	1-5 gal.	1 in.	$39	$51
2	2½ "	1-3 "	1¼ "	41	56
3	3 "	1-2 "	1½ "	45	62
4	3½ "	6-7 "	2 "	51	81
5	4 "	7-8 "	2 "	63	114
6	4½ "	1 "	2 "	80	155

Dis., 40%.

With Tight and Loose Pulleys.

No. 1, cap. per rev., 1-6 gal.; size of pipe, 1¼ in.; price, iron, $26; bronze, $45.

No. 2, cap. per rev., 1-5 gal.; size of pipe, 1½ in.; price, iron, $31; bronze, $55.

No. 4, cap. per rev., 1-3 gal.; size of pipe, 2 in.; price, iron, $48; bronze, $75.

Pulleys on Nos. 1 and 2 are 8 in. diam., 2¼ in. face; on No. 4, 12 in. diam., 3¼ in. face.

Balance wheels for above pumps, $1, $2, and $3, according to size. Dis., 45%.

No. 2, ⅛ to 2 gal. per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, ¾ in.; discharge, ⅜ in.; price, $9.

No. 3, 1 to 4 gal. per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, 1 in.; discharge, ⅜ in.; price, $11.

No. 4, 2 to 8 gal. per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, 1½ in.; discharge, ½ in.; price, $14.

No. 5, 3 to 14 gal, per min.; length of drive pipe, 25 to 40 ft.; calabre of pipes, drive, 2 in.; discharge, 1 in.; price, $22.

No. 6, 4 to 25 gal. per min.; length of drive pipe, 30 to 40 ft.; calibre of pipes, drive, 2½ in.; discharge, 1¼ in.; price, $40.

No. 7, 8 to 60 gals. per min.; length of drive pipe, 30 to 40 ft.; calibre of pipes, drive, 4 in.; discharge, 2 in.; price, $75.

No. 8, 12 to 120 gal. per min.; length of drive pipe, 30 to 50 ft.; calibre of pipes, drive, 6 in.; discharge, 2½ in.; price, $125.

Dis., 45%.

Railroad Dumping Cars and Carts.

A. C. McEWEN.

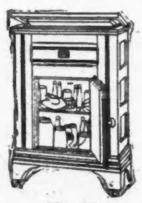
Cars.	Gauge.	Cap.	Net	Cap.	Net	Cap.	Net
Side Dumping	24"	1 c. y.	$55	2 c. y.	$65	3 c. y.	$75*
End "	"	"	55	"	65	"	75*
Revolving "	"	"	70	"	80	"	90*
Bottom "	"	"	80	"	90	"	100*
Tunnel	"	"	55	"	65	"	75*
Mine	"	"	50	"	60	"	70*
Plantation	30"		43				
Logging	36"		170				
"	4' 8½"		185				
Hand	36"		45				
"	4' 8½"		50				
Push	36"		40				
"	4' 8½"		45				
R.R. Construction	36"		60				
"	4' 8½"		65				
Carts.							
Plantation and Railroad			45 to 75				
Wagons.							
McEwen Patent Dumping		1 "	175	1½ "	200		

*These cars built of any gauge from 18" to 56½" and of any capacity from ½ to 6 cu. yd.

Refrigerators.

Indurated Fibre and Stoneware-Lined.

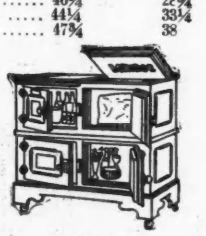
Cordley & Hayes.



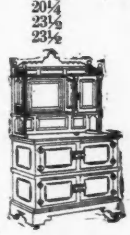
No. 35.

Nos. 75, 85.

No.	High.	Wide.	Deep.	Price.
35	46¼	28¾	20¼	$20.00
75	44¼	33¼	23½	28.00
85	47¾	38	23½	34.00



No. 2.



No. 6.

No.	High.	Wide.	Deep.	Price.
2	41	46	26	$36.00
6	84	46	26	60.00

Mirror 16 by 18 in. Dis., 30 and 5%.

Rules.

"Lufkin." Steel Rules, per doz.

	Rules only.	In leather cases.
No. 31, 1 ft. folding pocket	$4.00	$5.50
" 31, 2 " " "	8.00	10.00
" 41, 1 " " "	4.00	5.50
" 41, 2 " " "	7.50	9.50
" 41, 3 " " "	11.00	13.50
" 41, 4 " " "	14.50	17.00

	1 ft.	2 ft.	3 ft.
No. 60, ¾ × 21 gauge	$4.00	$8.00	......
No. 62, 1¼ × 16 "	8.00	15.00	$22.00

Discount, 60 and 10%.

Tinner's Rules.

No. 95, 3 ft. circumference rules .... each $2.50
No. 95, 4 ft. " " .... " 3.00

Discount, in dozen lots, 50%.

	℔ doz.
No. 51, 3½ ft. steel board rules	$42.00
No. 52, 3 " " "	36.00
No. 52½, 2½ ft. " "	33.00

Discount, 50%.

Sash Chains.

No. A. "Giant" metal, 15c. pr. ft., wts. not over 125 lbs.

No. 1. "Giant" metal, 12c. pr. ft., wts. not over 75 lbs.

No. 2. "Giant" metal, 10c. pr. ft., wts. not over 40 lbs.

No. 0. "Giant" metal, 8c. pr. ft., wts. not over 25 lbs.

No. 1. Red metal, 10c. pr. ft., wts. not over 40 lbs.

No. 2. Red metal, 8c. pr. ft., wts. not over 30 lbs.

No. 0. Red metal, 6c. pr. ft., wts. not over 15 lbs.

No. 1. Steel, 8c. pr. ft., wts. not 75 lbs.

No. 2. Steel, 6c. pr. ft., wts. not over 30 lbs.

No. 0. Steel, 4c. pr. ft., wts. not over 15 lbs.

No. 1. Steel, black enameled, 9c. pr. ft., wts. not over 75 lbs.

No. 2. Steel, black enameled, 7c. pr. ft., wts. not over 30 lbs.

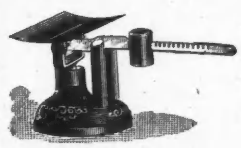
No. 0. Steel, black enameled, 5c. pr. ft., wts. not over 15 lbs.

Fastenings for hanging a window of 2 sashes for Nos. 1 and 2 chains, consisting of 4 hooks, 4 rings, 4 sash irons, a set, 18c. per set.

Fastenings for hanging a window of 2 sashes for No. 0 chains, 14c. per set.

Dis. on "Giant" metal chain	40	10	10%	
" " Red metal chain	40	10	10	10%
" " Steel " "	40	10	10	10%
" " Fastenings	40	10	10%	

Scales.—Discount on all scales 50 per cent.



Postal scales.

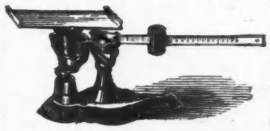
No 1, capacity ½ to 9 oz. $3.00.

No. 2, capacity ½ to 12 oz., $4.00.

No. 3, capacity ½ to 34 oz. $6.00

No. 4, capacity ½ oz. to 4 lbs., $8.00

Even balance trip scales seamless scoop, with weights.



No. 1, capacity ½ oz. to 2 lbs., tin scoop, $5.50 brass scoop, $6.50.

No. 2, capacity ½ oz. to 4 lbs., tin scoop, $6.50; brass scoop, $7.50.

No. 2½, capacity ½ oz. to 18 lbs, tin scoop, $11; brass scoop, $12.50.

Butter Trip Scales, slab, weights and scoop.

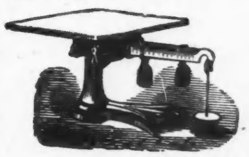
No. 7, ½ oz. to 10 lbs., 10 in. slab, without side beam $10.50
" " " " " " with " 11.50
" 8 " " 20 lbs., 12 in. " without " 12.50
" " " " " " " " 13.50

Tea Scales—All Seamless Scoops.

Capacity.	Scoop.		Capacity.	Scoop.	
¼ oz. to 10 lbs.	Tin	$8.00	¼ oz. to 10 lbs.	Brass	9.00

Druggists.

Capacity.	Scoop.		Capacity.	Scoop.	
1-16 oz. to 8 lbs.	Tin	$10.00	1-16 oz. to 8 lbs.	Brass	$11.00



Counter.

Capacity.	Scoop.		Capacity.	Scoop.	
½ oz. to 36 lbs.	Tin	$10.00	½ oz. to 36 lbs.	Brass	$12.00

Grocer.

Capacity.	Scoop.		Capacity.	Scoop.	
½ oz. to 62 lbs.	Tin	$12.00	½ oz. to 62 lbs.	Brass	$14.00

Meat or Butter Scales, with Slab.

½ oz. to 62 lbs., with Single Beam $14.00
" " " " Double " 15.00

Patent Boston platform, 13½ in. long by 10 in. wide.

Pillar, 18 in. high, double beam, marked both sides.

With large seamless tin scoop, $25.00
" " " brass " 27.00

Platform scales.—Without Wheels.

No.	Capacity.	Platform.	Price.
1	400 lbs.	21½ by 15 inches.	$23.00
2	600 lbs.	25 by 16 "	30.00
3	800 lbs.	25 by 17 "	34.00
4	1,000 lbs.	26 by 17 "	39.00
5	1,200 lbs.	28 by 20 "	45.00
6	1,600 lbs.	29 by 21 "	55.00
7	2,000 lbs.	32 by 23 "	70.00

With Wheels.

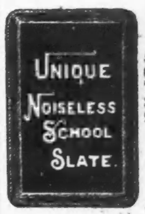
No.	Capacity.	Platform.	Price.
1	400 lbs.	21½ by 15 inches.	$26.00
2	600 lbs.	25 by 16 "	33.00
3	800 lbs.	25 by 17 "	38.00
4	1,000 lbs.	26 by 17 "	43.00
5	1,200 lbs.	28 by 20 "	49.00
6	1,600 lbs.	29 by 21 "	60.00
7	2,000 lbs.	32 by 23 "	75.00

Brass sliding poise at same price if so specified in order.

With Wheels and Drop Lever.

No.	Capacity.	Platform.	Price.
4	1,000 lbs.	26 by 17 inches.	$51.00
5	1,200 lbs.	28 by 20 "	59.00
6	1,600 lbs.	29 by 21 "	70.00
7	2,000 lbs.	32 by 23 "	82.00
8	2,500 lbs.	33¼ by 24¾ "	94.00
9	3,000 lbs.	38 by 30 "	125.00

School Slates.



Noiseless School Slates.

Winsboro Cord Bound.

Size.	Doz. in case.	Price per case.
5 by 7	18	$18.00
6 by 9	12	15.00
7 by 11	10	14.40
8 by 12	8	14.00
9 by 13	6	12.00

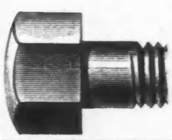
Dis., 50 and 2½%.

"D" School Slates.

Winsboro Oval Round Corner

	Doz. in case.	Price per case.
4 by 6	24	$10.80
5 by 7	18	9.00
6 by 8	12	8.20
6 by 9	12	8.64
6½ by 10	12	9.00
7 by 10	10	7.70
7 by 11	10	8.00
8 by 12	8	8.00
9 by 13	6	7.20

Dis., 200 case lots, 50 and 2½%.



Screws.

STEEL SCREWS ADD 50% TO LIST.

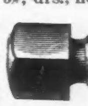
Prices are per 100.

Hexagon Cap Screws.

Heads on Steam-tight Screws not polished, unless so ordered. Can make these 12 inches long.

Diam. head.	7-16	½	9-16	⅝	¾	13-16	⅞	1	1⅛	1¼	1⅜
Length head.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
Diam. screw.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞		1⅛
L'gth under head. ¾	3.00	3.25	3.75	4.40	5.50	7.00					
1	3.25	3.50	4.00	4.70	5.70	7.00	9.50				
1¼	3.50	3.75	4.25	5.00	6.00	7.50	9.50	12.20			
1½	3.75	4.00	4.50	5.30	6.30	8.00	10.00	12.20	16.00		
1¾	4.00	4.25	4.75	5.60	6.60	8.50	10.60	12.80	16.60	21.20	
2	4.25	4.60	5.05	5.95	7.00	9.10	11.20	13.40	17.20	22.30	29.00
2¼		5.00	5.40	6.35	7.50	9.70	11.90	14.10	17.90	23.00	30.50
2½			5.80	6.80	8.00	10.40	12.70	14.90	18.80	25.10	32.30
2¾				7.30	8.60	11.20	13.60	15.90	20.00	26.90	34.40
3					9.30	12.10	14.70	17.00	21.80	29.00	37.00
Thread to in.	20	18	16	14	12	12	11	10	9	8	7
Add for each ¼ in.	.30	40	50	60	80	1.00	1.30	1.60	2.00	2.40	3.00

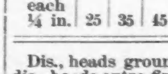
Dis., heads ground, 60%; dis., heads black, 60 and 5%; dis., heads extra finish, 50%; dis., heads case-hardened, 5%; dis., heads polished after hardening, 45%.



SQUARE CAP SCREWS.

Diam. head.	⅜	7-16	½	9-16	⅝	11-16	¾	⅞	1⅛	1¼	1⅜
Length head.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
Diam screw.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
L'gth under head. ¾	2.40	2.75	3.20	3.80	4.40	5.75					
1	2.60	2.95	3.40	4.00	4.70	5.75	7.70				
1¼	2.75	3.10	3.65	4.20	4.95	6.05	7.70	10.50			
1½	2.90	3.30	3.85	4.45	5.25	6.35	8.25	10.50	14.00		
1¾	3.05	3.50	4.10	4.70	5.55	6.65	8.80	11.10	14.80	18.00	
2	3.25	3.70	4.35	4.95	5.90	7.05	9.40	11.80	15.70	19.00	22.50
2¼		4.00	4.65	5.25	6.30	7.55	10.10	12.60	16.70	20.20	24.00
2½			5.00	5.60	6.75	8.15	10.90	13.50	17.80	21.50	25.80
2¾				6.00	7.25	8.85	11.80	14.60	19.10	23.10	27.90
3					7.80	9.65	12.80	15.90	20.60	25.00	30.50
Thread to in.	20	18	16	14	12	12	11	10	9	8	7
Add for each ¼ in.	25	35	45	55	65	90	1.20	1.50	1.80	2.30	3.00

Dis., heads ground, 65%; dis., heads black, 65 and 5%; dis., heads extra finish, 55%; dis., heads case hardened, 60%; dis., heads polished-hardened, 50%.

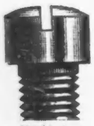


MILLED HEADS, COLLAR SCREWS.

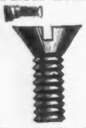
Diameter of Collar.	¼	11/32	7/16	½	⅝	11/16	13/16	15/16	1	1¼
Diameter of Screw.	⅛	3/16	¼	5/16	⅜	7/16	½	9/16	⅝	¾
Length under Head to Point, ¾	2.50	2.80	3.10	3.75	4.40	5.00	6.25			
1	2.80	3.10	3.40	4.05	4.70	5.30	6.60	8.25		
1¼	3.10	3.40	3.70	4.35	5.00	5.60	7.00	8.60	11.25	
1½	3.45	3.70	4.00	4.70	5.30	5.95	7.40	9.00	11.90	15.00
1¾		4.05	4.35	5.05	5.65	6.35	7.80	9.45	12.60	15.60
2			4.70	5.45	6.25	6.85	8.40	10.00	13.35	16.25
2¼				5.95	6.85	7.40	9.00	10.60	14.15	17.10
2½					7.50	8.10	9.60	11.25	15.00	18.00
2¾						8.75	10.30	11.90	15.90	19.00
3							11.00	12.60	16.85	20.00
Threads to inch	40	30	20	18	16	14	12 or 13	12	11	10
Add for each ¼ inch	30	40	50	60	80	1.00	1.30	1.60	2.00	2.40

Dis., 25%.

MILLED FROM SOLID BAR.



Fillister.



Bevel Head.

Button Herd

Diam. Head	3-16	¼	⅜	7-16	9-16	⅝	¾	13-16	⅞	1
Length Head	⅛	3-16	¼	5-16	⅜	7-16	½	9-16	⅝	¾
Diam. Screw	⅛	3-16	¼	5-16	⅜	7-16	½	9-16	⅝	¾
Length under Head. ¾	2.00	2.25	2.50	3.00	3.50	4.00	5.00			
1	2.25	2.50	2.75	3.25	3.75	4.25	5.30	6.60		
1¼	2.50	2.75	3.00	3.50	4.00	4.50	5.60	6.90	9.00	
1½	2.75	3.00	3.25	3.75	4.25	4.75	5.90	7.20	9.50	12.00
1¾		3.25	3.50	4.00	4.50	5.00	6.20	7.50	10.00	12.50
2			3.75	4.35	5.00	5.50	6.75	8.00	10.75	13.00
2¼				4.75	5.50	6.00	7.25	8.50	11.50	13.75
2½					6.00	6.50	7.75	9.00	12.00	14.50
2¾						7.00	8.25	9.50	12.75	15 25
3							8.75	10.00	13.50	16.00
Threads to inch.	40	30	20	18	16	14	12	12	11	10

Head on Bevel and Button Head Screws, 1-16 larger in diameter than above specifications.

Price, according to size of head.

Discount, 50%; case hardened, 45%; case hardened and polished, 35%.

Soups (French). Franco-American Brand

Per dozen.	In Cans— Quarts.	Pints.	In Glass. 1½ pt.
Green turtle..... Terrapin..........	$8.00	$4.32	$9.00
Chicken .... Mulligatawny. ..	3.75	2.25	
Mock turtle...... Ox tail........... Consommé....... Tomato........... Julienne......... Printanier........ French bouillon........ Mutton broth......... Vegetable............ Beef.................. Pea.....................	3.50	2.10	4.50 (Chicken to French bouillon); None in glass (Mutton broth to Pea)
Packed in cases of......	2 doz.	4 doz.	1 doz.

Regular Assorted Cases. In Cans—Quarts.

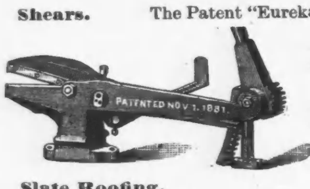
2 Chicken, 1 Mulligatawny, 3 Mock Turtle, 3 Ox Tail, 2 Consommé, 2 Tomato, 3 Julienne, 1 Printanier, 1 Mutton Broth, 1 Vegetable, 1 Beef, 2 French Bouillon, 2 Pea. Per doz., $3.55.

In Glass.

11 Chicken, 1 Mulligatawny, 2 Mock Turtle, 1 Ox Tail, 2 Consommé, 2 Tomato, 1 Julienne, Printanier, 1 Mutton Broth.

Terms cash Discounts: 5% for lots of 10 cases, 10% for lots of 25 cases. 15% for lots of 50 cases.

Shears. The Patent "Eureka



No. 1 cuts round metal up to ¼ in. steel to ⅛, $12.

No. 2 cuts round metal up to ½ in., steel to 3-16, $20.

Discount, 25%.

Slate Roofing.

F. o. b. New York. Stowage allowed.

Purple and Green, per 100 feet sq....................... $4.50

Dark blue, per 100 feet sq....................... 4.10

Sizes, 24 × 12 = 115 to sq., 650 lbs. weight.

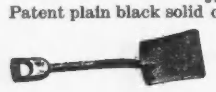
Sizes, 20 × 10 = 170 to sq., 650 lbs. weight.

Spades and Shovels.

The D. F. Jones Mfg. Co., of Gananoque (Ld.).

JONES'

Patent plain black solid cast-steel shovels and spades.



Meyer's patent steel shovel.

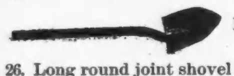
No.		No.	Per Doz. Black.	Per Doz. Pol's'd
20.	D. or long handle sq.-point shovels.	2	$15.50	$16.50
21.	" " " " "	3	16.25	17.25
22.	" " " " "	4	17.00	18.50
23.	" " " " "	6	17.50	19.00
24.	" " " " charcoal.	8	20.50	22.00

Pt. plain back solid cast steel shovel.

25.	D or long handle round-point shovels.	3	16.25	17.25

Patent steel spade.

28.	D or long handle spades..........	2	16.00	17.00
29.	" " " "	3	16.50	18.00



Patent plait back solid cast steel.

26.	Long round joint shovel No. 2..........		15.50	16.50
27.	" square " " No. 2..........		15.50	16.50
32.	D. handle square-point molders' shovels....................	2	.....	17.00
33.	D. handle square point railroad, extra heavy....................	2	15.75	
34.	D. handle round point railroad, extra heavy....................	3	16.50	
35.	L. handle round point shovel, with foot cap....................	2	16.00	17.00

GRAY'S

Patent plain back solid-steel shovels and spades.

50.	D. or long handle sq.-point shovels.	2	$12.00	$13.00
51.	" " " " "	3	12.75	14.00
52.	" " " round point "	3	12.75	14.00
55.	D. handle spades....................	2	12.25	13.25
56.	" " "	3	13.00	14.25

Patent solid corrugated scoop

SCOOPS.

Jones' patent plain back solid corrugated scoops.

90.	D. or long handle solid cast steel...	2	$13.50	$14.50
91.	" " " " " ...	4	14.50	15.50
91½.	" " " " " ...	6	16.50	17.50

Jones' riveted scoops.

92.	Cast steel D. or long handle...	2	13.50	14.50
93.	" " " "	4	14.50	15.50
94.	" " " "	6	16.50	17.50
				Half polished.
95.	" " "	8		$20.00
96.	" " "	10		22.50
97.	" " " Locomotive or coal (heavy)..........	6	17.50	
98.	" Long or D. handle for salt (heavy)..........	6	17.50	
99.	" D. handle flour and house furnace..........		10.50	
100.	" D. handle r'd-pt. for coal (extra heavy)..........	6	20.00	
				Polished.
101.	" ash pit, furnace L. handle..........	2		13.00
102.	" " " 32 in. D..	2		13.50
103.	" " " 42 " iron D. handle..........	2		14.00

Ditching spade.

124.	D handle ditching (flat)....................	18.00	19.50
125.	D handle post hole (concave)....................	18.00	19.50
126.	D handle Alcock (for clay and brick)...	16.00	17.00

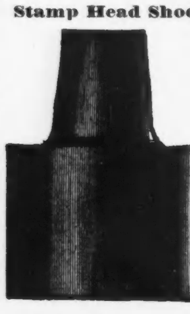
Discount on shovels and spades, 50 and 10.

" " scoops, 50.

Boxed f.o.b. New York, Boston or Montreal.

The solid shovels, spades and scoops are made from the bar, by a recent patent process, the blade and strap being in one piece, not welded. All goods are American patterns.

Stamp Head Shoes and Dies.



Shoe & Die (Adamantine), showing even wear from end to end.

Chrome Steel Works.

8 cents per lb f.o.b. New York.

Stencil Inks.

S. H. QUINT & SON.

No.	Per can.	Per cake.	No.	Per can.	Per cake.
Black.					
1.......	7 cents	3 cents	3.......	20 cents.	12 cents
2.......	10 "	5 "	4.......	30 "	20 "
Blue.					
1.......	10 cents.	6 cents	3.......	30 cents.	22 cents
2.......	15 "	9 "	4.......	50 "	40 "
Red and Green.					
1.......	12 cents	8 cents	3.......	50 cents.	42 cents
2.......	20 "	15 "	4.......	90 "	80 "

Per doz. cans or cakes, net, per gross, 10% less.

Indelible Ink.

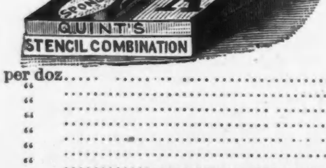
Small bottles per 100.............................. $2.75

" " 500.............................. 12.00

" " 1,000.............................. 20.00

STENCIL COMBINATIONS.

Contains Alphabet, Figures, Brush. and Ink.



⅛ inch, per doz.............................. $5.00

¾ " " 5.40

1 " " 5.75

1¼ " " 7.50

1½ " " 8.40

" " 10.00

2½ " " 15.00

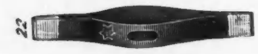
Dis., 10%.

Tools.

ARTISANS.

Chisel (Mason).

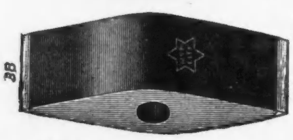
Stone, 5 and 8c. lb., net.



Mill Picks.

Cast steel, 2 to 3 lbs., $22 per doz.

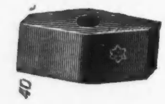
Dis., 60 and 5%.

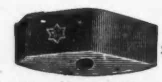


Stone Axes, Cast Steel.

All sizes, 50c. per lb.

Dis., 70 and 10%.





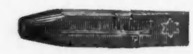
Five lbs. and over, 40c.; with teeth, 45c.; 3 to 5 lbs., 45c.; with teeth, 50c.; under 3 lbs., 50c.; with teeth, 55c.

Nos. 40 and 41, spalling or stone hammer, 5 lbs. and ver, 36c.; 3 to 5 lbs., 40c.; under 3 lbs., 45c. per lb.

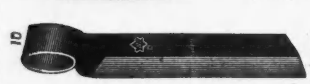
Nos. 40 and 41, spalling hammers, 9 to 20 lbs., steel face, per lb., 17c. Dis., 70 and 10%

Ship or Top Mauls, Steel Face, 4 to 8 lbs., 28c. per lb.

Dis., 50, 10 and 5%.



Steel Wedges, wood, 1st qual., 5c. lb.



Cooper Froes.

8 in.. ₩ doz. $13.00

10 in.. ₩ doz. 13.50

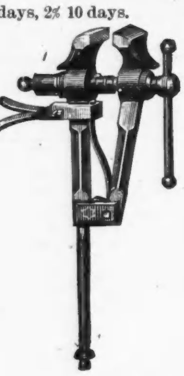
12 in.. ₩ doz. 14.00

14 in.. ₩ doz. 14.50

16 in.. ₩ doz. 15.00

Discount, 60%.

60 days, 2% 10 days. Vise.



No 1. Solid Box Vises.

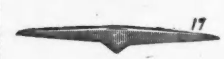
	Each.
No. 25, 3⅜ in. Jaw......	$12.00
" 30, 3½ "	11.00
" 35, 3⅞ "	10.00
" 40, 4 "	10.50
" 45, 4¼ "	11.00
" 50, 4¼ "	11.50
" 55, 4½ "	12.00
" 60, 4½ "	13.00
" 65, 4¾ "	14.00
" 70, 5 "	15.00
" 75, 5 "	16.00
" 80, 5¼ "	17.50
" 85, 5¼ "	18.50
" 90, 5½ "	20.00
" 95, 5¾ "	21.00
" 100, 6 "	22.00
" 105, 6 "	23.00
" 110, 6¼ "	24.00
" 115, 6¼ "	25.00
" 120, 6½ "	26.00
" 125, 6½ "	27.50
" 130, 6¾ "	29.00

	Each.		Each.
No. 135, 6¾ in. Jaw...	$31.50	No. 170, 7¼ in. Jaw...	$44.50
" 140, 7 "	33.00	" 180, 8 " ...	47.00
" 145, 7 "	35.00	" 190, 8 " ...	53.00
" 150, 7 "	36.00	" 200, 8 " ...	56.00
" 160, 7¼ "	41.50		

Dis., 60 and 10%.

MINERS.

Adze Eye Coal Picks. Same list and dis. as No. 16.



Anthracite Coal Picks. Same list and dis. as No. 16.

Stone Picks, per doz.

No. 18, 6 to 7 lbs... $16.50.

No. 18, 7 to 8 lbs... 17.50.

No. 18, 8 to 9 lbs... 18.50.

Dis., 60 and 5%.

Coal Picks.

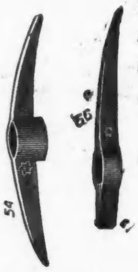
No.		Per doz.
16,	Weight, 2 lbs..............................	$8.50
16,	" 2½ "	9.00
16,	" 3 "	9.50
16,	" 3½ "	10.00
16,	" 4 "	10.50
16,	" 4½ "	11.00
16,	" 5 "	11.50
16,	" 5½ "	12.00
16,	" 6 "	12.50
16,	" 6½ "	13.00
16,	" 7 "	14.00

Packages charged at cost. Dis., 60%.

Adze Eye Miners Picks—Surface, Drifting and Poll.

No.			per doz.
19,	Surface.	No. 1, 4 lbs......	$14.00
19,	"	No. 2, 4½ "	15.00
19,	"	No. 3, 5 "	16.00
19,	"	No. 4, 5½ "	17.00
19,	"	No. 5, 6 "	18.00
19,	"	No. 6, 6½ "	19.00
19,	"	No. 7, 7 "	20.00
20,	Drifting,	No. 1, 3 "	12.50
20,	"	No. 2, 4 "	14.00
20,	"	No. 3, 4½ "	15.00
20,	"	No. 4, 5 "	16.00
20,	"	No. 5, 6 "	17.50
21,	Poll,	No. 1, 3½ "	15.00
21,	"	No. 2, 4 "	16.00
21,	"	No. 3, 4½ "	17.00
21,	"	No. 4, 5 "	18.50
21,	"	No. 5, 6 "	20.00
21,	"	No. 6, 6¾ "	21.50

Dis., 60, 10 and 5%.



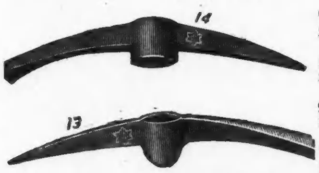
No.	Ore Picks.	
54,	Adze Eye, 5 to 6 lbs.... ₩ doz.	$12.00
54,	" 6 to 7 " ..... "	$13.00
54,	" to 8 " .... "	$14.00

56, Steel Lake Superior Mining Pick*

(Special Price and Quality.)

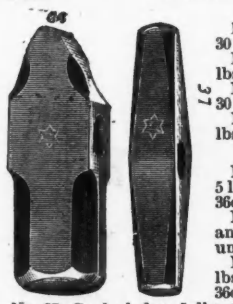
Dis, 60 and 10

Tamping Picks.



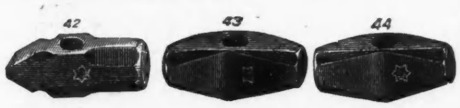
Adze eye, 6 to 7 lbs., per doz., $17.
Adze eye, 7 to 8 lbs., per doz., $18.
Adze eye, 8 o 9 lbs., per doz., $19.
Hunt eye, 6 tc 7 lbs., per doz., $17.
Hunt eye, 7 to 8 lbs., per doz., $18.
Hunt eye, 8 to 9 lbs., per doz., $19.
Dis., 60 and 10%.

Steel Face Hammers.
No. 43, hand drilling hammers, 2 to 5 lbs.; No. 45, napping hammers, 2 to 5 lbs.; No. 39, mason hammers, 3 to 8 lbs.; No. 42, smiths' hand hammers, 2 to 5 lbs.; No. 44, smiths' striking hammers, 2 to 5 lbs., all steel face, per b., 26c. Dis.. 70 and 10%.



Steel Face Sledges.
No. 34. Smiths' sledges, 6 to 30 lbs., steel face, 17c. per lb.
No. 35. Stone sledges, 6 to 30 lbs., steel face, 17c. per lb.
No. 36. Striking sledges, 6 to 30 lbs., steel face, 17c. per lb.
No. 37. Coal sledges, 5 to 10 lbs., steel face, 18c. per lb.

Cast Steel Sledges.
No. 34. Blacksmiths' sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 35. Stone sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 36. Striking sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 37. Coal sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.



No. 43, hand drilling hammer, 5 lbs. and over, 36c.; 3 to 5 lbs., 40c.; under 3 lbs., 45c. per lb.
Dis., 70 and 10%.

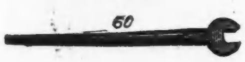
Cast Steel.
No. 42, blacksmiths' hand hammer, 5 lbs. and over, 30c.; 3 to 5 lbs., 34c.; under 3 lbs., 45c. per lb.
No. 44, drilling or striking hammer, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 45, napping hammer, 5 lbs. and over, 30c.; 3 to 5 bs., 35c., under 3 lbs., 45c. per lb.
Dis., 70 and 10%.

RAILROADS.

Railway Track Punch

Round Point.
15c. lb., net.

Track Wrench.



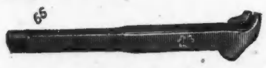
7¾c. lb., net.

Rail Fork.

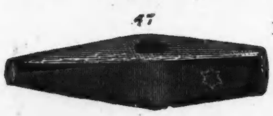
9c. lb., net.

Crow Bars.
Wedge Points,
3½c. lb., net.
Pinch Point,
3½c. lb., net.

65 Tamping Bar,
6c. lb., net.

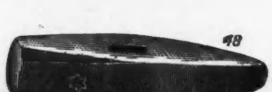


66 Claw Bar,
7c. lb., net.



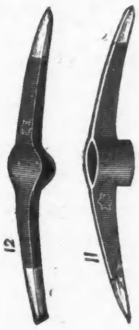
Railroad Spike Mauls
6 to 16 lbs., Steel Face
18c. lb.

Dis., 50, 10, and 5%.



Steel Track Chisel,
15c. per lb., net.

Railroad or Clay Picks.

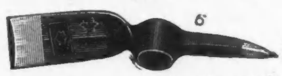


No.		Per doz.
11,	Adze eye, 4 to 5 lbs	$11.00
11,	" 5 to 6 "	12.00
11,	" 6 to 7 "	13.00
11,	" 7 to 8 "	14.00
11,	" 8 to 9 "	16.00
11,	" 9 to 10 "	18.00
12,	Hunt eye, 4 to 5 "	11.00
12,	" 5 to 6 "	12.00
12,	" 6 to 7 "	13.00
12,	" 7 to 8 "	14.00

Dis., 60 and 10%.

Mattocks—Price per doz.
2, Adze Eye, Long Cutter, 6 lbs., $16.00.
3, Adze Eye, Short Cutter, 5½ lbs., $15.50.
2, Adze Eye, Long Cutter, Light, $15.00.
3, Adze Eye, Short Cutter, Light, $15.00.
4, Hunt Eye, Long Cutter, 6 lbs., $16.00.
5, Hunt Eye, Short Cutter, 5½ lbs., $15.50.

Adze Eye Pick Mattocks..........$16.

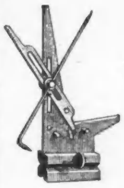


Hunt Eye Pick Mattocks.........$16

Dis., 60 and 10%.

Grub Hoes.
Western Pattern, No. 0, 3 lbs., ₩ doz., $10.50.
Western Pattern, No. 1, 3½ lbs., ₩ doz., $11.
Western Pattern, No. 2, 4 lbs., ₩ doz., $11.50.
Western Pattern, No. 3, 4½ lbs., ₩ doz., $12.
Baltimore Pattern, No. 1, 3½ lbs., ₩ doz., $11.
Baltimore Pattern, No. 2, 4½ lbs., ₩ doz., $11.75
Baltimore Pattern, No. 3, 5 lbs., ₩ doz., $12.75.
Baltimore Pattern, No. 4, 5¾ lbs., ₩ doz., $13.75.
Dis., 60 and 10%.

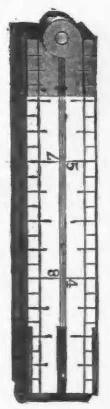
MACHINISTS'.



Combination Square, Bevel and Surface Gauge.

Price complete..........$3.00

Dis., 20, 10 and 5%.



Tools, Carpenters'.

BOXWOOD RULES.

Two feet, four-fold, 1 inch wide.

Plate.	Middle.	Edge.	Bound.
Round joint..........	$4	...	...
Square "	5	$7	$15
Arch "	6	8	16

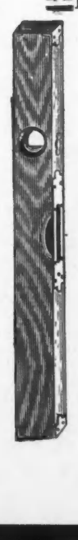
Two feet, four-fold, 1⅜ inches wide.

Plate.	Middle.	Edge.	Bound.
Square joint..........	$7	$9	$18
Arch "	9	11	20

Two feet, two-fold, 1½ inches wide.

Square joint.	Arch.	Arch Bound.
$5	$7	$16
12	14	24

Gunter's Slide.
Dis. 80, 10 and 10%.



LEVELS.

	10 to 16 in.	18 to 24 in.
Arch top plate, 2 side views..	$9.00	$12.00

PLUMBS AND LEVELS.
Arch top plate, 2 side views.

	12 to 18 in.	18 to 24 in.	24 to 30 in.
Polished..........	$14.00	$16.00	$18.00
Mahogany..........		16.50	22.50
Mahogany tp'd and lp'd	27.00	.....	.....
Polished and l pped.....	.....	.....	24.00
Polished and tipped.....	.....	.....	28.00
Polished, lip'd and tip'd	.....	.....	35.00

	in.	
Mason's level, 2 plumbs, polished,	36,	$30.00
Mason's level, 2 plumbs, p'd and t'd,	36,	36.00
Mason's level, 2 plumbs, polished,	42,	36.00

PATENT ADJUSTABLE PLUMBS AND LEVEL.

Arch Top plate, 2 side views	26 to 30 in.
Polished and lipped..........	$27.00
Polished and tipped..........	30.00
Polished, lipped and tipped..........	39.00
Mahogany..........	27.00
Mahogany, lipped..........	33.00
Mahogany, lipped and tipped..........	48.00
Polished, triple stock, lipped and tipped..........	48.00
Mahogany " " " "	60.00
Rosewood, lipped and tipped..........	90.00

Dis., 70, 10, 10%.

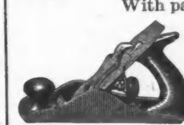
POCKET LEVELS.

Iron top, Japanned..........	2 50
Brass top..........	3.00

Dis., 70, 10, 10%.

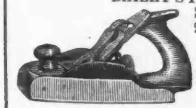
SCREWDRIVERS.
Varnished handles, pat. metallic fastening.
Size 1½, $1 per dozen; 2, $1.50; 3, $2; 4, $2.50; 5, $3; 6, $3.50; 7, $4; 8, $4.75; 10, $6; 12, $8.
Dis., 75%.

PLANES, BAILEY'S PATENT IRON.
With pat. lateral adjustment.



Smooth, 8 in. × 1¾ in., $3; 9 in. × 2 in., $3.25; 10 in. × 2⅜ in., $3.75 each.
Jack, 14 in. × 2 in., $3.75.
Fore, 18 in. × 2⅜ in., $4.75
Jointer, 24 in. × 2⅜ in., $6.50 each.
Dis., 40, 10 and 10%.

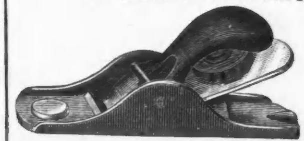
BAILEY'S PATENT WOOD PLANES.



Smooth.		Handle smooth.
9 × 8¾ in.	8 × 2 in.	9 × 2 in.
$2	$2	$2.50 each
Jack.	Fore.	Jointer.
15 × 2⅛ in.	20 × 2⅜ in.	26 × 2⅝ in.
$2.50	$2.75.	$3.25 each

Dis., 40, 10 and 10%.

STANLEY IRON BLOCK PLANES.



3½ × 1 in.
20c.

5½ × 1¼ in.
40c.

7½ × 1¾ in.
60c. each.

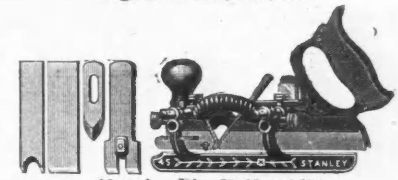
ADJUSTABLE.

5½ × 1¼ in.
60c.

7½ × 1¾ in.
85c. each.

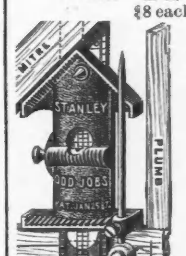
Dis. , 40, 10 and 10%.

STANLEY'S BEADING, RABBET, SLITTING AND MATCHING PLANE.
Eighteen Tools, Bits, etc.



$8 each. Dis., 20, 10 and 10%.

STANLEY "ODD JOBS."



Embraces in combination with ordinary Carpenters' Rule:

010 Try square.
020 Mitre square.
030 T—— square.
040 Marking gauge.
050 Mortise gauge.
060 Depth gauge.
070 Mitre level.
080 Spirit level and plumb.
090 Beam compass.
0100 Inside square for making boxes and frames.

Price 75 cents.
Dis., 20, 10 and 10%.

TACK HAMMERS.

	Doz.
Magnetic, small..........	$1.25
Medium..........	1.50
Large..........	1.75

Discount, 30, 10, 10%.

MALLEABLE IRON.
Inlaid Handle.
Per Doz..........$2.50
Discount, 30, 10, 10%.

STEAK HAMMERS.

Japanned..........	$2.25
X Plated..........	3.00

Discount, 30, 10, 10%.

Trucks.

New York Pattern.

Size.	Length of hdles. Ft.	In.	Width at nose. Inches.	Width at upper bar. Inches.	Size of wheel. Inches.	Price.
No. 0	3	6½	12	13¼	6½ × 1¾	$4.50
No. 1	4	1	13⅞	15⅝	6½ × 1¾	4.85
No. 2	4	5	15	16½	7¾ × 1⅞	6.00
No. 3	4	8	16	17¾	8¾ × 2¼	7.00
No. 4	5	0	16¼	17¼	9¾ × 2¼	8.00
No. 5	5	4	17¼	18⅞	10¾ × 2¾	9.50

Discount 50%.
Special net prices on quantity orders.

Tuyeres.

No. 2. $25.00 No. 4. $35.00 per doz.

20 % dis.

Valves. Brass Globe and Angle Valves.

Size, inches	⅛	¼	⅜	½	¾	1
Star globe and angle valves	$0.80	$0.85	$0.90	$1.20	$1.55	$2.00
Star globe and angle valves, heavy patterns	...	...	...	1.50	1.95	2.80
Extra heavy Star and Lion patterns	...	...	...	2.00	2.60	3.60
All brass, yoke top	...	...	...	...	...	3.75
Cross valves	...	1.15	1.25	1.50	2.00	2.50
Star check valves	.70	.70	.75	.95	1.20	1.65
do. heavy pattern	...	...	...	1.15	1.50	2.00
Crescent globe and angle valves	.60	.60	.75	1.00	1.35	1.80
Crescent hose valves	..	..	..	..	..	..
check valves		.50	.60	.85	1.15	1.55
Vertical check v'lv's		.50	.60	.85	1.15	1.55
Jenkins globe and angle valves		1.10	1.25	1.60	2.20	2.80
Jenkins check valv's		1.10	1.20	1.30	1.90	2.60
Gate valves, Chapman		...	...	1.30	1.75	2.25
Gate valves, other makes		...	1.00	1.20	1.75	2.50
Brass safety valves		2.00	2.25	2.75	3.50	5.00
Brass butterfly v'lv's		...	...	...	...	3.50

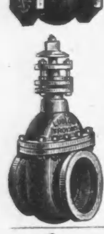
Size, inches	1¼	1½	2	2½	3
Star globe and angle valves	$3.00	$4.00	$6.50	$12.50	$19.00
do. heavy pattern	3.95	5.30	8.35	14.00	22.00
Extra heavy Star and Lion patterns	5.40	7.20	10.80	18.20	28.60
All brass, yoke top	5.00	7.00	10.00	18.00	30.00
Cross valves	3.50	5.00	8.00	16.00	24.00
Star check valves	2.50	3.25	5.00	11.00	15.00
do heavy pattern	3.00	4.00	6.50	12.50	17.00
Crescent globe and angle valves	2.80	3.90	5.90	11.25	16.00
Crescent hose valves	4.00	5.50	7.00	10.00	....
" check valves	2.30	3.25	5.20	10.00	14.00
Vertical check valves	2.30	3.25	5.20	10.00	14.00
Jenkins globe and angle valves	4.00	5.50	8.00	15.75	22.00
Jenkins check valves	3.60	5.00	7.50	13.50	20.50
Gate valves, Chapman	3.25	4.25	6.25	11.50	16.00
" " other makes	3.50	5.00	7.50	15.00	22.00
Brass safety valves	7.00	8.50	12.00	20.00	30.00
Brass butterfly valves	4.50	5.50	8.00	11.00	16.00

Pressure Regulating.

Mason Regulator Co.

Size pipe.	Price.	Size pipe.	Price.	Size pipe.	Price
1 inch.	$22.	1¼ inch.	$28.	1½ inch.	$35.
2 "	44.	2½ "	57.	3 "	72.

Ludlow Valve Co.
Double Gate Brass Val ves.
Gland in packing box.



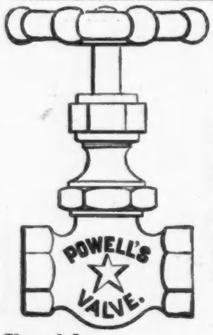
Size.	Screw socket.	Flange.	Diameter of Standard Flange.	Face to face of Screw socket	Face to face of Flanges.	Extra for slide stem and lever subject to discount.
In.	$	$	In.	In.	In.	
½	1.25	......	......	2¼	......	$1.00
¾	1.65	......	......	2½	......	1.00
1	2.15	......	......	2⅞	......	1.00
1¼	3.15	......	......	3⅜	......	1.00
1½	4.25	......	......	3¾	......	1.00
2	6.25	11.50	6	4⅛	4⅝	1.00
2½	11.50	18.00	6½	4 13-16	5⅜	1.25
3	16.00	22.00	7	5	6¼	1.25
3½	21.00	31.00	7½	....	....	1.25
4	35.00	43.00	9	....	7 1-16	1.25
5	52.00	64.00	10	....	....	1.25
6	78.00	90.00	11	....	9	1.25
8	......	......	....	....	....	....
10	......	......	....	....	....	....
12	......	......	....	....	....	....

Rubber-Faced Slide Gate Fire Hydrant.
See cuts on pages 19 and 20.

Diameter of pipe connection.	Diameter of stand pipe.	Diameter of seat ring.	One 2½ nozzle.	Two 2½ nozzles.	Three 2½ nozzles.
Inches.	Inches.	Inches.			
3 or 4	4⅝	3	$28	....	....
3--4--6	5¾	4	31	$33.00	$35.00
4 or 6	7	5	....	38.50	40.50
6 or 8	8	6	....	49.00	51.00
8 or 10	10	8	....	....	....

Four 2½ nozzles.	Six 2½ nozzles.	One steamer nozzle.	One steamer and one 2½ nozzle.	One steamer and two 2½ nozzles.	Frost case, standard length.
......	......	......	......	......	$4.50
......	......	$33.00	$35.00	$37.00	5.00
......	......	38.50	40.50	42.50	6.50
$53.00	......	49.00	51.00	53.00	7.50
......	......	......	......	......	......

For each 6 inches more or less than standard length of stand pipe, add or deduct from list.	For each 6 inches more or less than standard length of frost case, add or deduct from list.	Extra charge for hub.	Independe't nozzle gates each.
$0.60	$0.44	....	....
.75	.50	6 in. $0.50	$3.50
.85	70	No ch'ge	3.75
1.00	.90	8 in. $1.25	3.75
....	....	....	4.50



Star Radiator Valves, with Brass T Handles or Wood Wheels.

Size, inches	½	¾	1
Plain brass	$1.60	$2.00	$2.50
Plated trim'gs.	1.80	2.25	2.80
Rough & Plat'd	2.00	2.45	3.05
Finish'd & P'l't.	2.50	3.00	3.65

Size, inches	1¼	1½	2
Plain brass	$3.60	$4.80	$7.50
Plated trim'gs.	3.95	5.20	8.00
Rough & Plat'd	4.20	5.50	8.50
Finish'd & P'l't.	4.95	6.50	9.75

Dis., 40, 10 and 5%.

Varnish.

E.S. 1827 & Co.

Edward Smith & Co.
For Finishing Coats. gal.
Wearing body varnish $5.50
Medium drying body.............. 5.50
One coat coach varnish........... 4.50
Wearing carriage................. 4.50
Heavy gear varnish.............. 4.00
Coach body " 4.05
No. 1 coach " 2.2

For Under Coats.
Hard drying body.....$4.50 | Black rubbing varnish.$4.00
Rubbing body varnish. 4.00 | Priming (1st coat)..... 2.50
Quick rubbing " 3.50 | Filling (2d coat) 2.50
Rough stuff............ 2.50

For Inside Work.
Best flowing varnish..$4.50 | Hard oil finish light...$2.75
Best polishing " .. 4.50 | " dark... 2.25
Cabinet " .. 3.00 | White copal.......... 4.00

Dryers.
Japan gold size....... $3.50 | Brown japan...........$1.25
Coach japan........... 1.75 | Liquid dryer.......... 1.25
Discount, 40 per cent. f.o.b. N. Y.

Preservative Coatings.
Spar coatings..........$4.00 | Exterior car coating..$4.00
I. X. L. No. 1........... 2.50 | Interior car coating... 3.25
I. X. L. No. 2........... 4.00 | Locomotive coating.... 4.00
Floor finish............ 2.50
Discount, 35 per cent, f.o.b. N. Y.

Watches.—Trenton Watch Co.

Open Face, Stem Wind and Set.

No. 51. Nickel Silver, Snap Back and Bezel.. .... $3.50

No. 55. Nickel Silver, Jointed Back and Bezel. 3.7

No. 60. Nickel Silver, Bassine style, (Smooth Edges), Double Joints 4.25

No. 65. Dueber Silverine Bassine... 4.50

No. 92. Silver, Engine Turned..... 6.30
No. 90. Silver, Engraved........... 6.50
No. 101. 14-karat Gold, Filled, Cases made of twoplates of 14-karat gold rolled on base metal, and warranted to wear for 15 years, Engine Turned 11.00
No. 102. Same, Engraved.......... 13.00
Dis., 15 and 6% cash.

Wheelbarrows.

Climax Bolted Barrow, with Wood Wheel per doz. $22.50. 1½ tire of iron,
Common Nailed Barrow per doz. $18.50.
" Bolted " " " 18.75.

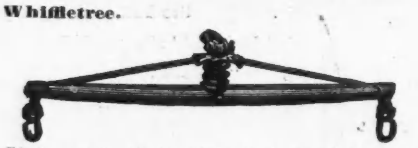
Lansing's Patent Iron-Bolted Barrow,	per doz.,			$25.50
Capital Patent Bolted Dirt	"	"	"	30.00
Red oak or Government	"	"	"	40.50
Wharf	"	"	"	72.50
Mortar	"	"	"	30.00
Bent Handle Stone	"	"	"	48.00
Coal or Ore	"	"	"	31.50
Pig Metal or Casting	"	"	"	40.50
Brick Yard 20 inch Iron Wheel	"	each		10.50

Globe Patent Bolted Garden Barrow, Box 30 by 24 by 12 deep, wood wheel } per doz., 42.50.

Capita Patent Barrows
With Iron Tray, A, per doz., ...$39.00
" " " B, " " 42.00

The Leader Iron and Steel Barrows.
Gas-pipe Legs and Handles in one price.
No. 1 Tray of 16 iron, capacity 3 cu. ft. of earth, each $12.
No. 2 " " 14 " " 5 " " " " or 250 lbs. of coal.................... " 15
3 Galvanized 18 iron, capacity same as No. 2...... " 15

Whiffletree.



Wilson spring (Jeffery Manufacturing Company).

	Single.	Double.
No. 1, 34 or 36 inches long	$1.25	$2.50
No. 2, " " "	1.40	2.75
No. 3, " " "	1.50	3.00
No. 4, " " "	1.65	3.25

Including either steel hooks or rings
Discount, 45 and 5%.

Whims—Horse.

Common sense Steel.

F. O. B.. $125
Dis., 25%., in car lots.

Windmills.

A. J. CORCORAN.
Patent Storm Defying Pumping Mills.

Wheel.	Weight, boxed.	Cubic feet.	Price.
8½ ft.	650 lbs.	55	95.00
10 "	700 "	75	120.00
12 "	900 "	95	150.00
14 "	1,350 "	135	250.00
16 "	1,850 "	195	375.00
18 "	2,150 "	250	450.00
20 "	3,500 "	335	600.00
Dis., 25%.			
25 "	5,400 lbs.	450	775.00
Dis., 20%.			
30 "	9,500 lbs.	795	975.00

Boxing for export extra.

Corcoran Storm Defying Geared Windmills for Driving Machinery.

Price includes upper set of Bessemer steel gears, one length of shaft.

Dia.	H. P.	Weight.	Cu. ft.	Price.
16 ft.	2½	1,900 lbs.	200	$400.00
20 "	5	3,600 "	340	650.00
25 "	6½	5,400 "	355	850.00
30 "	8	9,600 "	816	1,150.00
36 "	10	12,000 "	856	1,500.00
40 "	12	14,500 "	896	2,000.00
50 "	30	16,500 "	956	3,500.00
30 "	40	20,000 "	1,015	4,500.00

Dis., 25%.

10 ft. pumping.... $75
12 ft. " 95
14 ft. " 140
16 ft. " 225
} Plus cost of packing.

Dis., 50 per cent.

Wire Cloth.

Brass and Copper Wire Cloth.

No. Mesh.		Price per foot.	No. Mesh.		Price per foot.
2	from No. 10 wire	$2 50	20	from No. 26 wire	$.80
3	" 11 "	2.50	22	" 27 "	.80
4	" 12 "	2.50	24	" 28 "	.80
5	" 13 "	2.50	30	" 30 "	.65
6	" 14 "	2.50	40	" 32 "	.70
8	" 16 "	2.50	50	" 34 "	.75
10	" 18 "	2.00	60	" 35 "	.78
12	" 19 "	2.00	70	" 37 "	.70
14	" 22 "	1.10	80	" 38 "	.90
16	" 24 "	.80	90	" 39 "	1.10
18	" 25 "	.80			

Dis., 60%.

Wire Goods.

Fly Traps. Per gross.
Paragon.......$18.00
Balloon....... 15.00

Dis. 10%.

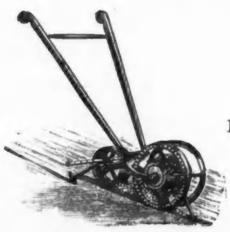
We offer our services to foreign correspondents who desire to purchase American goods, and shall be pleased to furnish them, without charge, information concerning American manufactures of every kind.

NEW YORK PRICES CURRENT. NOVEMBER 2, 1889.

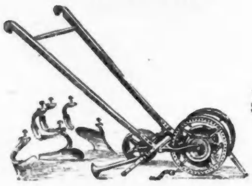
Discounts are for Export Only.

In the interest of the extension of the markets for American manufactures the ENGINEERING AND MINING JOURNAL has secured the services of gentlemen thoroughly acquainted with the export trade and with foreign markets, and it offers its services to foreign buyers who may desire information concerning any article whatever of American manufacture. No charge will be made for these services, either directly or indirectly through commissions on goods purchased. The proprietors of the ENGINEERING AND MINING JOURNAL are neither commission merchants nor exporters, but they have many sources of information, both at home and in foreign countries, and place these at the service of manufacturers and exporters here and of importers and consumers in other countries.

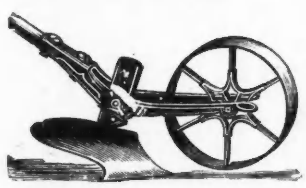
Agricultural Implements.



"Planet, Jr." No. 2 Seed Drill, $9.



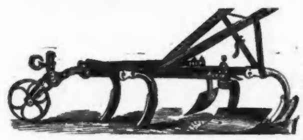
Combined Drill Cultivator, Rake, Plow, etc., $12.



"Fire Fly" single-wheel Hoe, Cultivator and Plow, $5.

"Fire Fly" Hand Plow, $2.50.

30 % discount, f.o.b. New York.

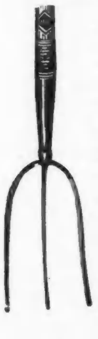


All Steel Horse Hoe and Cultivator combined, with wheel, $11.

All Steel Plain Cultivator, $6.00.

40% discount, f.o.b., New York.

HAY FORKS.



Ely Hoe & Fork Co.—Gold Finish, Patent Overcaps.

Three Tine Forks.

No.	Tine.	Handles.		Per doz.
30	10 in.	4½ ft.	Boy's	$7.75
32	12 "	4 to 6 ft.		9.00
32 S	12 "	"	Strapped	10.50
32 B	12 "	"	Bent	9.50
32 B S	12 "	"	Bent & St'pd	11.00
33	12 "	"		9.50
33 S	13 "	"	Strapped	11.00
33 B	13 "	"	Bent	10 00
33 B S	13 "	"	Bent & St'pd	11.50
34	14 "	"		10.25
34 B	14 "	"	Bent	10.75
35	15 "	"		11.25
35 B	15 "	"	Bent	11.75
42 B	12 "	"	Bent	12.50
42 B S	12 "	"	Bent & St'pd	14.00

Manure Forks, Solid Steel Shanks, Gold Bronze Finish, Patent Overcaps.

No. 44, oval, 4 tine, 12 in. tine, 4 ft. handle, plain ferrules, $12.50 per doz.

No. 44 S, oval, 4 tine, 12 in. tine, 4 ft. handle, strapped ferrules, $14.

No. 44½, oval, 4 tine, 12 in. tine, 4½ ft. handle, plain ferrules, $12.50.

No. 44½ S, oval, 4 tine, 12 ft. tine, 4½ ft. handle, strapped ferrules, $14.

No. 54, oval, 5 tine, 13 in. tine, 4 ft. handle, plain ferrules, $19.50.

No. 54 S, oval, 5 tine, 13 in. tine, 4 ft. handle, strapped ferrules, $21.

No 64, oval, 6 tine, 13 in. tine, 4 ft. handle, plain ferrules, $22.50.

No. 64 S, oval, 6 tine 13 in. tine, 4 ft. handle, strapped ferrules, $24.

HOES.

Ely Standard Socket, all Gold Bronze Neck, full Pol'd, C. S. Blade.

Field, 7 × 5 in., selected handles	$9.00
" 7½ × 4½ " " "	9.00
" 8 × 4¾ " " "	9.00
" 8½ × 4½ " " "	9.00
" 8 × 5 " " "	9.00
Washington County Pattern, spring handles	10.00
Rhode Island, 7 to 9 in., spr'g handles	9.00
" " 9½ in. " "	9.25
" " 10 " " "	9.50
Meadow, 9 × 4 in., poplar handles	9.00
Meadow, 9½ × 3½ in., poplar handles	9.25
Meadow, 10 × 3½ in., poplar handles	9.50
Broom Corn, 7½ × 4½ in., poplar handles	9.00

Popular Handles in Meadow Socket Hoes, unless otherwise ordered.

PLOWS.

Reversible Oneonta Clipper.

16. Oneonta Clipper, Reversible, Iron beam Cutter	$14
" Oneonta Clipper, Reversible, Iron Wheel and Cutter	15
18. Oneonta Clipper, Reversible, Iron Beam Cutter	15
" Oneonta Clipper, Reversible, Iron Beam, Wheel and Cutter	16
17. Hard Metal, Reversible, Iron Beam Cutter	17
17. Hard Metal, Reversible, Iron Beam, Wheel and Jointer	17
19. Hard Metal, Reversible, Wood Beam Cutter	16
" " " " " Wheel and Jointer	17
20. Steel Mould Board, Reversible, Wood Beam Cutter	15
" " " " " " Wheel and Cutter	16

Iron Beam Plows.

Two-horse Sod and Stony Land.... 8.50 plain.
Curtis's Sod Two horse............ 11.50 "
" " " " .... 13.00 cutter.
" " " " .... 14.25 wheel & cutter.

Subsoil Plows.

Two-horse 9.50 Draft Rod.
" " 11.00 Wheel and Draft Rod.

Hitchcock's Potato Digger and Shovel Plow.

Improved adjustable handle shovel plow	7.00
Hitchcock's Potato Digger	8.00
" " " and shovel plow	10.50

Dis. 30%.

RAKES.

The S. R. Nye Improved.

22 Teeth Rake, $32.00

26 " " 34.00

25% dis.

Chieftain Hay Rake Co.

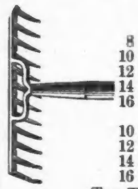
Chieftain Lock Lever
No. 1............$30.00
No. 2............ 30.00
No. 5............ 29.00
Iron wheels, $2 extra.
With Pole, Double Tree and Neck Yoke, $2 extra.
22 cubic feet packed, 400 lbs. gro., 225 lbs. net.

Golden Farmer Self-Dumping Rake, $37.00; 22 cu. ft., 430 lbs. gro., 250 lbs. net.

Chieftain Hay Tedders, $59.00; 700 lbs. gro., 450 lbs. net.

Potato Diggers, $7.00; 100 lbs. gro., 60 lbs. net; dis., 40% f.o.b. ship New York or Boston.

RAKES (GARDEN).



Braced steel garden rakes.

	Per doz
8 teeth	$8.00
10 "	9.00
12 "	10.00
14 "	11.00
16 "	12.00

Braced malleable garden rakes.

10 teeth	$5.50
12 "	6.00
14 "	6.50
16 "	7.00

	Ten-Teeth Malleable Garden. Plain.	Braced.	Steel Garden. Plain.	Braced.
10-Teeth	$5.50	$6.00	$9.00	$10.50
12 "	6.00	6.50	10.00	11.50
14 "	6.50	7.00	11.00	12.50
16 "	7.00	7.50	12.00	13.50

Dis. 70 and 5%.

Cast steel garden rakes.

	Per doz.
10 teeth, polished, tapering bar, tempered rake	$9.00
12 " " " " "	10.00
14 " " " " "	11.00
16 " " " " "	12.00

Cast steel lawn rakes.

12 teeth, polished, tapering bar, tempered rake	$10.00
14 teeth polished tapering bar, tempered rake	11.00
16 teeth polished tapering bar, tempered rake	12.00
18 teeth polished tapering bar, tempered rake	13.00

Dis. 70% from Standard Association list.

Prices made where XX handles, etc., are required.

SCYTHES (GRASS).

Waldron's pattern, oiled	$8.50
Silver steel, painted	8.50
Western dutchman, bronzed and painted	9.00
Clipper, polished web	9.00
Fine cutlery steel, full polished	10.00
All steel, full polished	11.00

Grain Scythes.

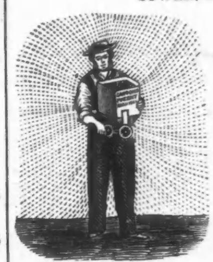
Waldron's pattern, oiled	11.25
Silver steel, painted	11.25
Clover, oiled	11.25
Clipper, bronzed and painted	11.50

Lawn Scythes.

Clipper, bronzed and painted	9.00

Dis.. 40 and 10%.

SOWER, BROADCAST SEED.



Goodell & Co.

Per dozen.............. $36 f.o.b,

Gross wt., 110 pounds per dozen

Net wt., 75 pounds per dozen.

Anvils.

"Eagle anvils.

	Weight about			Weight about	
No. 000	½ lb	$1 00	No. 4	40 lbs	$4.25
" 00	4 "	1.70	" 5	50 "	5.05
" 0	10 "	2.20	" 6	60 "	5.50
" 1	15 "	2.75	" 7	70 "	6.00
" 2	20 "	3.00	" 8	80 "	7.00
" 3	30 "	3.75	" 9	90 "	8.00

Anvils weighing 100 to 800 lbs., 10 cts. per lb. Discount 20 and 10 %.

Arms and Ammunition.

Wood Powder.

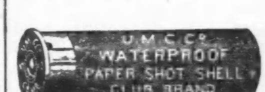
American Wood Powder Company.

	Kegs, 25 lbs.	¼ kegs. 6¼ lbs.	1 lb. cans.
Trap for first quality arms only	$19.50	5.00	.85
A, for large bore; C, for general use; D, fine for small bore and rifles; E, very fine for small bore rifles and gallery shooting	17.00	4.35	.75

		Discount. Per cent.	
Bullet Breech Caps	per lb.	1.60	10
Conical Bullet Caps	"	1.75	10

	Discount. Per cent.	
Rim Fire Cartridges	60	10
Military Rim Fire Cartridges	15	10
Central Fire Pistol and Rifle Cartridges	40	10
Central Fire Metallic Cartridges for Target and Sporting Rifles	30	10
Military Cartridges, Central Fire	30	10
Lefaucheux Cartridges		60

			Special
Gatling Cartridges			
Primed Shells and Bullets		25	10
Friction Cannon Primers		20	10
Primers			10
Percussion Caps, F. C	per M.	33c.	
U. M. C	"	42½c.	
Musket	"	45c.	
Brass Shot Shells, U. M. C., 1st qual.		60	10
Club brand		65	10



Paper Shot Shells.

14, 16 and 20 ga. First quality, 30, 10 and 10 per cent; 4, 8, 10 and 12 ga., First quality, 25, 10 and 10 per cent.

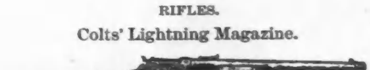
14, 16 and 20 ga. Club brand, 30, 10 and 10 per cent.

10 and 12 ga. Club brand, 33⅓, 10 and 10 per cent.

Gun Wads, 20 and 5 per cent.

RIFLES.

Colts' Lightning Magazine.



Discount 10 per cent

40/60 and 45/60 calibre octagon barrel	10	lbs.	$15.38
" " " " round "	9¾	"	14.25
" " " " carbine "	9	"	14.25
32, 38, and 44 calibres, octagon "	7¼	"	13.50
" " " " round "	6¾	"	12.38
" " " " carbine "	6¼	"	12.38
" " " " baby carbine	5¼	"	12.38
22 calibre, rim fire, octagon barrel			15.38
" " round			14.25

Remington Light (Baby) carbines, 44 cal., nick., $7.50.

MARLIN RIFLE. MODEL, 1889.

The best in the market, embodying all latest improvements.

32, 38 and 44 calibres, using the same cartridges as Winchester rifles of the respective sizes.

Octagon barrel,	24 inch,	6½ lbs	....	$19.50
" "	26 "	6¾ "	....	21.50
" "	28 "	7 "	....	23.50
Round "	24 "	6½ "	....	18.50
Carbine	20 "	5½ "	....	17.50

Discount, 25, 10 and 10%.

REVOLVERS.

Smith & Weston

32, Single Action, 3, 3½ in., $8.00.
32, Double Action, 3, 3½ in., $9.35.
32, Safety Hammerless, 3, 3½ in., $11.00.

38, Single Action, 3¼ in., $9.40; 38, Single Action, 4 in., $9.65; 38, Single Action, 5 in., $10.00; 38, Double Action, 3¼ in., $10.40; 38, Double Action, 4 in., $10.65; 38, Double Action, 5 in., $11.00; 38, Safety Hammerless, 3¼ in., $12.00; 38, Safety Hammerless, 4 in., $12.25; 38, Safety Hammerless, 5 in., $12.50; 44, Single Action, 4 in., $11.50; 44, Single Action, 5 in., $11.75; 44, Single Action, 6, 6½ in., $12.00; 44, Double Action, 4 in., $12.50; 44, Double Action, 5 in., $12.75; 44, Double Action, 6½ in., $13.00; 44, Double Action Favorite, 5 in., $12.75.

Colts.

Discount, 10 per cent from following prices.

Double Action Army, 44 and 45 calibre, 4¾, 5½, 7½ inch bbl., $13.00.
Double Action, 41 calibre, 2½ to 6 inch bbl., $11.20.
" " 38 " 2½ to 6 " " $10.00.
Single " Army, 45 calibre, 4¾, 5½, and 7½ inch bbl., $12.00.
Single Action Army, 44 calibre, "Frontier," 4¾, 5½, and 7½ inch bbl., $12.00.
New Line, 41 calibre, blued or nickeled, $4.00.
" " 32 " " " 4.00.
" " 30 " " " 2.00.
" " 22 " half or full plate, 2.10.
Old Model, 22 calibre, by the hundred, half or full plate, $1.50.
Colt Deringer, 41 calibre, per pair half or full plate, $5.50.

American Bull Dog

Double Action 32, 38 and 44 calibre, 2½ inch barrel, $1.60; Double Action 32, 38 and 44 calibre, 4½ inch barrel, $1.85; Double Action 32, 38 and 44 calibre, 6 inch barrel, $2.10.

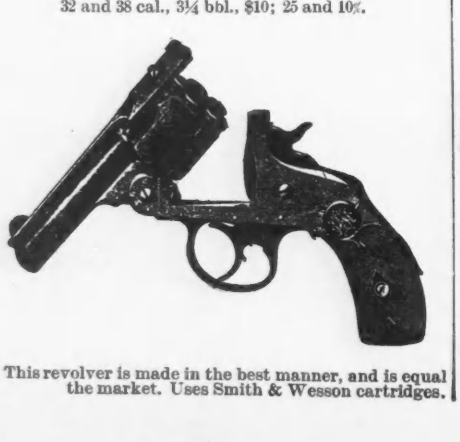
F. & W. British Bull Dog revolvers, 32 and 38 calibre 2½ inch bbl., $1.80.
F. & W. Automatic revolver, 32 and 38 calibre, 3¼ inch bbl., $5.50.
H. & R. Automatic revolver, 32 and 38 calibre, 3¼ inch bbl., $4.75.
Defender revolvers, Single Action, 22, wood handle, 65.
" " " " 22, rubber " 70.
" " " " 32, wood " 85.
" " " " 32, rubber " 90.

Remington Army revolver, Single Action, 44 cal., frontier cartridge, 5¾ inch barrel, $6.50.
Remington Army revolver, Single Action, 44 cal., frontier cartridge, 7½ inch barrel, $6.00.
Remin gton Double Deringers, 41 cal., rim fire, $4.05.
National Deringers, 41 calibre, per pair, half or ful plate, $4.00.

New House, 41 or 38 calibre, blued or nickeled, $5.00.
" Police, 38 calibre, 6 in., " " 7.00.
" " 38 " 4½ in., " " 7.00.

MARLIN AUTOMATIC DOUBLE ACTION REVOLVERS.

32 and 38 cal., 3¼ bbl., $10; 25 and 10%.



This revolver is made in the best manner, and is equal the market. Uses Smith & Wesson cartridges.

H. & R. AUTOMATIC DOUBLE ACTION REVOLVERS.

32 and 38 cal., 3¼-in. barrel, 4.75 net.

H. & R. EJECTING DOUBLE ACTION REVOLVERS.

32 and 38 cal., 3¼-in. barrel, 4.00 net.

AMERICAN DOUBLE-ACTION REVOLVERS.

32, 38 and 44 cal., $1.75, net, 2½ in. bl.

32, 38 and 44 cal., $2, net, 4½ in. bl.

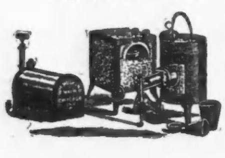
32, 38 and 44 cal. $2.30, net, 6 in. bl.

AMERICAN BULLDOG REVOLVERS.

32, 38, 44 cal., 2½ in. bl., $1.60, net.

Assay Furnace.

Hydro-Carbon Blow-Pipe Assay Furnace.



No. 2, Muffle Furnace taking C Battersea Muffle 8x4¾x3 in.............	$10.00
No. 3, taking F Muffle, 10x6x4 in.............	15.00
No. 1, Crucible Furnace, taking Battersea, U or Colorado B Crucible, 4 in. dia. 5½ deep..	4.00
No. 2, taking Battersea E, round, 5 in. dia., 6½ deep.....................	5.00
Blow-Pipe No. 1, with half gallon tank, made of plain, strong sheet metal.....................	18.00
Blow-Pipe No. 2, with half gallon tank, made entirely of seamless brass.....................	23.00
Blow-Pipe No. 3, with one gallon tank, otherwise same as No. 2.....................	26.00
Blow-Pipe No. 1, Muffle Furnace No. 2, and Crucible Furnace No. 1.....................	32.00
Blow-Pipe No. 2, Muffle Furnace No. 2, and Crucible Furnace No. 1.....................	37.00

Axes, etc.

Shingling Hatchets.
1. 2. 3.
Collins', $4.75, $5.25, $5.75 doz., dis 10%.
Peck's, $8.00, $8.50, $9.00 doz. dis. 45%.
Ryder's, $8.00, $8.50. $9.00 doz., dis. 50%.

Claw Hatchets.
1. 2. 3.
Collins', $5.25, $5.75, $6.25 doz., dis. 10%.
Peck's, $9.00, $9.50 $10.00, doz., dis. 45%.
Ryder's, $9.00, $9.50, $10.00 doz., dis. 10%

Hatchets, Broad Single Bevel.

Collins', cut in., 5, $9.50; 5½, $10.00; 6, $10.50; 6½, $11.00; 7½, $11.50; dis. 10%.

Peck's, cut in., 4, $10.50; 4½, $11.50; 5, $13.00; 5½, $14.50; 6, $16.50; 6½, $18.00; 7½, $19.50; 8¼, $22.00; dis. 45%.

Ryder's, cut in., 5, $13.00; 5½, $14.50; 6, $16.50; 6½, $18.00; 7½, $19.50; dis. 50%.

Adzes.

	House. Half flat head. Dozen.	Ship spur poll. Dozen.	Discount. Per cent.
Collins'...	$14.00	$13.00	10
Peck's....	24.00	25.00	45
Ryder's...	24.00	25.00	50

Broad Axes—Pittsburgh Pattern.

5 to 8 pounds, $32.00 dozen.
7 to 9 pounds, $35.00 dozen.
8 to 10 pounds, $38.00 dozen.
9 to 12 pounds, $45.00 dozen.
Western pattern same price.

Spanish Pattern. Detumba round eye, $10.50 per doz.

Spanish Pattern Media labor, $12.25 per dozen.

Axle Grease.

Frazer's (2-lb. tins), per gross.....................	$18.00
2-lb. wooden boxes, "	12.00
Discount, 25 and 5 %.	
Dixon's Everlasting, boxes 1 lb., per doz.........	$1.20
" " " 2 lbs., "	2.00

Lovell, Tracy & Co. English coach axle grease.

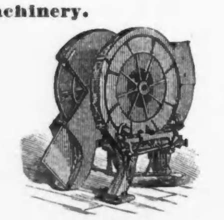
Regular wooden boxes per gross, $8.50.

Axleine.

Decorated tin boxes, per gross $12.

Special prices on quantity, and goods in large packages.

Barrel Machinery.



Stave Jointers.

Single Whee Beer Keg Stave Jointer, 16 to 22 in.	8	8	$190
Double " " " " " 16 " 22 "	8	8	330
Single Wheel Half Barrel " " 24 " 30 "	8	8	275
Double " " " " " 24 " 30 "	8	8	440
Single " Barrel " " 30 " 36 "	8	8	330
Double " " " " 30 " 36 "	8	8	50C
Double Independent Barrel Stave Jointer with Wheels, on separate shafts, but suspended in one frame, 30 to 36 in.....................	8	8	520
Single Wheel Barrel Stave Jointer, 32 to 38 in.	8	8	350
Double " " " " 32 to 38 "	8	8	550
Double Independent Barrel Stave Jointer, 32 to 38 in.....................	8	8	575

Bellows.

Miner's Bellows: 24 in., $8.50; 26 in., $9.75; 28 in., $11.00; 30 in., $11.25; 32 in., $13.50.
60 and 5% dis.
Standard, each: 18 to 24 in., $10; 28 in., $12; 32 in., $14; 34 in. $16; 36 in., $18; 38 in., $20; 40 in., $23; 44 in., $32.
60 and 5% dis.
Hand Bellows, per doz.: 6 in., plain, $10; fancy, $20; 7 in., plain, $12; fancy, $24; 8 in., plain, $14; fancy, $28; 9 in., plain, $16; fancy, $32; 10 in., plain, $18; fancy, $36.
50% dis.

Belting. LEATHER BELTS.

Standard Manufacturers List.
Single belts per foot.

Width.		Width.		Width.	
1 inch	10	6 inch	.76	20 inch	2.84
1¼ "	13	7 "	.90	21 "	3.02
1½ "	17	8 "	1.02	22 "	3.20
1¾ "	20	9 "	1.15	23 "	3.37
2 "	23	10 "	1.29	24 "	3.54
2¼ "	26	11 "	1.42	26 "	3.92
2½ "	30	12 "	1.55	28 "	4.30
2¾ "	33	13 "	1.68	30 "	4.64
3 "	36	14 "	1.82	32 "	5.00
3½ "	43	15 "	1.98	34 "	5.35
4 "	50	16 "	2.14	36 "	5.70
4½ "	56	17 "	2.31	40 "	6.40
5 "	63	18 "	2.49	44 "	7.10
5½ "	70	19 "	2.66	48 "	7.80

Double belts twice the price of single.
Discounts of Newark Leather Belting Co.

Dis. single and double belts, cemented, 50 and 5%.

Dis. single and double belts, riveted and cemented, 50 and 5%.

Dis. single belts, cemented and lacesewn, water proofed, 50%.

Dis. double belts, cemented and lacesewn, water proofed, 45%.

GASKETS.

Corrugated Copper.

Price, 2 cents per square inch, less 30 per cent. discount for home trade.

Less 60% discount for export trade.

Bolts.

Philadelphia Tire Bolt, with forged nuts.
Price per hundred.
Condensed list.

Length	1-8	3-16	7-32	1-4	5-16	3-8
1	$1.50	$1.50	$1.50	....	....	....
2	1.50	1.60	1.85	$2.25	$3.05	$5.00
3	....	1.90	2.25	2.75	3.65	5.80
4	....	....	....	3.25	4.25	6.60
5	....	....	....	....	4.90	7.40

Fractional sizes, intermediate prices.
Discount 80 and 2 %.

Common Carriage Bolts, price per hundred.

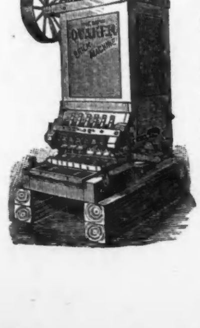
Length.	3-16 & 1-4	5-16	3-8	7-16	1-2	9-16 & 5-8	3-4
1 to 1½	$1.35	$1.60	$2.30	$3.10	$3.80	$7.50	
2	1.45	1.75	2.30	3.10	3.80	7.50	
3	1.65	2.05	2.70	3.60	4.44	7.50	$13.50
4	1.85	2.35	3.10	4.10	5.08	8.50	14.90
5	2.05	2.65	3.50	4.60	5.72	9.50	16.30
6	2.25	2.95	3.90	5.10	6.36	10.50	17.70
7	2.45	3.25	4.30	5.60	7.00	11.50	19.10
8	2.65	3.55	4.70	6.10	7.64	12.50	20.50
9	2.85	3.85	5.10	6.60	8.28	13.50	21.90
10	3.05	4.15	5.50	7.10	8.92	14.50	23.30
12	3.45	4.75	6.30	8.10	10.20	16.50	26.10
14	3.85	5.35	7.10	9.10	11.48	18.50	28.90
16	4.25	5.95	7.90	10.10	12.76	20.50	31.70

Fractional sizes, intermediate prices Dis. 75 and 10%

Philadelphia Carriage Bolt, price per hundred.

Length	1-8, 3-16 & 1-4	5-16	3-8	7-16	1-2
1 inch.	$3.00	$4.00	$5.00	$7.40	$9.00
2 "	3.40	4.10	5.00	7.40	9.00
3 "	3.80	4.70	5.80	8.20	10.00
4 "	4.20	5.30	6.60	9.00	11.00
5 "	4.80	6.00	7.40	9.80	12.00
6 "	5.40	6.60	8.20	10.60	13.00
7 "	....	7.30	9.00	11.40	14.00
8 "	....	7.90	9.80	12.20	15.00
9 "	....	8.50	10.60	13.00	16.00
10 "	....	....	11.40	13.80	17.00
11 "	....	....	....	14.60	18.00

Fractional sizes, intermediate prices. Dis. 80 and 5 %.

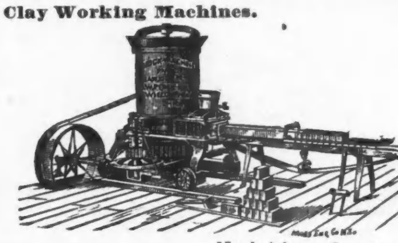


Brick Machinery.

BENNETT BROS. & CO.

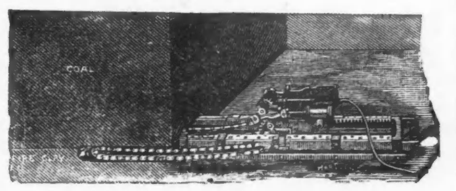
Heavy Steam Power Machine $525.00
Horse-Power Machines.. 300.00
Additional Horizontal Pugmill 225.00
Brick Moulds ....$2.50 to $3.00
Brick Trucks..... 5.00 to 13.50
Brick Barrows...... 7.25
Brick Barrows with Springs 8.25
Sand Barrows, steel tray............ 6.50

Clay Working Machines.



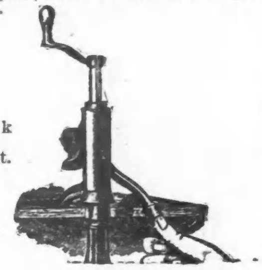
	No. brick per day.	Compl'te.
No. 10 D brick machine	50,000	$1,500
No. 10 S " "	30,000	1,200
No. 4 " "	40,000	1,100
No. 7 S " "	20,000	650
No. 6 S " "	15,000	575
No. 2 E. H. P. "	6,000	3,360

Coal Mining Machine.



Jeffrey.
6 feet undercut........$1500 | 5 feet undercut........$1400
Jeffrey Power Coal Drills.
Air feed drill..........$275 | Screw feed drill........$200
Discount, 10%.

Cork Pullers.



The Samson Cork Puller, per dozen, $12 net.

Crucibles. E. H. Sargent & Co.

Battersea Crucibles, Triangular.

No.	Height. Inches.	Width. Inches.	Crucibles. Per doz.	Covers. Per doz.
S	4½	4⅛	$1.00	$0.50
T	4	3¾	0.80	0.50
U	3½	3¼	0.60	0.40
V	3¼	2⅞	0.45	0.40
W	2⅝	2⅝	0.35	0.30
X	2½	2¼	0.30	0.30
Y	2⅛	2⅛	0.25	0.30
Z	1¾	1¾	0.20	0.30

Battersea Muffles, any size, made to order.
See Illustration in advertisement.

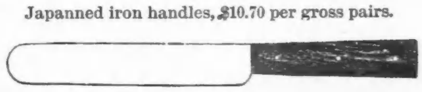
No.	Long. Inches.	Wide. Inches.	High. Inches.	Price. Each.
A	7	3½	2½	$ .60
B	7½	4⅜	2⅞	.75
C	8	4¾	3	.85
D	8½	5	3¼	1.00
E	9	5½	3⅝	1.15
F	10	6	4	1.25
G	11	4	3⅛	1.00
H	10½	5¼	3⅞	1.00
J	12	6	4	1.25
K	14	8	5	1.75
L	15	9	6	2.00

Export discount 15 %.

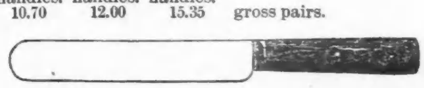
Cutlery.

(Tommins & Adams.)
TABLE KNIVES AND FORKS.

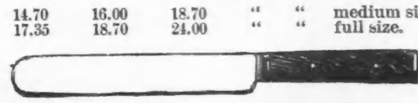
Japanned iron handles, $10.70 per gross pairs.



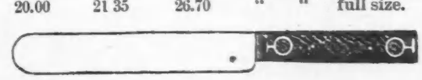
Cocobola handles. 10.70 Ebony handles. 12.00 Bone handles. 15.35 gross pairs.



14.70 16.00 18.70 " " medium size.
17.35 18.70 24.00 " " full size.



17.35 18.70 21.35 " " medium size.
20.00 21.35 26.70 " " full size.



22.70 24.00 29.35 " "

27.35 28.70 36.00 " "

Cocobola handles. Ebony handles. Bone handles. gross pairs.

28.00 29.35 38.00 " "

28.65 30.00 38.00 " "

28.65 30.00 38.00 " "

32.00 33.35 38.00 " "

34.70 36.00 48.00 " "

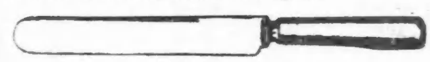
33.35 34.70 46.70 " "

37.35 38.70 50.70 " "

40.00 41.35 53.35 " "

Hard rubber handles, 5.75 per dozen pairs.

Solid bone handles, 4.80 per dozen pairs.



Celluloid handles, 7.35 per dozen pairs.

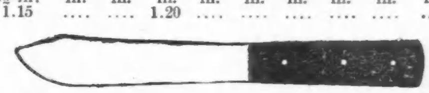
Forks are made to match all above patterns, with either three or four prongs.

Discount 25 %.

BUTCHERS' KNIVES COCOBOLA HANDLES.

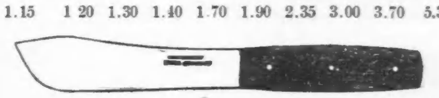
Per dozen.

4 and 4½ in.	5 in.	5½ in.	6 in.	6½ in.	7 in.	8 in.	9 in.	10 in.	12 in.
1.15	....	....	1.20	....	....	....	....	....	....

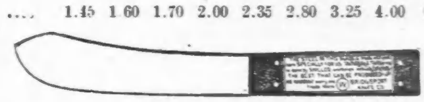


1.40	...	....	1.50	....	....	....	....	....	....

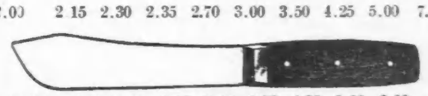
1.15	1.20	1.30	1.40	1.70	1.90	2.35	3.00	3.70	5.35



....	1.45	1.60	1.70	2.00	2.35	2.80	3.25	4.00	6.0

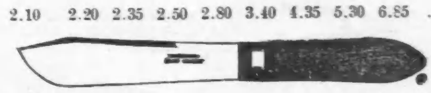


2.00	2.15	2.30	2.35	2.70	3.00	3.50	4.25	5.00	7.50

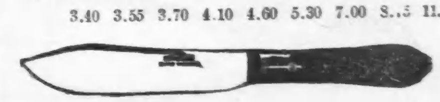


2.45	2.70	2.95	3.15	3.45	3.70	4.35	5.00	6.00	8.25

2.10	2.20	2.35	2.50	2.80	3.40	4.35	5.30	6.85	...



	3.40	3.55	3.70	4.10	4.60	5.30	7.00	8..5	11.75



.... 4.10 4.25 4.40 4.80 5.30 6.00 7.75 9.50 12.50

2.00 2.15 2.30 2.35 2.70 3.00 3.50 ....

Discount 25 and 10 %.

HUNTING KNIVES—EBONY HANDLES.

5 in. 5½ in. 6 in. 6½ in. 7 in. 8 in. 9 in. 10 in.
Per Dozen.

2.10 2.20 2.35 2.75 3.00 3.60 4.30 5.25

2.10 2.20 2.35 2.75 3.00 3.60 4.30 5.25

2.55 2.70 3.00 3.30 3.55 4.00 5.00 6.00

2.55 2.70 3.00 3.30 3.55 4.00 5.00 6.00
Discount, 25 and 10 %.

Per Dozen.
Putty knives, cocobola handles.................... $1.30

Putty knives. cocobola handles.................. 1.50

TAILORS' SHEARS—JAPANNED OR NICKEL HANDLES.

Per pair.
12 in. 6.00
12½ in. 7.00
13 in. 8.00
13½ in. 9.00
14 in. 10.00
14½ in. 11.00
in .... 12.00 | 16 in 14.00
Discount, japanned, 60 %; nickle, 45 %.

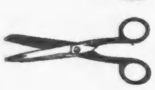
BENT TRIMMERS.

Per dozen.
6 in ..... 13.00 | 10 n 27.00
7 in ..... 15.00 | 11 in 30.00
8 in ..... 17.00 | 12 in 33.00
9 in ..... 22.00 |

STRAIGHT TRIMMERS.

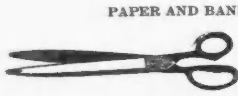
Per dozen,
6 in .... 12.00 | 10 in 25.00
7 in .... 14.00 | 11 in 30.00
8 in .... 16.00 | 12 in 33.00
9 in .... 19.00 |

LADIES' SCISSORS.



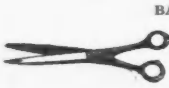
Per dozen.
4½ in .... 10.00 | 6 in. 11.00
5 in .... 10.00 | 6½ in 12.00
5½ in .... 10.50 | 7 in 13.00

PAPER AND BANKERS' SHEARS.



Per dozen.
9 in ... 18.00 | 13 in ... 36.00
10 in ... 25.00 | 14 in ... 42.00
11 in ... 27.00 | 16 in ... 54.00
12 in. .. 32.00 | 18 in ... 20.00

BARBERS' SHEARS.



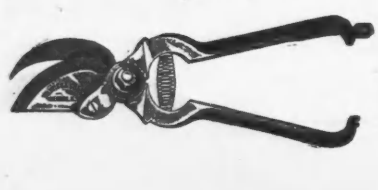
Per dozen.
7½ in .... 15.00 | 9 in 18.00
8 in .... 16.00 | 9½ in 20.00
8½ in 17.00

BUTTON-HOLE SCISSORS.

5 and 5½in., 14 00 per dozen.

Discount, japanned, 70 and 10 % nickel, 60 and 10 %.

PRUNING SHEARS.
1 B., 9 in., 24 per dozen; 2 B., 8½ in., 21; 3 B., 7¾ in., 9.80.

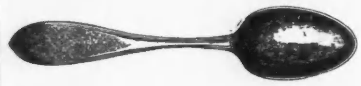


No. 110, 10 in., $30 per doz.

PRUNING SHEARS FOR LONG HANDLES.
No. 1, $36 per dozen; No. 2, $30 per dozen.
Discount, 35%.

SPOONS, FORKS, ETC., BEST PLATE ON HARD WHITE METAL.

Tipped Tea Spoon.



Oval Tea Spoon.

Perfect Tea Spoon.

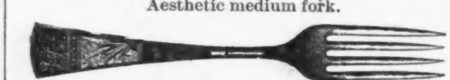
Leader Tea Spoon.

	—5 oz. or extra plate—		
	Tipd.	Oval.	Perfect and Leader.
Tea spoons	4.25	4.50	4.75 per doz.
Dessert spoons	7.50	8.00	8.50 " "
Table spoons	8.50	9.00	9.50 " "
Coffee spoons	4.25	4.50	4.75 " "
Dessert forks	7.50	8.00	8.50 " "
Medium forks	8.50	9.00	9.50 " "

Discount, 60 and 5%.
Spoons and forks, German silver, tipped pattern.

Tea spoons.	Table spoons.	Medium forks.
22.50	45.00	45.00 per gross.

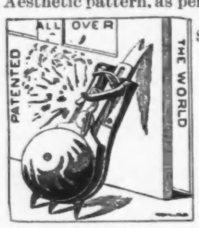
Discount, 60 %.
Spoons and forks, made from brass, and silver plated on a coating of hard, white nickel.
Aesthetic medium fork.



Tea spoons.	Table spoons.	Medium forks.
7.50	15.00	15.00 per gross.

Discount, 30 and 5 %.
Children's sets *on cards.*

	3 pcs.	4 pcs.	
Leader pattern, as per cut	21.00	24.00 doz.	60 and 5 %
Aesthetic pattern, as per cut	5.75	7.25 doz.	30 and 5 %



SAFETY AUTOMATIC BURGLAR ALARM AND DOOR FASTENER.

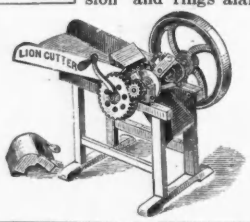
REQUIRES NO WINDING UP.

Per doz., $24. Dis., 40%.

The slightest push on the door explodes two caps in succession and rings alarm bell.

Cutters.

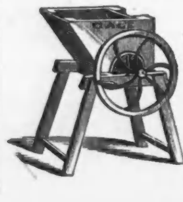
FEED.



No. of cutter.	No. of knives.	Length in inches of knives.	Length in inches of feed cut.	Price.
1	2	6¼	½, ¾ and 1⅛	$18 00
2	2	7¼	½, ¾ and 1⅛	21.00
2½	1	7¼	⅝, ⅞, 1¼ and 1¾	21.00
2½	2	7¼	5/16, 7/16, ⅝ and ⅞	23 00
3	1	8½	⅝, ⅞, 1¼ and 1¾	25.00
3	2	8½	5/16, 7/16, ⅝ and ⅞	27.00
4	1	10	⅝, ⅞, 1¼ and 1¾	30.00
4	2	10	5/16, 7/16, ⅝ and ⅞	33.00
5	2	10	7/16, ⅝, ⅞ and 1¼	35.00
6	2	11	7/16, ¾, 1¼ and 2	45.00
6½	2	11	7/16, ¾, 1¼ and 2	45.00
7	2	13	7/16, ¾, 1¼ and 2	60.00
7½	2	13	7/16, ¾, 1¼ and 2	60.00
10	2	16	7/16, ¾, 1¼ and 2	80.00
12	2	20	7/16, ¾, 1¼ and 2	100 00
11	2	11	7/16, ¾, 1¼ and 2	45.00
13	2	13	7/16, ¾, 1¼ and 2	60.00
16	2	16	7/16, ¾, 1¼ and 2	80.00
20	2	20	7/16, ¾, 1¼ and 2	100.00

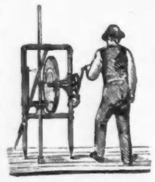
The knife arbors for all sizes are made of machinery steel. 30 per cent. dis.

VEGETABLE—GALE'S.



Size.	Weight of Fly Wheel. Pounds.	Will cut per hour. Pounds.	Price
No. 1½	20	1,500	$12
No. 2½	32	1,700	15
No. 3½	32	1,700	15
No. 4	42	2,000	18
No. 5	50	3,000	25
No. 10	65	8,000	35

30% dis.



Drill—Portable Hand Rock.

Price, $225.

Dis., 20%.

Duck and Twine.

22-inch, Hard, Medium and Soft.

No.	Weight per yd.	Cents, per yd.	No.	Weight per yd.	Cents, per yd.
No. 0...	19 oz.	35	No. 6...	13 oz.	26
1...	18 "	33	7...	12 "	25
2...	17 "	32	8...	11 "	23
3...	16 "	30	9...	10 "	21
4...	15 "	28	10...	9 "	20
5...	14 "	27			

Ravens, 28½-inch.—Eight ounce, 15 cents per yard Ten ounce, 19 cents per yard; twelve ounce, 22 cents per yard; Fifteen ounce, 27 cents per yard. Dis. 25 and 1%.

Cotton Sail Twine.—Three-fold and upward, 17 to 20 cents per pound. Dis. 3%.

Electroplate.—Babcock & Co.'s.

Dis. 60 and 2%.

CASTERS.

1,200—Dinner

232—Breakfast.

Dinner Casters.
No. 1,200. 17½ in. high, $8.00, quadruple plate.
No. 80. 17 in., $6.00, quadruple plate.
No. 140. 16 in., $7.50, " "
No. 830. 16 in., $5.00, " " Plain, 50 cents less.
No. 25. 16 in., $4.00, double plate.
No. 33. 16 in., $3.75, " "
No. 53. 15 in., $3.00, " "
No. 15½. 14½ in., $2.00, single plate.
No. 19. 14½ in., $1.85, " "
No. 40. 14 in., $1.75, " "

reakfast Casters.
231. 10 in. high, $4.00, quadruple plate.
No. 232. 12 in. high, $6.00 quadruple plate.
No. 13. 12 in. high, $2.25, double plate.
No. 12. 10½ in. high, $1.75, single plate.

No. 681.

CAKE BASKETS.
Quadruple Plate.
No. 448. 7 in. high-chased, $16; gold lined, $17.
No. 690. 7½ in. high, chased, $7; gold lined, $8.
No. 686. 6½ in. high-chased, $4.50; gold lined, $5.50.
No. 681. 6 in. high, chased, $3; gold lined, $3.50.

BUTTER DISHES.

No. 126. 11 inches high, $5.50.

No. 127. 7 inches high, $5.50.

No. 75. 8 inches high, $1.85.

No. 78. 7½ inches high, $2.00.

Discount.

CHILD'S SETS.

No. 90.

No. 90. Satin lined case, cup, saucer, knife. fork and spoon, $2.25.

No. 41. Cup, gold lined, in fancy case, $1.15.

No. 43. Cup and saucer, gold-lined, fancy case, $1.15.

FLAT WARE.

Calla Lily, Empress, Windsor and Olive Patterns, 18 Per Cent Nickel Silver Base.

	Extra plate, per doz.	Double plate, per doz.	Triple plate, per doz.
Tea spoons	$4.75	$6.00	$7.25
Dessert spoons	8.50	10.50	12.50
Table spoons	9.50	12.50	14.50
French coffee spoons	4.75	6.00	7.25
Berry or nut spoons	24.00	30.00	36.00
Bar spoons, small	4.75	6.00	7.25
Dessert forks	8.50	10.50	12.50
Medium forks	9.50	12.00	14.50
Oyster forks	7.00	9.00	11.00
Sugar shells	9.00	11.00	13.00
Sugar tongs	25.50	31.50	37.50
Butter knives, twist or reversed handles	10.50	12.50	14.50
Nut picks	4.75	6.00	7.25
Pie knives, engraved blades	42.00	51.00	60.00
Soup ladles	48.00	60.00	72.00

PICKLE DISHES

No. 144. 12 in. high, $3.50

No. 66. 10½ in. high, $2; assorted colored glass.

No. 155. 12 in. high, $4; assorted colored glass.

No. 146. 12½ in. high, $9; hand decorated glass.

No. 156. 12½ in. high, $6; hand decorated glass.

No. 146.

No. 25c.

TEA SETS.

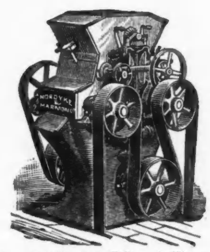
No. 255. 6 pieces, $35, quadruple plate.

No. 301. 4 pieces, $23, quadruple plate.

No. 1847. 6 pieces, $42, quadruple plate.

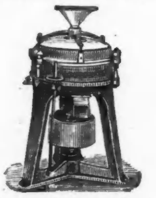
Flouring Mill Machinery.

Nordyke & Marmon Co.



Roller Mills for Wheat Flour.
Prices of Double and Single Roller Mills.

Size.	All smooth.	½ Corrug. ½ smooth.	All corrug.	Single machines. Corrug.	Single machines. Smooth.
6 × 12	$465	$475	$480	......	......
6 × 16	515	525	530	......	......
6 × 20	565	575	580	......	......
7 × 14	515	525	530	......	......
7 × 18	560	570	575	......	......
7 × 24	635	645	650	......	......
9 × 18	625	640	650	$350	$335
9 × 24	700	720	735	390	375
9 × 30	785	810	830	440	420



20-inch New Era Mill for Wheat, Corn, and Middlings.

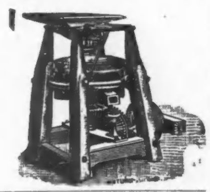
Size. Inch.	Power. H. P.	Pulley. Inch.	Capacity Bush.
20	4 to 10	14 × 7	12 to 40

Speed.	Weight. Lbs.	Price.
500 to 800	660	$150

The Nordyke Bradford Portable Mill.

Size of stones, In.	Grinding capacity. Corn, bu. per hour.	Grinding capacity. Wheat bu. per hour.	Horse-power.	Weights. Sing'l gear.	Weights. Double gear.	Pulley mill.	Geared mills. Iron wh'ls.	Geared mills. Mortise wh'ls.
18	8 to 10	....	4	550	625	$130	$165	$180
20	10 to 12	....	5	600	700	140	175	190
22	12 to 15	....	5	700	850	160	190	210
24	15 to 18	....	6	900	1050	175	210	225
26	18 to 20	8 to 10	8	1200	1400	185	225	250
30	20 to 25	10 to 12	10	1500	1700	225	265	290
36	25 to 30	14 to 17	12	1800	2100	315	355	380
42	35 to 40	19 to 21	15	2000	2300	390	435	460

Farm and Plantations Mills.



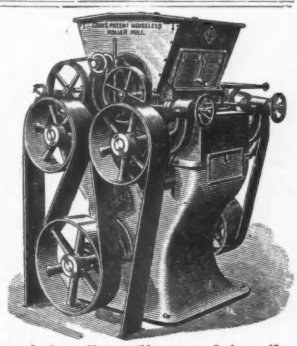
Diameter of burrs.	Power to drive.	Size of pulley.	Capacity per hour.	Revolutions per minute.	Weight.	Price
	H. P.					
14 in.	2 to 4	9×5½	4 to 14 bushels	600 to 1200	370 lbs.	
18 in.	4 to 10	11 × 6½	8 to 40 bushels	400 to 700	600 lbs.	

The Dixey Mill—Stiff Spindle Style.

Size.	Power.	Capacity.	Weight. Pulley.	Weight. Geared	Pulley.	Iron gear.	Mortise gear.
18	4 to 6H.P.	8 to 25 bu	560 lbs	650	$130	$165	
22	6 to 8 "	12 to 30 "	800 "	1000	165	200	
26	8 to12 "	16 to 40 "	1100 "	1500	185	220	
30	10 to15 "	25 to 60 "	1300 "	1700	215	255	

Flour Mills.

E. P. Allis & Co.

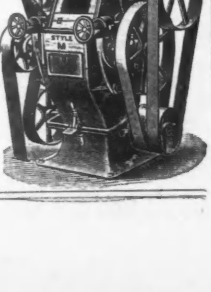


Gray's pat. noiseless belt roller-mills, porcelain rolls.

Size of Rolls.	Height.	Length.	Width.	Driving pulley.	Revolutions per minute.	Approximate power required.	Length of driving belt above floor.	Approximate shipping weight.	Price
14" × 16" single	5' 7"	3' 2"	4' 5"	20" × 6½"	200 to 300	1¾ to 2½ H. P.	16' 3"	2,700 lbs.	$600.00
14" × 16" double	5' 10"	5' 6"	4' 10"	20" × 6½"	200 " 300	3 " 4 H. P.	19' 3"	4,000 "	800.00
9" × 14"	5' 1½"	3' 10"	3' 10"	12" × 5¼"	300 " 400	1½ " 2½ H. P.	16' 6"	2,700 "	580.00
With corrugated chilled iron rolls.									
9" × 14"	5' 1½"	3' 10'	3' 10"	12" × 5¼"	300 to 400	1½ to 2½ H. P.	16' 6"	2,700 lbs.	$600.00
With Wegmann's patent porcelain rolls.									
9" × 14'	5' 1½"	3' 10'	3' 10 '	12" × 5¼"	300 to 400	1½ to 2½ H. P.	16' 6"	2,700 lbs.	$650.00
Divided four roller machines.									
9" × 14' 1-pr. cor. 1-pr. sm.	5' 1½"	3' 10"	3' 10"	12" × 5¼"	300 to 400	1½ to 2½ H. P.	16' 6"	2,700 lbs.	$590.00
9" × 14" 1-pr. sm. 1-pr. por.	5' 1½"	3' 10"	3 10"	12" × 5¼"	300 to 400	1½ to 2½ H. P.	16 6"	2,700 lbs.	615.00
9" × 14" 1-pr. cor. 1-pr. por.	5' 1½"	3' 10"	3 10"	12" × 5¼"	300 to 400	1½ to 2½ H. P.	16' 6"	2,700 lbs.	625.00

For grinding corn, feed, rye, etc,

Size.	Height.	Width.	Length.
6" × 12"	4' 6"	3' 5"	2' 7"
9" × 14"	5' 8"	3' 10"	3' 5"
9" × 18"	5' 8"	4' 9"	3' 5"
9" × 24"	5' 8"	5' 6"	3'



Driving pulley.	Revolutions per minute.	Length of belt above floor.	Approximate shipping weight	Price.
10" × 5¼"	400 to 500	14'	....	$500.00
14" × 6¼"	350 to 450	18'	2600 lb.	600.00
14" × 7¼"	350 to 450	18'	3050 lb.	650.00
14" × 8¼"	350 to 450	18'	3350 lb.	735.00

Flue Cleaner.

Hurley's Automatic Steam Flue Cleaner.

No.	Outside diam. of tubes.	With hose clamps.	Globe Valves.	Best 4-ply steam hose. Per foot.
1	1½ to 2	$5.00	⅛, 95 cents	¾, 67 cents.
2	2 to 2½	6.25	½, 95 cents	¾, 67 cents.
3	2½ to 3	7.50	¾, $1.30	¾, 67 cents.
4	3 to 3½	8.75	1, 1.75	1¾, 83 cents.
5	3½ to 4½	10.00	1¼ 2.90	1¼, $1.04

Dis. on flue cleaners, 60 and 70%.

Dis. on steam hose, 50%, good to 90 lbs steam.

Forges (Portable).

Fairbanks.

No. 2c, weight, 155 lbs. 21 × 27 hearth.............. $42.00
" 3a, " 80 " 18 in. diam. hearth.......... 27.00
" 3b, " 75 " 18 " " " 24.00
" 3c, " 85 " 18 " " " 30.00
" 6a, " 45 " 14 " " " 18.00
" 6B, " 45 " 14 " " " 16.00

Dis. 60%.

No. 1, 18 in. bellows, $20; No. 2, 20 in. bellows, 25; No. 3, 22 in. bellows, $30.

20% dis.

Stationary.

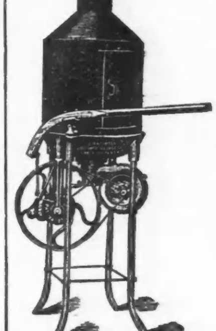
27 in. bellows, $21; 30 in. bellows, $25; 33 in. bellows, $33; 36 in. bellows, $45.

20% dis.

Riveting Forges.

Bellows, 18 in., 20 in., 22 in., 24 in., $8.00. $10.00. $13.00. $17.00.

20% dis.



Light work, 12 × 17; height, 15 in., $16.00.

Same, with Hood, 12 × 17; height, 28 in., $20.00.

Bridge, Boiler or Railroad work, Pan, 17 × 19; height, 29 in.; Fan, 8 in., $27.00.

Same, with Hood, $30.00.

Water Tank, $4.00 extra.

Iron Fire Ring Round Tuyere $1.00 extra.

50% dis.

Fruit Evaporator.

No. 1. Evaporator.......................... $30

No. 2. Fruit Drier and Baker, with Bleacher attachment. Weight, 225 lbs. Capacity, 5 to 7 bushels apples per day; 24 in. deep, 26 in. wide, 5½ ft. high; 12 trays, 22 22; 40 square feet drying surface. Complete.......................... $50

No. 3. Capacity, 15 to 20 bushels per day.......................... 100

No. 4. Capacity, 20 to 30 bushels per day.......................... 16

Dis., No. 1, 3 and 4 = 20%.
" 2 = 30%

Boxing, extra:
No. 1, $3.00; No. 2, $5.00; No. 3, $7.50; No. 4, $12.50.

Freight to New York:
No. 1, $4.00; No. 2, $6.00; No. 3, $12.00; No. 4, $18.00.

Glass Tube Cutters.

One Arm Carries Rotary Cutter Price, $2.50 each.

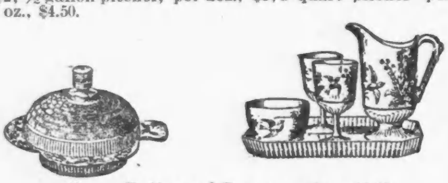
Glassware.

6-in. bowl and cover, per doz.......... $3.25
7-in. " " " 4.50
8-in. " " " 6.00
9-in. " " " 8.00
10-in. " " " 10.50
Net.

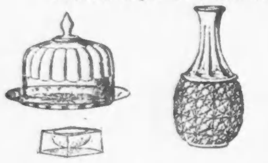
Nappy, 4½-inch., per doz., 50c.; 6-inch., per doz., $2 7-inch., per doz., $3; 8-inch., per doz, $4.

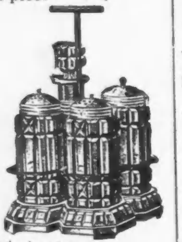
Cream Pitcher, 1 pint, per doz., $1.25; one quart, pe doz., $3.5 ; 3 pints, per doz., $4.50.

Pint Pitcher, per doz., $1.50; quart pitcher, per doz., $2; ½ gallon pitcher, per doz., $3, 3 quart pitcher per oz., $4.50.



Flange Butter and Cover, per doz., $1.75.
Water Set, per doz., sets of 60 pieces $7.50.





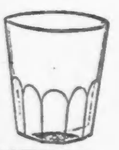
Cheese Dish and Cover, 8 in., per doz., $4.50.
Quart Water Bottle, per doz., $4.50.
Ind. Salts; per gross, $2.00. Assorted patterns.
4 Bottle Castors, per doz., $7.50; 3 bottle, per doz., $4.50.

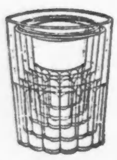
Berry Dish, 4½-inch, per doz., 50c.; 10-inch, per doz., $4.
Butter Dish and Cover, per doz., $1.25.
Butter Dish and Cover, per doz., 75c.

Candlesticks, per doz., $2.00. Glass Slipper for Flowers, per doz., 50 cents; slipper and tray, per doz., $1. Jam Jar and Cover, 1 qt., per doz., $2.50; ½ gal., per doz., $3.25; ¾ gal., per doz., $4; 1 gal., per doz., $5; 1½ gals., $9; 2 gals., per doz., $12. Pocket Flask, 1 pint, $1.

Tumblers.
1⅞ oz., per doz., 50 cents.
8 " " 75 "

9 oz., per doz., $2.75.





11 oz., assorted patterns, per doz., 30 cts.

9½ oz., assorted patterns, per doz., 25 cts.

1 oz. to 12 oz., nested for shipping, per doz. nest, $2.

Goblets, banded, per doz., 65 cents.
Claret to match, per doz., 55 cents.
Wines, to match, per doz., 50 cents.
Cordials, to match, per 45 cents.

Goblets, per doz., 50 cts.
Claret, " 50 "
Wine " 35 "

Banded, open, hollow stem.

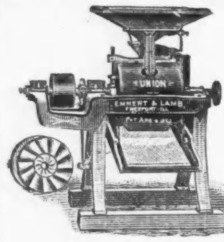
Champagne, per doz., $1.25.

½ Pt. tumbler, per doz. 55 cts.
½ Pt. mug to match, " 65 "
Goblet, " 50 "
Spoon holder, cream pitcher, sugar, butter dish to match.
Sets of 4 pieces, per doz. sets, 48 pieces, $3.75.

Grinding Mills.—Emmert & Lamb

"Daisy," without Shaking Bolt, 170 pounds, 9 cubic feet, $40.
"Daisy," with Shaking Bolt, 185 pounds, 9 cubic feet, $48.
} Discount 25 per cent.

"The Union Mill."



Diameter of Buhr Stones	Size of Pulleys Diam.	Face.
12 in.	8 in.	6¼ in.
16 "	9 "	7½ "

Horse Power	Capacity in B'sh's	Speed	Without Bolt	With Bolt	Sacking Elevator, Extra	Extra Metal Buhrs
8 to 10	12 to 30	1200 to 1500	$90.00	$105.00	$15.00	$1.20 pair
10 to 15	20 to 50	1000 to 1600	160.00	178.00	17.50	1.50 "

Hammers.

H. Cheney Hammer Co.

Adz-eye Hammers.—Per Dozen.

No.	Weight.		No.	Weight.	
5. Round.	1 lb., 4 oz	$9.00	7½. Round.	13 oz	$8.00
7. "	1 lb.	8.50	8 "	7 oz	7 50

Adz-eye Hammers.—Per Dozen.

No. 17. Octagon. weight, 1 lb., 4 oz. $9.00

Adz-eye Hammers.—Patent Nail Holder.—Per Dozen.

No.	Weight.		No.	Weight.	
33. Bell-face.	1 lb., 4 oz	$9.50	35. Round h.	1 lb., 4 oz	$9.50
34. "	1 lb.	9 00	36. "	1 lb.	9.00

Adz-eye Hammers.—Bell Face.—Per Dozen.

No.	Weight.		No.	Weight.	
37.	1 lb., 4 oz	$9.00	38½.	13 oz	$8.00
38.	1 lb.	8.50	39½.	7 oz	7.50

Farriers' Hammers.—Per Dozen.

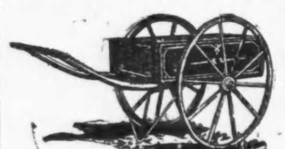
No.		Weight.	
55.	Adz-eye. Octagon.	9 oz	$7.75
56.	" "	7 oz	7.50
57.	Plain. "	7 oz	6 25
58.	Plain Brad.	4 oz	5 50
60.	Adz-eye, Round Head.	7 oz	7 50
61.	" Octagon. Boston pattern	10 oz	8.00
62.	" " "	7 oz	7 50

Machinists' Ball Pein Hammers.—Octagon.—Per Dozen.

No.	Weight.		No.	Weight.	
90.	3 lbs	$22.00	94.	1 lb., 4 oz	$13 50
90½.	3 lbs., 8 oz	19.00	95.	1 lb	12.50
91.	4 lbs., 4 oz	17.50	96.	12 oz	12.00
92.	2 lbs	16.50	97.	8 oz	12.00
92½.	1 lb., 12 oz	15.50	98.	6 oz	12.00
93.	1 lb., 8 oz	14 50			

Discount, 35 and 5 per cent. Net Cash, 30 days. 10 per cent. Cash, 10 days. Cases at Cost.

Hand Carts No. 0 42 wheel, 1 in. tread, 1 in. axle box 48x28x10 deep, $10.50.



No. 1, 36 wheel, 1 in. tread, ⅞ in. axle, box 40x23x10 deep, $9.00.

No. 2, 30 wheel, ¾ in tread, ¾ in. axle, box 32x20x9 deep, $8.25.

With Wagon-Seat Spring.

No. 6, same sizes as No. 0 ....$12.00
" 7, same sizes as No. 1 .... 10.50
" 8, " " " No. 2 .... 9.75

With Third Wheel, Without Springs.

No. 3, same sizes as No. 0 ....$12.00
" 4, " " " No. 1 .... 10.50
" 5, " " " No. 2 .... 9.5

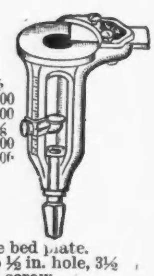
Hardware Specialties.

AUGERS.

Patent Adjustable Hollow.

Cuts from ¼ to 1¼, pivoted jaws, graduated scale to 1-16ths, per doz., $60.00

Discount, 15 and 10%.



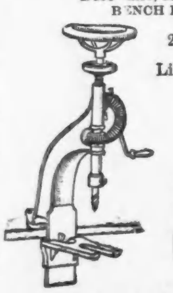
Patent Hollow Auger.

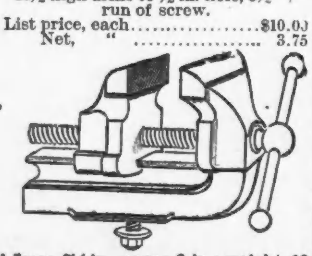
Inch	5-16	⅜	7-16	½	
With bits	12.00	12.00	12.00	12.00	
Without bits	8.00	8.00	8.00	8.00	
9-16	⅝	¾	⅞	1	1⅛
14.00	14.00	14.00	16.00	16.00	20.00
9.00	9.00	9.00	13.00	13.00	14.00
1¼	1⅜	1½			
20.00	24.00	24.00			
14.00	16.00	15.00			

Discount, 15 and 10%.

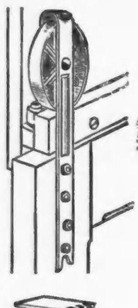
BENCH DRILL.

Adjustable bed plate.
26½ high drills to ½ in. hole, 3½ run of screw.
List price, each $10.00
Net, " 3.75



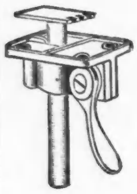


Bench Vise, Steel Jaws, 3½ in., opens 3 in.; weight, 12 lbs.; list price, each, $4.00.; net price, each, $1.60.



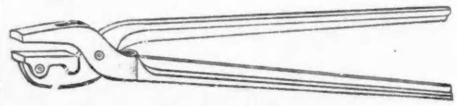
BARN DOOR HANGER.

4 in., per doz. pairs $12.00
5 " " " 14.40
Track, per foot .... .08
One dozen pairs in case.
Dis., 50%.



BENCH HOOK.

Patent, adjustable and reversible
List $9 dozen, ½ dozen in box.
Discount, 20 and 10%.



BLACKSMITH'S TONGS.

Swivel Jaw.

No. 1, 16 in., per doz. $10.00
" 2, 18 " " 10.00
Dis. 20%.

CASTERS.

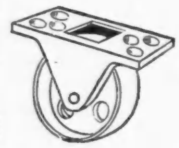
Swivel Store Truck

No. 20, japanned, 4 in. wheel, each ..... .55
No. 25, " 5 " " " ..... .75

Noiseless turned wheel.

No. 30, japanned, 4 in. wheel, each 1.30
No. 35, " 5 " " " 1.60

Discount, 25%.



Store Truck, stationary.

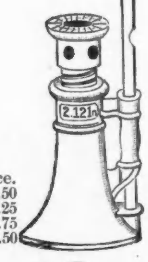
No. 50, 5-inch wheel, 1½ inch wide, each, $1.05.

No. 60, 5-inch, extra heavy, 1½ inch wide, each $1.50.

Discount, 25%.

CLOTHES REEL.

Extra heavy, gray iron, japanned.
List per doz $15.00
Net " 7.00

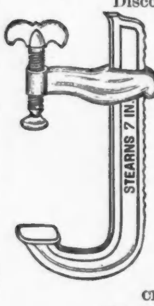


JACK SCREWS.

New pattern wrought iron screw.

No.	Rise of screw.	High.	Diameter screw.	Price.
20	4½ in.	10 in.	2 in.	$4.50
25	6½ "	12 "	2 "	5.25
30	8½ "	14 "	2 "	5.75
	11½ "	16 "	2 "	6.50

Discount, 40%.

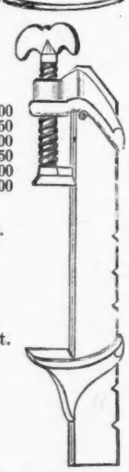


SCREW CLAMPS.

Adjustable.

3 in., per doz $4.00
5 " " 6.50
7 " " 9.00
9 " " 10.50
12 " " 15.00
16 " " 20.00

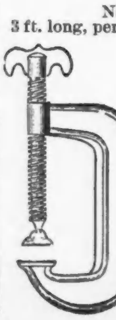
½ doz. in box.
Discount, 20 and 10%.



CLAMPS.

New Door Frame.

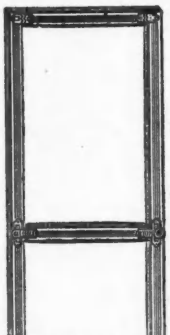
3 ft. long, per doz., $8 list; $5 per doz. net.



Malleable Iron Screw Clamps.

	Per Doz.		Per Doz.
3 in	$7.00	7 in	$20.00
4 "	10.00	8 "	25.00
5 "	12.00	9 "	27.50
6 "	16.00	10 "	30.00

3, 4, 5, 6 in., ½ doz. in box.
Dis., 70%.



DOOR SCREEN FRAMES.

Patent Corners.

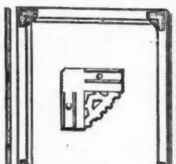
No. 22, 3 by 7 ft. sticks, ⅞ by 2, per doz. sets, $11.

No. 24, 3½ by 8 ft. sticks, ⅞ by 2, per doz. sets, $12.

No. 26, 3 by 7 ft. sticks, ⅞ by 2½, per doz. sets, $12.50.

No. 28, 3½ by 8 ft. sticks, ⅞ by 2½, per doz. sets, $14.50.

Dis., 20%.



WINDOW SCREEN FRAMES.

Patent Japanned Corners.

No.25, 36 by 36 corners and screws, without bead, per doz., $2.50.
No.25, 36 by 36 corners and screws, with bead, per doz., $2.90.
No.35, 42 by 42 corners and screws, without bead, per doz., $2.90.
No.35, 42 by 42 corners and screws, with bead, per doz., $3.30.
Black satin stain, sticks ⅞ by 1 in.

Dis., 20%.

PULLEYS.

Side, No. 45, Japanned.

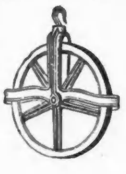
Inches...	1	1½	2	2½	3	4	5
Per doz..	.90	1.00	1.60	2.40	3.50	9.00	15.00

2 inch and under, 2 dozen in box: 2½, 3 and 4, 1 dozen in box; 5 inch, ½ dozen in box.

Discount, 50%.

PULLEY HOOK (New Floor.)
Deep cut thread, forged point.

Per doz.
¾ in. wrought iron, 8 in. long, list........ $1.90
net........ 1.00



WELL WHEEL.
New pattern.
Japanned.

In.	8	10	12	14	16
Pr.d.	7.00	9.50	12.50	20.00	30.00

Discount, 70%.

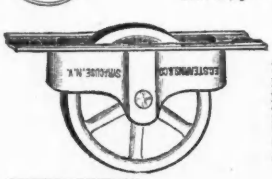
HAY FORK PULLEY.

New pattern.

No. 15, 5 in. iron wheel..........per doz. $4.50
25, 5 in. wood " .... " 4.50
66, 6 in. " " .... " 6.00

4 dozen in case, 8 dozen in barrel.

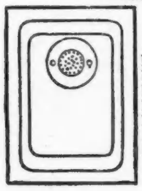
No. 15, per dozen, $2 net.



SHEAVES.
Patent Common
Turned and polished iron wheels, round corners, brass pin, one set in box.

2½ inch $1.50
3 " 1.60
4 " 2.00
5 " 2.60

Discount, 50%.



SINKS.
All 6 inch deep.

14 × 20 in....	$1.50	18 × 30 in....	$2.50
15 × 25 in....	1.75	18 × 32 in....	3.00
15 × 27 in....	2.00	18 × 36 in....	3.00
16 × 24 in....	1.80	20 × 30 in....	3.00
16 × 28 in....	2.10	20 × 36 in....	3.70
17 × 30 in....	2.25	20 × 40 in....	4.00
18 × 24 in....	2.10		

Discount, 60%.

SPOKE POINTERS.

Per doz.
No. 1, points 1⅞ in. diameter, $9.00
No. 2, points 2⅝ in. diameter, $15.00

Discount, 15 and 10%.

⅙ dozen in box.

VISE.
(Bench Vise, Steel Jaws.)
3½ in. opens 5 in., weight 12 lbs.
List price, each. $4.00
Net " " .. 1.60

Silent Saw Vise.
No. 10., 10 in. jaw, per doz....$15.00
Dis., 33⅓%.

Moore & Barnet Mfg. Co.

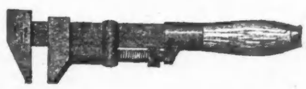
No.		per dz.	per gr., lbs.	No.	per dz.	gr., lbs.
1	Amateur vise.....	$2.25	70	Clamp.		
Anvil.				1½	3.00	80
2	....	3.75	200	2½	5.00	220
3	....	11.25	615	3½	14.25	700
4	....	18.00	1,350	4½	21.00	1,425
10	....	24.00	1,675	Combination hand.........	5.25	85

Spot cash discount, 33, 20 and 2, f.o.b.

Nos. 1, 1½, 2 and 2½ are packed in dozens; Nos. 3 and 3½ in half dozens; Nos. 4, 4½ and 10 in quarter dozens, and No. 20 singly. Each hand vise is put up in neat box and packed in half dozen lots.

1 Hinge pipe vise, 0 to 2 in. pipe................Each $10.00
2 " " " 0 to 4 in. pipe.................... 20.00
1 Malleable pipe vise, 0 to 2 in. pipe................ 8.00
1 Combination pipe and bench vise, 0 to 2 in. pipe...16.00

Discount, 50%.



WRENCHES.

Coes' Knife Handle Wrenches.

BLACK.

Size.	℔ doz.	Size.	℔ doz.
6 inch..............	$9.00	15 inch............	$24.00
8 "	10.00	18 "	30.00
10 "	12.00	21 "	36.00
12 "	14.00		

BRIGHT.

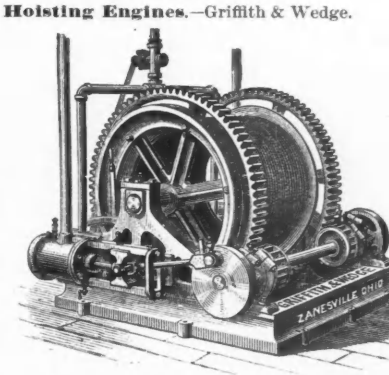
4 inch..............	$10.00	12 inch............	$16.00
6 "	10.00	15 "	26.00
8 "	11.00	18 "	32.00
10 "	14.00	21 "	38.00

Discount, 55, 10, 7½ and 3%.

Coes Mechanics' Screw Wrenches, same list, less 55, 10, 10, 7½ and 3%.

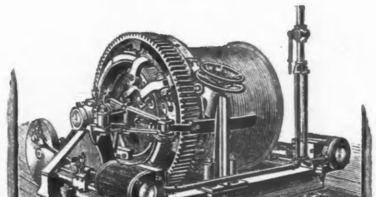
A. G. Coes & Co. Pat. Screw Wrenches, same list as above. Discount, 55, 10, 7½ and 3%.

Hoisting Engines.—Griffith & Wedge.



	Weight.	$
Hoisting Engines, Miner's Prospecting.....	4,500	750
Hoisting Engines, No. 1 Double Cylinder...	4,500	800
Discount, 20%.		
" " No. 2 Double Cylinder...	6,000	1,000
" " No. 3 " " ...	11,000	1,550
" " No. 4 " " ...	15,500	1,800
" " No. 5 " " ...	17,000	2,100
" " No. 6 " " ...	13,600	1,750
" " No. 7 " " ...	17,000	2,100
" " No. 8 " " ...	19,000	2,400
" " No. 9 " " ...	48.000	4,500

Discount, 25%.

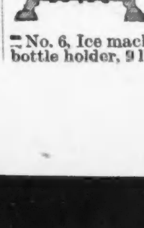


Webster, Camp & Lane Machine Co.

Single drum.	No.	Average Load. Pounds	Approx. weight, complete. Pounds.	Double drum.
$825.00 =	5	1,950	6,000 =	....
918.50 =	6	1,650	6,500 =	....
1,177.00 =	7	2,200	8,000 =	$1,661.00
1,331.00 =	8	3,000	8,500 =	1,815.00
1.694.00 =	9	3,500	14,000 =	2,722 50
1,914.00 =	16½	3,700	16,000 =	3,124 00
2,343.00 =	17½	5,500	19,000 =	3,333.00
2,475.00 =	18	5,500	22,000 =	3,872.00

Ice Machines (Family).

L. DERMINGNY & Co.



No. 1, Ice machine, ice and ice cream molds, 1 lb. ice, $15.00.

No. 2, Ice machine, ice and ice cream molds, 1½ lbs. ice, $20.00.

No. 3, Ice machine, ice and ice cream molds, 1 carafe 1 bottle holder, 2 lbs. ice, $26.50.

No. 4, Ice machine, ice and ice cream molds, 2 carafe 1 bottle holder, 4 lbs. ice, $33.00.

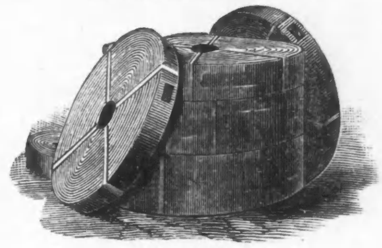
No. 5, Ice machine, ice and ice cream molds, 3 carafe 1 bottle holder, 6 lbs. ice, $40.00.

No. 6, Ice machine, ice and ice cream molds, 4 carafe 1 bottle holder, 9 lbs. ice, $46.50.

India Rubber Goods.

MECHANICAL.

Commonwealth Rubber Co.

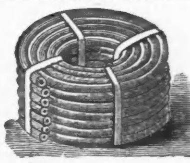


RUBBER BELTING.

Inches.	2 ply per foot.	3 ply per foot.	4 ply per foot.	5 ply per foot.	6 ply per foot.
1	$0.07	....	....	....	....
1¼	0.09	....	....	....	....
1½	0.11	....	....	....	....
2	0.15	$0.17	$0.21	....	....
2½	0.18	0.22	0.26	....	....
3	0.22	0.26	0.31	....	....
3½	0.26	0.30	0.37	....	....
4	0.30	0.34	0.42	....	....
4½	0.33	0.39	0.47	....	....
5	0.36	0.43	0.52	....	....
6	0.43	0.52	0.62	....	....
7	0.51	0.60	0.73	....	....
8	0.59	0.70	0.84	$1.05	$1.25
9	0.67	0.80	0.95	1.18	1.42
10	0.75	0.90	1.07	1.33	1.60
11	0.83	1.00	1.18	1.47	1.77
12	0.91	1.08	1.30	1.62	1.95
13	1.00	1.18	1.42	1.77	2.13
14	1.08	1.28	1.54	1.92	2.31
15	1.16	1.38	1.66	2.07	2.49
16	1.25	1.50	1.78	2.22	2.67
18	1.41	1.70	2.02	2.52	3.03
20	1.58	1.90	2.26	2.82	3.39
22	1.76	2.12	2.52	3.15	3.74
24	1.96	2.36	2.80	3.50	4.20
26	2.18	2.60	3.08	3.85	4.62
28	2.42	2.84	3.36	4.20	5.04
30	....	....	3.64	4.55	5.46
32	....	....	3.92	4.90	5.88
34	....	....	4.20	5.25	6.30
36	....	....	4.48	5.60	6.72
38	....	....	4.76	5.95	7.14
40	....	....	5.04	6.30	7.56
42	....	....	5.32	6.65	7.98
44	....	....	5.60	7.00	8.40
46	....	....	5.88	7.35	8.82
48	....	....	6.16	7.70	9.24
50	....	....	6.44	8.05	9.66
52	....	....	6.72	8.40	10.08

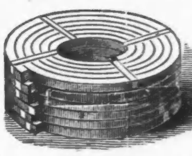
Dis. Reliance, 60 and 5. Dis. Royal, 60, 10 and 10. Dis Manhattan, 70 and 5. See Link Belting, page 9.

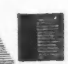
PACKING.



Piston Packing.

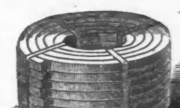
Round Piston Packing Per lb. 85c.
Discount, 60, 10 and 5 per cent.

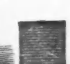




Square Piston Packing.

Price same as above. Round and square piston packing is made in lengths of twelve or twenty-four feet.





Square Piston Packing. Rubber back, per pound $1. Discount 60 der cent. Best only.
Square piston packing rubber back is made in lengths of twenty feet.

Steam Packing.
Cloth Insertion, Rubber Outside.
Cloth Insertion, Cloth on one or both sides.

Thickness.	1-Ply.	2-Ply.	3-Ply.	4-Ply.
1-64 inch..............	70 cts.	....	....	....
1-32 "	65 cts.	....	....	....
1-16 "	60 cts.	63 cts.	66 cts.	....
3-32 "	55 cts.	58 cts.	61 cts.	....
1-8 "	55 cts.	55 cts.	58 cts.	61 cts.
3-16 "	55 cts.	55 cts.	55 cts.	58 cts.
1-4 "	55 cts.	55 cts.	55 cts.	55 cts.

One-ply of cloth to every 1-16 inch thickness.

Three cents per pound additional will be charged for each extra ply of cloth. Each cloth, whether insertion or on outside, to count as one ply.

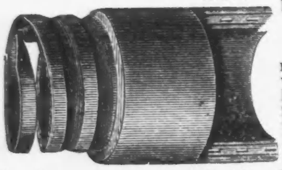
All cloth insertion or plain packing is one yard wide, and any length desired.

Wire insertion packing, all thicknesses, per lb, 50 cents.

Discounts: Reliance, 70 & 10; Royal, 60, 10 & 10: Manhattan, 60 per cent.

See "Link" Packing, page 9.

HOSE.



Improved "Smooth Bore" Rubber Suction Hose.

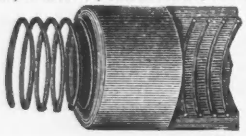
On spiral flat or round tinned steel wire.

Int. Diam.	Per ft.
2 inch	$2.60
2½ "	3.50
3 "	4.00
3½ "	5.50

In. Diam.	Per ft.	Per. Diam.	Per ft.
4 inch	6.50	7 inch	$13.50
4½ "	7.50	7½ "	15.00
5 "	8.50	8 "	16.50
5½ "	9.50	9 "	19.50
6 "	10.50	10 "	22.50
6½ "	12.00	12 "	27.50

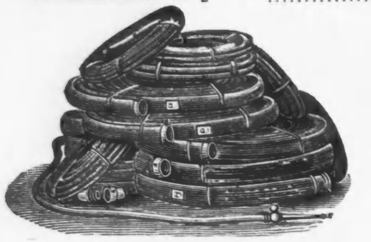
Suction hose discount: Reliance, 50 and 10%; Royal, 60, 10 and 5%; Manhattan, 70 and 5%.

SUCTION HOSE.



On spiral brass or iron wire

Int. Diam.	Per. ft.
¾-inch	$ .77
1 "	1.00
1¼ "	1.25
1½ "	1.65
1¾ "	2.10
2 "	2.50



RUBBER HOSE.

Conducting Hose—Two-ply.

Int. diam.	Per ft.	Int. diam.	Per ft.	Int. diam.	Per ft.
½ in.	$0.20	2 in.	$0.66	5 in.	$1.65
¾ in.	25	2¼ in.	75	6 in.	1.98
1 in.	33	2½ in.	83	7 in.	2.31
1¼ in.	42	2¾ in.	92	8 in.	2.64
1½ in.	50	3 in.	99	9 in.	2.97
1¾ in.	58	4 in.	1.32	10 in.	3.33
HYDRANT HOSE—THREE-PLY.					
½ in.	$0.25	1½ in.	$0.60	2½ in.	$1.00
¾ in.	30	1¾ in.	70	2¾ in.	1.10
1 in.	40	2 in.	80	3 in.	1.20
1¼ in.	60	2¼ in.	90	3½ in.	1.40
				4 in.	1.60

Discount—Reliance, 60; Royal, 70; Manhattan, 70 and 10 per cent.

GASKETS AND RINGS.

Fibrous.

⅛ inch thich, or less, per lb. $0.90

5-32 inch thick, and upwards, per lb. $0.80

Cloth Insertion.

1-16 inch thick, or less, per lb. $1.25

3-32 inch thick, and upwards, per lb. $1.00

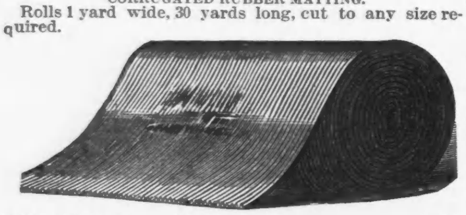
There is one ply of cloth to every 1-16 in thickness.

Five cents per pound additional for each extra ply of cloth.

Dis., 60, 10 and 5%.

CORRUGATED RUBBER MATTING.

Rolls 1 yard wide, 30 yards long, cut to any size required.

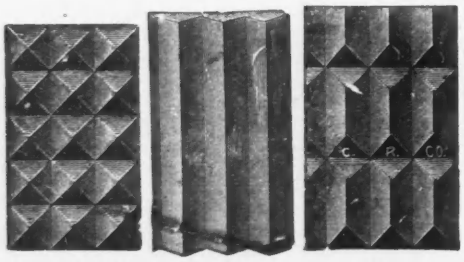


3-32 in. thick, per sq. ft.	$0.33
⅛ " " "	0.40
5-16 " " "	0.56
¼ " " "	0.73
⅜ " " "	1.03
½ " " "	1.30

Dis., 25 and 5%.

TENNIS SHOE SOLING.

Cuts show full size of pattern.

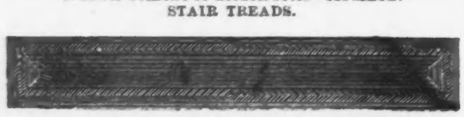


Diamond Point. Corrugated. Oblong.

Price, $1 per [illegible]

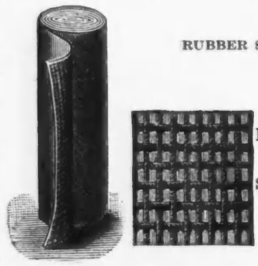
Rubber cement to attach so[illegible] [illegible]ished.

STAIR TREADS.



No.	Inches.	Thick.	Per doz.	Thick.	Per doz.
1.	6 x18	⅛	$4.00	3/32	$3.30
2.	7 x24	⅛	6.00	3/32	5.00
3.	4 x39	⅛	5.50	3/32	4 70
4.	7 x40	⅛	10.00	3/32	8 30
5.	7½x42	⅛	11.00	3/32	9.10
6.	7½x48	⅛	12.50	3/32	10 40
7.	9 x40	⅛	12.50	3/32	10.40
8	9 x48	⅛	15.00	3/32	12.50
9.	9 x36	⅛	11.25	3/32	9.40
10.	6 x48	⅛	10.20	3/32	8.[illegible]0
11.	7 x28	⅛	7.00	3/32	5 85
12.	9 x54	⅛	16 80	3/32	14 00
13.	8 x52	⅛	14.60	3/32	12.15
14.	10 x24	⅛	8.40	3/32	7.00

RUBBER SOLING FOR BOOTS.



Rough finish, 1-16 to 5-16 thick.

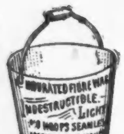
Smooth finish. 1-32 to 1-16 thick.

85 cents per lb.

Indurated Fibre Ware.

SPITTOONS.

	Doz.
16 in. dia., 8 in. high	$24.00
12½ in. dia., 5½ in. high	10.80
9 in. dia., 5 in. high	7.80

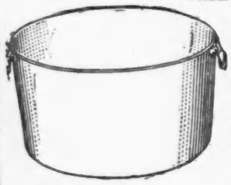


Dis. on all 25 and 20%.

CORDLEY & HAYES.

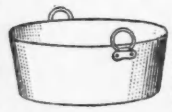
Pails.	No. doz. in crate.	Cubic feet.	Price per doz.
Ladies' or Weaver's pails, 6 qt.	1	2¾	$5.35
Half or buggy pails, 6 qt.	1	3	4.80
Star pails (standard plain), 12 qt., stenciled "for fire only" without extra charge	1	3½	6.00
Deck or Mason's pails (same size as Star, but heavier, with heavy wire bail)	1	4	6.60
Railroad or fire pails, 14 qt. (also stenciled "fire" without extra charge)	½	3½	7.80
Fire pails, round bottoms	1	4	7.80
Milk pails, 14 qt	1	4	7.80
Stable pails, flush bottom, heavy wire bail, 14 qt	1	4	7.80
Stable pails, 16 qt., same as above	½	3½	8.40
" 18 " "	½	3¾	10.70
" 20 " "	½	4	12.00
Covers for fire or star pails		1	3.35

WASH TUBS.



No. 0, 23 in.	½	12	27.00
Nos. 0, 1, 2 and 3, nested	1 n.	3½	22.50
No. 1, 21 in.	½	10½	24.00
No. 2, 19½ in.	½	9	21.00
No. 3, 18½ in.	½	9	18.00
Nos. 1, 2, and 3, nested	½	9¾	21.00

KEELERS.



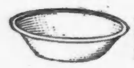
		Doz.
A—20 in.	7 in. deep	16.20
B—19 "	" "	15.00
C—18½ "	" "	14.00
1—17½ "	" "	13.20
2—15½ "	6 in. "	12.00
3—13½ "	5 in. "	10.20
4—12 "	4 in. "	9.00

MILK OR VEGETABLE PANS.

13½ in. dia 3¼ in. deep, 6 quarts,

$3.60 per doz.

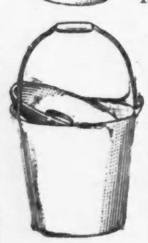
WASH BASINS.



	Doz.
12½ in	$4.80
12½ in	4.20
11½ in	3.60

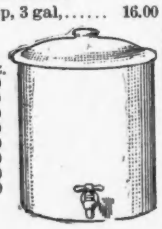
CHAMBER PAILS.

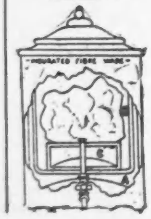
12 in. dia., 9 in. deep, 3 gal, 16.00



WATER COOLERS.

	Doz.
3 gal	$32.00
4 "	40.00
5 "	44.00
6 "	48.00
8 "	64.00
10 "	80.00
12 "	96.00
15 "	120.00





WATER COOLERS AND FILTERS.

	Doz.
4 gal	$96.00
5 "	108.00
6 "	120.00
8 "	144.00
10 "	192.00
15 "	288.00

Lamps. F. H. Lovell & Co.

Drummond Electric Hanging Lamp, 300 candle power, complete, each $3.50.

The electric lamp, 60 candle-power.

With decorated shades, nickel, per doz. $22.00

With opal plain shades, nickel, per doz. 18.00.

With decorated shades, brass, per doz. 21.00.

With opal plain shades, brass, per doz. 17.00.

Lamp chimney patent for Sun burners. Per doz. No. 0, 50 cents. No. 1, 60c. No. 2, 75c.

Hitchcock nickel table lamp (No. 654), each $3.75

" " hanging " 656 " 7.25

" " bracket " 651 " 4.00

" " " with reflector 653 " 4.00

" French bronze bracket, with reflector, No. 653, each $3.75.

Harp, complete, with square tin shade, per doz., $9.50.

Complete, with Burner and chimney, per doz., $1.50.

Hurricane lanterns 25 cents extra with guards.

875, ⅜ wick, without guards, per doz., $5.00.

876, square safety lifting globe, per doz., $5.50.

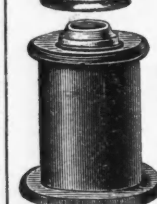
877, ⅝ wick, safety lifting globe, per doz., $6.75.

Nickel plated diamond reflector reading lamp, 30 candle-power, $13.50 per doz.

Net.

Illuminated night clock, per doz., $27.

PAPER LAMPS.



Lined with oil proof composition.

	No. 0.	No. 1.	No. 2.
Height	2½ in.	3 in.	3¾ in.
Diameter	3½ in.	2½ in.	2½ in.
Weight, ℔ doz.	3¾ lbs.	1¾ lbs.	2 lbs.
Price	$2.75 per doz.	$2.25	$2.75

	No. 0.	No. 3.	No. 4.
Height	2½ in.	5 in.	6½ in.
Diameter	3½ in.	3½ in.	4 in.
Weight, ℔ doz.	3¾ lbs.	3½ lbs.	7 lbs.
Price	$2.75 per doz.	$3.25	$4.50

Dis., 20%.

Miners'.

Brass, Collar and Breast in one piece, Spout and Body in one piece.

Price, $9 per gross net.

Laundry Appliances.

EMPIRE CLOTHES WRINGERS.

Rolls.

"Volunteer." Length, 10 in.x1¾ in. dia. $40 per doz.

"Volunteer." Length, 11 in.x1¾ in. dia. $50 per doz.

"Volunteer." Length 12 in.x1¾ in. dia. $50 per doz.

Dis., 40%.

"Daisy." Length, 10 in.x1¾ in. dia. $30 per doz.

"Daisy." Length, 12 in.x1¾ in. dia. $48 per doz.

Dis., 40%.

"Empire." Length, 10 in.x1¾ in. dia. $63 per doz.

"Empire." Length, 11 in.x1¾ in dia. $74 per doz.

"Empire." Length, 12 in.x1⅞ in. dia. $84 per doz.

"Empire." Length, 12 in.x1⅞ in. dia. $87 per doz.

"Empire." Length, 14 in.x2¼ in. dia. $156 per doz.

"Empire." Length, 14 in.x2¼, with pulleys. $220 per doz.

"Empire." Length, 16 in.x2½, with pulleys. $360 per doz.

Dis., 40%.

EMPIRE CLOTHES DRYING BARS. $10 per doz. Dis., 40%.

Closed.

Open for use,

EMPIRE FOLDING WASH BENCHES
$15 per doz. Dis., 40%.

Royal Keystone cog wheel, 10 by 1¾ rolls, $36 per doz.
No. 10, wood frame cog wheel, 10 by 1¾ rolls, $24.50.
No. 16, wood frame cog wheel, 11 by 1¾ rolls, $29.
No. 18, wood frame cog wheel, 11 by 1⅞ rolls, $33.50.
No. 20, wood frame cog wheel, 11 by 2 rolls, $39.50.
No. 22, wood frame cog wheel, 12 by 1⅞ rolls $39.50.
No. 24, wood frame cog wheel, 12 by 2 rolls, $48.50.
No. 11, iron frame cog wheel, 10 by 1⅝ rolls, $20.
No. 2, iron frame cog wheel, 10 by 1¾ rolls, $24.
Solance iron frame (Eureka Pat.), 10 by 1¾ rolls, $20.
Solance iron frame (Eureka Pat.), 11 by 1¾ rolls, $24.50
F.o.b.cars at works; 60 cents doz entra f.o.b. New York.
Keystone Double Bench Wringer.
Rolls, 10 by 1¾, $36.50 per doz. Made to fold.
Folding Double Folding Wash Bench, packed 6 in crate per doz., $14.

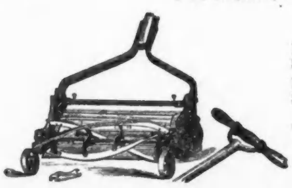
Adams Ironing Table, per doz	$15.00
Keystone Washing Machines, per doz	24.00
Complete " " "	13.50
People's " " "	13.50
Lovell " " "	13.50

Lawn Mowers.

Forward Cut Mowers.

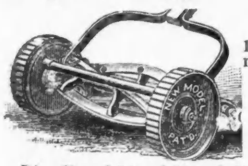
In.	Lbs.		In.	Lbs.	
10 Weight,	30¾	$13.00	16 Weight,	38	$19.00
12 "	31½	15.00	18 "	41	21.00
14 "	36	17.00	21		34.00

Dis. 60 and 5%.



10 in.	12 in.	14 in.
$13.00	$15.00	$17.00
16 in.	18 in.	20 in.
$19.00	$21.00	$23.00

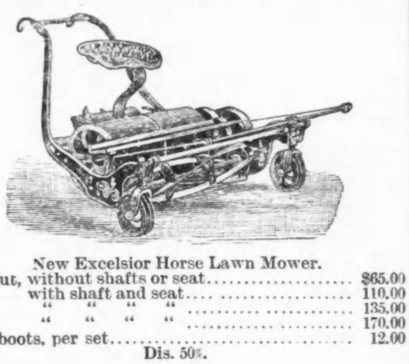
24 in., $30.00.
Geared at both ends.
Dis. 60 and 5 and 5%.



Chadborn & Caldwell Mfg. Co.

10 in. Croquet, 18 pound, mower	$11.00
10 in.	13.00
12 in.	15.00
14 in.	17.00
16 in.	19.00
18 in.	21.00
20 in.	23.00

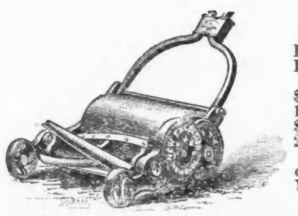
Dis., 60 and 5% and 5% cash 30 days, f.o.b. New York.



New Excelsior Horse Lawn Mower.

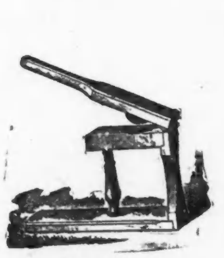
25 in. cut, without shafts or seat	$65.00
30 " with shaft and seat	110.00
35 " " " " "	135.00
40 " " " " "	170.00
Horse boots, per set	12.00

Dis. 50%.

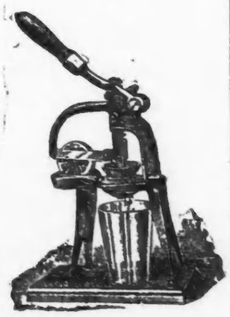


Excelsior Three-Blade Mower and Roller.
8 in., $11.00; 10 in., $13.00; 12 in., $15.00; 14 in., $17.00; 16 in., $19.00; 18 in., $21.00; 20 in., $23.00.
Dis. 60% and 5% cash 30 days f.o.b. New York.

Lemon Squeezers.



THE SAMSON



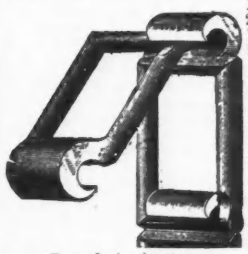
THE ACME.

The Acme Lemon Squeezers, knife and squeezer, per dozen, $15.00.
The Samson, per dozen, $3.00.

Porcelain lined, No. 1, per doz	$6.00
25 and 30 % discount.	
Wood, No. 2, per doz	$3.00
30 % discount.	
Wood, common, per doz	$1.70

Link Belting.

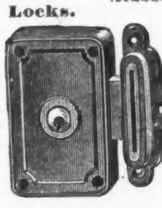
Link-Belt Machinery Co.'s. Price per running foot net.



No.	Price.	No.	Price.
25	$0.13	78	$0.40
32	.13	83	.45
33	.12	85	.50
34	.13	88	.50
35	.14	95	.60
42	.16	103	.75
45	.16	105	.70
51	.20	106	.90
52	.25	107	.80
55	.22	108	.80
57	.24	109	.90
62	.30	114	1.10
66	.30	122	1.50
67	.30	124	1.30
75	.35	146	1.40
77	.35		

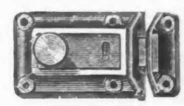
Sprocket wheels 25%
(Rubber belting, see page 6.)

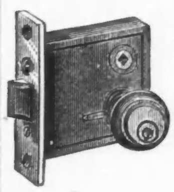
Locks.



YALE PATENT.
RIM STORE LATCH.

	Per doz.
3 × 5 in., 4 keys	$48.00
2½ × 4 in., 3 keys	39.00



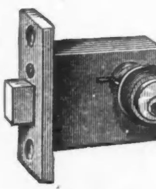


RIM NIGHT LATCH.

Spring lock, 3 keys	18.00
Dead lock, 3 keys	25.00

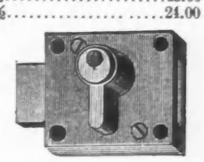
NIGHT LATCH.

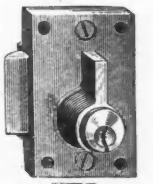
Escutcheon	39.00
"	36.00



MORTISE DEAD LOCK.

4⅝ × 3½	45.00
2⅜ × 3½	24.00



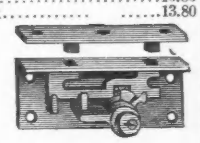


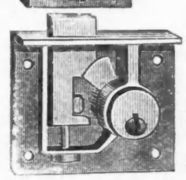
CUPBOARD LOCKS.

Plated Nose	13.20
Brass Nose	12.00

CUPBOARD

Dead Lock	10.80
Spring Lock	13.80





CHEST LOCKS.

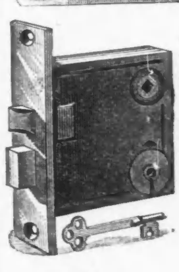
Plated nose	19.20
Brass "	18.00

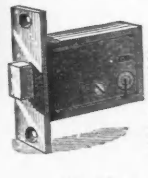
DRAWER LOCK.

Plated nose	10.20
Brass "	9.00

KNOB LOCKS.

5 × 3⅜	22.50
5 × 3⅜	20.00
4¼ × 3⅜	13.25
3½ × 3⅜	10.50





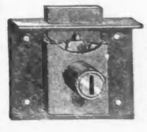
STANDARD LATCHES.

Dead locks.

3¾ × 2¾	24.00
2½ × 3⅜	14.00
1¾ × 2⅜	12.00

NIGHT LATCHES.

3¼ × 3⅜	20.00
2½ × 3¾	18.00



DRAWER LOCKS.
2 × 1⅝, two tumblers.

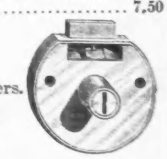
Plated nose	7.50
Brass "	6.00

Three tumblers.

Plated nose	9.00
Brass "	7.50

RIM FLUSH DRAWER LOCK.
2 in. diameter.

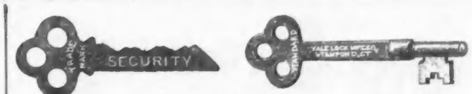
	2 tumblers.	3 tumblers.
Plated nose	7.50	9.00
Brass "	6.00	7.50



BRONZE SPRING PADLOCK.
2 flat steel keys.

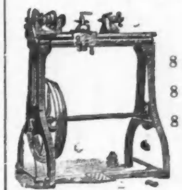
In.	
1	11.00
1¼	12.00
1½	13.50
1¾	14.50
2	16.00
2¼	17.50

Subject to special net prices; no discount.



YALE KEYS.

Machinery—Foot Power.



S., M. & Co.'s Screw-Cutting Engine Lathes.

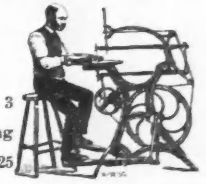
8 in. swing, 20 in. bet. centers, 36 in. bed, 240 lbs. weight, $60.
8 in. swing, 30 in. bet. centers, 46 in. bed, 260 lbs. weight, $70.
8 in. swing, 36 in. bet. centers, 52 in. bed, 280 lbs. weight, $75.

Boxing for export, $2.50 extra; f.o.b. at Cincinnati. 25 % dis.

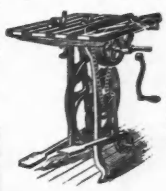
SAWS AND LATHES.

Victor Scroll Saw, Cuts to 3 Inches.

24-inch swing, with 12 saw blades $40
Dis., 20%.



Empire Scroll Saw, Cuts to 3 Inches.
24-in. swing, drill and tilting table.
Price, boxed $25
Dis., 20%



The Acme Combination Saw.

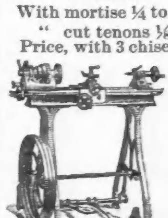
Hand or steam power.
Adjustable table and gauges.

Price, boxed	$40
Scroll saw attachment	7
Boring attachment	10
Moulding attachment	10

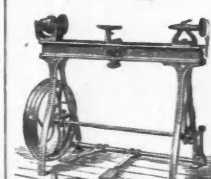
Dis., 20%.

Paragon Self Feed Rip Saw.
Two changes of speed; three changes of feed.
Price, with one 10 in. saw, $50.00.
Dis., 20%.

Diamond Mortising Machine.
With mortise ¼ to 1 in. wide, 3 in. deep.
" cut tenons ⅛ to ¾ thick, 3 in. wide.
Price, with 3 chisels $25.00
Dis., 20%.



The "Star" Lathe.
Swings 9 × 25 in., back geared, screw cutting.
Feeds in or out, right or left. Adjustable Tail Stock for Tapers.
Price $75.00
Dis., 15%.



The Crown Lathe.

Swings 10 × 36 in.

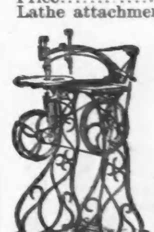
Price, boxed	$45.00
Compound slide rest	15.00
Countershaft	10.00

Dis., 20%.

Rival Scroll Saw, with six extra saw blades, twist drill and wrench.

Price	$10.00
Lathe attachment	$3.00

Dis., 25%.



The Challenge Scroll Saw, for shell, bone wood, or metal.
Nickel Plated, with six extra saws, twist drill and wrench.

Boxed	$20.00
With lathe attachment	$5.00

Dis., 25%.

Hand Circular Rip Saw.

Cuts 3¾ thick, 19 in. wide.

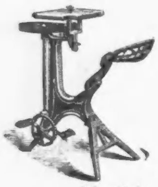
Price $50.00.

Dis., 35%.

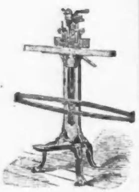
W. F. & J. Barnes Co.
Scroll and Circular saw Combined.
Combined Machines.

Combined circular scroll saw and boring attachment—2 circular saws, 12 assorted scroll saws, boring attachment, and self-centering drill chuck..... $50.00
Combined circular and scroll saw—2 circular and 12 scroll saws.............................. 40.00
Circular saw—1 extra rip and 1 cross-cut saw.................. 35.00
Scroll saw—12 assorted scroll saws.................. 32.00
Counter shaft for steam power...................... 10.00

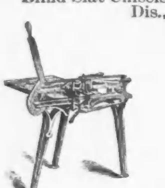
Dis., 35%.



Foot Power Former.
$20.00; Knives extra, $1.00 each.
Dis., 35%.



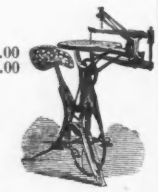
Mortising Machine.
$22.00; Chisels, $1.00 each.
Dis., 35%.
Blind Slat Chisels, 3 set bits, $5.00.
Dis., 20%.



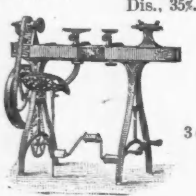
Tenoning Machine,

Price, $25.

Dis., 35%.



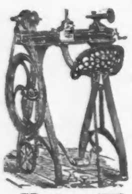
Velocipede Scroll Saw,
Without boring attachment...... $20.00
With " " 23.00
1 doz. saw blades, 1 3-16 bit. } Included.
Dis., 35%.



Lathe.

3 centres, 1 spur, 2 tool rests and sockets, 1 turned face-plate, $35.

Dis., 30%.



Lathe.

One turned face-plate, two pointed and one spur center, two rests, with sockets and plate for hand tools, slide rest-wrench, belting, etc., $40.

Dis., 25%.

Motors (Water).

Size No. 8, for Sewing Machines, etc , $18 each.

No. 9, 1/8 horse-power (30 lbs. pressure), 1/4 h. p. (50 lbs.), 1/2 h. p. 100 lbs.), 3/4 h. p. (150 lbs.), 1 h. p. (200 lbs.), $30.

No. 10, 1/4 horse-power (30 lbs. pressure), 1/2 h. p. (50 lbs.), 1 h. p. (100 lbs.), 1½ h. p. (150 lbs.), 2 h. p. (200 lbs.), $50.

No. 10½, 1/2 horse-power (30 lbs. pressure), 1 h. p. (50 lbs), 2 h. p. (100 lbs.), 3 h. p. (150 lbs.), 4 h. p. (200 lbs.), $75.

No. 11, 1 horse-power (30 lbs. pressure), 1½ h. p. (50 lbs.), 3 h. p. (100 lbs.), 4½ h. p. (150 lbs.), 6 h. p. (200 lbs.), $100.

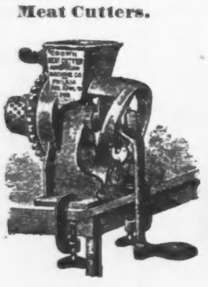
No. 12, 2 horse-power (30 lbs. pressure), 3 h. p. (50 lbs.), 6 h. p. (100 lbs.), 9 h. p. (150 lbs.), 12 h. p. (200 lbs.), $175.

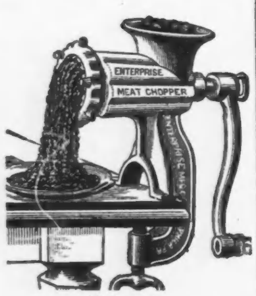
No. 13, 3 horse-power (30 lbs. pressure), 5 h. p. (50 lbs.), 10 h. p. (100 lbs.), 15 h. p. (150 lbs.), 20 h. p. (200 lbs.), $285.

Dis., 40%.

Governors for 11 and 12, $25 extra; for No. 13, $35 extra.

Meat Cutters.





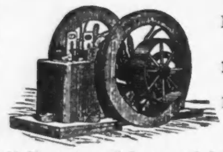
American.
1 2 3 4
each, $5.00 7.00 10.00 25.00
Dis., —.

Enterprise.
10 12 22 32 42
each, $3.00 2.50 4.00 6.00 15.00
Dis., 30%.

Mining Machinery.

N. B.—Special attention is invited to the goods advertised and illustrated in the advertising pages of the ENGINEERING AND MINING JOURNAL, quotations and discounts upon which would only mislead buyers.

Price-lists and other information may be obtained by addressing the advertisers direct, or by writing to the ENGINEERING AND MINING JOURNAL.



Concentrating Machinery.
Fort Scott Foundry & Machine Works Co.

Blake Improved Crusher: 10x7, weight 7,500; $410.00.

Blake Improved Crusher: 15x9, weight 9,000; $580.00.
Discount 25%.

Cornish Crushing Rollers: 20 diameter, 10 face, weight 5,400; $450.00.

Cornish Crushing Rollers: 20 diameter, 14 face, weight 6,000; $500.00.

Cornish Crushing Rollers: 22 diameter, 14 face, weight 9,500; $625.00.

Cornish Crushing Rollers: 27 diameter, 14 face, weight 13,000; $750.00.

Cornish Crushing Rollers: 30 diameter, 14 face, weight 15,000, $850.00.

Discount 25%.

Complete Sizing Arrangement, consisting of Revolving Screens of Steel Sheet and Hydraulic Classifier.

For Concentrator, 25 tons capacity, $250; 50 tons capacity, $350; 75 tons capacity, $450; 100 tons capacity, $800. Discount, 10 per cent.

Automatic working Jig Machines, all complete, woodword included, with slidemotion: 2 sieves, $3.0; 3 sieves, $360; 4 sieves, $450.

With Eccentric Motion, all complete, woodwork included: 1 sieves, $200; 2 sieves, $270; 3 sieves, $320; 4 sieves, $330.

Automatic working Double Jig Machines, all complete, woodwork included: 4 sieves, $210; 6 sieves, $335; 8 sieves, $425. Discount, 25 per cent.

Single Rittinger Percussion Tables, all the iron parts, $350; Double Rittinger Percussion Tables, all the iron parts, $500. Discount, 10 per cent.

Improved Rotary Tables, all the iron parts and pipes, $2.0. Discount, 25 per cent.

Mouse Traps.

The Cyclone Mouse Trap, per gross, $4.05.

The Idea Mouse Trap per gross, $8.25.

Slayer Rat Traps, per gross, $10. Net prices

Nails and Tacks.

Swedes. Tacks.
Per doz. 1/2 3/4 1 1½ 2 2½ 3
1/2 wt.. 35 40 46 50 55 60 65 75
6 8 10 12 14 16 18 20 24 oz.
85 1.00 1.20 1.40 1.60 1.75 1.85 2.15 2.55
Doz. full 1/2 3/4 1 1½ 2 2½ 3 4
weight 60 70 80 90 1.00 1.10 1.20 1.40
6 8 10 12 14 16 18 20 24 oz.
1.60 1.90 2.30 2.70 3.10 3.40 3.80 4.20 5.00
lb., bulk 1/2 3/4 1 1½ 2 2½ 3 4
or paper 1.60 1.25 1.00 80 66 58 52 46
6 8 10 12 14 16 18 20 24
36 32 31 30 29 28 28 28 28
Discount, 67½, 10 and 2%.

O. H. Swedes.
Price, same as Swedes.
Swedes steel tacks same list price as iron.

Upholsterers.

Discounts, 72½, 10 and 2%.

Price, same as Swedes.

Cut Tacks. Price per dozen ounces.

1 1½ 2 2½ 3 4 6 8 10
1/4 wt..... .. .. 35 40 45 50 55
12 14 16 18 20
60 70 80 90 1.00
1/2 wt. 1 1½ 2 2½ 3 4 6 8 10
45 50 50 55 60 65 70 80 95
12 14 16 18 20
1.10 1.25 1.40 1.55 1.70
Full wt... 1 1½ 2 2½ 3 4 6 8
80 90 90 1.00 1.10 1.20 1.30 1.50
10 12 14 16 18 20
1.80 2.10 2.40 2.70 3.00 3.30
Discount, 70, 10 and 2%.

Carpet Tacks, flat and oval heads.

Blued, doz. oz. 4 6 8 10 12 14 16 18 20
1/4 wt. 35 40 45 50 55 65 75 85 95
22 24
1.05 1.15
" 1/2 wt. 4 6 8 10 12 14 16
65 70 80 95 1.10 1.25 1.40
18 20 22 24
1.55 1.70 1.85 2.00
Tinned, doz. 1/4 wt. 4 6 8 10 12 14 16
50 55 60 75 85 1.00 1.10
18 20 22 24
1.20 1.35 1.45 1.60
Tinned, doz. 1/2 wt. 4 6 8 10 12 14
95 1.05 1.15 1.40 1.60 1.85
16 18 20 22 24
2.10 2.35 2.60 2.85 3.10
Discount, 72½, 10 and 2%.

Finishing Nails.
Inch.... 3/8 3½-8 4-8 4½-8 5/8 5½-8 6-8 7-8 1
Per lb... 48 40 32 28 26 24 22 20 18
1⅛ and larger.
16
Discount, 60, 10 and 2%.

Chair Nails.
Doz. 1/2 wt. ; doz. full wt. ; pound B. or P.
Inch.. 3/8 3½-8 4-8 4½-8 5/8 5½-8 6-8 7-8
Per lb. 51 43 35 31 29 27 25 23
1 1⅛
21 19
Discount, 60, 10 and 2%.

Common and patent brads.

inch.	Price per doz. ½ wt.	Price per doz. full wt.	Price per lb. in papers or bulk.
2-8.........	.50	1.00	1.25
3-8.........	.60	1.20	.80
4-8.........	.65	1.30	.58
5-8.........	.72	1.44	.48
6-8.........	.80	1.60	.36
7-8.........	.90	1.80	.30
1...........	1.00	2.00	.26
1⅛........	1.12	2.24	.25
1¼........	1.26	2.52	.24
1½.	1.82	3.64	.22
1¾........	2.25	4.50	.20
2...........	2.43	4.86	.18

Dis. 60, 10 and 2%.

Oils.

LUBRICATING.—Fiske Bros.
Lubroleine A cylinder oil 50 in. barrels.
Lubroleine D cylinder oil 40 in. barrels.
Lubroleine A machine oil 45 in. barrels.
Lubroleine B machine oil 35 in. barrels.
Lubroleine A engine oil 50 in. barrels.
Lubroleine B engine oil 40 in. barrels.
In cases 5c gal. extra.

Crescent Axle Grease.—Barrels, 3c per lb; 100-lb. kegs 3½c lb.; 2-lb. decorated tins, $12, gross less 5 per cent.

Texas Star Axle Grease.—Barrels, 2½c per lb.; 100-lb. kegs, 3c per lb.

Oil Stones.

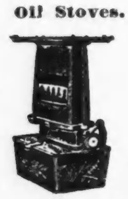
Best White Washita.
Green Paper Brand, 8 × 2 × 1⅛ inches.......per lb. .32
Oil stone, No. 1, " " .... " .22½
" Extra, " " .... " .30
High rounds, " " .... " .30
Round edge slips, Nos. 1, 3½ to 5, in boxes 10 lbs. upwards....................... " .40
Round edge slips, extra, in boxes 10 lbs. upwards.................................. " .50
Pen knife pieces, ass't 3 to 5 × 1 × 1⅜, in boxes 10 lbs. upwards....................... " .50
Needle pieces.........................per hundred. $5.00
Wheels, 1½ to 5¾ in. thick.......... .....per inch. .40

Good Washita,
Oil Stone No. 1, 8x2x1⅛.........................per lb. .15
" " 2, " .... " .12
Axe Stone, assorted sizes.......... .... " .10
Round Edge Slips, assorted sizes............ .. " .25

Arkansas.
Oil Stone No. 1, 4 to 6 in. long x2x¾ to 1 in. per lb. $1.35
Oil Stone No. 1, 6 to 9 in. long x2x¾ to 1 in. " 1.75
Oil Stone No. 2, 4 to 9 in. long x2x¾ to 1 in. " .75
Round Edged Slips, assorted sizes . ... " 2.00
Square File Slips, 3 to 4 inches long........per doz. 1.75
Diamonds, 3½ to 4 inches long.............. " 3.00
Triangulars, 3½ to 4 inches long..... ...... " 3.00
Flat Files, 3 to 4 inches long........ .... " 2.00
Beveled Files, 3½ to 4 inches long.......... " 2.50
Knife Blades, 3 to 4 inches long............. " 3.00
Points, extra long, 3 to 3½ inches........... " 2.00
Points.................................. " 1.50
Pen Knife Pieces, assorted sizes...........per lb. 2.00
Needle Pieces...........................per hund. 8.00
Wheels, 2 to 4 inches, ½ inch thick.........per inch 1.25
Oil Stone Powder...........................per lb. 15

10, 10 and 2½ dis.

Oil Stoves.



Burns 8 hours; holds 1 quart oil.

Nickel plated crown plate, per doz., $12.

Packings.

SELDEN'S PATENT.
For Steam, Air, Water and Ammonia.
With Rubber Core, 60 cents per lb.
Dis., 25 and 5%.
With canvas core, 50 cents per lb.
Dis., 30 and 5%.

Paints.

For Assorted Cans of 1, 2, 3 and 5 pounds. 100-lb. cases.

No.	lb. c.	No.	lb. c.
533. Scotch yellow.......	18	583. Black	18
534. Lead color	18	584. Dark blue...........	25
536. Brown	18	585. Chrome yellow.....	30
537. Light drab..........	18	586. Vermilion...........	30
539. Buff..................	18	587. Indian red..........	25
542. Warm drab.........	18	588. Bronze green........	25
544. Dark green.........	25	589. Quaker green	25
581. Light green.........	25	546. Inside white........	18
582. Norway red.........	18	547. Outside white.......	18

Discount 50 per cent.

Ordinary shades. Per gal.	Per gal.
One to 5 gallon cans.. $1.90	Half gallon cans...... $2.00

Tuscan Red, Green and Yellow.

Per gal.	Per gal.
One to 5 gallon cans.. $3.10	Half gallon cans...... $3.30

Vermilion.

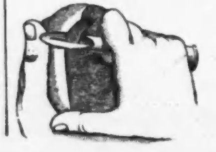
Per gal.	Per gal.
One to 5 gallon cans.. $5.00	Half gallon cans $5.20

Discount 40 per cent.

The list in barrels, half-barrels and kegs (of 5 gallons or larger) will be 10c. a gallon less than in gallon cans. Kegs of less than 5 gallons will be charged at gallon price. One-quarter gallon cans not put up. Special shades made to order.

Special cash discount for large orders.

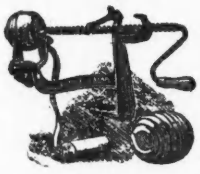
Parers and Corers.



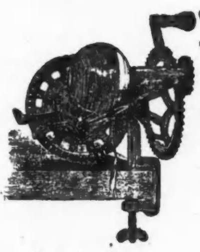
SAML. LEES & CO.

List, $9 per gross.

APPLE.



Little Gem.



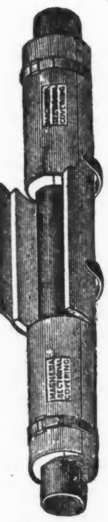
Rocking Table.

	Per doz.
Advance	$4.75
Baldwin	5.25
Champion	7.25
Hudson's '88	3.75
Improved Bay State	30.
Monarch	31.50
Oriole	4.00
Turntable	4.50
Victor	13.50
White Mountain	4.50
Rocking Table	4.25
Little Gem Corer and Slicer	3.70

Pipe Covering.

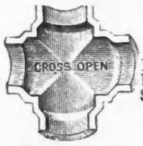
Magnesia Sectional Covering.

For Wrought Iron Pipe. In Canvas Jacketed Sections, 36 inches in length.



Inside dia. of pipe.	Weight of cover per lineal ft.	Price per lineal foot canvas jacketed.
½ in.	8 ozs.	$0.25
¾ "	9 "	0.25
1 "	10 "	0.25
1¼ "	12 "	0.25
1½ "	15 "	0.25
2 "	18 "	0.27
2½ "	20 "	0.31
3 "	24 "	0.36
3½ "	26 "	0.40
4 "	30 "	0.44
4½ "	38 "	0.47
5 "	40 "	0.50
6 "	48 "	0.60
7 "	55 "	0.65
8 "	65 "	0.75
9 "	75 "	0.80
10 "	85 "	0.90

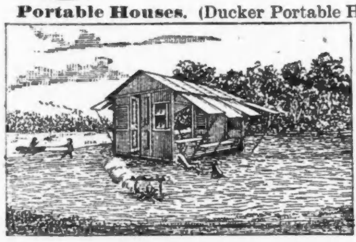
Elb'ws.	Tees.	G Valv's.	Crosses.	Unions.
$0.20	$0.30	$0.25	$0.35	$0.30
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.27	0.36	0.27	0.48	0.33
0.31	0.41	0.41	0.53	0.41
0.36	0.48	0.48	0.60	0.48
0.40	0.53	0.53	0.68	0.53
0.44	0.59	0.59	0.75	0.59
0.50	0.65	0.65	0.80	0.63
0.58	0.75	0.75	0.90	0.67
0.65	0.90	0.90	1.00	0.77
0.83	1.20	1.20	1.10	0.90
1.00	1.35	1.35	1.20	1.00
1.10	1.50	1.50	1.35	1.10
1.25	1.75	1.75	1.50	1.25



Magnesia Plastic Covering (dry)—Prepared Carbonate Magnesia and Fiber, for Trowel Work per barrel, $8.00

Dis. 25%.

Portable Houses. (Ducker Portable House.

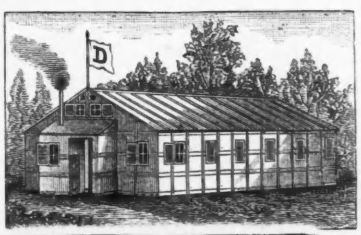


Weight, 450 lbs.

Price, $150.

Closes securely.

Dis., 10%.



Weight, 85 lbs. per section.

Price, $220.

Dis., 10%.

Weight, complete, 5000 pounds.

No. 10.—26 × 33 ft., including veranda and rear extension. Main part, 19 × 26 ft. $500.00

	No. 1. Veranda on side.	No. 2. Veranda on end.	No. 3. without veranda.
12 × 12, 1 door, 3 windows,	$120.00	$120.00	$105.00
12 × 14, 1 " 3 "	135.00	130.00	120.00
12 × 17, 1 " 3 "	155.00	150.00	135.00
12 × 19, 2 " 4 "	175.00	165.00	150.00
12 × 21, 3 " 5 "	190.00	180.00	165.00
12 × 23, 3 " 5 "	200.00	190.00	175.00
12 × 26, 3 " 5 "	220.00	205.00	190.00
14 × 21, 3 " 5 "	205.00	195.00	180.00
10 × 12, 1 " 3 "		100.00	90.00
10 × 14, 1 " 3 "		105.00	95.00
7 × 10, 1 " 2 "			65.00
7 × 12, 1 " 2 "			75.00
7 × 14, 1 " 2 "			85.00

Hunter's Cabins.

7 × 12, with 4 berths $80.00
7 × 14, " 4 " 90.00

Discount, 20%.

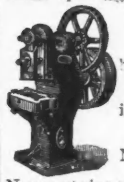
Post Hole Diggers.

Chieftain Hay Rake Co.

Little Giant	$36.00 doz	11 cu ft.
Hercules	30.00 "	" " "
New Champion	20.00 "	" " "
Scheidler	36.00 "	" " "

Dis. 40% f.o.b. New York or Boston.

Press.



Combined press for cutting, forming, horning and seaming.

Particulars of flat front presses, including beds, slides, bolsters, plates, etc.

Prices are net, delivered on steamers in New York, including insurance, etc.

Nominal size of press	41	42	43	44	450
Price, including et ceteras	$130	$200	$260	$420	$660
Weight, about ... lbs	600	1050	1900	3600	7200
Greatest diameter that can be wired ... ins	5	7	10	14	20
Greatest depth that can be wired ... ins	8	10	13	16½	20
Hole through bed—circle intersecting ... ins	4½	6	8½	12	17
Hole through back—width ... ins	8	9½	12	15½	20½
Width between die clamps—clear ... ins	8	11	15	20	27
Distance back from center of slide bar ... ins	4½	5½	7	9	12
Height to slide-bar, when up ... ins	5¼	6½	7½	8½	9
Stroke of slide-bar ... ins	1	1¼	1½	1¾	2
Adjustment of slide-bar ... ins	1	1¼	1½	1¾	2
Diameter of fly-wheel ... ins	20	26	32	38	44
Width of fly-wheel ... ins	3	4	5	6	7
Weight of fly-wheel, about ... lbs	125	250	420	725	1100
Speed per minute, about ... rev	120	110	100	90	80
Cubic feet boxed, about	30	40	50	60	70

Printers' Sundries.

Vanderburgh, Wells & Co.
And Liberty Machine Works.

Wood rules, 12 cents per yard.
Wood rules, on end wood, 15 cents per foot.

EUREKA STAND.
12 full cases.

Price without cases $12.00
Boxing and cartage 1.25

SHOOTING STICKS.

Each.
No. 1, 75c.
No. 2, $1.
No. 4, 45c., black.
No. 4, 60c., bright.
No. 5, 60c., black.
No. 5, 75c., bright.

GAUGE PINS—ALL SIZES.

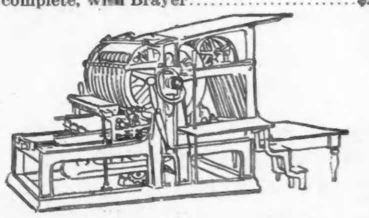
Brass, 40c. doz. | Steel, 60c. doz.
Wire, 25c. doz. | Golden, 40c. doz.

MITRE BOXES.
Regular size, 2 in., 50c. each.
Extra size, 3½ in., 75c. each.

LEAD CUTTER.

Curtis' Lead Cutter $2.00

PROOF PRESS, "OUR OWN."
9 × 32, complete, with Brayer $28.00



THE "LIBERTY" CYLINDER PRESS.
For Newspaper and Job Printing.

Bed.	Form.	
No. 5—29 × 42	24 × 40	$1,200
6—33 × 47	28½ × 45	1,300
7—37 × 51	33 × 49	1,600

Dis., 20 and 5%.

THE "LIBERTY" JOB PRINTING PRESS.

Size of chase.

No. 2 — 7 × 11 .... $200
2a— 9 × 13 250
3 —10 × 15 300
3a—11 × 17 350
4 —13 × 19 400
5 —14½ × 22 500

Dis., 12% and 5%.

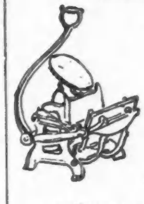
Two sizes built extra strong for boxmakers, embossing, etc.

No. 3a—11 × 17 .... $375
4 —13 × 19 425

Dis., 12 and 5%.

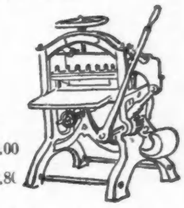
Fountains, either size, $25 extra, if ordered with press.
Steam fixtures, either size, $15 extra.

THE AMERICAN CARD AND BILL HEAD PRESS.



No. 5—4 × 6 .... $16
7—6 × 9 36
8—8 × 12 60

Dis., 20% and 5%.



THE "LIBERTY" PAPER CUTTER.

Cuts 30 inches $140.00
Extra knife 18.80

Dis., 12% and 5%.

THE "LIBERTY" IMPOSING TABLES

Marble top.

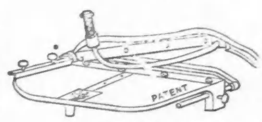
No. 1—24 × 36 .... $24
2—32 × 48 38
3—26 × 74 44
4—36 × 48 48

Dis., 12% and 5%.

Slate Top.

No. 1—24 × 36 .... $18
2—32 × 48 25
3—26 × 74 32

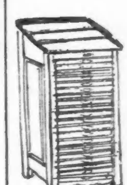
Dis., 12% and 5%.



Kelsey & Co.,

The Eagle Card and Paper Cutter, 24½ inch, $12 each, $100 per doz.

THE "LIBERTY" TYPE CABINETS.



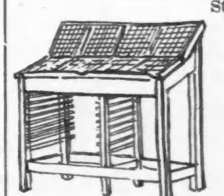
Number of cases.	Stained. Flat. $	Stained. Galley.* $	Grained. Flat. $	Grained. Galley.* $
12⅔	12.00	14.50	14.00	17.00
16⅔	15.00	17.50	17.00	20.00
18⅔	16.50	19.00	18.50	21.50
20⅔	18.00	20.50	20.00	23.00
12¾	15.00	17.50	17.00	20.00
16¾	18.00	20.50	20.00	23.00
18¾	19.50	22.00	21.50	24.50
20¾	22.00	24.50	23.00	26.00
12 full	18.00	20.50	20.00	23.00
16 "	22.00	24.50	24.00	27.00
18 "	24.00	26.50	26.00	29.00
20 "	26.00	28.50	28.00	31.00

Number of cases.	Pine. Flat. $	Pine. Galley.* $	Cherry. Flat. $	Cherry. Galley.* $	Napanoch. Flat. $	Napanoch. Galley.* $	Walnut. Flat. $	Walnut. Galley.* $
12⅔	18.00	21.00	20.00	23.00	22.00	25.00	23.00	26.00
16⅔	22.00	25.00	24.00	27.00	26.00	29.00	27.00	30.00
18⅔	24.00	27.00	.....	.....	.....	.....	.....	.....
20⅔	26.00	29.00	28.00	31.00	30.00	33.00	31.00	34.00
12¾	21.00	24.00	23.00	26.00	25.00	28.00	26.00	29.00
16¾	25.00	28.00	27.00	30.00	29.00	32.00	30.00	33.00
18¾	27.00	30.00	.....	.....	.....	.....	.....	.....
20¾	29.00	32.00	31.00	34.00	33.00	36.00	34.00	37.00
12 full	24.00	27.00	26.00	29.00	28.00	31.00	29.00	32.00
16 "	28.00	31.00	30.00	33.00	32.00	35.00	33.00	36.00
18 "	30.00	33.00	.....	.....	.....	.....	.....	.....
20 "	32.00	35.00	34.00	37.00	36.00	39.00	37.00	40.00

*Furnished with galley top and extra drawer for copy.

Dis., 20 and 5%.

THE "LIBERTY" CASE STANDS AND RACKS.



Stands.

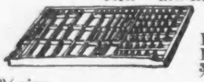
Single, without racks $3.75
" with racks for 8 full cases 4.00
Single, with racks for 10 full cases 4.25
Single, with racks for 12 full cases 4.50
Single, with racks for 14 full cases 4.75
Double, without racks 4.25
" with racks for 8 full cases 4.50
Double, with racks for 16 full cases, and gal. rest 6.25
Double, with racks for 20 full cases and gal. rest 6.50
" " " " 24 " " " " " 6.75
" " " " 24 ⅔ cases 5.25
" " " " 8 full and 8 ⅔ cases 5.00
" " " " 8 " " 8 ¾ " 5.25
" " " " 10 " " 12 ⅔ " 5.50
" " " " 12 " " 16 ⅔ " 5.75
" " " " 12 " " 16 ¾ " 6.00
Stands with closed ends, extra 2.00
Extra slides for stands, each .... .05

Case Racks.

Cases.	Inches High.	Price.	Inclosed Back and Sides.	Cases.	Inches High.	Price.	Inclosed Back and Sides.
12	41	$6.00	$8.50	30	84	$10.00	$13.50
16	50	7.00	9.50	32	51	12.50	16.00
20	60	8.00	11.00	40	60	14.00	17.50
24	70	9.00	12.00	60	84	18.00	23.00

Dis., 20 and 5%.

THE "LIBERTY" TYPE CASES.



Name.	Outside Measurements.
Full size	32¼x16½x1 9-16
Rooker size	28¼x14¼x1 9-16
¾ size	26x16¼x1⅜
⅔ size	22⅝x16½x1⅜
Enlarged size	32¼x23x2 3-16
Wood type "	32¼x23x1 9-16
Mammoth "	44x23x1 9-16

Cabinet case sides extend 1½ to 3 inches. In ordering cabinet cases, state whether high or low fonts are wanted.

	Without Pat. Clasps.	With Pat. Clasps.
News, full, per pair	$1 60	$1.75
" Rocker, "	1.60	1.75
" ¾ "	1.50	1.60
" ⅔ "	1.40	1.50
German, full, "	1 60	1.75
Music " "	2 00	2.20
Job " "	.90	1.00
Job, full size, California	.90	1.00
" Rooker	.90	1.00
" full, Yankee	.90	1.00
" ¾ Regular	.80	.90
" ⅔ Yankee	.75	.85
" " Boston	.75	.85
" " California	.75	.85
" " improved	.90	1.00
" full size, Middletown	1.20	....
" " Paterson	.90	....
" " New York	.90	1.00
Quadruple, full size	1.20	....
Double lower, "	1.20	....

Name.	Without pat. clasps.	With pat. clasps.
Galley lower, full size	$1.10	
Enlarged Yankee job	2.20	
Enlarged German	2.20	
Founder's sort case	2.20	
Half-cap	.50	
L. S. lead, full-size	1.00	
" rule "	1.15	$1.25
" " ¾ size	.95	1.05
" " ⅔ "	.80	.90
Improved, ⅔ "	.90	1.00
Space and quad, full-size	1.00	
Slug "	1.00	
Figure "	.90	
Triple "	.90	1.00
Improved triple "	.90	1.00
Triple, ¾ size	.80	.90
Blank, full-size	.65	
" ¾ size	.55	
" ⅔ size	.50	
Script, full-size	.90	
" ¾ size	.80	
" ⅔ size	.75	
Wood type, 23x32¼	1.10	
Mammoth, 23x44	1.30	
Metal furniture, full-size	1.25	
Border "	1.25	
" ⅔ size	1.00	
Leader, ⅔ size, per pair	1.40	
Butler jobs, full-size, per pair	3.00	
For pulls on cabinet cases add per case		.10
For rollers " " "		.30

Dis., 25 and 5%.

THE "LIBERTY" GALLEYS.

All brass "indestructible."

Single, 3¾ x 23¾ inside	$2.50
" 3¾ x 1. ¾ "	2.00
" 3¾ x 11¾ "	1.75
Medium, 5 x 23¾ inside	2.75
Double, 6¼ x 23¾ inside	3.00

Dis., 33⅓%.

SMOOTH LINED NEWS GALLEYS.

	Half-lined.	Full-lined.		Half-lined.	Full-lined
Single col.	$1.75	$2.00	Double col.	$2.00.	$2.50

Dis., 20% and 5%.

SCREW GALLEYS.

	Unlined.	Half-lined.	Full-lined.
Single column	$1.25	$1.50	$1.75
Double column	1.50	1.75	2.00

Dis., 20% and 5%.

SMOOTH LINED JOB GALLEYS.

Size.	Unlined.	Full-lined.	Size.	Unlined.	Full-lined.
6 × 10	$1.25	$2.00	12 × 18	$2.50	$3.50
8¼ × 13	1.50	2.50	14 × 20	3.00	4.00
9 × 14	1.75	2.75	15 × 22	3.50	5.00
10 × 16	2.00	3.00	18 × 25	4.00	5.50

Dis., 20% and 5%.

RULED GALLEYS.

These have a rule laid out on one of the rims, divided into quarter inches, by which to set advertisements. Cost of ruling extra, 25 cents.

Dis., 20% and 5%.

MAILING GALLEYS.

Zinc bottom, 50 cents; brass bottom, 90 cents. Brass closed both ends, $3.

Dis., 20% and 5%.

GALLEY RACKS.

From $3 up.

LEAD CUTTERS.

From $2 up.

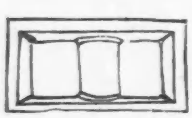
Dis., 20% and 5%.

THE "LIBERTY" STEEL SHOOTING STICKS.

Bright, $1 each.

Nickelplated, $1.25 each.

Dis., 40%.

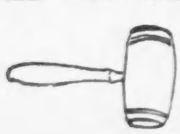


STANDARD METAL FURNITURE

25c. a pound.

In fonts of 25, 50, 75 and 100 lbs.

Dis., 15%.

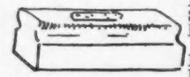


THE "LIBERTY" MALLETS.

Hickory, small	$ .20
" medium	.25
" large	.30
" iron bound	1.00
Lignum Vitæ, No. 4	.30
" " No. 3	.40
" " No. 2	.50
" " No. 1	.70

Dis., 30 and 5%.

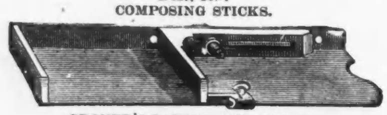
THE "LIBERTY" PLANERS AND PROOF PLANERS.



Midget planer	10c.
Small Maple	20c.
Large "	25c.
" " b'ked with leather	30c.
Midget " " "	12c.
Proof planer, faced with cloth,	50c.

Dis., 40%.

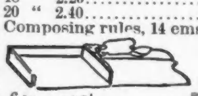
COMPOSING STICKS.



GROVER'S PATENT AND UNION.

	Screw or News.
6 in., 1.10	$ .90
8 " 1.20	1.10
10 " 1.40	1.20
12 " 1.60	1.40
14 " 1.80	1.60
16 " 2.00	1.80
18 " 2.20	2.00
20 " 2.40	2.20

Composing rules, 14 ems pica and under, 25 cents.



THE "LIBERTY" COMPOSING STICKS.

Grover.

6 in., Steel	$ .90	16 in., Steel	$1.80
8 "	1.00	18 "	2.00
10 "	1.20	20 "	2.20
12 "	1.40	Extra Clasp	.10
14 "	1.60	Extra Knee	.40

Screw.

6 in., Steel	$ .75	16 in., Steel	$1.45
8 "	.80	18 "	1.60
10 "	1.00	20 "	1.75
12 "	1.15	Extra Knee	.30
14 "	1.30	" Screw and Nut.	.10

Dis., 40%.

Yankee.

6-in., Steel	$ .75	12 in., Steel	$1.15
8 "	.80	Extra Knee	.30
10 "	1.00	" Clamp and Screw	.15

Other Sizes to Order.

Dis., 40%.

Albion.

6-in., Steel	$1.00	6-in, German Silver	$1.50
8 "	1.10	8 " " "	1.75
Extra Knee	.40	Extra Screw and Nut.	.10

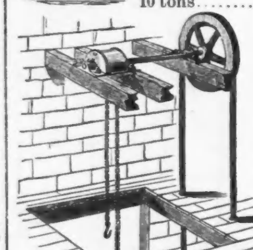
Pulley Blocks.

WESTON DIRECT.

	Each.
⅛ ton	$10
¼ ton	13
½ ton	15
1 ton	20
1½ tons	25
2 tons	30
3 tons	40

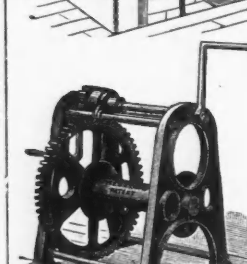
Geared.

1 ton	35
2 tons	45
3 tons	60
4 tons	80
5 tons	110
6 tons	150
8 tons	210
10 tons	275



DOUBLE LIFT HOISTS FOR HATCHWAYS, ETC.

500 lbs	$25.00
1000 "	50.00
1500 "	65.00
2000 "	80.00
500 "	30.00



WESTON CRAB SAFETY BRAKE, HANDLES CANNOT FLY BACK.

	Each.
21	$35.00
22	45.06
23	65.00
25	100.00

Pumps. Rumsey & Co.

Prices on all pumps include cylinders.

No.	Dia. Cyl.	Suction.	Cap. stroke.	Price Iron.	Price Brass cyl.
0	2 in.	1 in.	1-15 gal.	$3.50	......
1	2¼ "	1 "	1-12 "	4.00	$6.00
2	2⅜ "	1¼ "	1-11 "	4.50	7.00
3	2½ "	1¼ "	1-10 "	5.00	8.00
4	3 "	1¼ "	1-6 "	5.50	10.00
5	3¼ "	2 "	1-5 "	6.50	14.00
6	3½ "	2 "	1-4 "	8.00	18.00
7	4 "	2½ "	1-3 "	12.00	20.00

Dis., 65%.

No.	Dia. Cyl.	Suction.	Cap. stroke.	Price Iron.	Price Brass cyl.
1	2½ in.	1¼ in.	1-10 gal.	4.25	.....
2	3 "	1¼ "	1-7 "	4.75	.....
3	3½ "	1¼ "	1-5 "	5.25	.....
4	4 "	1½ "	1-4 "	5.75	.....
5	4½ "	1½ "	1-3 "	6.25	.....

Dis., 70%.

Standard and Cylinder for 1½ in. Iron Pipe, $16.00.

Dis., 55%

No. 6½, standard and cylinder, 1¼ in. pipe, $13.00.

No. 7½, standard and cylinder, 1¼ in. pipe, $15.00.

No. 8½, standard and cylinder, 1½ in. pipe, $18.00.

With hose and discharge pipe, add $3.00 to list price.

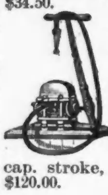
Dis. 55%.

No. 1, diam. cyl., 2½ in.; cap. stroke, 1-8 gal.; size pipe, 1¼ in. Price, iron, $12.50; brass cyl., $17.50.

No. 2, diam. cyl., 3 in.; cap. stroke, 1-6 gal.; size pipe, 1¼ or 1½ in. Price, iron, $14.50; brass cyl., $18.50.

No. 3, diam. cyl., 4 in.; cap. stroke, 2-5 gal.; size pipe, 1½ or 2 in. Price, iron, $23.50; brass cyl., $34.50.

Dis., 55%.



No. 1, diam. cyl., 3 in.; suction, 1¼ in. cap. stroke, 3-10 gal. Price, iron, $28.00; brass cyl., $58.00.

No. 2, diam. cyl., 4 in.; suction, 1½ in.; cap. stroke, 1-2 gal. Price, iron, $32.00; brass cyl., $60.00.

No. 3, diam. cyl., 5 in.; suction, 2 in.; cap. stroke, 6-7 gal. Price, iron, $35.00; brass cyl., $90.00.

No. 4, diam. cyl., 6 in.; suction, 2½ in.; cap. stroke, 1 1-5 gal. Price, iron, $45.00; brass cyl. $120.00.

Dis., 45%.

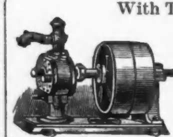
No.	Diam. cyl.	Cap. stroke.	Stroke.	Pipe.	Price.
0	2 in.	1-11 gal.	7 in.	1 in.	$21.50
00	2½ "	1-7 "	7 "	1¼ "	23.00
1	3 "	1-5 "	7 "	1½ "	25.25
2	3½ "	1-3 "	7 "	1½ "	27.25
3	4 "	4-10 "	7 "	2 "	30.50
3½	4½ "	1-2 "	7 "	2 "	37.50
4	5 "	8-10 "	10 "	2½ "	44.00
4½	5½ "	1 "	10 "	2½ "	47.00
5	6 "	1 1-5 "	10 "	3 "	50.00

Dis., 40%.

No.	Diam. cyl.	Cap. stroke.	Diam. pipe.	Price Iron.	Price Br's cyl.
1	2 in.	1-5 gal.	1 in.	$39	$51
2	2½ "	1-3 "	1¼ "	41	56
3	3 "	1-2 "	1½ "	45	62
4	3½ "	6-7 "	2 "	51	81
5	4 "	7-8 "	2 "	63	114
6	4½ "	1 "	2 "	80	155

Dis., 40%.

With Tight and Loose Pulleys.



No. 1, cap. per rev., 1-6 gal.; size of pipe, 1¼ in.; price, iron, $26; bronze, $45.

No. 2, cap. per rev., 1-5 gal.; size of pipe, 1½ in.; price, iron, $31; bronze, $55.

No. 4, cap. per rev., 1-3 gal.; size of pipe, 2 in.; price, iron, $48; bronze, $75.

Pulleys on Nos. 1 and 2 are 8 in. diam., 2½ in. face; on No. 4, 12 in. diam., 3½ in face.

Balance wheels for above pumps, $1, $2, and $3, according to size.

Dis., 45%.

No. 2, ½ to 2 gal. per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, ¾ in.; discharge, ⅜ in.; price, $9.

No. 3, 1 to 4 gal. per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, 1 in.; discharge, ⅜ in.; price, $11.

No. 4, 2 to 8 gal. per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, 1½ in.; discharge, ½ in.; price, $14.

No. 5, 3 to 14 gal, per min.; length of drive pipe, 25 to 40 ft.; calabre of pipes, drive, 2 in.; discharge, 1 in.; price, $22.

No. 6, 4 to 25 gal. per min.; length of drive pipe, 30 to 40 ft.; calibre of pipes, drive, 2½ in.; discharge, 1¼ in.; price, $40.

No. 7, 8 to 60 gals. per min.; length of drive pipe, 30 to 40 ft.; calibre of pipes, drive, 4 in.; discharge, 2 in.; price, $75.

No. 8, 12 to 120 gal. per min.; length of drive pipe, 30 to 50 ft.; calibre of pipes, drive, 6 in.; discnarge, 2½ in.; price, $125.

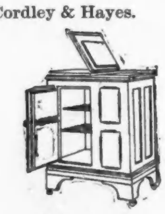
Dis., 45%.

Refrigerators.

Indurated Fibre and Stoneware-Lined.

Cordley & Hayes.

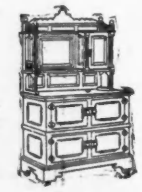
No. 35.



Nos. 75, 85.

No.	High.	Wide.	Deep.	Price.
35	46¼	28¾	20¼	$20.00
75	44¼	33¼	23½	28.00
85	47¾	38	23½	34.00

No. 2.



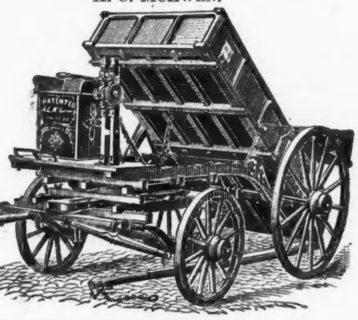
No. 6.

No.	High.	Wide.	Deep.	Price.
2	41	46	26	$36.00
6	84	46	26	60.00

Mirror, 16 by 18 in, Dis., 30 and 5%.

Railroad Dumping Cars and Carts.

A. C. McEWEN.



Cars.	Gauge.	Cap.	Net	Cap.	Net	Cap.	Net
Side Dumping	24″	1 c. y.	$55	2 c. y.	$65	3 c. y.	$75*
End "	"	"	55	"	65	"	75*
Revolving "	"	"	70	"	80	"	90*
Bottom "	"	"	80	"	90	"	100*
Tunnel........	"	"	55	"	65	"	75*
Mine..........	"	"	50	"	60	"	70*
Plantation....	30″		43				
Logging.	36″		170				
"	4′ 8½″		185				
Hand.........	36″		45				
"	4′ 8½″		50				
Push..........	36″		40				
"	4′ 8½″		45				
R.R. Construction	36″		60				
"	4′ 8½″		65				
Carts.							
Plantation and Railroad..........			45 to 75				
Wagons.							
McEwen Patent Dumping....	....	1 "	175	1½ "	200		

*These cars built of any gauge from 18″ to 56½″ and of any capacity from ½ to 6 cu. yd.

Sash Chains.

No. A. "Giant" metal, 15c. pr. ft., wts. not over 125 lbs.

No. 1. "Giant" metal, 12c. pr. ft., wts. not over 75 lbs.

No. 2. "Giant" metal, 10c. pr. ft., wts. not over 40 lbs.

No. 0. "Giant" metal, 8c. pr. ft., wts. not over 25 lbs.

No. 1. Red metal, 10c. pr. ft., wts. not over 40 lbs.

No. 2. Red metal, 8c. pr. ft., wts. not over 30 lbs.

No. 0. Red metal, 6c. pr. ft., wts. not over 15 lbs.

No. 1. Steel, 8c. pr. ft., wts. not 75 lbs.

No. 2. Steel, 6c. pr. ft., wts. not over 30 lbs.

No. 0. Steel, 4c. pr. ft., wts. not over 15 lbs.

No. 1. Steel, black enameled, 9c. pr. ft., wts. not over 75 lbs.

No. 2. Steel, black enameled, 7c. pr. ft., wts. not over 30 lbs.

No. 0. Steel, black enameled, 5c. pr. ft., wts. not over 15 lbs.

Fastenings for hanging a window of 2 sashes for Nos. 1 and 2 chains, consisting of 4 hooks, 4 rings, 4 sash irons, a set, 18c. per set.

Fastenings for hanging a window of 2 sashes for No. 0 chains, 14c. per set.

Dis. on "Giant" metal chain	40	10	10%	
" " Red metal chain..............	40	10	10	10%
" " Steel " "	40	10	10	10%
" " Fastenings..................	40	10	10%	

Scales.—Discount on all scales 50 per cent.

Postal scales.

No 1, capacity ½ to 9 oz. $3.00.

No. 2, capacity ½ to 12 oz., $4.00.

No. 3, capacity ½ to 34 oz. $6.00

No. 4, capacity ½ oz. to 4 lbs., $8.00

Even balance trip scales seamless scoop, with weights.

No. 1, capacity ½ oz. to 2 lbs., tin scoop, $5.50 brass scoop, $6.50.

No. 2, capacity ½ oz. to 4 lbs., tin scoop, $6.50; brass scoop, $7.50.

No. 2½, capacity ½ oz. to 18 lbs, tin scoop, $11; brass scoop, $12.50.

Butter Trip Scales, slab, weights and scoop.

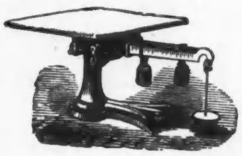
No. 7, ½ oz. to 10 lbs., 10 in. slab, without side beam	$10.50
" " " " " " with "	11.50
" 8 " " 20 lbs., 12 in. " without "	12.50
" " " " " " " "	13.50

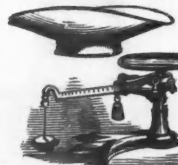
Tea Scales—All Seamless Scoops.

Capacity.	Scoop.		Capacity.	Scoop.	
¼ oz. to 10 lbs.	Tin	..$8.00	¼ oz. to 10 lbs.	Brass	.. 9.00

Druggists.

Capacity.	Scoop.		Capacity.	Scoop.	
1-16 oz. to 8 lbs.	Tin	..$10.00	1-16 oz. to 8 lbs.	Brass	..$11.00





Counter.

Capacity.	Scoop.		Capacity.	Scoop.	
½ oz. to 36 lbs.	Tin	..$10.00	½ oz. to 36 lbs.	Brass	..$12.00

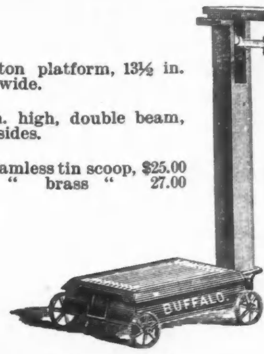
Grocer.

Capacity.	Scoop.		Capacity.	Scoop.	
½ oz. to 62 lbs.	Tin...	$12.00	½ oz. to 62 lbs.	Brass	..$14.00

Meat or Butter Scales, with Slab.

½ oz. to 62 lbs., with Single Beam....................$14.00

" " " " Double " 15.00



Patent Boston platform, 13½ in. long by 10 in. wide.

Pillar, 18 in. high, double beam, marked both sides.

With large seamless tin scoop, $25.00

" " " brass " 27.00

Platform scales.—Without Wheels.

No.	Capacity.	Platform.	Price.
1..............	400 lbs.	21½ by 15 inches.	$23.00
2..............	600 lbs.	25 by 16 "	30.00
3..............	800 lbs.	25 by 17 "	34.00
4..............	1,000 lbs.	26 by 17 "	39.00
5..............	1,200 lbs.	28 by 20 "	45.00
6..............	1,600 lbs.	29 by 21 "	55.00
7..............	2,000 lbs.	32 by 23 "	70.00

With Wheels.

No.	Capacity.	Platform.	Price.
1..............	400 lbs.	21½ by 15 inches.	$26.00
2..............	600 lbs.	25 by 16 "	33.00
3..............	800 lbs.	25 by 17 "	38.00
4..............	1,000 lbs.	26 by 17 "	43.00
5..............	1,200 lbs.	28 by 20 "	49.00
6..............	1,600 lbs.	29 by 21 "	60.00
7..............	2,000 lbs.	32 by 23 "	75.00

Brass sliding poise at same price if so specified in order

With Wheels and Drop Lever.

No.	Capacity.	Platform.	Price.
4..............	1,000 lbs.	26 by 17 inches.	$51.00
5..............	1,200 lbs.	28 by 20 "	59.00
6..............	1,600 lbs,	29 by 21 "	70.00
7..............	2,000 lbs.	32 by 23 "	82.00
8..............	2,500 lbs.	33¼ by 24¾ "	94.00
9..............	3,000 lbs.	38 by 30 "	125.00

School Slates.

Noiseless School Slates.

Winsboro Cord Bound.

Size.	Doz. in case.	Price per case.
5 by 7..............	18	$18.00
6 by 9..............	12	15.00
7 by 11..............	10	14.40
8 by 12..............	8	14.00
9 by 13..............	6	12.00

Dis., 50 and 2½%.

"D" School Slates.

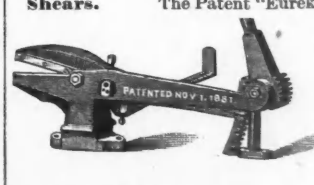
Winsboro Oval Round Corner

Size.	Doz. in case.	Price per case.
4 by 6..............	24	$10.80
5 by 7..............	18	9.00
6 by 8..............	12	8.20
6 by 9..............	12	8.64
6½ by 10..............	12	9.00
7 by 10..............	10	7.70
7 by 11..............	10	8.00
8 by 12..............	8	8.00
9 by 13..............	6	7.20

Dis., 200 case lots, 50 and 2½%.

Shears.

The Patent "Eureka



No. 1 cuts round metal up to ¼ in. steel to ⅛, $12.

No. 2 cuts round metal up to ½ in., steel to 3-16, $20.

Discount, 25%.

Steel Wire Mats.

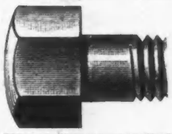
Hartman Mfg. Co.

Galvanized Steel Wire. (Style A) "Hartman Flexible."

No. 2.	Size 16x24.	Each	..$1.50
No. 3.	" 18x30.	"	.... 2.00
No. 4.	" 22x36.	"	.... 3.00
No. 5.	" 26x48.	"	.... 4.50
No. 6.	" 30x48.	"	.... 5.25
No. 7.	" 36x48.	"	.... 6.50
No. 8.	" 36x60.	"	.... 8.00
No. 9.	" 36x72.	"	....10.00

Brass mats "list" double the price of galvanized (Style A) for similar sizes.

Screws.



STEEL SCREWS ADD 50% TO LIST.

Prices are per 100.

Hexagon Cap Screws.

Heads on Steam-tight Screws not polished, unless so ordered. Can make these 12 inches long.

Diam. head.	7-16	½	9-16	⅝	¾	13-16	⅞	1	1⅛	1¼	1⅜
Length head.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
Diam. screw.	[illegible]	5-16	⅜	7-16	½	9-16	⅝	¾	⅞		1⅛
L'gth under head. ¾..	3.00	3.25	3.75	4.40	5.50	7.00					
1..	3.25	3.50	4.00	4.70	5.70	7.00	9.50				
1¼..	3.50	3.75	4.25	5.00	6.00	7.50	9.50	12.20			
1½..	3.75	4.00	4.50	5.30	6.30	8.00	10.00	12.20	16.00		
1¾..	4.00	4.25	4.75	5.60	6.60	8.50	10.60	12.80	16.60	21.20	
2..	4.25	4.60	5.05	5.95	7.00	9.10	11.20	13.40	17.20	22.30	29.00
2¼..		5.00	5.40	6.35	7.50	9.70	11.90	14.10	17.90	23.60	30.50
2½..			5.80	6.80	8.00	10.40	12.70	14.90	18.80	25.10	32.30
2¾..				7.30	8.60	11.20	13.60	15.90	20.00	26.90	34.40
3..					9.30	12.10	14.70	17.00	21.80	29.00	37.00
Thread to in.	20	18	16	14	12	12	11	10	9	8	7
Add for each ¼ in.	30	40	50	60	80	1.00	1.30	1.60	2.00	2.40	3.00

Dis., heads ground, 60%; dis., heads black, 60 and 5%; dis., heads extra finish, 50%; dis., heads case-hardened, 5%; dis., heads polished after hardening, 45%.

SQUARE CAP SCREWS.

Diam. head.	⅜	7-16	½	9-16	⅝	11/16	¾	⅞	1⅛	1¼	1⅜
Length head.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
Diam screw.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
L'gth under head. ¾	2.40	2.75	3.20	3.80	4.40	5.75					
1	2.60	2.95	3.40	4.00	4.70	5.75	7.70				
1¼	2.75	3.10	3.65	4.20	4.95	6.05	7.70	10.50			
1½	2.90	3.30	3.85	4.45	5.25	6.35	8.25	10.50	14.00		
1¾	3.05	3.50	4.10	4.70	5.55	6.65	8.80	11.10	14.80	18.00	
2	3.25	3.70	4.35	4.95	5.90	7.05	9.40	11.80	15.70	19.00	22.50
2¼		4.00	4.65	5.25	6.30	7.55	10.10	12.60	16.70	20.20	24.00
2½			5.00	5.60	6.75	8.15	10.90	13.50	17.80	21.50	25.80
2¾				6.00	7.25	8.85	11.80	14.60	19.10	23.10	27.90
3					7.80	9.65	12.80	15.90	20.60	25.00	30.50
Thread to in.	20	18	16	14	12	12	11	10	9	8	7
Add for each ¼ in.	25	35	45	55	65	90	1.20	1.50	1.80	2.30	3.00

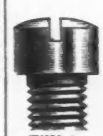
Dis., heads ground, 65%; dis., heads black, 65 and 5%; dis., heads extra finish, 55%; dis., heads case hardened, 60%; dis., heads polished-hardened, 50%.

MILLED HEADS, COLLAR SCREWS

Diameter of Collar.	¼	11/32	7/16	½	⅝	11/16	13/16	13/16	1	1¼
Diameter of Screw.	⅛	3/16	¼	5/16	⅜	7/16	½	9/16	⅝	¾
Length under Head to Point. ¾	2.50	2.80	3.10	3.75	4.40	5.00	6.25			
1	2.80	3.10	3.40	4.05	4.70	5.30	6.60	8.25		
1¼	3.10	3.40	3.70	4.35	5.00	5.60	7.00	8.60	11.25	
1½	3.45	3.70	4.00	4.70	5.30	5.95	7.40	9.00	11.90	15.00
1¾		4.05	4.35	5.05	5.65	6.35	7.80	9.45	12.60	16.25
2			4.70	5.45	6.25	6.85	8.40	10.00	13.35	16.25
2¼				5.95	6.85	7.40	9.00	10.60	14.15	17.10
2½					7.50	8.10	9.60	11.25	15.00	18.06
2¾						8.75	10.30	11.90	15.90	19.00
3							11.00	12.60	16.85	20.00
Threads to inch	40	30	20	18	16	14	12 or 13	12	11	10
Add for each ¼ inch	30	40	50	60	80	1.00	1.30	1.60	2.00	2.40

Dis., 25%.

MILLED FROM SOLID BAR.



Fillister.

Bevel Head.

Button Head.

Diam. Head	3-16	¼	⅜	7-16	9-16	⅝	¾	13-16	⅞	1
Length Head	⅛	3-16	¼	5-16	⅜	7-16	½	9-16	⅝	¾
Diam. Screw	⅛	3-16	¼	5-16	⅜	7-16	½	9-16	⅝	¾
Length under Head. ¾	2.00	2.25	2.50	3.00	3.50	4.00	5.00			
1	2.25	2.50	2.75	3.25	3.75	4.25	5.30	6.60		
1¼	2.50	2.75	3.00	3.50	4.00	4.50	5.60	6.90	9.00	
1½	2.75	3.00	3.25	3.75	4.25	4.75	5.90	7.20	9.50	12.00
1¾		3.25	3.50	4.00	4.50	5.00	6.20	7.50	10.00	12.50
2			3.75	4.35	5.00	5.50	6.75	8.00	10.75	13.00
2¼				4.75	5.50	[illegible]	6.75	8.50	11.50	13.75
2½					6.00	6.50	7.75	9.00	12.00	14.50
2¾						7.00	8.25	9.50	12.75	15.25
3							8.75	10.00	13.50	16.00
Threads to inch.	40	30	20	18	16	14	12	12	11	10

Head on Bevel and Button Head Screws, 1-16 larger in diameter than above specifications.

Price, according to size of head.

Discount, 50%; case hardened, 45%; case hardened and polished, 35%.

Soups (French). Franco-American Brand

Per dozen.	In Cans — Quarts.	In Cans — Pints.	In Glass. 1½ pt.
Green turtle / Terrapin	$8.00	$4.32	$9.00
Chicken / Mulligatawny	3.75	2.25	4.50
Mock turtle / Ox tail / Consommé / Tomato / Julienne / Printanier / French bouillon	3.50	2.10	4.50
Mutton broth / Vegetable / Beef / Pea	3.50	2.10	None in glass.
Packed in cases of	2 doz.	4 doz.	1 doz.

Regular Assorted Cases. In Cans—Quarts.
2 Chicken, 1 Mulligatawny, 3 Mock Turtle, 3 Ox Tail, 2 Consommé, 2 Tomato, 3 Julienne, 1 Printanier, 1 Mutton Broth, 1 Vegetable, 1 Beef, 2 French Bouillon, 2 Pea. Per doz., $3.55.

In Glass.
11 Chicken, 1 Mulligatawny, 2 Mock Turtle, 1 Ox Tail, 2 Consommé, 2 Tomato, 1 Julienne, Printanier, 1 Mutton Broth.

Terms cash Discounts: 5% for lots of 10 cases, 10% for lots of 25 cases. 15% for lots of 50 cases.

Slate Roofing.
F. o. b New York. Stowage allowed.
Purple and Green, per 100 feet sq. $4.50
Dark blue, per 100 feet sq. 4.10
Sizes, 24 × 12 = 115 to sq., 650 lbs. weight.
Sizes, 20 × 10 = 170 to sq., 650 lbs. weight.

Spades and Shovels.
The D. F. Jones Mfg. Co., of Gananoque (Ld.).
JONES'
Patent plain black solid cast-steel shovels and spades.

Patent solid steel shovel.

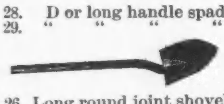
No.		No.	Per Doz. Black.	Per Doz. Pol's'd
20.	D. or long handle sq.-point shovels	2	$15.50	$16.50
21.	" " " " "	3	16.25	17.25
22.	" " " " "	4	17.00	18.50
23.	" " " " "	6	17.50	19.00
24.	" " " " charcoal	8	20.50	22.00

Pt. plain back solid cast steel shovel.

25.	D or long handle round-point shovels	3	16.25	17.25

Patent solid cast steel spade

28.	D or long handle spades	2	16.00	17.00
29.	" " " "	3	16.50	18.00



Patent plain back solid cast steel.

26.	Long round joint shovel No. 2		15.50	16.50
27.	" square " " No. 2		15.50	16.50
32.	D. handle square-point molders' shovels	2	.....	17.00
33.	D. handle square point railroad, extra heavy	2	15.75	
34.	D. handle round point railroad, extra heavy	3	16.50	
35.	L. handle round point shovel, with foot cap	2	16.00	17.00

GRAY'S CAST.
Patent plain back solid-steel shovels and spades.

50.	D. or long handle sq.-point shovels	2	$12.00	$13.00
51.	" " " " "	3	12.75	14.00
52.	" " " round point "	3	12.75	14.00
55.	D. handle spades	2	12.25	13.25
56.	" " "	3	13.00	14.25

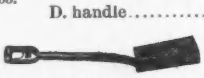
Patent solid corrugated cast steel scoop.

SCOOPS.
Jones' patent plain back solid corrugated cast steel scoops.

90.	D. or long handle solid cast steel	2	$13.50	$14.50
91.	" " " " "	4	14.50	15.50
91½.	" " " " "	6	16.50	17.50

Jones' riveted scoops.

92.	Cast steel D. or long handle	2	13.50	14.50
93.	" " " "	4	14.50	15.50
94.	" " " "	6	16.50	17.50
				Half polished.
95.	" " " "	8		$20.00
96.	" " " "	10		22.50
97.	" " " " Locomotive or coal (heavy)	6	17.50	
98.	" Long or D. handle for salt (heavy)		17.50	
99.	" D. handle flour and house furnace		10.50	
100.	" D. handle r'd-pt. for coal (extra heavy)	6	20.00	
				Polished.
101.	" ash pit, furnace L. handle	2		13.00
102.	" " " 32 in. D.	2		13.50
103.	" " " 42 " iron D. handle	2		14.00

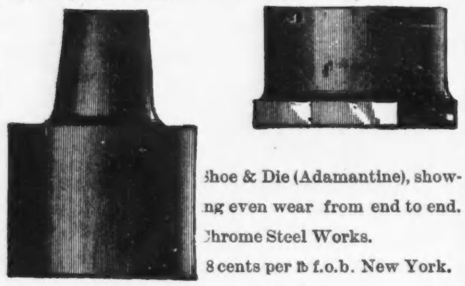


Ditching spade.

124.	D handle ditching (flat)		18.00	19.50
125.	D handle post hole (concave)		18.00	19.50
126.	D handle Alcock (for clay and brick)		16.00	17.00

Discount on shovels and spades, 50 and 10.
" " scoops, 50.
Boxed f.o.b. New York, Boston or Montreal.
The solid shovels, spades and scoops are made from cast steel bars by a recently patented process, the blade and strap being in one piece, not welded. All goods are American patterns.

Stamp Head Shoes and Dies.



Shoe & Die (Adamantine), showing even wear from end to end.
Chrome Steel Works.
8 cents per lb f.o.b. New York.

Stencil Inks.
S. H. QUINT & SON.

No.	Per can.	Per cake.	No.	Per can.	Per cake.
	Black.				
1	7 cents	3 cents	3	20 cents.	12 cents
2	10 "	5 "	4	30 "	20 "
	Blue.				
1	10 cents.	6 cents	3	30 cents.	22 cents
2	15 "	9 "	4	50 "	40 "
	Red and Green.				
1	12 cents	8 cents	3	50 cents.	42 cents
2	20 "	15 "	4	90 "	80 "

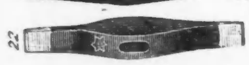
Per doz. cans or cakes, net, per gross, 10% less.
Indelible Ink.
Small bottles per 100 .... $2.75
" " 500 .... 12.00
" " 1,000 .... 20.00

STENCIL COMBINATIONS.
Contains Alphabet, Figures, [illegible] Ink.

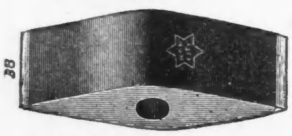
½ inch, per doz. $5.00
¾ " " 5.40
1 " " 5.75
1¼ " " 7.50
1½ " " 8.40
2 " " 10.00
2½ " " 15.00
Dis., 10%.

Tools. ARTISANS.

Chisel (Mason).
Stone, 5 and 8c. lb., net.



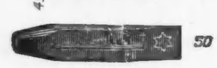
Mill Picks.
Cast steel. 2 to 3 lbs., $22 per doz.
Dis., 60 and 5%.



Stone Axes, Cast Steel.
All sizes, 50c. per lb.
Dis., 70 and 10%.

Five lbs. and over, 40c.; with teeth, 45c.; 3 to 5 lbs., 45c.; with teeth, 50c.; under 3 lbs., 50c.; with teeth, 55c.
Nos. 40 and 41, spalling or stone hammer, 5 lbs. and ver, 36c.; 3 to 5 lbs., 40c.; under 3 lbs., 45c. per lb.
Nos. 40 and 41, spalling hammers, 9 to 20 lbs., steel face, per lb., 17c. Dis., 70 and 10%

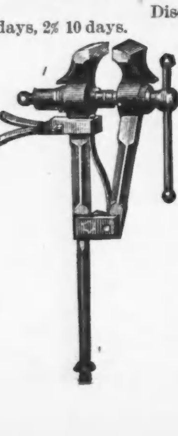
Ship or Top Mauls, Steel Face 4 to 8 lbs., 28c. per lb.
Dis., 50, 10 and 5%..



Steel Wedges, wood, 1st qual., 5c. lb.

Cooper Froes.
8 in. ₩ doz. $13.00
10 in. ₩ doz. 13.50
12 in. ₩ doz. 14.00
14 in. ₩ doz. 14.50
16 in. ₩ doz. 15.00
Discount, 60%.

60 days, 2% 10 days.
Vise.



No 1. Solid Box Vises.

		Each.
No. 25	3⅜ in. Jaw	$12.00
" 30	3½ "	11.00
" 35	3⅞ "	10.00
" 40	4 "	10.50
" 45	4¼ "	11.00
" 50	4¼ "	11.50
" 55	4½ "	12.00
" 60	4½ "	13.00
" 65	4¾ "	14.00
" 70	5 "	15.00
" 75	5 "	16.00
" 80	5¼ "	17.50
" 85	5¼ "	18.50
" 90	5½ "	20.00
" 95	5¾ "	21.00
" 100	6 "	22.00
" 105	6 "	23.00
" 110	6¼ "	24.00
" 115	6¼ "	25.00
" 120	6½ "	26.00
" 125	6½ "	27.50
" 130	6¾ "	29.00
No. 135	6¾ in. Jaw	$31.50
" 140	7 "	33.00
" 145	7 "	35.00
" 150	7 "	36.00
" 160	7¼ "	41.50
No. 170	7¼ in. Jaw	$44.50
" 180	8 "	47.00
" 190	8 "	53.00
" 200	8 "	56.00

Dis., 60 and 10%.

MINERS.

Adze Eye Coal Picks.
Same list and dis. as No. 16.

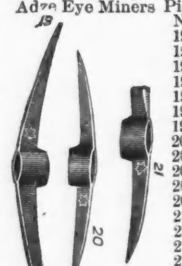
Anthracite Coal Picks.
Same list and dis. as No. 16.

Stone Picks, per doz.
No. 18, 6 to 7 lbs. ... $16.50.
No. 18, 7 to 8 lbs. ... 17.50.
No. 18, 8 to 9 lbs. ... 18.50.
Dis., 60 and 5%.

No.	Coal Picks.	Per doz.
16,	Weight, 2 lbs.	$8.50
16,	" 2½ "	9.00
16,	" 3 "	9.50
16,	" 3½ "	10.00
16,	" 4 "	10.50
16,	" 4½ "	11.00
16,	" 5 "	11.50
16,	" 5½ "	12.00
16.	" 6 "	12.50
16,	" 6½ "	13.00
16,	" 7 "	14.00

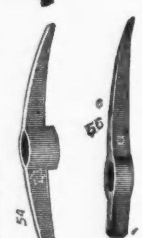
Packages charged at cost. Dis., 60%.

Adze Eye Miners Picks—Surface, Drifting and Poll.



No.			per doz.
19,	Surface.	No. 1, 4 lbs.	$14.00
19,	"	No. 2, 4½ "	15.00
19,	"	No. 3, 5 "	16.00
19,	"	No. 4, 5½ "	17.00
19,	"	No. 5, 6 "	18.00
19,	"	No. 6, 6½ "	19.00
19,	"	No. 7, 7 "	20.00
20,	Drifting,	No. 1, 3 "	12.50
20,	"	No. 2, 4 "	14.00
20,	"	No. 3, 4½ "	15.00
20,	"	No. 4, 5 "	16.00
20,	"	No. 5, 6 "	17.50
21,	Poll,	No. 1, 3½ "	15.00
21,	"	No. 2, 4 "	16.00
21,	"	No. 3, 4½ "	17.00
21,	"	No. 4, 5 "	18.50
21,	"	No. 5, 6 "	20.00
21,	"	No. 6, 6¾ "	21.50

Dis., 60, 10 and 5%.



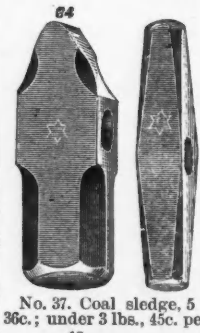
No. Ore Picks.
54, Adze Eye, 5 to 6 lbs. ... ₩ doz. $12.00
54, " 6 to 7 " ... " $13.00
54, " to 8 " ... " $14.00

56, Steel Lake Superior Mining Pick*
(Special Price and Quality.)
Dis, 60 and 10

Tamping Picks.

Adze eye, 6 to 7 lbs., per doz., $17.
Adze eye, 7 to 8 lbs., per doz., $18.
Adze eye, 8 o 9 lbs., per doz., $19.
Hunt eye, 6 to 7 lbs., per doz., $17.
Hunt eye, 7 to 8 lbs., per doz., $18.
Hunt eye, 8 to 9 lbs., per doz., $19.
Dis., 60 and 10%.

Steel Face Hammers.
No. 43, hand drilling hammers, 2 to 5 lbs.; No. 45, napping hammers, 2 to 5 lbs.; No. 39, mason hammers, 3 to 8 lbs.; No. 42, smiths' hand hammers, 2 to 5 lbs.; No. 44, smiths' striking hammers, 2 to 5 lbs., all steel face, per lb., 26c. Dis.. 70 and 10%.



Steel Face Sledges.
No. 34. Smiths' sledges, 6 to 30 lbs., steel face, 17c. per lb.
No. 35. Stone sledges, 6 to 30 lbs., steel face, 17c. per lb.
No. 36. Striking sledges, 6 to 30 lbs., steel face, 17c. per lb.
No. 37. Coal sledges, 5 to 10 lbs., steel face, 18c. per lb.

Cast Steel Sledges.
No. 34. Blacksmiths' sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 35. Stone sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 36. Striking sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 37. Coal sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.

No. 43, hand drilling hammer, 5 lbs. and over, 36c.; 3 to 5 lbs., 40c.; under 3 lbs., 45c. per lb.
Dis., 70 and 10%.

Cast Steel.
No. 42, blacksmiths' hand hammer, 5 lbs. and over, 30c.; 3 to 5 lbs., 34c.; under 3 lbs., 45c. per lb.
No. 44, drilling or striking hammer, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 45, napping hammer, 5 lbs. and over, 30c.; 3 to 5 lbs., 35c., under 3 lbs., 45c. per lb.
Dis., 70 and 10%.

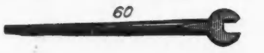
RAILROADS.

Railway Track Punch

Round Point.

15c. lb., net.

Track Wrench.



7¾c. lb., net.

Rail Fork.

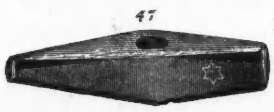
9c. lb., net.

Crow Bars.
Wedge Points,
3½c. lb., net.
Pinch Point,
3½c. lb., net.

65 Tamping Bar,
6c. lb., net.

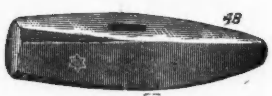
66 Claw Bar,

7c. lb., net.



Railroad Spike Mauls
6 to 16 lbs., Steel Face
18c. lb.

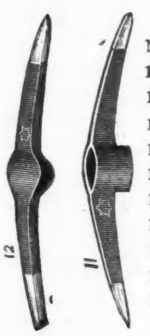
Dis., 50, 10, and 5%.



Steel Track Chisel,

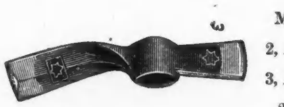
15c. per lb., net.

Railroad or Clay Picks.

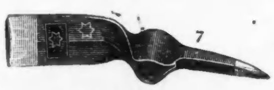


No.			Per doz.
11,	Adze eye,	4 to 5 lbs.	$11.00
11,	"	5 to 6 "	12.00
11,	"	6 to 7 "	13.00
11,	"	7 to 8 "	14.00
11,	"	8 to 9 "	16.00
11,	"	9 to 10 "	18.00
12,	Hunt eye,	4 to 5 "	11.00
12,	"	5 to 6 "	12.00
12,	"	6 to 7 "	13.00
12,	"	7 to 8 "	14.00

Dis., 60 and 10%.



Mattocks—Price per doz.
2, Adze Eye, Long Cutter, 6 lbs., $16.00.
3, Adze Eye, Short Cutter, 5½ lbs., $15.50.
2, Adze Eye, Long Cutter, Light, $15.00.
3, Adze Eye, Short Cutter, Light, $15.00.
4, Hunt Eye, Long Cutter, 6 lbs., $16.00.
5, Hunt Eye, Short Cutter, 5½ lbs., $15.50.

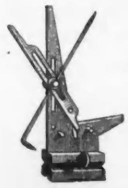


Adze Eye Pick Mattocks..........$16.

Hunt Eye Pick Mattocks.........$16

Dis., 60 and 10%.

Grub Hoes.
Western Pattern, No. 0, 3 lbs., ℔ doz., $10.50.
Western Pattern, No. 1, 3½ lbs., ℔ doz., $11.
Western Pattern, No. 2, 4 lbs., ℔ doz., $11.50.
Western Pattern, No. 3, 4½ lbs., ℔ doz., $12.
Baltimore Pattern, No. 1, 3½ lbs., ℔ doz., $11.
Baltimore Pattern, No. 2, 4½ lbs., ℔ doz., $11.75
Baltimore Pattern, No. 3, 5 lbs., ℔ doz., $12.75.
Baltimore Pattern, No. 4, 5¾ lbs., ℔ doz., $13.75.
Dis., 60 and 10%.



MACHINISTS'.

Combination Square, Bevel and Surface Gauge.

Price complete..........................$3.00

Dis., 20, 10 and 5%.

Tools, Carpenters'.

BOXWOOD RULES.

Two feet, four-fold, 1 inch wide.

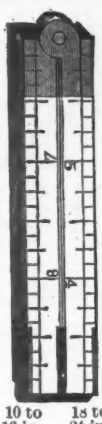
Plate.	Middle.	Edge.	Bound.
Round joint	$4	...	...
Square "	5	$7	$15
Arch "	6	8	16

Two feet, four-fold, 1⅜ inches wide.

Plate.	Middle.	Edge.	Bound.
Square joint	$7	$9	$18
Arch "	9	11	20

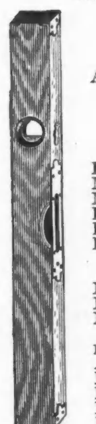
Two feet, two-fold, 1½ inches wide.

Square joint.	Arch.	Arch Bound.
$5	$7	$16
12	14	24



Gunter's Slide.

Dis. 80, 10 and 10%.



LEVELS.

	10 to 16 in.	18 to 24 in.
Arch top plate, 2 side views	$9.00	$12.00

PLUMBS AND LEVELS.

Arch top plate, 2 side views.

	12 to 18 in.	18 to 24 in.	24 to 30 in.
Polished	$14.00	$16.00	$18.00
Mahogany	.....	16.50	22.50
Mahogany tp'd and lp'd	27.00	.....	.....
Polished and l pped	.....	.....	24.00
Polished and tipped	.....	.....	28.00
Polished, lip'd and tip'd	.....	.....	35.00

	in.	
Mason's level, 2 plumbs, polished,	36,	$30.00
Mason's level, 2 plumbs, p'd and t'd,	36,	36.00
Mason's level, 2 plumbs, polished,	42,	36.00

PATENT ADJUSTABLE PLUMBS AND LEVEL.

Arch Top plate, 2 side views	26 to 30 in.
Polished and lipped	$27.00
Polished and tipped	30.00
Polished, lipped and tipped	39.00
Mahogany	27.00
Mahogany, lipped	33.00
Mahogany, lipped and tipped	48.00
Polished, triple stock, lipped and tipped	48.00
Mahogany " " " "	60.00
Rosewood, lipped and tipped	90.00

Dis., 70, 10, 10%.

POCKET LEVELS.

Iron top, Japanned	2 50
Brass top	3.00

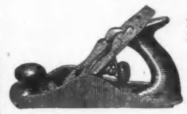
Dis., 70, 10, 10%.

SCREWDRIVERS.

Varnished handles, pat. metallic fastening. Size 1½, $1 per dozen; 2, $1.50; 3, $2; 4, $2.50; 5, $3; 6, $3.50; 7, $4; 8, $4.75; 10, $6; 12, $8.
Dis., 75%.

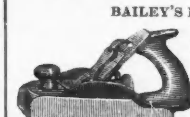
PLANES, BAILEY'S PATENT IRON.

With pat. lateral adjustment.



Smooth, 8 in. × 1¾ in., $3; 9 in. × 2 in., $3.25; 10 in. × 2⅜ in., $3.75 each.
Jack, 14 in. × 2 in., $3.75.
Fore, 18 in. × 2⅜ in., $4.75
Jointer, 24 in. × 2⅜ in., $6.50 each.
Dis., 40, 10 and 10%.

BAILEY'S PATENT WOOD PLANES.



Smooth. 9 × 8¾ in.	8 × 2 in.	Handle smooth. 9 × 2 in.
$2	$2	$2.50 each

Jack. 15 × 2⅜ in.	Fore. 20 × 2⅜ in.	Jointer. 26 × 2⅜ in.
$2.50	$2.75.	$3.25 each

Dis., 40, 10 and 10%.

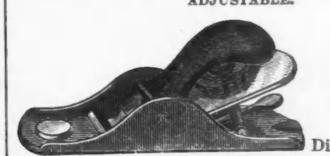
STANLEY IRON BLOCK PLANES.

3½ × 1 in.
20c.

5½ × 1¼ in.
40c.

7½ × 1¾ in.
60c. each.

ADJUSTABLE.



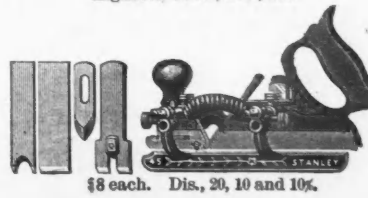
5½ × 1¼ in.
60c.

7½ × 1¾ in.
85c. each.

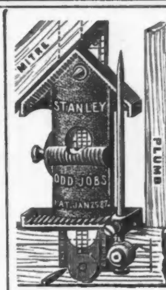
Dis., 40, 10 and 10%.

STANLEY'S BEADING, RABBET, SLITTING AND MATCHING PLANE.

Eighteen Tools, Bits, etc.



$8 each. Dis., 20, 10 and 10%.



STANLEY "ODD JOBS."

Embraces in combination with ordinary Carpenters' Rule:

010 Try square.
020 Mitre square.
030 T—— square.
040 Marking gauge.
050 Mortise gauge.
060 Depth gauge.
070 Mitre level.
080 Spirit level and plumb.
090 Beam compass.
0100 Inside square for making boxes and frames.

Price 75 cents.
Dis., 20, 10 and 10%.

TACK HAMMERS.

	Doz.
Magnetic, small	$1.25
Medium	1.50
Large	1.75

Discount, 30, 10, 10%.

MALLEABLE IRON.

Inlaid Handle.

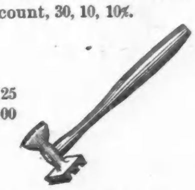
Per Doz.........................$2.50

Discount, 30, 10, 10%.

STEAK HAMMERS.

Japanned	$2.25
X Plated	3.00

Discount, 30, 10, 10%.



Trucks.

New York Pattern.

Size.	Length of hdles. Ft.	In.	Width at nose. Inches.	Width at upper bar. Inches.	Size of wheel. Inches.	Price.
No. 0	3	6½	12	13¾	6½ × 1¾	$4.50
No. 1	4	1	13⅝	15⅝	6½ × 1¾	4.85
No. 2	4	5	15	16½	7¾ × 1¾	6.00
No. 3	4	8	16	17¾	8¾ × 2¼	7.00
No. 4	5	0	16¼	17¾	9¾ × 2¼	8.00
No. 5	5	4	17¼	18⅞	10¾ × 2¾	9.50

Discount 50%.

Special net prices on quantity orders.

Tuyeres.

No. 2.	No. 4.
$25.00	$35.00 per doz.

20% dis.

Valves. Brass Globe and Angle Valves.

Size, inches	⅛	¼	⅜	½	¾	1
Star globe and angle valves	$0.80	$0.85	$0.90	$1.20	$1.55	$2.00
Star globe and angle valves, heavy patterns	...	...	...	1.50	1,95	2.80
Extra heavy Star and Lion patterns	...	...	...	2.00	2.60	3.60
All brass, yoke top	...	...	...	....	....	3.75
Cross valves	...	1.15	1.25	1.50	2.00	2.50
Star check valves	.70	.70	.75	.95	1.20	1.65
do. heavy pattern	..	...	...	1.15	1.50	2.00
Crescent globe and angle valves	.60	.60	.75	1.00	1.35	1.80
Crescent hose valves	..	...	...	...	...	...
check valves	.	.50	.60	.85	1.15	1.55
Vertical check v'lv's	.	.50	.60	.85	1.15	1.55
Jenkins globe and angle valves	.	1.10	1.25	1.60	2.20	2.80
Jenkins check valv's	..	1.10	1.20	1.30	1.90	2.60
Gate valves, Chapman	..	...	...	1.30	1.75	2.25
Gate valves, other makes	..	...	1.00	1.20	1.75	2.50
Brass safety valves	..	2.00	2.25	2.75	3.50	5.00
Brass butterfly v'lv's	..	...	...	...	...	3.50

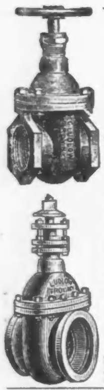
Size, inches	1¼	1½	2	2½	3
Star globe and angle valves.	$3.00	$4.00	$6.50	$12.50	$19.00
do. heavy pattern.	3.95	5.30	8.35	14.00	22.00
Extra heavy Star and Lion patterns	5.40	7.20	10.80	18.20	28.60
All brass, yoke top	5.00	7.00	10.00	18.00	30.00
Cross valves	3.50	5.00	8.00	16.00	24.00
Star check valves	2.50	3.25	5.00	11.00	15.00
do heavy pattern	3.00	4.00	6.50	12.50	17.00
Crescent globe and angle valves	2.80	3.90	5.90	11.25	16.00
Crescent hose valves	4.00	5.50	7.00	10.00	....
" check valves	2.30	3.25	5.20	10.00	14.00
Vertical check valves	2.30	3.25	5.20	10.00	14.00
Jenkins globe and angle valves	4.00	5.50	8.00	15.75	22.00
Jenkins check valves	3.60	5.00	7.50	13.50	20.50
Gate valves, Chapman	3.25	4.25	6.25	11.50	16.00
" " other makes	3.50	5.00	7.50	15.00	22.00
Brass safety valves	7 00	8.50	12.00	20.00	30.00
Brass butterfly valves	4.50	5.50	8.00	11.00	16.00

Pressure Regulating.

Mason Regulator Co.

Size pipe.	Price.	Size pipe.	Price.	Size pipe.	Price.
1 inch,	$22.	1¼ inch,	$28.	1½ inch,	$35.
2 "	44.	2½ "	57.	3 "	72.

Ludlow Valve Co.
Double Gate Brass Valves.
Gland in packing box.



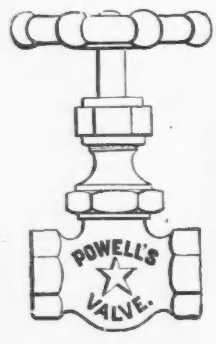
Size.	Screw socket.	Flange.	Diameter of Standard Flange.	Face to face of Screw socket	Face to face of Flanges.	Extra for slide stem and lever subject to discount.
In.	$	$	In.	In.	In.	
½	1.25	....	....	2¼	....	$1.00
¾	1.65	....	....	2½	....	1.00
1	2.15	....	....	2⅞	....	1.00
1¼	3.15	....	....	3⅜	....	1.00
1½	4.25	....	....	3¾	....	1.00
2	6.25	11.50	6	4⅛	4⅝	1.00
2½	11.50	18.00	6½	4 13-16	5⅜	1.00
3	16.00	22.00	7	5	6¼	1.25
3½	21.00	31.00	7½	....	....	1.25
4	35.00	43.00	9	....	7 1-16	1.25
5	52.00	64.00	10	....	....	1.25
6	78.00	90.00	11	....	9	1.25
8	.....	.....	....	....	....	....
10	.....	.....	....	....	....	....
12	.....	.....	....	....	....	....

Rubber-Faced Slide Gate Fire Hydrant.

Diameter of pipe connection.	Diameter of stand pipe.	Diameter of seat ring.	One 2½ nozzle.	Two 2½ nozzles.	Three 2½ nozzles.
Inches.	Inches.	Inches.			
3 or 4	4⅝	3	$28	......	......
3--4--6	5¾	4	31	$33.00	$35.00
4 or 6	7	5	....	38.50	40.50
6 or 8	8	6	....	49.00	51.00
8 or 10	10	8	...	......	......

Four 2½ nozzles.	Six 2½ nozzles.	One steamer nozzle.	One steamer and one 2½ nozzle.	One steamer and two 2½ nozzles.	Frost case, standard length.
......	......	......	......	......	$4.50
......	......	$33.00	$35.00	$37.00	5.00
......	......	38.50	40 50	42.50	6.50
$53.00	......	49.00	51.00	53.00	7.50
......	......	......	......	......	......

For each 6 inches more or less than standard length of stand pipe, add or deduct from list.	For each 6 inches more or less than standard length of frost case, add or deduct from list.	Extra charge for hub.	Independe't nozzle gates each.
$0.60	$0.44	....	....
.75	.50	6 in. $0.50	$3.50
.85	70	No ch'ge	3.75
1.00	.90	8 in. $1.25	3.75
....	....	....	4.50



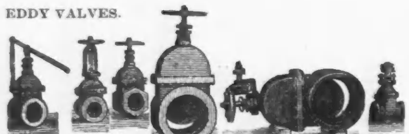
Star Radiator Valves, with Brass T Handles or Wood Wheels.

Size, inches.....	½	¾	1
Plain brass....	$1.60	$2.00	$2.50
Plated trim'gs.	1.80	2.25	2.80
Rough & Plat'd	2.00	2.45	3.05
Finish'd & P'l't.	2.50	3.00	3.65

Size, inches....	1¼	1½	2
Plain brass.....	$3.60	$4.80	$7.50
Plated trim'gs.	3.95	5.20	8.00
Rough & Plat'd	4.20	5.50	8.50
Finish'd & P'l't.	4.95	6.50	9.75

Dis., 40, 10 and 5%.

EDDY VALVES.



S. & O. S. L. & Y. Class 2. Class 2. Class 3 and 4. Cl'ss 5.

	Class 2.		Class 3.	Class 4.	Class 5.		
	Iron, brass mounted.		All ir'n for gas. Hub ends.	Water works valves. Hub ends.	Quick opening valves with rack and pinion stem. Iron, brass mounted.		
Size.	Screw, or flange, ends.	Add for S S&L			Hub ends.	Screwed.	Flanged.
2	$7.00	$1.00	$8.00	$10.00	$10.00	$9.00	$9.00
2½	10.50	1.30	....	......	15.00	14.00	14.00
3	13.00	1.40	10.00	15.00	20.00	17.00	17.00
3½	16.50	1.50	....	......	25.00	21.00	21.00
4	18.00	1.70	15.00	18.00	30.00	25.00	25.00
4½	22.00	1.80	....	......	......	......	......
5	25.00	2.00	20.00	25.00	35.00	31.00	31.00
6	31.00	2.30	25.00	31.00	40.00	37.00	37.00
7	37.00	2.70	30.00	37.00	......	......	......
8	45.00	3.00	35.00	45.00	55.00	55.00	55.00
10	60.00	3.50	48.00	60.00			
12	80.00	4.00	65.00	80.00			

All Iron Valves, Classes 2 and 5, 10 per cent. less than Brass Mounted.

Varnish.

E.S. 1827 & Co.

Edward Smith & Co.
For Finishing Coats.

	gal.
Wearing body varnish	$5.50
Medium drying body..............	5.50
One coat coach varnish............	4.50
Wearing carriage...................	4.50
Heavy gear varnish......	4.00
Coach body "	4.05
No. 1 coach "	2.2

For Under Coats.

Hard drying body.....	$4.50	Black rubbing varnish.	$4.00
Rubbing body varnish.	4.00	Priming (1st coat).....	2.50
Quick rubbing "	3.50	Filling (2d coat)	2.50
		Rough stuff............	2.50

For Inside Work.

Best flowing varnish..	$4.50	Hard oil finish light...	$2.75
Best polishing " ..	4.50	" dark...	2.25
Cabinet " ..	3.00	White copal..........	4.00

Dryers.

Japan gold size.... ..	$3.50	Brown japan...........	$1.25
Coach japan..........	1.75	Liquid dryer..........	1.25

Discount, 40 per cent. f.o.b. N. Y.

Preservative Coatings.

Spar coatings..........	$4.00	Exterior car coating..	$4.00
I. X. L. No. 1..........	2.50	Interior car coating...	3.25
I. X. L. No. 2..........	4.00	Locomotive coating....	4.00
Floor finish............	2.50		

Discount, 35 per cent, f.o.b. N. Y.

Wagons, Carts, Etc.

D. F. Sargent & Son.

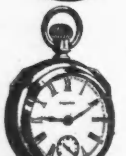
No. 0. Cart, top and fenders.......................$150
No. 1. Cart, top and fenders.................. 90
No. 2. Cart, one man cart, open.................. 65
No. 2. Cart, one man, top. 86
No. 2. Cart, one man, top and fenders............ 90
No. 3. Cart, two man, open.................. 60
No. 3-H. Cart, two man, open.................. 54
No 4. Cart, two man, top. 86
No. 5. Cart, two man, top and fenders.................. 90
No. 6. Cart, two men, top and fenders.............. 90
No. 7. Two man combination cart.............. 110
Wide track 5 feet.
Narrow track 4 feet 8 inches.
Discount 33⅓ per cent. off.

Watches.—Trenton Watch Co.

Open Face, Stem Wind and Set.

No. 51. Nickel Silver, Snap Back and Bezel.. .... $3.50

No. 55. Nickel Silver, Jointed Back and Bezel 3.7

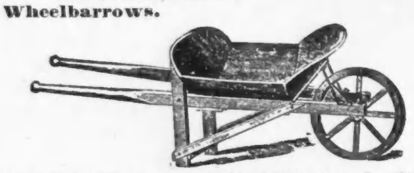


No. 60. Nickel Silver, Bassine style, (Smooth Edges), Double Joints 4.25

No. 65. Dueber Silverine Bassine... 4.50

No. 92. Silver, Engine Turned..... 6.30
No. 90. Silver, Engraved........... 6.50
No. 101. 14-karat Gold, Filled, Cases made of twoplates of 14-karat gold rolled on base metal, and warranted to wear for 15 years, Engine Turned 11.00
No. 102. Same, Engraved.......... 13.00
Dis., 15 and 6% cash.

Wheelbarrows.



Climax Bolted Barrow, with Wood Wheel per doz. $22.50.
1½ tire of iron,
Common Nailed Barrow per doz. $18.50.
" Bolted " " " 18.75.

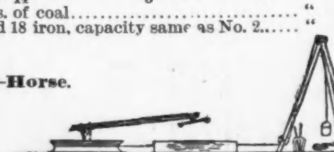
Lansing's Patent Iron-Bolted Barrow,	per doz.,			$25.50
Capital Patent Bolted Dirt	"	"	"	30.00
Red oak or Government	"	"	"	40.50
Wharf	"	"	"	72.50
Mortar	"	"	"	30.00
Bent Handle Stone	"	"	"	48.00
Coal or Ore	"	"	"	31.50
Pig Metal or Casting	"	"	"	40.50
Brick Yard 20 inch Iron Wheel	"	each		10.50

Globe Patent Bolted Garden Barrow, Box 30 by 24 by 12 deep, wood wheel } per doz., 42.50.

Capita Patent Barrows
With Iron Tray, A, per doz., ...$39.00
" " " B, " " 42.00

The Leader Iron and Steel Barrows.
Gas-pipe Legs and Handles in one price.
No. 1 Tray of 16 iron, capacity 3 cu. ft. of earth, each $12.
No. 2 " " 14 " " 5 " " " " or 250 lbs. of coal................................ " 15
3 Galvanized 18 iron, capacity same as No. 2...... " 15

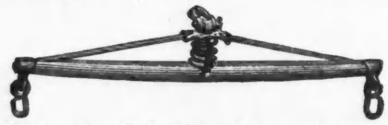
Whims—Horse.



Common-sense Steel.

F. O. B..$125
Dis., 25%, in car lots.

Whiffletree.

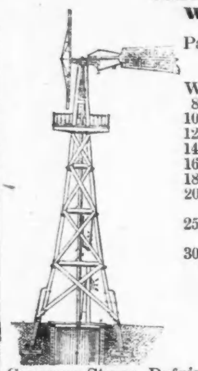


Willson spring (Jeffery Manufacturing Company).

	Single.	Double.
No. 1, 34 or 36 inches long.................	$1.25	$2.50
No. 2, " " "	1.40	2.75
No. 3, " " "	1.50	3.00
No. 4, " " "	1.65	3.25

Including either steel hooks or rings'
Discount, 45 and 5%.

Windmills.



A. J. CORCORAN.
Patent Storm Defying Pumping Mills.

Wheel.	Weight, boxed.	Cubic feet.	Price.
8½ ft.	650 lbs.	55	95.00
10 "	700 "	75	120.00
12 "	900 "	95	150.00
14 "	1,350 "	135	250.00
16 "	1,850 "	195	375.00
18 "	2,150 "	250	450.00
20 "	3,500 "	335	600.00
Dis., 25%.			
25 "	5,400 lbs.	450	775.00
Dis., 20%.			
30 "	9,500 lbs.	795	975.00

Boxing for export extra.

Corcoran Storm Defying Geared Windmills for Driving Machinery.

Price includes upper set of Bessemer steel gears, one length of shaft.

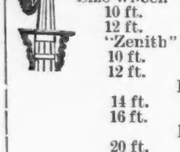
Dia.	H. P.	Weight.	Cu. ft.	Price.
16 ft.	2½	1,900 lbs.	200	$400.00
20 "	5	3,600 "	340	650.00
25 "	6½	5,400 "	355	850.00
30 "	8	9,600 "	816	1,150.00
36 "	10	12,000 "	856	1,500.00
40 "	12	14,500 "	896	2,000.00
50 "	30	16,500 "	956	3,500.00
60 "	40	20,000 "	1,015	4,500.00

Dis., 25%.

10 ft. pumping.... $75
12 ft. " 95
14 ft. " 140
16 ft. " 225
} Plus cost of packing.

Dis., 50 per cent.

EMMERT & LAMB.



"Stover" Pumping Windmills (no tower).

Size wheel.	Wt. packed.	Cubic ft.	Price.
10 ft.	650	50	$80.00
12 ft.	750	58	100.00
"Zenith" Pumping Windmills (no tower)			
10 ft.	650	48	85.00
12 ft.	750	57	110.00
Dis., 50 per cent.			
14 ft.	1,400	108	160.00
16 ft.	1,600	114	250.00
Dis., 45 per cent.			
20 ft.	2,950	220	400.00
25 ft.	4,225	280	600.00
Dis., 40 per cent.			

"Zenith" Geared Windmill (no tower).
Prices include upper set of Gears and about 5 feet vertical extra heavy shaft in windmill head.

14 ft.	1,550	178	260.00
16 ft.	1,780	198	300.00
20 ft.	3,170	216	500.00

Dis., 40 per cent.

Wire Cloth.

Brass and Copper Wire Cloth.

No. Mesh.		Price per foot.	No. Mesh.		Price per foot.
2	from No. 10 wire....	$2 50	20	from No. 26 wire....	$.80
3	" 11 "	2.50	22	" 27 "	.80
4	" 12 "	2.50	24	" 28 "	.80
5	" 13 "	2.50	30	" 30 "	.65
6	" 14 "	2.50	40	" 32 "	.70
8	" 16 "	2.50	50	" 34 "	.75
10	" 18 "	2.00	60	" 35 "	.78
12	" 19 "	2.00	70	" 37 "	.70
14	" 22 "	1.10	80	" 38 "	.90
16	" 24 "	.80	90	" 39 "	1.10
18	" 25 "	.80			

Dis., 60%.

Wire Goods.

Fly Traps. Per gross.
Paragon....... $18.00
Balloon... ...... 15 50

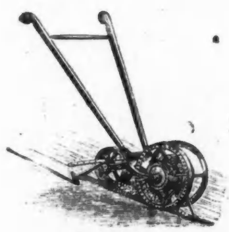
Dis., 10%.

NEW YORK PRICES CURRENT. DECEMBER 7, 1889.

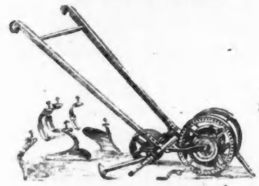
Discounts are for Export Only.

In the interest of the extension of the markets for American manufactures the ENGINEERING AND MINING JOURNAL has secured the services of gentlemen thoroughly acquainted with the export trade and with foreign markets, and it offers its services to foreign buyers who may desire information concerning any article whatever of American manufacture. No charge will be made for these services, either directly or indirectly through commissions on goods purchased. The proprietors of the ENGINEERING AND MINING JOURNAL are neither commission merchants nor exporters, but they have many sources of information, both at home and in foreign countries, and place these at the service of manufacturers and exporters here and of importers and consumers in other countries.

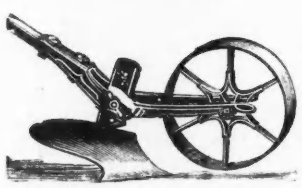
Agricultural Implements.



"Planet, Jr." No. 2 Seed Drill, $9.



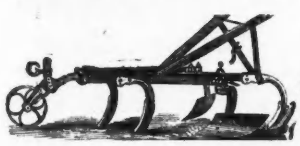
Combined Drill Cultivator Rake, Plow, etc., $12.



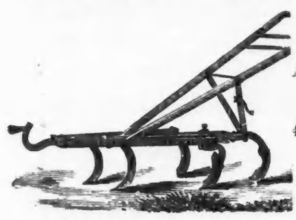
"Fire Fly" single-wheel Hoe, Cultivator and Plow, $5.

"Fire Fly" Hand Plow, $2.50.

30 % discount, f.o.b. New York.



All Steel Horse Hoe and Cultivator combined, with wheel, $11.



All Steel Plain Cultivator, $6.00.

40% discount, f.o.b., New York.

HAY FORKS.

Ely Hoe & Fork Co.—Gold Finish, Patent Overcaps.

Three Tine Forks.

No.	Tine.	Handles.		Per doz.
30	10 in.	4½ ft.	Boy's	$7.75
32	12 "	4 to 6 ft.		9.00
32 S	12 "	"	Strapped	10.50
32 B	12 "	"	Bent	9.50
32 B S	12 "	"	Bent & St'pd	11.00
33	12 "	"		9.50
33 S	13 "	"	Strapped	11.00
33 B	13 "	"	Bent	10 00
33 B S	13 "	"	Bent & St'pd	11.50
34	14 "	"		10.25
34 B	14 "	"	Bent	19.75
35	15 "	"		11.25
35 B	15 "	"	Bent	11.75
42 B	12 "	"	Bent	12.50
42 B S	12 "	"	Bent & St'pd	14.00

Manure Forks, Solid Steel Shanks, Gold Bronze Finish, Patent Overcaps.

No. 44, oval, 4 tine, 12 in. tine, 4 ft. handle, plain ferrules, $12.50 per doz.

No. 44 S, oval, 4 tine, 12 in. tine, 4 ft. handle, strapped ferrules, $14.

No. 44½, oval, 4 tine, 12 in. tine, 4½ ft. handle, plain ferrules, $12.50.

No. 44½ S, oval, 4 tine, 12 ft. tine, 4½ ft. handle, strapped ferrules, $14.

No. 54, oval, 5 tine, 13 in. tine, 4 ft. handle, plain ferrules, $19.50.

No. 54 S, oval, 5 tine, 13 in. tine, 4 ft. handle, strapped ferrules, $21.

No. 64, oval, 6 tine, 13 in. tine, 4 ft. handle, plain ferrules, $22.50.

No. 64 S, oval, 6 tine 13 in. tine, 4 ft. handle, strapped ferrules, $24.

HOES.

Ely Standard Socket, all Gold Bronze Neck, full Pol'd, C. S. Blade.

Field, 7 × 5 in., selected handles	$9.00
" 7½ × 4½ " " "	9.00
" 8 × 4¾ " " "	9.00
" 8½ × 4½ " " "	9.00
" 8 × 5 " " "	9.00
Washington County Pattern, spring handles	10.00
Rhode Island, 7 to 9 in., spr'g handles	9.00
" " 9½ in. " "	9.25
" " 10 " " "	9.50
Meadow, 9 × 4 in., poplar handles	9.00
Meadow, 9½ × 3½ in., poplar handles	9.25
Meadow, 10 × 3½ in., poplar handles	9.50
Broom Corn, 7½ × 4½ in., poplar handles	9.00

Popular Handles in Meadow Socket Hoes, unless otherwise ordered.

PLOWS.

Reversible Oneonta Clipper.

16. Oneonta Clipper, Reversible, Iron beam Cutter	$14
" Oneonta Clipper, Reversible, Iron Wheel and Cutter	15
18. Oneonta Clipper, Reversible, Iron Beam Cutter	15
" Oneonta Clipper, Reversible, Iron Beam, Wheel and Cutter	16
17. Hard Metal, Reversible, Iron Beam Cutter	17
17. Hard Metal, Reversible, Iron Beam, Wheel and Jointer	17
19. Hard Metal, Reversible, Wood Beam Cutter	16
" " " " " " Wheel and Jointer	17
20. Steel Mould Board, Reversible, Wood Beam Cutter	15
" " " " " " " Wheel and Cutter	16

Iron Beam Plows.

Two-horse Sod and Stony Land.... 8.50 plain.
Curtis's Sod Two horse.......... 11.50 "
" " " " .... 13.00 cutter.
" " " " .... 14.25 wheel & cutter.

Subsoil Plows.

Two-horse 9.50 Draft Rod.
" " 11.00 Wheel and Draft Rod.

Hitchcock's Potato Digger and Shovel Plow.

Improved adjustable handle shovel plow	7.00
Hitchcock's Potato Digger	8.00
" " " and shovel plow	10.50

Dis. 30%.

RAKES.

The S. R. Nye Improved.

22 Teeth Rake, $32.00

26 " " 34.00

25% dis.

Chieftain Hay Rake Co.

Chieftain Lock Lever

No. 1............$30.00
No. 2............ 30.00
No. 5............ 29.00

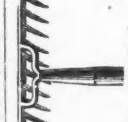
Iron wheels, $2 extra. With Pole, Double Tree and Neck Yoke, $2 extra. 22 cubic feet packed, 400 lbs. gro., 225 lbs. net.

Golden Farmer Self-Dumping Rake, $37.00; 22 cu. ft., 430 lbs. gro., 250 lbs. net.

Chieftain Hay Tedders, $59.00; 700 lbs. gro., 450 lbs. net.

Potato Diggers, $7.00; 100 lbs. gro., 60 lbs. net: dis., 40% f.o.b. ship New York or Boston.

RAKES (GARDEN).



Braced steel garden rakes.	Per doz
8 teeth	$8.00
10 "	9.00
12 "	10.00
14 "	11.00
16 "	12.00

Braced malleable garden rakes.	
10 teeth	$5.50
12 "	6.00
14 "	6.50
16 "	7.00

	Ten-Teeth Malleable Garden. Plain.	Braced.	Steel Garden. Plain.	Braced.
10-Teeth	$5.50	$6.00	$9.00	$10.50
12 "	6.00	6.50	10.00	11.50
14 "	6.50	7.00	11.00	12.50
16 "	7.00	7.50	12.00	13.50

Dis. 70 and 5%.

Cast steel garden rakes.

	Per doz.
10 teeth, polished, tapering bar, tempered rake.	$9.00
12 " " " " " "	10.00
14 " " " " " "	11.00
16 " " " " " "	12.00

Cast steel lawn rakes.

12 teeth, polished, tapering bar, tempered rake	$10.00
14 teeth polished tapering bar, tempered rake	11.00
16 teeth polished tapering bar, tempered rake	12.00
18 teeth polished tapering bar, tempered rake	13.00

Dis. 70% from Standard Association list.

Prices made where XX handles, etc., are required.

SCYTHES (GRASS).

Waldron's pattern, oiled	$8.50
Silver steel, painted	8.50
Western dutchman, bronzed and painted	9.00
Clipper, polished web	9.00
Fine cutlery steel, full polished	10.00
All steel, full polished	11.00

Grain Scythes.

Waldron's pattern, oiled	11.25
Silver steel, painted	11.25
Clover, oiled	11.25
Clipper, bronzed and painted	11.50

Lawn Scythes.

Clipper, bronzed and painted	9.00

Dis. 40 and 10%.

SOWER, BROADCAST SEED.

Goodell & Co.

Per dozen.............. $36 f.o.b.

Gross wt., 110 pounds per dozen

Net wt., 75 pounds per dozen.

Anvils.

"Eagle anvils.

	Weight about			Weight about	
No. 000	½ lb.	$1 00	No. 4	40 lbs	$4.25
" 00	4 "	1.70	" 5	50 "	5.05
" 0	10 "	2.20	" 6	60 "	5.50
" 1	15 "	2.75	" 7	70 "	6.00
" 2	20 "	3.00	" 8	80 "	7.00
" 3	30 "	3.75	" 9	90 "	8.00

Anvils weighing 100 to 800 lbs., 10 cts. per lb. Discount 20 and 10 %.

Arms and Ammunition.

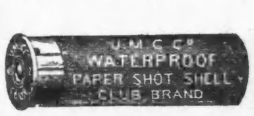
Wood Powder.
American Wood Powder Company.

	Kegs, 25 lbs.	¼ kegs. 6¼ lbs.	1 lb. cans.
Trap for first quality arms only	$19.50	5.00	.85
A, for large bore; C, for general use; D, fine for small bore and rifles; E, very fine for small bore rifles and gallery shooting	17.00	4.35	.75

			Discount. Per cent.
Bullet Breech Caps	per lb.	1.60	10
Conical Bullet Caps	"	1.75	10

		Discount. Per cent.
Rim Fire Cartridges	60	10
Military Rim Fire Cartridges	15	10
Central Fire Pistol and Rifle Cartridges	40	10
Central Fire Metallic Cartridges for Target and Sporting Rifles	30	10
Military Cartridges, Central Fire	30	10
Lefaucheux Cartridges		60

Gatling Cartridges		Special
Primed Shells and Bullets	25	10
Friction Cannon Primers	20	10
Primers		10
Percussion Caps, F. C .... per M.	33c.	
U. M. C "	42½c.	
Musket "	45c.	
Brass Shot Shells, U. M. C., 1st qual.	60	10
Club brand	65	10



Paper Shot Shells.

14, 16 and 20 ga. First quality, 30, 10 and 10 per cent; 4, 8, 10 and 12 ga., First quality, 25, 10 and 10 per cent.

14, 16 and 20 ga. Club brand, 30, 10 and 10 per cent.
10 and 12 ga. Club brand, 33⅓, 10 and 10 per cent.
Gun Wads, 20 and 5 per cent.

RIFLES.

Colts' Lightning Magazine.

Discount 10 per cent

40/60 and 45/60 calibre octagon barrel	10	lbs.	$15.38
" " " " round "	9¾	"	14.25
" " " " carbine "	9	"	14.25
32, 38, and 44 calibres, octagon "	7¼	"	13.50
" " " " round "	6¾	"	12.38
" " " " carbine "	6¼	"	12.38
" " " " baby carbine	5¼	"	12.38
22 calibre, rim fire, octagon barrel			15.38
" " round			14.25

Remington Light (Baby) carbines, 44 cal., nick., $7.50.

MARLIN RIFLE. MODEL, 1889.

The best in the market, embodying all latest improvements.

32, 38 and 44 calibres, using the same cartridges as Winchester rifles of the respective sizes.

Octagon barrel, 24 inch, 6½ lbs			$19.50
"	" 26 " 6¾ "		21.50
"	" 28 " 7 "		23.50
Round	" 24 " 6½ "		18.50
Carbine	20 " 5½ "		17.50

Discount, 25, 10 and 10%.

REVOLVERS.

Smith & Weston

32, Single Action, 3, 3½ in., $8.00.
32, Double Action, 3, 3½ in., $9.35.
32, Safety Hammerless, 3, 3½ in., $11.00.

38, Single Action, 3¼ in., $9.40; 38, Single Action, 4 in., $9.65; 38, Single Action, 5 in., $10.00; 38, Double Action, 3¼ in., $10.40; 38, Double Action, 4 in., $10.65; 38, Double Action, 5 in., $11.00; 38, Safety Hammerless, 3¼ in., $12.00; 38, Safety Hammerless, 4 in., $12.25; 38, Safety Hammerless, 5 in., $12.50; 44, Single Action, 4 in., $11.50; 44, Single Action, 5 in., $11.75; 44, Single Action, 6, 6½ in., $12.00; 44, Double Action, 4 in., $12.50; 44, Double Action, 5 in., $12.75; 44, Double Action, 6½ in., $13.00; 44, Double Action Favorite, 5 in., $12.75.

Colts.

Discount, 10 per cent from following prices.

Double Action Army, 44 and 45 calibre, 4¾, 5½, 7½ inch bbl., $13.00.
Double Action, 41 calibre, 2½ to 6 inch bbl., $11.20.
" " 38 " 2½ to 6 " " $10.00.
Single " Army, 45 calibre, 4¾, 5½, and 7½ inch bbl., $12.00.
Single Action Army, 44 calibre, "Frontier," 4¾, 5½, and 7½ inch bbl., $12.00.
New Line, 41 calibre, blued or nickeled, $4.00.
" " 32 " " " 4.00.
" " 30 " " " 2.00.
" " 22 " half or full plate, 2.10.
Old Model, 22 calibre, by the hundred, half or full plate, $1.50.
Colt Deringer, 41 calibre, per pair half or full plate, $5.50.

American Bull Dog

Double Action 32, 38 and 44 calibre, 2½ inch barrel, $1.60; Double Action 32, 38 and 44 calibre, 4½ inch barrel, $1.85; Double Action 32, 38 and 44 calibre, 6 inch barrel, $2.10.

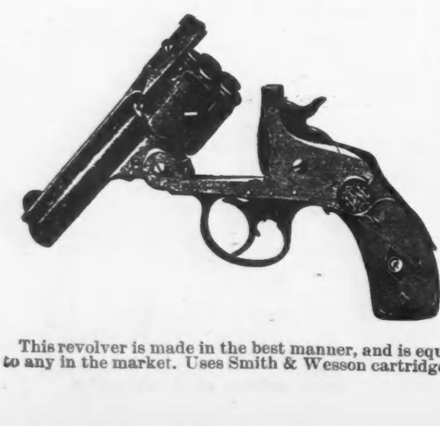
F. & W. British Bull Dog revolvers, 32 and 38 calibre 2½ inch bbl., $1.80.
F. & W. Automatic revolver, 32 and 38 calibre, 3¼ inch bbl., $5.50.
H. & R. Automatic revolver, 32 and 38 calibre, 3¼ inch bbl., $4.75.
Defender revolvers, Single Action, 22, wood handle, 65.
" " " " 22, rubber " 70.
" " " " 32, wood " 85.
" " " " 32, rubber " 90.

Remington Army revolver, Single Action, 44 cal., frontier cartridge, 5¾ inch barrel, $6.50.
Remington Army revolver, Single Action, 44 cal., frontier cartridge, 7½ inch barrel, $6.00.
Remington Double Deringers, 41 cal., rim fire, $4.05.
National Deringers, 41 calibre, per pair, half or ful plate, $4.00.

New House, 41 or 38 calibre, blued or nickeled, $5.00.
" Police, 38 calibre, 6 in., " " 7.00.
" " 38 " 4½ in., " " 7.00.

MARLIN AUTOMATIC DOUBLE ACTION REVOLVERS.

32 and 38 cal., 3¼ bbl., $10; 25 and 10%.



This revolver is made in the best manner, and is equal to any in the market. Uses Smith & Wesson cartridges.

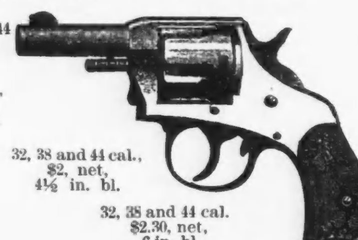
H. & R. AUTOMATIC DOUBLE ACTION REVOLVERS.

32 and 38 cal., 3¼-in. barrel, 4.75 net.

H. & R. EJECTING DOUBLE ACTION REVOLVERS.

32 and 38 cal., 3¼-in. barrel, 4.00 net.

AMERICAN DOUBLE-ACTION REVOLVERS.

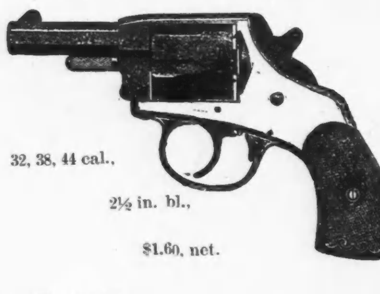


32, 38 and 44 cal., $1.75, net, 2½ in. bl.

32, 38 and 44 cal., $2, net, 4½ in. bl.

32, 38 and 44 cal. $2.30, net, 6 in. bl.

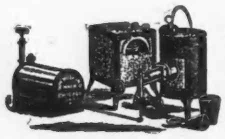
AMERICAN BULLDOG REVOLVERS.



32, 38, 44 cal., 2½ in. bl., $1.60, net.

Assay Furnace.

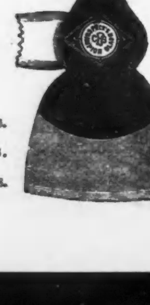
Hydro-Carbon Blow-Pipe Assay Furnace.



No. 2, Muffle Furnace taking C Battersea Muffle 8x4¾x3 in	$10.00
No. 3, taking F Muffle, 10x6x4 in	15.00
No. 1, Crucible Furnace, taking Battersea, U or Colorado B Crucible, 4 in. dia. 5½ deep	4.00
No. 2, taking Battersea E, round, 5 in. dia., 6½ deep	5.00
Blow-Pipe No. 1, with half gallon tank, made of plain, strong sheet metal	18.00
Blow-Pipe No. 2, with half gallon tank, made entirely of seamless brass	23.00
Blow-Pipe No. 3, with one gallon tank, otherwise same as No. 2	26.00
Blow-Pipe No. 1, Muffle Furnace No. 2, and Crucible Furnace No. 1	32.00
Blow-Pipe No. 2, Muffle Furnace No. 2, and Crucible Furnace No. 1	37.00

Axes, etc.

Shingling Hatchets.
1. 2. 3.
Collins', $4.75, $5.25, $5.75 doz., dis 10%.
Peck's, $8.00, $8.50, $9.00 doz. dis. 45%.
Ryder's, $8.00, $8.50, $9.00 doz., dis. 50%.



Claw Hatchets.
1. 2. 3.
Collins', $5.25, $5.75, $6.25 doz., dis. 10%.
Peck's, $9.00, $9.50 $10.00, doz., dis. 45%.
Ryder's, $9.00, $9.50, $10.00 doz., dis. 10%

Hatchets, Broad Single Bevel.

Collins', cut in., 5, $9.50; 5½, $10.00; 6, $10.50; 6½, $11.00; 7½, $11.50; dis. 10%.

Peck's, cut in., 4, $10.50; 4½, $11.50; 5, $13.00; 5½, $14.50; 6, $16.50; 6½, $18.00; 7½, $19.50; 8¼, $22.00; dis. 45%.

Ryder's, cut in., 5, $13.00; 5½, $14.50; 6, $16.50; 6½, $18.00; 7½, $19.50; dis. 50%.

Adzes.

	House. Half flat head. Dozen.	Ship spur poll. Dozen.	Discount. Per cent.
Collins'	$14.00	$13.00	10
Peck's	24.00	25.00	45
Ryder's	24 00	25.00	50

Broad Axes—Pittsburgh Pattern.

5 to 8 pounds, $32.00 dozen.
7 to 9 pounds, $35.00 dozen.
8 to 10 pounds, $38.00 dozen.
9 to 12 pounds, $45.00 dozen.
Western pattern same price.

Spanish Pattern. Detumba round eye, $10.50 per doz.

Spanish Pattern Media labor, $12.25 per dozen.

Axle Grease.

Frazer's (2-lb. tins), per gross	$18.00
2-lb. wooden boxes, "	12.00
Discount, 25 and 5 %.	
Dixon's Everlasting, boxes 1 lb., per doz	$1.20
" " " 2 lbs.. "	2.00

Lovell, Tracy & Co.

English coach axle grease.

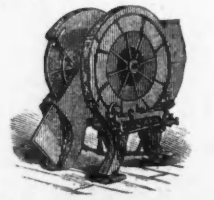
Regular wooden boxes per gross, $8.50.

Axleine.

Decorated tin boxes, per gross $12.

Special prices on quantity, and goods in large packages.

Barrel Machinery.



Stave Jointers.

Single Whee Beer Keg Stave Jointer, 16 to 22 in.	8	8	$190
Double " " " " 16 " 22 "	8	8	330
Single Wheel Half Barrel " 24 " 30 "	8	8	275
Double " " " " 24 " 30 "	8	8	440
Single " Barrel " " 30 " 36 "	8	8	330
Double " " " " 30 " 36 "	8	8	500
Double Independent Barrel Stave Jointer with Wheels, on separate shafts, but suspended in one frame, 30 to 36 in	8	8	520
Single Wheel Barrel Stave Jointer, 32 to 38 in.	8	8	350
Double " " " " 32 to 38 "	8	8	550
Double Independent Barrel Stave Jointer, 32 to 38 in.	8	8	575

Bellows.

Miner's Bellows: 24 in., $8.50; 26 in., $9.75; 28 in., $11.00; 30 in., $11.25; 32 in., $13.50. 60 and 5% dis.

Standard, each: 18 to 24 in., $10; 28 in., $12; 32 in., $14; 34 in. $16; 36 in., $18; 38 in., $20; 40 in., $23; 44 in., $32. 60 and 5% dis.

Hand Bellows, per doz.: 6 in., plain, $10; fancy, $20; 7 in., plain, $12; fancy, $24; 8 in., plain, $14; fancy, $28; 9 in., plain, $16; fancy, $32; 10 in., plain, $18; fancy, $36. 50% dis.

Belting. LEATHER BELTS.

Standard Manufacturers List.

Single belts per foot.

Width.		Width.		Width.	
1 inch	.10	6 inch	.76	20 inch	2.84
1¼ "	.13	7 "	.90	21 "	3.02
1½ "	.17	8 "	1.02	22 "	3.20
1¾ "	.20	9 "	1.15	23 "	3.37
2 "	.23	10 "	1.29	24 "	3.54
2¼ "	.26	11 "	1.42	26 "	3.92
2½ "	.30	12 "	1.55	28 "	4.30
2¾ "	.33	13 "	1.68	30 "	4.64
3 "	.36	14 "	1.82	32 "	5.00
3½ "	.43	15 "	1.98	34 "	5.35
4 "	.50	16 "	2.14	36 "	5.70
4½ "	.56	17 "	2.31	40 "	6.40
5 "	.63	18 "	2.49	44 "	7.10
5½ "	.70	19 "	2.66	48 "	7.80

Double belts twice the price of single.

Discounts of Newark Leather Belting Co.

Dis. single and double belts, cemented, 50 and 5%.

Dis. single and double belts, riveted and cemented, 50 and 5%.

Dis. single belts, cemented and lacesewn, water proofed, 50%.

Dis. double belts, cemented and lacesewn, water proofed, 45%.

GASKETS.

Corrugated Copper.

Price, 2 cents per square inch, less 30 per cent. discount for home trade.

Less 60% discount for export trade.

Bolts.

Philadelphia Tire Bolt, with forged nuts.

Price per hundred.

Condensed list.

Length	1-8	3-16	7-32	1-4	5-16	3-8
1	$1.50	$1.50	$1.50	....	....	....
2	1.50	1.60	1.85	$2.25	$3.05	$5.00
3	....	1.90	2.25	2.75	3.65	5.80
4	....	....	....	3.25	4.25	6.60
5	....	....	....	....	4.90	7.40

Fractional sizes, intermediate prices.

Discount 80 and 2 %.

Common Carriage Bolts, price per hundred.

Length.	3-16 & 1-4	5-16	3-8	7-16	1-2	9-16 & 5-8	3-4
1 to 1½	$1.35	$1.60	$2.30	$3.10	$3.80	$7.50	
2	1.45	1.75	2.30	3.10	3.80	7.50	
3	1.65	2.05	2.70	3.60	4.44	7.50	$13.50
4	1.85	2.35	3.10	4.10	5.08	8.50	14.90
5	2.05	2.65	3.50	4.60	5.72	9.50	16.30
6	2.25	2.95	3.90	5.10	6.36	10.50	17.70
7	2.45	3.25	4.30	5.60	7.00	11.50	19.10
8	2.65	3.55	4.70	6.10	7.64	12.50	20.50
9	2.85	3.85	5.10	6.60	8.28	13.50	21.90
10	3.05	4.15	5.50	7.10	8.92	14.50	23.30
12	3.45	4.75	6.30	8.10	10.20	16.50	26.10
14	3.85	5.35	7.10	9.10	11.48	18.50	28.90
16	4.25	5.95	7.90	10.10	12.76	20.50	31.70

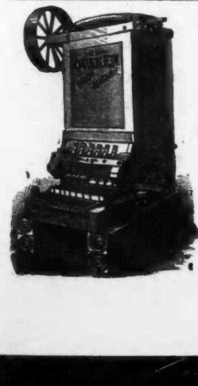
Fractional sizes, intermediate prices. Dis. 75 and 10%

Philadelphia Carriage Bolt, price per hundred.

Length	1-8, 3-16 & 1-4	5-16	3-8	7-16	1-2
1 inch.	$3.00	$4.00	$5.00	$7.40	$9.00
2 "	3.40	4.10	5.00	7.40	9.00
3 "	3.80	4.70	5.80	8.20	10.00
4 "	4.20	5.30	6.60	9.00	11.00
5 "	4.80	6.00	7.40	9.80	12.00
6 "	5.40	6.60	8.20	10.60	13.00
7 "	....	7.30	9.00	11.40	14.00
8 "	....	7.90	9.80	12.20	15.00
9 "	....	8.50	10.60	13.00	16.00
10 "	....	....	11.40	13.80	17.00
11 "	....	....	....	14.60	18.00

Fractional sizes, intermediate prices. Dis. 80 and 5 %.

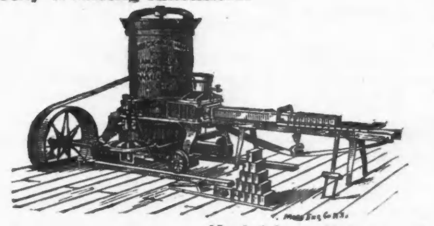
Brick Machinery.



BENNETT BROS. & CO.

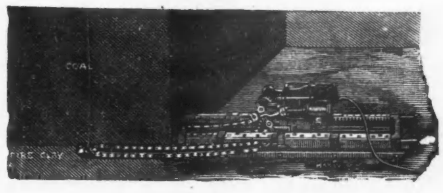
Heavy Steam Power Machine	$525.00
Horse-Power Machines	300.00
Additional Horizontal Pugmill	225.00
Brick Moulds	$2.50 to $3.00
Brick Trucks	5.00 to 13.50
Brick Barrows	7.25
Brick Barrows with Springs	8.25
Sand Barrows, steel tray	6.50

Clay Working Machines.



	No. brick per day.	Compl'te.
No. 10 D brick machine	50,000	$1,500
No. 10 S " "	30,000	1,200
No. 4 " "	40,000	1,100
No. 7 S " "	20,000	650
No. 6 S " "	15,000	575
No. 2 E. H. P. "	6,000	3,360

Coal Mining Machine.



Jeffrey.

6 feet undercut........$1500 | 5 feet undercut........$1100

Jeffrey Power Coal Drills.

Air feed drill........$275 | Screw feed drill........$200

Discount. 10%.

Cork Pullers.

The Samson Cork Puller, per dozen, $12 net.

Crucibles. E. H. Sargent & Co.

Battersea Crucibles, Triangular.

No.	Height. Inches.	Width. Inches.	Crucibles. Per doz.	Covers. Per doz.
S	4½	4⅛	$1.00	$0.50
T	4	3¾	0.80	0.50
U	3½	3¼	0.60	0.40
V	3¼	2⅞	0.45	0.40
W	2⅝	2⅝	0.35	0.30
X	2½	2¼	0.30	0.30
Y	2⅛	2⅛	0.25	0.30
Z	1¾	1¾	0.20	0.30

Battersea Muffles, any size, made to order.

See Illustration in advertisement.

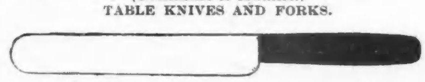
No.	Long. Inches.	Wide. Inches.	High. Inches.	Price. Each.
A	7	3½	2½	$ .60
B	7½	4⅜	2⅞	.75
C	8	4¾	3	.85
D	8½	5	3¼	1.00
E	9	5½	3⅜	1.15
F	10	6	4	1.25
G	11	4	3⅛	1.00
H	10½	5¼	3⅞	1.00
J	12	6	4	1.25
K	14	8	5	1.75
L	15	9	6	2.00

Export discount 15 %.

Cutlery.

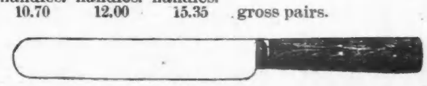
(Tommins & Adams.)

TABLE KNIVES AND FORKS.

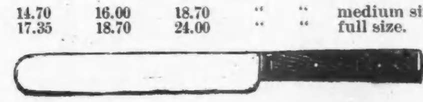


Japanned iron handles, $10.70 per gross pairs.

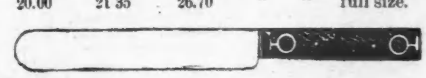
Cocobola handles.	Ebony handles.	Bone handles.	
10.70	12.00	15.35	gross pairs.



14.70	16.00	18.70	"	"	medium size.
17.35	18.70	24.00	"	"	full size.



17.35	18.70	21.35	"	"	medium size.
20.00	21 35	26.70	"	"	full size.



22.70 24.00 29.35 " "

22.35 23.70 36.00 "

Cocobola handles. Ebony handles. Bone handles. gross pairs.

28 00 29.35 38.00 " "

28.65 30.00 38.00 " "

2 .65 30.00 38.00 " "

32.00 33.35 38.00 "

34.70 36.00 48.00 " "

33.35 34.70 46.70 " "

37.35 38.70 50.70 " "

40.00 41.35 53.35 " "

Hard rubber handles, 5.75 per dozen pairs.

Solid bone handles, 4.80 per dozen pairs.

Celluloid handles, 7.35 per dozen pairs.

Forks are made to match all above patterns, with either three or four prongs.

Discount 25 %.

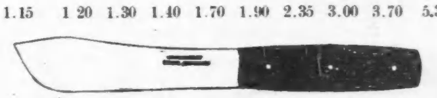
BUTCHERS' KNIVES COCOBOLA HANDLES.

Per dozen.

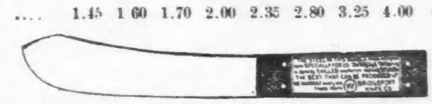
4 and 4½ in.	5 in.	5½ in.	6 in.	6½ in.	7 in.	8 in.	9 in.	10 in.	12 in.
1.15	....	....	1.20	....	....	....	....	....	....

1.40 ... . 1.50 ....

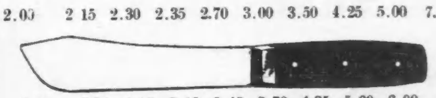
1.15 1 20 1.30 1.40 1.70 1.90 2.35 3.00 3.70 5.35



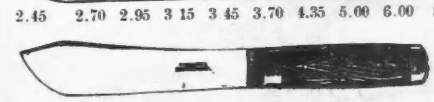
.... 1.45 1 60 1.70 2.00 2.35 2.80 3.25 4.00 6.00



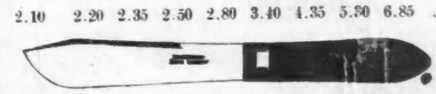
2.00 2 15 2.30 2.35 2.70 3.00 3.50 4.25 5.00 7.50



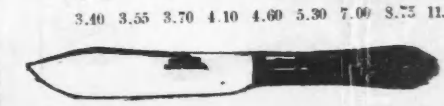
2.45 2.70 2.95 3 15 3.45 3.70 4.35 5.00 6.00 8



2.10 2.20 2.35 2.50 2.80 3.40 4.35 5.30 6.85 ...



3.40 3.55 3.70 4.10 4.60 5.30 7.00 8.75 11.75



.... 4.10 4.25 4.40 4.80 5.30 6.00 7.75 9.50 12.5

2.00 2.15 2.30 2.35 2.70 3.00 3.50 ....

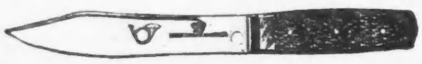
Discount 25 and 10 %.

HUNTING KNIVES—EBONY HANDLES.

5 in. 5½ in. 6 in. 6½ in. 7 in. 8 in. 9 in. 10 in.
Per Dozen.

2.10 2.20 2.35 2.75 3.00 3.60 4.30 5.25

2.10 2.20 2.35 2.75 3.00 3.60 4.30 5.25

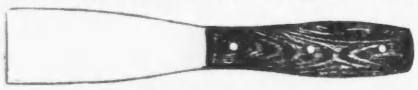


2.55 2.70 3.00 3.30 3.55 4.00 5.00 6.00

2.55 2.70 3.00 3.30 3.55 4.00 5.00 6.00

Discount, 25 and 10 %.

Per Dozen.
Putty knives, cocobola handles.......... $1.30



Putty knives. cocobola handles.......... 1.50

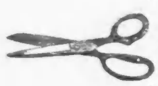
TAILORS' SHEARS—JAPANNED OR NICKEL HANDLES.

Per pair.
12 in........ 6.00
12½ in........ 7.00
13 in........ 8.00
13½ in........ 9.00
14 in........ 10.00
14½ in........ 11.00
in .... 12.00 | 16 in........ 14.00
Discount, japanned, 60 %; nickle, 45 %.

BENT TRIMMERS.

Per dozen.
6 in..... 13.00 | 10 n..... 27.00
7 in..... 15.00 | 11 in..... 30.00
8 in..... 17.00 | 12 in..... 33.00
9 in..... 22.00 |

STRAIGHT TRIMMERS.

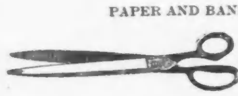


Per dozen,
6 in........ 12.00 | 10 in........ 25.00
7 in........ 14.00 | 11 in........ 30.00
8 in........ 16.00 | 12 in........ 33.00
9 in........ 19.00 |

LADIES' SCISSORS.

Per dozen.
4½ in....... 10.00 | 6 in....... 11.00
5 in....... 10.00 | 6½ in....... 12.00
5½ in....... 10.50 | 7 in....... 13.00

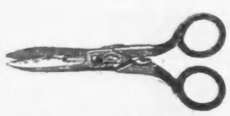
PAPER AND BANKERS' SHEARS.



Per dozen.
9 in...18.00 | 13 in....36.00
10 in...25.00 | 14 in.. 42.00
11 in...27.00 | 16 in....54.00
12 in. .32.00 | 18 in ..20.00

BARBERS' SHEARS.

Per dozen.
7½ in...... 15.00 | 9 in........ 18.00
8 in........ 16.00 | 9½ in...... 20.00
8½ in ..... 17.00 |

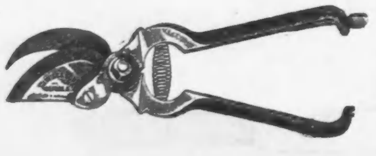


BUTTON-HOLE SCISSORS.

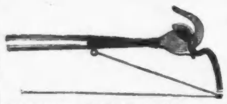
5 and 5½in., 14 00 per dozen.

Discount, japanned, 70 and 10 % nickel, 60 and 10 %.

PRUNING SHEARS.
1 B., 9 in., 24 per dozen; 2 B., 8½ in., 21; 3 B., 7¾ in., .9.80.



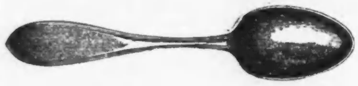
No. 110, 10 in., $30 per doz.



PRUNING SHEARS FOR LONG HANDLES.
No. 1, $36 per dozen; No. 2, $30 per dozen.
Discount. 35%.

SPOONS, FORKS, ETC., BEST PLATE ON HARD WHITE METAL.

Tipped Tea Spoon.



Oval Tea Spoon.

Perfect Tea Spoon.

Leader Tea Spoon.

	—5 oz. or extra plate—		
	Tipd	Oval.	Perfect and Leader.
Tea spoons	4.25	4.50	4.75 per doz.
Dessert spoons	7.50	8.00	8.50 " "
Table spoons	8.50	9.00	9.50 " "
Coffee spoons	4.25	4.50	4.75 " "
Dessert forks	7.50	8.00	8.50 " "
Medium forks	8.50	9.00	9.50 " "

Discount, 60 and 5%.

Spoons and forks, German silver, tipped pattern.

Tea spoons.	Table spoons.	Medium forks.
22.50	45.00	45.00 per gross.

Discount, 60 %.

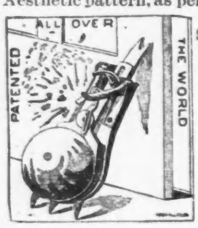
Spoons and forks, made from brass, and silver plated on a coating of hard, white nickel.
Aesthetic medium fork.

Tea spoons.	Table spoons.	Medium forks.
7.50	15.00	15.00 per gross.

Discount, 30 and 5 %.

Children's sets *on cards*.

	3 pcs.	4 pcs.	
Leader pattern, as per cut	21.00	24.00 doz.	60 and 5 %
Aesthetic pattern, as per cut	5.75	7.25 doz.	30 and 5 %



SAFETY AUTOMATIC BURGLAR ALARM AND DOOR FASTENER.

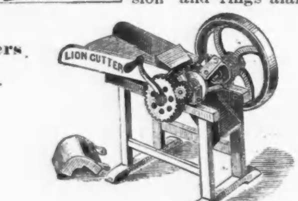
REQUIRES NO WINDING UP.

Per doz., $24. Dis., 40%.

The slightest push on the door explodes two caps in succession and rings alarm bell.

Cutters.

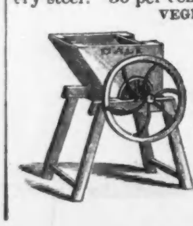
FEED.



No. of cutter.	No. of knives.	Length in inches of knives.	Length in inches of feed cut.	Price.
1	2	6¼	½, ¾ and 1⅛	$18.00
2	2	7¼	½, ¾ and 1⅛	21.00
2½	1	7¼	⅝, ⅞, 1¼ and 1¾	21.00
2½	2	7¼	5/16, 7/16, ⅝ and ⅞	23 00
3	1	8½	⅝, ⅞, 1¼ and 1¾	25.00
3	2	8½	5/16, 7/16 ⅝ and ⅞	27.00
4	1	10	⅝, ⅞, 1¼ and 1¾	30.00
4	2	10	5/16, 7/16, ⅝ and ⅞	33.00
5	2	10	7/16, ⅝, ⅞ and 1¼	35.00
6	2	11	7/16, ¾, 1¼ and 2	45.00
6½	2	11	7/16, ¾, 1¼ and 2	45.00
7	2	13	7/16, ¾, 1¼ and 2	60.00
7½	2	13	7/16, ¾, 1¼ and 2	60.00
10	2	16	7/16, ¾, 1¼ and 2	80.00
12	2	20	7/16, ¾, 1¼ and 2	100.00
11	2	11	7/16, ¾, 1¼ and 2	45.00
13	2	13	7/16, ¾, 1¼ and 2	60.00
16	2	16	7/16, ¾, 1¼ and 2	80.00
20	2	20	7/16, ¾, 1¼ and 2	100.00

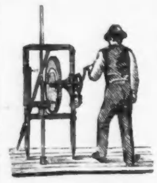
The knife arbors for all sizes are made of machinery steel. 30 per cent. dis.

VEGETABLE—GALE'S.



Size.	Weight of Fly Wheel. Pounds.	Will cut per hour. Pounds.	Price
No. 1½	20	1,500	$12
No. 2½	32	1,700	15
No. 3½	32	1,700	15
No. 4	42	2,000	18
No. 5	50	3,000	25
No. 10	65	8,000	35

30% dis.



Drill—Portable Hand Rock.

Price, $225.

Dis., 20%.

Duck and Twine.

22-inch, Hard, Medium and Soft.

No.	Weight per yd.	Cents, per yd.	No.	Weight per yd.	Cents, per yd.
No. 0...	19 oz.	35	No. 6...	13 oz.	26
1...	18 "	33	7...	12 "	25
2...	17 "	32	8...	11 "	23
3...	16 "	30	9...	10 "	21
4...	15 "	28	10...	9 "	20
5...	14 "	27			

Ravens, 28½-inch.—Eight ounce, 15 cents per yard Ten ounce, 19 cents per yard; twelve ounce, 22 cents per yard; Fifteen ounce, 27 cents per yard. Dis. 25 and 1%.

Cotton Sail Twine.—Three-fold and upward, 17 to 20 cents per pound. Dis. 3%.

Electroplate.—Babcock & Co.'s.

Dis. 60 and 2%.

CASTERS.

1,200—Dinner'

232—Breakfast.

Dinner Casters.
No. 1,200. 17½ in. high, $8.00, quadruple plate.
No. 80. 17 in., $6.00, quadruple plate.
No. 140. 16 in., $7.50, " "
No. 830. 16 in., $5.00, " " Plain, 50 cents less.
No. 25. 16 in., $4.00, double plate.
No. 33. 16 in., $3.75, " "
No. 53. 15 in., $3.00, " "
No. 15½. 14½ in., $2.00, single plate.
No. 19. 14½ in., $1.85, " "
No. 40. 14 in., $1.75, " "

No. 681.

reakfast Casters.
231. 10 in. high, $4.00, quadruple plate.
No. 232. 12 in. high, $6.00 quadruple plate.
No. 13. 12 in. high, $2.25, double plate.
No. 12. 10½ in. high, $1.75, single plate.

CAKE BASKETS.
Quadruple Plate.
No. 448. 7 in. high-chased, $16; gold lined, $17.
No. 690. 7½ in. high, chased, $7; gold lined, $8.
No. 686. 6½ in. high-chased, $4.50; gold lined, $5.50.
No. 681. 6 in. high, chased, $3; gold lined, $3.50.

BUTTER DISHES.

No. 126. 11 inches high, $5.50.

No. 127. 7 inches high, $5.50.

No. 75. 8 inches high, $1.85.

No. 78. 7½ inches high, $2.00.

Discount.

CHILD'S SETS.

No. 90.

No. 90. Satin lined case, cup, saucer, knife. fork and spoon, $2.25.

No. 41. Cup, gold lined, in fancy case, $1.15.

No. 43. Cup and saucer, gold lined, fanc case, $1.15.

FLAT WARE.

Calla Lily, Empress, Windsor and Olive Patterns, 18 Per Cent Nickel Silver Base.

	Extra plate, per doz.	Double plate, per doz.	Triple plate, per doz.
Tea spoons	$4.75	$6.00	$7.25
Dessert spoons	8.50	10.50	12.50
Table spoons	9.50	12.50	14.50
French coffee spoons	4.75	6.00	7.25
Berry or nut spoons	24.00	30.00	36.00
Bar spoons, small	4.75	6.00	7.25
Dessert forks	8.50	10.50	12.50
Medium forks	9.50	12.00	14.50
Oyster forks	7.00	9.00	11.00
Sugar shells	9.00	11.00	13.00
Sugar tongs	25.50	31.50	37.50
Butter knives, twist or reversed handles	10.50	12.50	14.50
Nut picks	4.75	6.00	7.25
Pie knives, engraved blades	42.00	51.00	60.00
Soup ladles	48.00	60.00	72.00

PICKLE DISHES.

No. 144. 12 in. high, $3.50

No. 66. 10½ in. high, $2; assorted colored glass.

No. 155. 12 in. high, $4; assorted colored glass.

No. 146. 12½ in. high, $9; hand decorated glass.

No. 156. 12½ in. high, $6; hand decorated glass.

No. 146.

TEA SETS.

No. 255. 6 pieces, $35, quadruple plate.

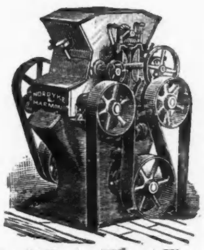
No. 301. 4 pieces, $23, quadruple plate.

No. 1847. 6 pieces, $42, quadruple plate.

No. 255.

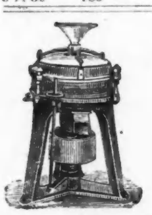
Flouring Mill Machinery.

Nordyke & Marmon Co.



Roller Mills for Wheat Flour.
Prices of Double and Single Roller Mills.

Size.	All smooth.	½ Corrug. ½ smooth.	All corrug.	Single machines. Corrug.	Single machines. Smooth.
6 × 12	$465	$475	$480	......	......
6 × 16	515	525	530	......	......
6 × 20	565	575	580	......	......
7 × 14	515	525	530	......	......
7 × 18	560	570	575	......	......
7 × 24	635	645	650	......	......
9 × 18	625	640	650	$350	$335
9 × 24	700	720	735	390	375
9 × 30	785	810	830	440	420

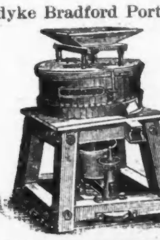


20-inch New Era Mill for Wheat, Corn, and Middlings.

Size. Inch.	Power. H. P.	Pulley. Inch.	Capacity Bush.
20	4 to 10	14 × 7	12 to 40

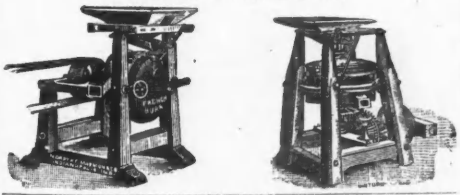
Speed.	Weight. Lbs.	Price.
500 to 800	660	$150

The Nordyke Bradford Portable Mill.



Size of stones. In.	Grinding capacity. Corn, bu. per hour.	Grinding capacity. Wheat bu. per hour.	Horse-power.	Weights. Sing'l gear.	Weights. Double gear.	Pulley mill.	Geared mills. Iron wh'ls.	Geared mills. Mortise wh'ls.
18	8 to 10	....	4	550	625	$130	$165	$180
20	10 to 12	....	5	600	700	140	175	190
22	12 to 15	....	5	700	850	160	190	210
24	15 to 18	....	6	900	1050	175	210	225
26	18 to 20	8 to 10	8	1200	1400	185	225	250
30	20 to 25	10 to 12	10	1500	1700	225	265	290
36	25 to 30	14 to 17	12	1800	2100	315	355	380
42	35 to 40	19 to 21	15	2000	2300	390	435	460

Farm and Plantations Mills.



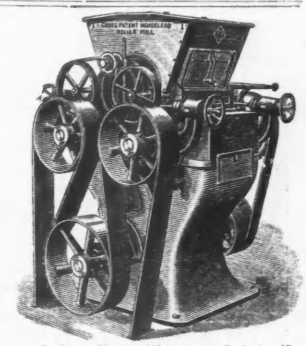
Diameter of burrs.	Power to drive.	Size of pulley.	Capacity per hour.	Revolutions per minute.	Weight.	Price
	H. P.					
14 in.	2 to 4	9×5½	4 to 14 bushels	600 to 1200	370 lbs.	
18 in.	4 to 10	11×6½	8 to 40 bushels	400 to 700	600 lbs.	

The Dixey Mill—Stiff Spindle Style.

Size.	Power.	Capacity.	Weight. Pulley.	Weight. Geared	Pulley.	Iron gear.	Mortise gear.
18	4 to 6 H.P.	8 to 25 bu	560 lbs	650	$130	$165	
22	6 to 8 "	12 to 30 "	800 "	1000	165	200	
26	8 to 12 "	16 to 40 "	1100 "	1500	185	220	
30	10 to 15 "	25 to 60 "	1300 "	1700	215	255	

Flour Mills.

E. P. Allis & Co.

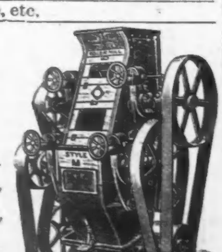


Gray's pat. noiseless belt roller-mills, porcelain rolls.

Size of Rolls.	Height.	Length.	Width.	Driving pulley.	Revolutions per minute.	Approximate power required.	Length of driving belt above floor.	Approximate shipping weight.	Price
14″ × 16″ single	5′ 7″	3′ 2″	4′ 5″	20″ × 6½″	200 to 300	1¾ to 2½ H. P.	16′ 3″	2,700 lbs.	$600.00
14″ × 16″ double	5′ 10″	5′ 6″	4′ 10″	20″ × 6½″	200 " 300	3 " 4 H. P.	19 3″	4,000 "	800.00
9″ × 14″	5′ 1½″	3′ 10″	3′ 10″	12″ × 5¼″	300 " 400	1½ " 2½ H. P.	16′ 6″	2,700 "	580.00
With corrugated chilled iron rolls.									
9″ × 14″	5′ 1½″	3′ 10′	3′ 10″	12″ × 5¼″	300 to 400	1½ to 2½ H. P.	16′ 6″	2,700 lbs.	$600.00
With Wegmann's patent porcelain rolls.									
9″ × 14′	5′ 1½″	3′ 10″	3′ 10′	12″ × 5¼″	300 to 400	1½ to 2½ H. P.	16′ 6″	2,700 lbs.	$650.00
Divided four roller machines.									
9″ × 14″, 1-pr. cor. 1-pr. sm.	5′ 1½″	3′ 10″	3′ 10″	12″ × 5¼″	300 to 400	1½ to 2½ H. P.	16′ 6″	2,700 lbs.	$590.00
9″ × 14″, 1-pr. sm. 1-pr. por.	5′ 1½″	3′ 10″	3 10″	12″ × 5¼″	300 to 400	1½ to 2½ H. P.	16 6″	2,700 lbs.	615.00
9″ × 14″, 1-pr. cor. 1-pr. por.	5′ 1½″	3′ 10″	3 10″	12″ × 5¼″	300 to 400	1½ to 2½ H. P.	16′ 6″	2,700 lbs.	625.00

For grinding corn, feed, rye, etc.

Size.	Height.	Width.	Length.
6″ × 12″...	4′ 6″	3′ 5″	2′ 7″
9″ × 14″...	5′ 8″	3′ 10″	3′ 5″
9″ × 18″...	5′ 8″	4′ 9″	3′ 5′
9″ × 24″...	5′ 8″	5′ 6″	3′



Driving pulley.	Revolutions per minute.	Length of belt above floor.	Approximate shipping weight	Price.
10″ × 5¼″	400 to 500	14′	....	$500.00
14″ × 6¼″	350 to 450	18′	2600 lb.	600.00
14″ × 7¼″	350 to 450	18′	3050 lb.	650.00
14″ × 8¼″	350 to 450	18′	3350 lb.	735.00

Flue Cleaner.

Hurley's Automatic Steam Flue Cleaner.

No.	Outside diam. of tubes.	With hose clamps.	Globe Valves.	Best 4-ply steam hose. Per foot.
1	1½ to 2	$5.00	½, 95 cents	¾, 67 cents.
2	2 to 2½	6.25	½, 95 cents	¾, 67 cents.
3	2½ to 3	7.50	¾, $1.30	¾, 67 cents.
4	3 to 3½	8.75	1, 1.75	1¾, 83 cents.
5	3½ to 4½	10.00	1¼ 2.90	1¼, $1.04

Dis. on flue cleaners, 60 and 70%.

Dis. on steam hose, 50%, good to 90 lbs steam.

Forges (Portable).

Fairbanks.

No. 2c, weight, 155 lbs. 21 × 27 hearth............ $42.00
" 3a, " 80 " 18 in. diam. hearth.......... 27.00
" 3b, " 75 " 18 " " " 24.00
" 3c, " 85 " 18 " " " 30.00
" 6a, " 45 " 14 " " " 18.00
" 6B, " 45 " 14 " " " 16.00

Dis. 60%.

No. 1, 18 in. bellows, $20; No. 2, 20 in. bellows, 25; No. 3, 22 in. bellows, $30.

20% dis.

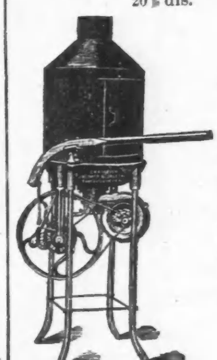
Stationary.

27 in. bellows, $21; 30 in. bellows, $25; 33 in. bellows, $33; 36 in. bellows, $45.

20% dis.

Riveting Forges.

Bellows, 18 in. 20 in., 22 in., 24 in.,
$8.00. $10.00. $13.00. $17.00.
20% dis.



Light work, 12 × 17; height, 15 in., $16.00.

Same, with Hood, 12 × 17; height, 28 in., $20.00.

Bridge, Boiler or Railroad work. Pan, 17 × 19; height, 29 in.: Fan, 8 in., $27.00.

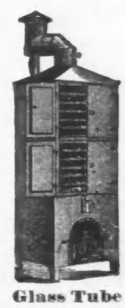
Same, with Hood, $30.00.

Water Tank, $4.00 extra.

Iron Fire Ring Round Tuyere $1.00 extra.

50% dis.

Fruit Evaporator.



No. 1. Evaporator.................... $30

No. 2. Fruit Drier and Baker, with Bleacher attachment. Weight, 225 lbs. Capacity, 5 to 7 bushels apples per day; 24 in. deep, 26 in. wide, 5½ ft. high; 12 trays, 22 22; 40 square feet drying surface. Complete $50

No. 3. Capacity, 15 to 20 bushels per day.................... 100

No. 4. Capacity, 20 to 30 bushels per day.................... 16

Dis., No. 1, 3 and 4 = 20%.
" 2 = 30%

Boxing, extra:
No. 1, $3.00; No. 2, $5.00; No. 3, $7.50; No. 4, $12.50.

Freight to New York:
No. 1, $4.00; No. 2, $6.00; No. 3, $12.00; No. 4, $18.00.

Glass Tube Cutters.

One Arm Carries Rotary Cutter Price, $2.50 each.

Glassware.

6-in. bowl and cover, per doz.......... $3.25
7-in. " " " 4.50
8-in. " " " 6.00
9-in. " " 8.00
10-in. " " 10.50

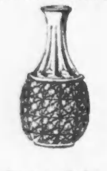
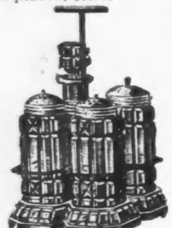
Net.

Nappy, 4½-inch., per doz., 50c.; 6-inch., per doz., $2; 7-inch., per doz., $3; 8-inch., per doz., $4.

Cream Pitcher, 1 pint, per doz., $1.25; one quart, per doz., $3.50; 3 pints, per doz., $4.50.
Pint Pitcher, per doz., $1.50; quart pitcher, per doz., $2; ½ gallon pitcher, per doz., $3; 3 quart pitcher per oz., $4.50.


Flange Butter and Cover, per doz., $1.75.
Water Set, per doz., sets of 60 pieces, $7.50.



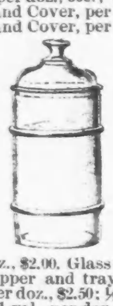



Cheese Dish and Cover, 8 in., per doz., $4.50.
Quart Water Bottle, per doz., $4.50.
Ind. Salts; per gross, $2.00. Assorted patterns.
4 Bottle Castors, per doz., $7.50; 3 bottle, per doz., $4.50.



Berry Dish, 4½-inch, per doz., 50c.; 10-inch, per doz., $4.
Butter Dish and Cover, per doz., $1.25.
Butter Dish and Cover, per doz., 75c.



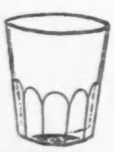



Candlesticks, per doz., $2.00. Glass Slipper for Flowers, per doz., 50 cents; slipper and tray, per doz., $1. Jam Jar and Cover, 1 qt., per doz., $2.50; ½ gal., per doz., $3.25; ¾ gal., per doz., $4; 1 gal., per doz., $5; 1½ gals., $9; 2 gals., per doz., $12. Pocket Flask, 1 pint, $1.

Tumblers.

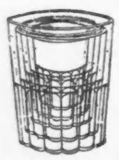
1⅝ oz., per doz., 50 cents.
8 " " 75


9 oz., per doz., $2.75.



11 oz., assorted patterns, per doz., 30 cts.

9½ oz., assorted patterns, per doz., 25 cts.



1 oz. to 12 oz., nested for shipping, per doz. nest, $2.


Goblets, banded per doz 65 cents.
Claret to match, per doz., 55 cents.
Wines, to match, per doz., 50 cents.
Cordials, to match, per 45 cents.

Banded, open, hollow stem

Goblets, per doz., 50 cts.
Claret, " 50 "
Wine " 35 "

Champagne, per doz., $1.25.

½ Pt. tumbler, per doz. 55 cts.
½ Pt. mug to match, " 65 "
Goblet, " 50 "
Spoon holder, cream pitcher, sugar, butter dish to match.
Sets of 4 pieces, per doz. sets, 48 pieces, $3.75.

Grinding Mills.—Emmert & Lamb.

"Daisy," without Shaking Bolt, 170 pounds, 9 cubic feet, $40.
"Daisy," with Shaking Bolt, 185 pounds, 9 cubic feet, $48.
Discount 25 per cent.

"The Union Mill."

Diameter of Buhr Stones	Size of Pulleys Diam.	Face.
12 in.	8 in.	6¼ in.
16 "	9 "	7½ "

Horse Power	Capacity in B'sh's	Speed	Without Bolt	With Bolt	Sacking Elevator, Extra	Extra Metal Buhrs
8 to 10	12 to 30	1200 to 1500	$90.00	$105.00	$15.00	$1.20 pair
10 to 15	20 to 50	1000 to 1600	160.00	178.00	17.50	1.50 "

Hammers.

H. Cheney Hammer Co.

Adz-eye Hammers.—Per Dozen.

No.	Weight.		No.	Weight.	
5. Round.	1 lb., 4 oz	$9.00	7½. Round.	13 oz	$8.00
7. "	1 lb.	8.50	8 "	7 oz.	7 50

Adz-eye Hammers.—Per Dozen.

No. 17. Octagon. weight, 1 lb., 4 oz. $9.00

Adz-eye Hammers.—Patent Nail Holder.—Per Dozen.

No.	Weight.		No.	Weight.	
33. Bell-face.	1 lb., 4 oz	$9.50	35. Round h.	1 lb., 4 oz	$9.50
34. "	1 lb.	9.00	36. "	1 lb.	9.00

Adz-eye Hammers.—Bell Face.—Per Dozen.

No.	Weight.		No.	Weight.	
37.	1 lb., 4 oz.	$9.00	38½.	13 oz	$8.00
38.	1 lb	8.50	39½.	7 oz	7.50

Farriers' Hammers.—Per Dozen.

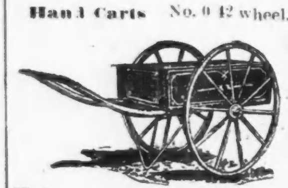
No.		Weight.	
55.	Adz-eye Octagon.	9 oz	$7.75
56.	" "	7 oz	7.50
57.	Plain. "	7 oz	6 25
58.	Plain Brad.	4 oz	5 50
60.	Adz-eye, Round Head.	7 oz	7 50
61.	" Octagon. Boston pattern	10 oz	8.00
62.	" " "	7 oz	7 50

Machinists' Ball Pein Hammers.—Octagon.—Per Dozen.

No.	Weight.		No.	Weight.	
90.	3 lbs	$22.00	94.	1 lb., 4 oz	$13 50
90½.	3 lbs., 8 oz	19.00	95.	1 lb	12.50
91.	4 lbs., 4 oz	17.50	96.	12 oz	12.00
92.	2 lbs	16.50	97.	8 oz	12.00
92½.	1 lb., 12 oz	15.50	98.	6 oz	12.00
93.	1 lb., 8 oz	14 50			

Discount, 35 and 5 per cent. Net Cash, 30 days. 10 per cent. Cash, 10 days. Cases at Cost.

Hand Carts No. 0 42 wheel, 1 in. tread, 1 in. axle box 48x28x10 deep, $10.50.



No. 1, 36 wheel, 1 in. tread, ⅞ in. axle, box 40x23x10 deep, $9.00.
No. 2, 30 wheel, ¾ in tread, ¾ in. axle, box 32x20x9 deep, $8.25.

With Wagon-Seat Spring.

No. 6, same sizes as No 0 .... $12.00
" 7, same sizes as No. 1 .... 10.50
" 8, " " " No. 2 .... 9.75

With Third Wheel, Without Springs.

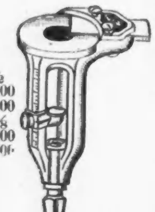
No. 3, same size as No. 0 .... $12.06
" 4, " " " No. 1 .... 10.50
" 5, " " " No. 2 .... 9.5

Hardware Specialties.

AUGERS.
Patent Adjustable Hollow.

Cuts from ¼ to 1¼, pivoted jaws, graduated scale to 1-16ths, per doz., $60.00

Discount, 15 and 10%.



Patent Hollow Auger.

Inch	5-16	⅜	7-16	½
With bits	12.00	12.00	12.00	12.00
Without bits	8.00	8.00	8.00	8.00

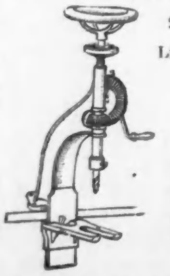
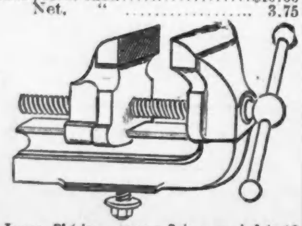
9-16	⅝	¾	⅞	1	1⅛
14.00	14.00	14.00	16.00	16.00	20.00
9.00	9.00	9.00	13.00	13.00	14.00

1¼	1⅜	1½
20.00	24.00	24.00
14.00	16.00	15.00

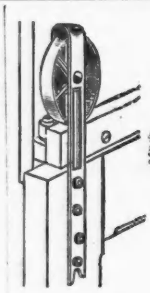
Discount, 15 and 10%.

BENCH DRILL.

Adjustable bed plate.
26½ high drills to ½ in. hole, 3½ run of screw.
List price, each $10.00
Net, " 3.75

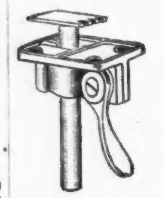



Bench Vise, Steel Jaws, 3½ in., opens 3 in.; weight, 12 lbs.; list price, each, $4.00.; net price, each, $1.60.

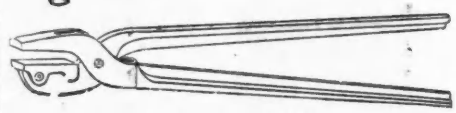


BARN DOOR HANGER.

4 in., per doz. pairs $12.00
5 " " " 14.40
Track, per foot .... .08
One dozen pairs in case.
Dis., 50%.

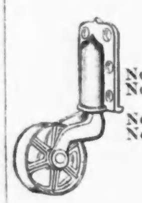


BENCH HOOK.
Patent, adjustable and reversible
List $9 dozen, ½ dozen in box.
Discount, 20 and 10%.



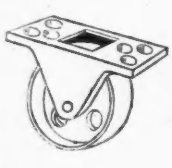
BLACKSMITH'S TONGS.
Swivel Jaw.

No. 1, 16 in., per doz. $10.00
" 2, 18 " " 10.00
Dis. 20%.



CASTERS.
Swivel Store Truck

No. 20, japanned, 4 in. wheel, each ..... .55
No. 25, " 5 " " " ..... .75
Noiseless turned wheel.
No. 30, japanned, 4 in. wheel, each 1.30
No. 35, " 5 " " " 1.60
Discount, 25%.



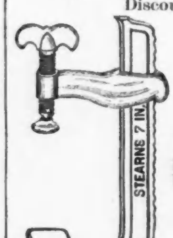
Store Truck, stationary.
No. 50, 5-inch wheel, 1½ inch wide, each, $1.05.
No. 60, 5-inch, extra heavy, 1½ inch wide, each $1.50.
Discount, 25%.

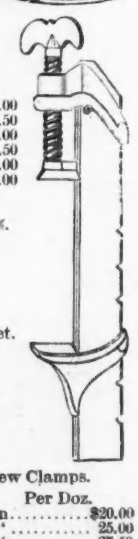
CLOTHES REEL.
Extra heavy, gray iron, japanned.
List per doz $15.00
Net " 7.00

JACK SCREWS.
New pattern wrought iron screw.

No.	Rise of screw.	High.	Diameter screw.	Price.
20	4½ in.	10 in.	2 in.	$4.50
25	6½ "	12 "	2 "	5.25
30	8½ "	14 "	2 "	5.75
	11½ "	16 "	2 "	6.50

Discount, 40%.



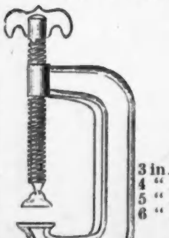


SCREW CLAMPS.
Adjustable.

3 in., per doz $4.00
5 " " 6.50
7 " " 9.00
9 " " 10.50
12 " " 15.00
16 " " 20.00

½ doz. in box.
Discount, 20 and 10%.

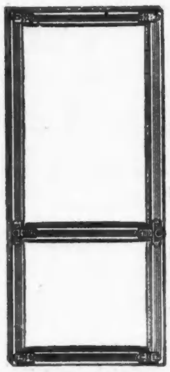
CLAMPS.
New Door Frame.
3 ft. long, per doz., $8 list; $5 per doz. net.



Malleable Iron Screw Clamps.

	Per Doz.		Per Doz.
3 in.	$7.00	7 in.	$20.00
4 "	10.00	8 "	25.00
5 "	12.00	9 "	27.50
6 "	16.00	10 "	30.00

3, 4, 5, 6 in., ½ doz. in box.
Dis., 70%.



DOOR SCREEN FRAMES.

Patent Corners.

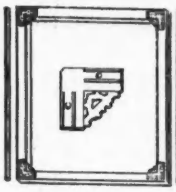
No. 22, 3 by 7 ft. sticks, ⅞ by 2, per doz. sets, $11.

No. 24, 3½ by 8 ft. sticks, ⅞ by 2, per doz. sets, $12.

No. 26, 3 by 7 ft. sticks, ⅞ by 2½, per doz. sets, $12.50.

No. 28, 3½ by 8 ft. sticks, ⅞ by 2½, per doz. sets, $14.50.

Dis., 20%.



WINDOW SCREEN FRAMES.

Patent Japanned Corners.

No. 25, 36 by 36 corners and screws, without bead, per doz., $2.50.

No. 25, 36 by 36 corners and screws, with bead, per doz., $2.90.

No. 35, 42 by 42 corners and screws, without bead, per doz., $2.90.

No. 35, 42 by 42 corners and screws, with bead, per doz., $3.30.

Black satin stain, sticks ⅞ by 1 in.

Dis., 20%.

PULLEYS.

Side, No. 45, Japanned.

Inches...	1	1½	2	2½	3	4	5
Per doz...	.90	1.00	1.60	2.40	3.50	9.00	15.00

2 inch and under, 2 dozen in box: 2½, 3 and 4, 1 dozen in box; 5 inch, ½ dozen in box.

Discount, 50%.

PULLEY HOOK (New Floor.)

Deep cut thread, forged point.

Per doz.

¾ in. wrought iron, 8 in. long, list........ $1.90

net........ 1.00

WELL WHEEL.

New pattern.

Japanned.

In.	8	10	12	14	16
Pr.d.	7.00	9.50	12.50	20.00	30.00

Discount, 70%.

HAY FORK PULLEY.

New pattern.

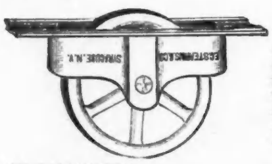
No. 15, 5 in. iron wheel..........per doz. $4.50

25, 5 in. wood " .... " 4.50

66, 6 in. " " .... " 6.00

4 dozen in case, 8 dozen in barrel.

No. 15, per dozen, $2 net.



SHEAVES.

Patent Common

Turned and polished iron wheels, round corners, brass pin, one set in box.

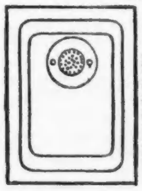
2½ inch $1.50

3 " 1.60

4 " 2.00

5 " 2.60

Discount, 50%.



SINKS.

All 6 inch deep.

14 × 20 in....	$1.50	18 × 30 in....	$2.50
15 × 25 in....	1.75	18 × 32 in....	3.00
15 × 27 in....	2.00	18 × 36 in....	3.00
16 × 24 in....	1.80	20 × 30 in....	3.00
16 × 28 in....	2.10	20 × 36 in....	3.70
17 × 30 in....	2.25	20 × 40 in....	4.00
18 × 24 in....	2.10		

Discount, 60%.

SPOKE POINTERS.

Per doz.

No. 1, points 1⅞ in. diameter, $9.00

No. 2, points 2⅝ in. diameter, $15.00

Discount, 15 and 10%.

⅙ dozen in box.

VISE.

(Bench Vise, Steel Jaws.)

3½ in. opens 5 in., weight 12 lbs.

List price, each. $4.00

Net " " .. 1.60

Silent Saw Vise.

No. 10., 10 in. jaw, per doz.... $15.00

Dis., 33⅓%.

Moore & Barnet Mfg. Co.

No.		per dz.	per gr., lbs.	No.	per dz.	gr., lbs.
1	Amateur vise......	$2.25	70	Clamp.		
Anvil.				1½..............	3.00	80
2	....	3.75	200	2½..............	5.00	220
3	....	11.25	615	3½..............	14.25	700
4	....	18.00	1,350	4½..............	21.00	1,425
10	....	24.00	1,675	Combination hand.........	5.25	85

Spot cash discount, 33, 20 and 2, f.o.b.

Nos. 1, 1½, 2 and 2½ are packed in dozens; Nos. 3 and 3½ in half dozens; Nos. 4, 4½ and 10 in quarter dozens, and No. 20 singly. Each hand vise is put up in neat box and packed in half dozen lots.

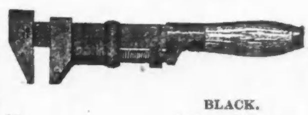
1 Hinge pipe vise, 0 to 2 in. pipe................Each $10.00

2 " " " 0 to 4 in. pipe.................... 20.00

1 Malleable pipe vise, 0 to 2 in. pipe.................... 8.00

1 Combination pipe and bench vise, 0 to 2 in. pipe... 16.00

Discount, 50%.



WRENCHES.

Coes' Knife Handle Wrenches.

BLACK.

Size.	₩ doz.	Size.	₩ doz.
6 inch..................	$9.00	15 inch..................	$24.00
8 "	10.00	18 "	30.00
10 "	12.00	21 "	36.00
12 "	14.00		

BRIGHT.

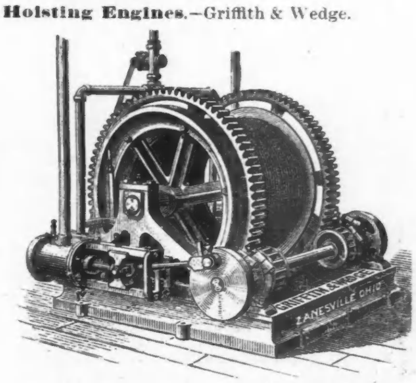
4 inch..................	$10.00	12 inch..................	$16.00
6 "	10.00	15 "	26.00
8 "	11.00	18 "	32.00
10 "	14.00	21 "	38.00

Discount, 55, 10, 7½ and 3%.

Coes Mechanics' Screw Wrenches, same list, less 55, 10, 10, 7½ and 3%.

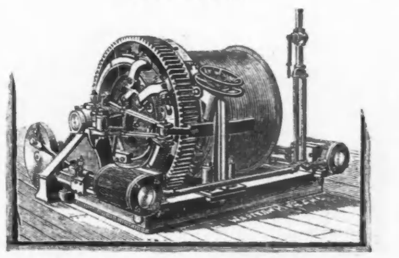
A. G. Coes & Co. Pat. Screw Wrenches, same list as above. Discount, 55, 10, 7½ and 3%.

Hoisting Engines.—Griffith & Wedge.



		Weight.	$.
Hoisting Engines,	Miner's Prospecting.....	4,500	750
Hoisting Engines,	No. 1 Double Cylinder....	4,500	800
Discount, 20%.			
" "	No. 2 Double Cylinder...	6,000	1,000
" "	No. 3 " " ...	11,000	1,550
" "	No. 4 " " ...	15,500	1,800
" "	No. 5 " " ...	17,000	2,100
" "	No. 6 " " ...	13,600	1,750
" "	No. 7 " " ...	17,000	2,100
" "	No. 8 " " ...	19,000	2,400
" "	No. 9 " " ...	48,000	4,500

Discount, 25%.

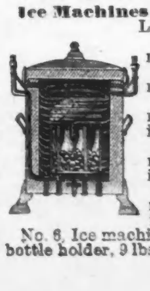


Webster, Camp & Lane Machine Co.

Single drum.	No.	Average Load. Pounds	Pounds.	Double drum. Approx. weight, complete.
$825.00 =	5	1,950	6,000 =	....
918.50 =	6	1,650	6,500 =	....
1.177.00 =	7	2,200	8.000 =	$1,661.00
1.331.00 =	8	3,000	8,500 =	1,815.00
1 694.00 =	9	3,500	14,000 =	2,722 50
1,914.00 =	16½	3,700	16,000 =	3,124 00
2,343.00 =	17½	5,500	19.000 =	3,338.00
2,475.00 =	18	5,500	22,000 =	3,872.00

Ice Machines (Family).

L. DERMINGNY & Co.



No. 1, Ice machine, ice and ice cream molds, 1 lb. ice, $15.00.

No. 2, Ice machine, ice and ice cream molds, 1½ lbs. ice, $20.00.

No. 3, Ice machine, ice and ice cream molds, 1 carafe 1 bottle holder, 2 lbs. ice, $26.50.

No. 4, Ice machine, ice and ice cream molds, 2 carafe 1 bottle holder, 4 lbs. ice, $33.00.

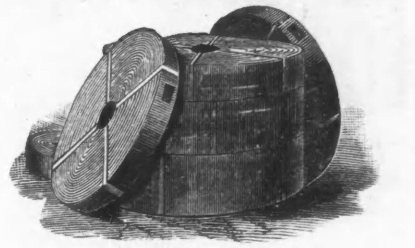
No. 5, Ice machine, ice and ice cream molds, 3 carafe 1 bottle holder, 6 lbs. ice, $40.00.

No. 6, Ice machine, ice and ice cream molds, 4 carafe 1 bottle holder, 9 lbs. ice, $46.50.

India Rubber Goods.

MECHANICAL.

Commonwealth Rubber Co.

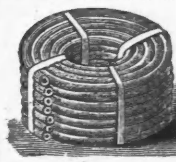


RUBBER BELTING.

Inches.	2 ply per foot.	3 ply per foot.	4 ply per foot.	5 ply per foot.	6 ply per foot.
1	$0.07	....	....	....	....
1¼	0.09	....	....	....	....
1½	0.11	....	....	....	....
2	0.15	$0.17	$0.21	....	....
2½	0.18	0.22	0.26	....	....
3	0.22	0.26	0.31	....	....
3½	0.26	0.30	0.37	....	....
4	0.30	0.34	0.42	....	....
4½	0.33	0.39	0.47	....	....
5	0.36	0.43	0.52	....	....
6	0.43	0.52	0.62	....	....
7	0.51	0.60	0.73	....	....
8	0.59	0.70	0.84	$1.05	$1.25
9	0.67	0.80	0.95	1.18	1.42
10	0.75	0.90	1.07	1.33	1.60
11	0.83	1.00	1.18	1.47	1.77
12	0.91	1.08	1.30	1.62	1.95
13	1.00	1.18	1.42	1.77	2.13
14	1.08	1.28	1.54	1.92	2.31
15	1.16	1.38	1.66	2.07	2.49
16	1.25	1.50	1.78	2.22	2.67
18	1.41	1.70	2.02	2.52	3.03
20	1.58	1.90	2.26	2.82	3.39
22	1.76	2.12	2.52	3.15	3.74
24	1.96	2.36	2.80	3.50	4.20
26	2.18	2.60	3.08	3.85	4.62
28	2.42	2.84	3.36	4.20	5.04
30	....	....	3.64	4.55	5.46
32	....	....	3.92	4.90	5.88
34	....	....	4.20	5.25	6.30
36	....	....	4.48	5.60	6.72
38	....	....	4.76	5.95	7.14
40	....	....	5.04	6.30	7.56
42	....	....	5.32	6.65	7.98
44	....	....	5.60	7.00	8.40
46	....	....	5.88	7.35	8.82
48	....	....	6.16	7.70	9.24
50	....	....	6.44	8.05	9.66
52	....	....	6.72	8.40	10.08

Dis. Reliance, 60 and 5. Dis. Royal, 60, 10 and 10. Dis Manhattan, 70 and 5. See Link Belting, page 9.

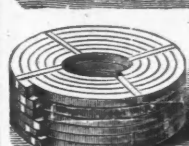
PACKING.



Piston Packing.

Round Piston Packing Per lb. 85c.

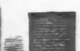
Discount, 60, 10 and 5 per cent.



Square Piston Packing.

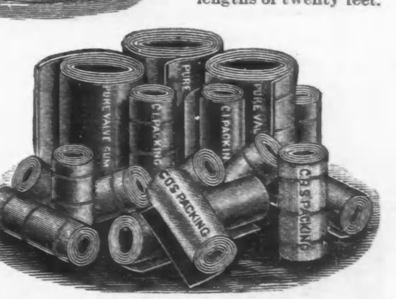
Price same as above.

Round and square piston packing is made in lengths of twelve or twenty-four feet.



Square Piston Packing. Rubber back, per pound $1. Discount 60 per cent. Best only.

Square piston packing rubber back is made in lengths of twenty feet.



Steam Packing.

Cloth Insertion, Rubber Outside.

Cloth Insertion, Cloth on one or both sides.

Thickness.	1-Ply.	2-Ply.	3-Ply.	4-Ply.
1-64 inch..............	70 cts.	....	....	....
1-32 "	65 cts.	....	....	....
1-16 "	60 cts.	63 cts.	66 cts.	....
3-32 "	55 cts.	58 cts.	61 cts.	....
1-8 "	55 cts.	55 cts.	58 cts.	61 cts.
3-16 "	55 cts.	55 cts.	55 cts.	58 cts.
1-4 "	55 cts.	55 cts.	55 cts.	55 cts.

One-ply of cloth to every 1-16 inch thickness.

Three cents per pound additional will be charged for each extra ply of cloth. Each cloth, whether insertion or on outside, to count as one ply.

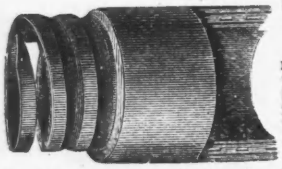
All cloth insertion or plain packing is one yard wide, and any length desired.

Wire insertion packing, all thicknesses, per lb. 50 cents.

Discounts: Reliance, 70 & 10; Royal, 60, 10 & 10; Manhattan, 60 per cent.

See "Link" Packing, page 3.

HOSE.



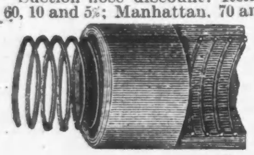
Improved "Smooth Bore" Rubber Suction Hose.
On spiral flat or round tinned steel wire.

Int. Diam.	Per ft.
2 inch	$2.60
2½ "	3.50
3 "	4.00
3½ "	5.50

In. Diam.	Per ft.	Per. Diam.	Per ft.
4 inch	6.50	7 inch	$13.50
4½ "	7.50	7½ "	15.00
5 "	8.50	8 "	16.50
5½ "	9.50	9 "	19.50
6 "	10.50	10 "	22.50
6½ "	12.00	12 "	27.50

Suction hose discount: Reliance, 50 and 10%; Royal, 60, 10 and 5%; Manhattan, 70 and 5%.

SUCTION HOSE.



On spiral brass or iron wire

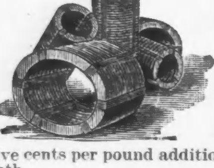
Int. Diam.	Per. ft.
¾-inch	$ .77
1 "	1.00
1¼ "	1.25
1½ "	1.65
1¾ "	2.10
2 "	2.50

RUBBER HOSE.
Conducting Hose—Two-ply.

Int. diam.	Per ft.	Int. diam.	Per ft.	Int. diam.	Per ft.
½ in.	$0.20	2 in.	$0.66	5 in.	$1.65
¾ in.	25	2¼ in.	75	6 in.	1.98
1 in.	33	2½ in.	83	7 in.	2.31
1¼ in.	42	2¾ in.	92	8 in.	2.64
1½ in.	50	3 in.	99	9 in.	2.97
1¾ in.	58	4 in.	1.32	10 in.	3.33
HYDRANT HOSE—THREE-PLY.					
½ in.	$0.25	1½ in.	$0.60	2½ in.	$1.00
¾ in.	30	1¾ in.	70	2¾ in.	1.10
1 in.	40	2 in.	80	3 in.	1.20
1¼ in.	60	2¼ in.	90	3½ in.	1.40
				4 in.	1.60

Discount—Reliance, 60; Royal, 70; Manhattan, 70 and 10 per cent.

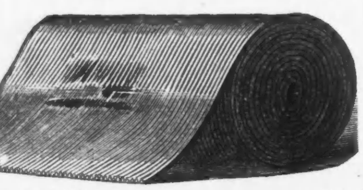
GASKETS AND RINGS.



Fibrous.
⅛ inch thick, or less, per lb. $0.90
5-32 inch thick, and upwards, per lb. $0.80
Cloth Insertion.
1-16 inch thick, or less, per lb. $1.25
3-32 inch thick, and upwards, per lb. $1.00
There is one ply of cloth to every 1-16 in thickness.
Five cents per pound additional for each extra ply of cloth.

Dis., 60, 10 and 5%.

CORRUGATED RUBBER MATTING.
Rolls 1 yard wide, 30 yards long, cut to any size required.



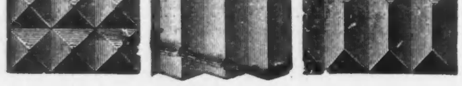
3-32 in. thick, per sq. ft.	$0.33
⅛ " " "	0.40
3-16 " " "	0.56
¼ " " "	0.73
⅜ " " "	1.03
½ " " "	1.30

Dis., 25 and 5%.

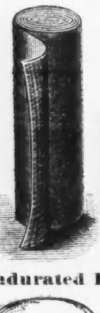
TENNIS SHOE SOLING.
Cuts show full size of pattern.

Diamond Point. Corrugated. Oblong.
Price, $1 per [illegible]
Rubber cement to attach soles [illegible]rnished.

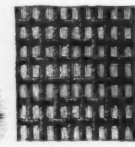
STAIR TREADS.



No.	Inches.	Thick.	Per doz.	Thick.	Per doz.
1.	6 x18	⅛	$4.00	3/32	$3.30
2.	7 x24	⅛	6.00	3/32	5.00
3.	4 x39	⅛	5.50	3/32	4.70
4.	7 x40	⅛	10.00	3/32	8.30
5.	7½x42	⅛	11.00	3/32	9.10
6.	7½x48	⅛	12.50	3/32	10.40
7	9 40	⅛	12.50	3/32	10.40
8	9 x48	⅛	15.00	3/32	12.50
9.	9 x36	⅛	11.25	3/32	9.40
10.	6 x48	⅛	10.20	3/32	8.[illegible]0
11.	7 x28	⅛	7.00	3/32	5.85
12.	9 x54	⅛	16.80	3/32	14.00
13.	8 x52	⅛	14.60	3/32	12.15
14.	10 x24	⅛	8.40	3/32	7.00



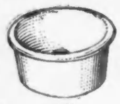
RUBBER SOLING FOR BOOTS.



Rough finish, 1-16 to 3-16 thick.
Smooth finish. 1-32 to 1-16 thick.
85 cents per lb.

Indurated Fibre Ware.

SPITTOONS.



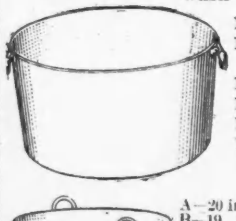
	Doz.
16 in. dia., 8 in. high	$24.00
12½ in. dia., 5½ in. high	10.80
9 in. dia., 5 in. high	7.80

Dis. on all 25 and 20%.

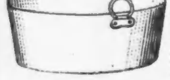
CORDLEY & HAYES.

Pails.	No. doz. in crate.	Cubic feet.	Price per doz.
Ladies' or Weaver's pails, 6 qt.	1	2¾	$5.35
Half or buggy pails, 6 qt.	1	3	4.80
Star pails (standard plain), 12 qt., stenciled "for fire only" without extra charge	1	3½	6.00
Deck or Mason's pails (same size as Star, but heavier, with heavy wire bail)	1	4	6.60
Railroad or fire pails, 14 qt. (also stenciled "fire" without extra charge)	½	3½	7.80
Fire pails, round bottoms	1	4	7.80
Milk pails, 14 qt.	1	4	7.80
Stable pails, flush bottom, heavy wire bail, 14 qt	1	4	7.80
Stable pails, 16 qt., same as above	½	3½	8.40
" 18 " "	½	3¾	10.70
" 20 " "	½	4	12.00
Covers for fire or star pails		1	3.35

WASH TUBS.



No. 0, 23 in.	½	12	27.00
Nos. 0, 1, 2 and 3, nested	1 n.	3½	22.50
No. 1, 21 in.	½	10½	24.00
No. 2, 19½ in.	½	9	21.00
No. 3, 18½ in.	½	9	18.00
Nos. 1, 2, and 3, nested	½	9¾	21.00



KEELERS.		Doz.
A—20 in.	7 in. deep	16.20
B—19 "	" "	15.00
C—18½ "	" "	14.00
1—17½ "	" "	13.20
2—15½ "	6 in. "	12.00
3—13½ "	5 in. "	10.20
4—12 "	4 in "	9.00

MILK OR VEGETABLE PANS.

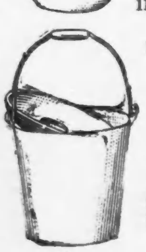
13½ in. dia 3¼ in. deep, 6 quarts,

$3.60 per doz.

WASH BASINS.

	Doz.
12½ in	$4.80
12½ in	4.20
11½ in	3.60

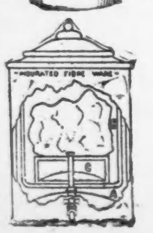
CHAMBER PAILS.



12 in. dia., 9 in. deep, 3 gal. 16.00

WATER COOLERS.

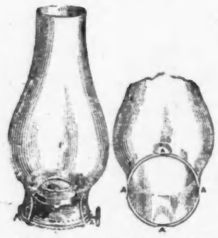
	Doz.
3 gal	$32.00
4 "	40.00
5 "	44.00
6 "	48.00
8 "	64.00
10 "	80.00
12 "	96.00
15 "	120.00



WATER COOLERS AND FILTERS.

	Doz.
4 gal	$96.00
5 "	108.00
6 "	120.00
8 "	144.00
10 "	192.00
15 "	288.00

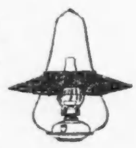
Lamps. F. H. Lovell & Co.

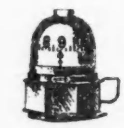


Drummond Electric Hanging Lamp, 300 candle power, complete, each $3.50.
The electric lamp, 60 candle-power.
With decorated shades, nickel, per doz. $22.00
With opal plain shades, nickel, per doz. 18.00.
With decorated shades, brass, per doz. 21.00.
With opal plain shades, brass, per doz. 17.00.
Lamp chimney patent for Sun burners.
Per doz. No. 0, 50 cents. No. 1, 60c. No. 2, 75c.

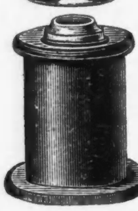
Hitchcock nickel table lamp	(No. 654),	each	$3.25
" " hanging	656	"	7.25
" " bracket	651	"	3.50
" " " with reflector	653	"	3.75

" French bronze bracket, with reflector, No 653, each $3.75.





Harp, complete, with square tin shade, per doz., $9.50.
Complete, with Burner and chimney, per doz., $1.50.
Hurricane lanterns 25 cents extra with guards.
875, ⅜ wick, without guards, per doz., $5.00.
876, square safety lifting globe, per doz., $5.50.
877, ⅝ wick, safety lifting globe, per doz., $6.75.
Nickel plated diamond reflector reading lamp, 30 candle-power, $13.50 per doz.
Net.
Illuminated night clock, per doz., $27.



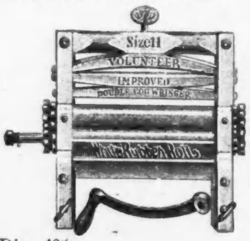
PAPER LAMPS.
Lined with oil proof composition.

	No. 0.	No. 1.	No. 2.
Height	2⅛ in.	3 in.	3¾ in.
Diameter	3½ in.	2½ in.	2½ in.
Weight, # doz.	3¾ lbs.	1¾ lbs.	2 lbs.
Price	$2.75 per doz.	$2.25	$2.75
	No. 0.	**No. 3.**	**No. 4.**
Height	2⅛ in.	5 in.	6½ in.
Diameter	3½ in.	3½ in.	4 in.
Weight, # doz.	3¾ lbs.	3½ lbs.	7 lbs.
Price	$2.75 per doz.	$3.25	$4.50

Dis., 20%.

Miners'.
Brass, Collar and Breast in one piece, Spout and Body in one piece.
Price, $9 per gross net.

Laundry Appliances.
EMPIRE CLOTHES WRINGERS.



Rolls.
"Volunteer." Length, 10 in.x1¾ in. dia. $40 per doz.
"Volunteer." Length, 11 in.x1¾ in. dia. $50 per doz.
"Volunteer." Length 12 in.x1¾ in. dia. $50 per doz.

Dis., 40%.
"Daisy." Length, 10 in.x1¾ in. dia. $30 per doz.
"Daisy." Length, 12 in.x1¾ in. dia. $48 per doz.
Dis., 40%.

"Empire." Length, 10 in.x1¾ in. dia. $63 per doz.
"Empire." Length, 11 in.x1¾ in dia. $74 per doz.
"Empire." Length, 12 in.x1⅞ in. dia. $84 per doz.
"Empire." Length, 12 in.x1⅞ in. dia. $87 per doz.
"Empire." Length, 14 in.x2¼ in. dia. $156 per doz.
"Empire." Length, 14 in.x2¼, with pulleys. $220 per doz.
"Empire." Length, 16 in.x2½, with pulleys. $360 per doz.
Dis., 40%.

EMPIRE CLOTHES DRYING BARS.
$10 per doz.
Dis., 40%.

Closed.

Open for use.

EMPIRE FOLDING WASH BENCHES
$15 per doz. Dis., 40%.

Royal Keystone cog wheel, 10 by 1¾ rolls, $36 per doz.
No. 10, wood frame cog wheel, 10 by 1¾ rolls, $24.50.
No. 16, wood frame cog wheel, 11 by 1¾ rolls, $29.
No. 18, wood frame cog wheel, 11 by 1⅞ rolls, $33.50.
No. 20, wood frame cog wheel, 11 by 2 rolls, $39.50.
No. 22, wood frame cog wheel, 12 by 1⅞ rolls $39.50.
No. 24, wood frame cog wheel, 12 by 2 rolls, $48.50.
No. 11, iron frame cog wheel, 10 by 1⅝ rolls, $20.
No. 2, iron frame cog wheel, 10 by 1¾ rolls, $24.
Solance iron frame (Eureka Pat.), 10 by 1¾ rolls, $20.
Solance iron frame (Eureka Pat.), 11 by 1¾ rolls, $24.50
F.o.b.cars at works; 60 cents doz entra f.o.b. New York.
Keystone Double Bench Wringer.
Rolls, 10 by 1¾, $36.50 per doz. Made to fold.
Folding Double Folding Wash Bench, packed 6 in crate per doz., $14.

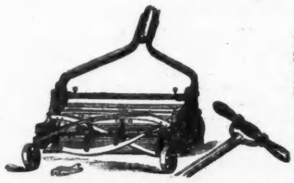
Adams Ironing Table, per doz				$15.00
Keystone Washing Machines, per doz				24.00
Complete	"	"	"	13.50
People's	"	"	"	13.50
Lovell	"	"	"	13.50

Lawn Mowers.

Forward Cut Mowers.

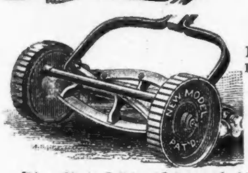
In.	Lbs.		In.	Lbs.	
10	Weight, 30¾	$13.00	16	Weight, 38	$19.00
12	" 31½	15.00	18	" 41	21.00
14	" 36	17.00	21		31.00

Dis. 60 and 5%.



10 in.	12 in.	14 in.
$13.00	$15.00	$17.00
16 in.	18 in.	20 in.
$19.00	$21.00	$23.00

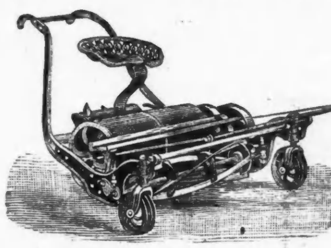
24 in., $30.00.
Geared at both ends.
Dis. 60 and 5 and 5%.



Chadborn & Caldwell Mfg. Co.

10 in. Croquet, 18 pound, mower	$11.00
10 in.	13.00
12 in.	15.00
14 in.	17.00
16 in.	19.00
18 in.	21.00
20 in.	23.00

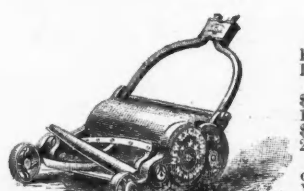
Dis., 60 and 5% and 5% cash 30 days, f.o.b. New York.



New Excelsior Horse Lawn Mower.

25 in. cut, without shafts or seat	$65.00
30 " with shaft and seat	110.00
35 " " " " "	135.00
40 " " " " "	170.00
Horse boots, per set	12.00

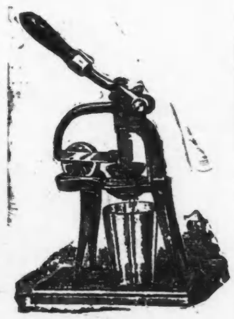
Dis. 50%.



Excelsior Three-Blade Mower and Roller.
8 in., $11.00; 10 in., $13.00; 12 in., $15.00; 14 in., $17.00; 16 in., $19.00; 18 in., $21.00; 20 in., $23.00.
Dis. 60% and 5% cash 30 days f.o.b. New York.

Lemon Squeezers.

THE SAMSON

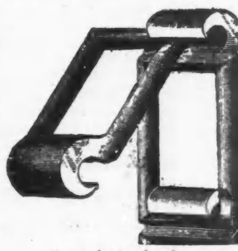


THE ACME.

The Acme Lemon Squeezers, knife and squeezer, per dozen, $15.00.
The Samson, per dozen, $3.00.
Porcelain lined, No. 1, per doz. $6.00
25 and 30% discount.
Wood. No. 2, per doz. $3.00
30% discount.
Wood, common, per doz. $1.75

Link Belting.

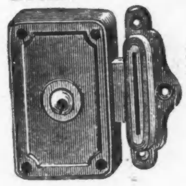
Link-Belt Machinery Co.'s. Price per running foot net.



No.	Price.	No.	Price.
25	$0.13	78	$0.40
32	.13	83	.45
33	.12	85	.50
34	.13	88	.50
35	.14	95	.60
42	.16	103	.75
45	.16	105	.70
51	.20	106	.90
52	.25	107	.80
55	.22	108	.80
57	.24	109	.90
62	.30	114	1.10
66	.30	122	1.50
67	.30	124	1.30
75	.35	146	1.40
77	.35		

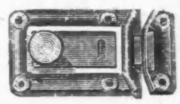
Sprocket wheels 25%
(Rubber belting, see page 6.)

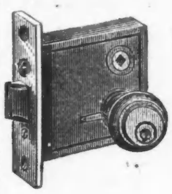
Locks.



YALE PATENT.
RIM STORE LATCH.

	Per doz.
3 × 5 in., 4 keys	$48.00
2½ × 4 in., 3 keys	39.00





RIM NIGHT LATCH.

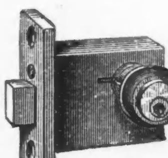
Spring lock, 3 keys	18.00
Dead lock, 3 keys	25.00

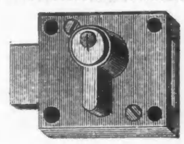
NIGHT LATCH.

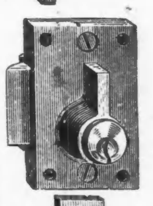
Escutcheon	39.00
"	36.00

MORTISE DEAD LOCK.

4⅝ × 3½	45.00
2⅜ × 3½	24.00





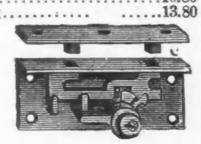


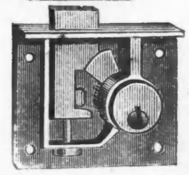
CUPBOARD LOCKS.

Plated Nose	13.20
Brass Nose	12.00

CUPBOARD

Dead Lock	10.80
Spring Lock	13.80





CHEST LOCKS.

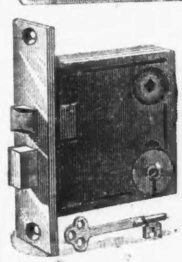
Plated nose	19.20
Brass "	18.00

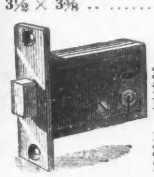
DRAWER LOCK.

Plated nose	10.20
Brass "	9.00

KNOB LOCKS.

5 × 3⅜	22.50
5 × 3⅜	20.00
4¼ × 3⅜	13.25
3½ × 3⅜	10.50





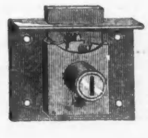
STANDARD LATCHES.

Dead locks.

3¾ × 2¾	24.00
2½ × 3⅜	14.00
1¾ × 2⅜	12.00

NIGHT LATCHES.

3¼ × 3⅜	20.00
2½ × 3⅜	18.00



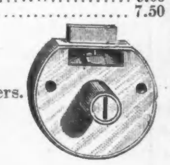
DRAWER LOCKS.
2 × 1⅝, two tumblers.

Plated nose	7.50
Brass "	6.00

Three tumblers.

Plated nose	9.00
Brass "	7.50

RIM FLUSH DRAWER LOCK.
2 in. diameter.



	2 tumblers.	3 tumblers.
Plated nose	7.50	9.00
Brass "	6.00	7.50

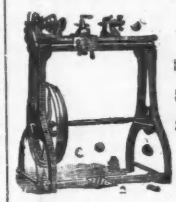
BRONZE SPRING PADLOCK.
2 flat steel keys.

In.	
1	11.00
1¼	12.00
1½	13.50
1¾	14.50
2	16.00
2¼	17.50

Subject to special net prices; no discount.

YALE KEYS.

Machinery—Foot Power.

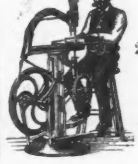


S., M. & Co.'s Screw-Cutting Engine Lathes.

8 in. swing, 20 in. bet. centers, 36 in. bed, 240 lbs. weight, $60.
8 in. swing, 30 in. bet. centers, 46 in. bed, 260 lbs. weight, $70.
8 in. swing, 36 in. bet. centers, 52 in. bed, 280 lbs. weight, $75.

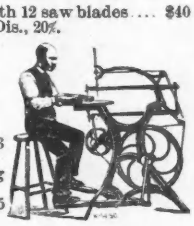
Boxing for export, $2.50 extra; f.o.b. at Cincinnati, 25% dis.

SAWS AND LATHES.

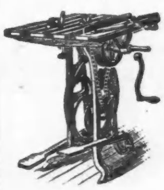


Victor Scroll Saw, Cuts to 3 Inches.

24-inch swing, with 12 saw blades $40
Dis., 20%.



Empire Scroll Saw, Cuts to 3 Inches.
24-in. swing, drill and tilting table.
Price, boxed $25
Dis., 20%



The Acme Combination Saw.

Hand or steam power.
Adjustable table and gauges.

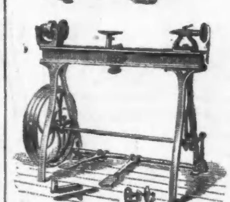
Price, boxed	$40
Scroll saw attachment	7
Boring attachment	10
Moulding attachment	10

Dis., 20%.

Paragon Self Feed Rip Saw.
Two changes of speed; three changes of feed.
Price, with one 10 in. saw, $50.00
Dis., 20%.

Diamond Mortising Machine.
With mortise ¼ to 1 in. wide, 3 in. deep.
" cut tenons ¼ to ¾ thick, 3 in. wide.
Price, with 3 chisels $25.00
Dis., 20%.

The "Star" Lathe.
Swings 9 × 25 in., back geared screw cutting.
Feeds in or out, right or left. Adjustable Tail Stock for Tapers.
Price $75.00
Dis., 15%.

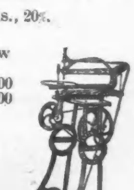


The Crown Lathe.

Swings 10 × 36 in.

Price, boxed	$45.00
Compound slide rest	15.00
Countershaft	10.00

Dis., 20%.



Rival Scroll Saw, with six extra saw blades, twist drill and wrench.

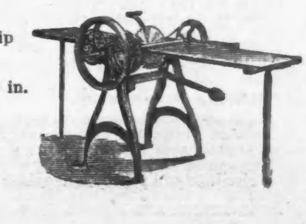
Price	$10.00
Lathe attachment	$3.00

Dis., 25%.

The Challenge Scroll Saw, for shell, bone wood, or metal.
Nickel Plated, with six extra saws, twist drill and wrench.

Boxed	$20.00
With lathe attachment	$5.00

Dis., 25%.



Hand Circular Rip Saw.

Cuts 3¾ thick, 19 in. wide.

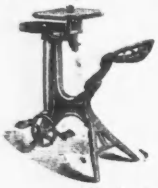
Price $50.00.

Dis., 35%.

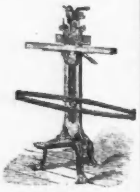
W. F. & J. Barnes Co.
Scroll and Circular saw Combined.
Combined Machines.

Combined circular scroll saw and boring attachment—2 circular saws, 12 assorted scroll saws, boring attachment, and self-centering drill chuck	$50.00
Combined circular and scroll saw—2 circular and 12 scroll saws	40.00
Circular saw—1 extra rip and 1 cross-cut saw	35.00
Scroll saw—12 assorted scroll saws	32.00
Counter shaft for steam power	10.00

Dis., 35%.

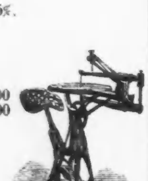


Foot Power Former.
$20.00; Knives extra, $1.00 each.
Dis., 35%.

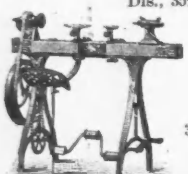


Mortising Machine.
$22.00; Chisels, $1.00 each.
Dis., 35%.
Blind Slat Chisels, 3 set bits, $5.00.
Dis., 20%.

Tenoning Machine,
Price, $25.
Dis., 35%.



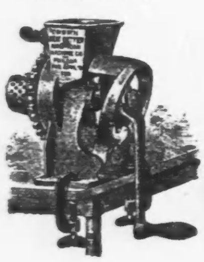
Velocipede Scroll Saw,
Without boring attachment...... $20.00
With " " 23.00
1 doz. saw blades, } Included.
1 3-16 bit.
Dis., 35%.

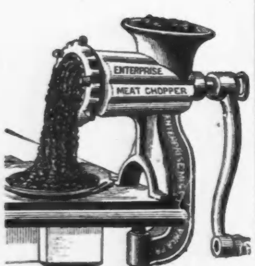


Lathe.
3 centres, 1 spur, 2 tool rests and sockets, 1 turned face-plate, $35.
Dis., 30%.

Lathe.
One turned face-plate, two pointed and one spur center, two rests, with sockets and plate for hand tools, slide rest-wrench, belting, etc., $40.
Dis., 25%.

Meat Cutters.





American.	1	2	3	4
each,	$5.00	7.00	10.00	25.00

Dis., — —.

Enterprise.	10	12	22	32	42
each,	$3.00	2.50	4.00	6.00	15.00

Dis., 30%.

Motors (Water).

Size No. 8, for Sewing Machines, etc , $18 each.

No. 9, ⅛ horse-power (30 lbs. pressure), ¼ h. p. (50 lbs.), ½ h. p. 100 lbs.), ¾ h. p. (150 lbs.), 1 h. p. (200 lbs.), $30.

No. 10, ¼ horse-power (30 lbs. pressure), ½ h. p. (50 lbs.), 1 h. p. (100 lbs.), 1½ h. p. (150 lbs.), 2 h. p. (200 lbs.), $50.

No. 10½, ½ horse-power (30 lbs. pressure), 1 h. p. (50 lbs), 2 h. p. (100 lbs.), 3 h. p. (150 lbs.), 4 h. p. (200 lbs.), $75.

No. 11, 1 horse-power (30 lbs. pressure), 1½ h. p. (50 lbs.), 3 h. p. (100 lbs.), 4½ h. p. (150 lbs.), 6 h. p. (200 lbs.), $100.

No. 12, 2 horse-power (30 lbs. pressure), 3 h. p. (50 lbs.), 6 h. p. (100 lbs.), 9 h. p. (150 lbs.), 12 h. p. (200 lbs.), $175.

No. 13, 3 horse-power (30 lbs. pressure), 5 h. p. (50 lbs.), 10 h. p. (100 lbs.), 15 h. p. (150 lbs.), 20 h. p. (200 lbs.), $285.

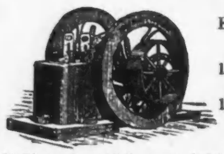
Dis., 40%.

Governors for 11 and 12, $25 extra; for No. 13, $35 extra.

Mining Machinery.

N. B.—Special attention is invited to the goods advertised and illustrated in the advertising pages of the Engineering and Mining Journal, quotations and discounts upon which would only mislead buyers.

Price-lists and other information may be obtained by addressing the advertisers direct, or by writing to the Engineering and Mining Journal.



Concentrating Machinery.
Fort Scott Foundry & Machine Works Co.

Blake Improved Crusher: 10x7, weight 7,500; $410.00.

Blake Improved Crusher: 15x9, weight 9,000; $580.00.

Discount 25%.

Cornish Crushing Rollers: 20 diameter, 10 face, weight 5,400; $450.00.

Cornish Crushing Rollers: 20 diameter, 14 face, weight 6,000; $500.00.

Cornish Crushing Rollers: 22 diameter, 14 face, weight 9,500; $625.00.

Cornish Crushing Rollers: 27 diameter, 14 face, weight 13,000; $750.00.

Cornish Crushing Rollers: 30 diameter, 14 face, weight 15,000, $850.00.

Discount 25%.

Complete Sizing Arrangement, consisting of Revolving Screens of Steel Sheet and Hydraulic Classifier.

For Concentrator, 25 tons capacity, $250; 50 tons capacity, $350; 75 tons capacity. $450; 100 tons capacity, $800. Discount, 10 per cent.

Automatic working Jig Machines, all complete, woodword included, with slidemotion: 2 sieves, $3.0; 3 sieves, $360; 4 sieves, $450.

With Eccentric Motion, all complete, woodwork included: 1 sieves, $200; 2 sieves, $270; 3 sieves, $320; 4 sieves, $330.

Automatic working Double Jig Machines, all complete, woodwork included: 4 sieves, $210; 6 sieves, $335; 8 sieves, $425. Discount, 25 per cent.

Single Rittinger Percussion Tables. all the iron parts, $350; Double Rittinger Percussion Tables, all the iron parts, $500. Discount, 10 per cent.

Improved Rotary Tables, all the iron parts and pipes, $2.0. Discount, 25 per cent.

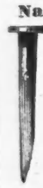
Mouse Traps.

The Cyclone Mouse Trap, per gross, $4.05.

The Idea Mouse Trap per gross, $8.25.

Slayer Rat Traps, per gross, $10. Net prices

Nails and Tacks.



Swedes. Tacks.
Per doz. ⅛ ¾ 1 1½ 2 2½ 3
½ wt.. 35 40 46 50 55 60 65 75
6 8 10 12 14 16 18 20 24 oz.
85 1.00 1.20 1.40 1.60 1.75 1.85 2.15 2.55
Doz.full ⅛ ¾ 1 1½ 2 2½ 3 4
weight 60 70 80 90 1.00 1.10 1.20 1.40
6 8 10 12 14 16 18 20 24 oz.
1.60 1.90 2.30 2.70 3.10 3.40 3.80 4.20 5.00
lb., bulk ⅛ ¾ 1 1½ 2 2½ 3 4
or paper 1.69 1.25 1.00 80 68 58 52 46
6 8 10 12 14 16 18 20 24
36 32 31 30 29 28 28 28 28
Discount, 67½, 10 and 2%.

O. H. Swedes.
Price, same as Swedes.
Swedes steel tacks same list price as iron.

Upholsterers.

Discounts, 72½, 10 and 2%.

Price, same as Swedes.

Cut Tacks. Price per dozen ounces.

¼ wt 1 1½ 2 2½ 3 4 6 8 10
35 40 45 50 55
12 14 16 18 20
60 70 80 90 1.00
½ wt..... 1 1½ 2 2½ 3 4 6 8 10
45 50 50 55 60 65 70 80 95
12 14 16 18 20
1.10 1.25 1.40 1.55 1.70
Full wt .. 1 1½ 2 2½ 3 4 6 8
80 90 90 1.00 1.10 1.20 1.30 1.50
10 12 14 16 18 20
1.80 2.10 2.40 2.70 3.00 3.30
Discount, 70, 10 and 2%.

Carpet Tacks, flat and oval heads.

Blued, doz. oz. 4 6 8 10 12 14 16 18 20
¼ wt. 35 40 45 50 55 65 75 85 95
22 24
1.05 1.15
" ½ wt. 4 6 8 10 12 14 16
65 70 80 95 1.10 1.25 1.40
18 20 22 24
1.55 1.70 1.85 2.00
Tinned, doz. ¼ wt. 4 6 8 10 12 14 16
50 55 60 75 85 1.00 1.10
18 20 22 24
1.20 1.35 1.45 1.60
Tinned, doz. ½ wt. 4 6 8 10 12 14
95 1.05 1.15 1.40 1.60 1.85
16 18 20 22 24
2.10 2.35 2.60 2.85 3.10
Discount, 72½, 10 and 2%.

Finishing Nails.
Inch....⅝ 3½-8 4-8 4½-8 ⅝ 5½-8 6-8 7-8 1
Per lb...48 40 32 28 26 24 22 20 18
1⅛ and larger.
16
Discount, 60, 10 and 2%.

Chair Nails.
Doz. ½ wt.; doz. full wt.; pound B. or P.
Inch..⅜ 3½-8 4-8 4½-8 ⅝ 5½-8 6-8 7-8
Per lb. 51 43 35 31 29 27 25 23
1 1⅛
21 19
Discount, 60, 10 and 2%.

Common and patent brads.

inch.	Price per doz. ½ wt.	Price per doz. full wt.	Price per lb. in papers or bulk.
2-8	.50	1.00	1.25
3-8	.60	1.20	.80
4-8	.65	1.30	.58
5-8	.72	1.44	.48
6-8	.80	1.60	.36
7-8	.90	1.80	.30
1	1.00	2.00	.26
1⅛	1.12	2.24	.25
1¼	1.26	2.52	.24
1½	1.82	3.64	.22
1¾	2.25	4.50	.20
2	2.43	4.86	.18

Dis. 60, 10 and 2%.

Oils.

LUBRICATING.—Fiske Bros.
Lubroleine A cylinder oil 50 in. barrels.
Lubroleine D cylinder oil 40 in. barrels.
Lubroleine A machine oil 45 in. barrels.
Lubroleine B machine oil 35 in. barrels.
Lubroleine A engine oil 50 in. barrels.
Lubroleine B engine oil 40 in. barrels.
In cases 5c gal. extra.

Crescent Axle Grease.—Barrels, 3c per lb; 100-lb. kegs 3½c lb.; 2-lb. decorated tins, $12, gross less 5 per cent.

Texas Star Axle Grease.—Barrels, 2½c per lb.; 100-lb. kegs, 3c per lb.

Oil Stones.

Best White Washita.

Green Paper Brand, 8 × 2 × 1⅛ inches	per lb.	.32
Oil stone, No. 1, " "	"	.22½
" Extra, " "	"	.30
High rounds, " "	"	.30
Round edge slips, Nos. 1, 3½ to 5, in boxes 10 lbs. upwards	"	.40
Round edge slips, extra, in boxes 10 lbs. upwards	"	.50
Pen knife pieces, ass't 3 to 5 × 1 × 1⅜, in boxes 10 lbs. upwards	"	.50
Needle pieces	per hundred.	$5.00
Wheels, 1½ to 5¾ in. thick	per inch.	.40

Good Washita,

Oil Stone No. 1, 8x2x1⅛	per lb.	.15
" " 2, "	"	.12
Axe Stone, assorted sizes	"	.10
Round Edge Slips, assorted sizes	"	.25

Arkansas.

Oil Stone No. 1, 4 to 6 in. long x2x¾ to 1 in.	per lb.	$1.35
Oil Stone No. 1, 6 to 9 in. long x2x¾ to 1 in.	"	1.75
Oil Stone No. 2, 4 to 9 in. long x2x¾ to 1 in.	"	.75
Round Edged Slips, assorted sizes	"	2.00
Square File Slips, 3 to 4 inches long	per doz.	1.75
Diamonds, 3½ to 4 inches long	"	3.00
Triangulars, 3½ to 4 inches long	"	3.00
Flat Files, 3 to 4 inches long	"	2.00
Beveled Files, 3½ to 4 inches long	"	2.50
Knife Blades, 3 to 4 inches long	"	3.00
Points, extra long, 3 to 3½ inches	"	2.00
Points	"	1.50
Pen Knife Pieces, assorted sizes	per lb.	2.00
Needle Pieces	per hund.	8.00
Wheels, 2 to 4 inches, ½ inch thick	per inch	1.25
Oil Stone Powder	per lb.	15

10, 10 and 2½ dis.

Oil Stoves.

Burns 8 hours; holds 1 quart oil.

Nickel plated crown plate, per doz., $12.

Packing.

SELDEN'S PATENT.
For Steam, Air, Water and Ammonia.
With Rubber Core, 60 cents per lb.
Dis., 25 and 5%.
With canvas core, 50 cents per lb.
Dis., 30 and 5%.
Hline & Robe tson.
Eureka, 75c. per lb. Dis., 40%.
Soapstone—Standard, 8c. per lb.
XX. 11c. per lb.
Crown—No. 1, 23c. per lb.
No. 2, 26c. per lb.
Climax, 9c. per lb.
Net.

Paints.

For Assorted Cans of 1, 2, 3 and 5 pounds. 100-lb. cases.

No.	lb. c.	No.	lb. c.
533. Scotch yellow	18	583. Black	18
534. Lead color	18	584. Dark blue	25
536. Brown	18	585. Chrome yellow	30
537. Light drab	18	586. Vermilion	30
539. Buff	18	587. Indian red	25
542. Warm drab	18	588. Bronze green	25
544. Dark green	25	589. Quaker green	25
581. Light green	25	546. Inside white	15
582. Norway red	18	547. Outside white	18

Discount 50 per cent.

Ordinary shades.	Per gal.		Per gal.
One to 5 gallon cans..	$1.90	Half gallon cans......	$2.00

Tuscan Red, Green and Yellow.

	Per gal.		Per gal.
One to 5 gallon cans..	$3.10	Half gallon cans......	$3.30

Vermilion.

	Per gal.		Per gal.
One to 5 gallon cans..	$5.00	Half gallon cans......	$5.20

Discount 40 per cent.

The list in barrels, half-barrels and kegs (of 5 gallons or larger) will be 10c. a gallon less than in gallon cans. Kegs of less than 5 gallons will be charged at gallon price. One-quarter gallon cans not put up. Special shades made to order.

Special cash discount for large orders.

Parers and Corers.

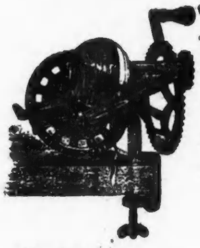
Saml. Lees & Co.

List, $9 per gross.

APPLE.

Little Gem.

	Per doz.
Advance	$4.75
Baldwin	5.25
Champion	7.25
Hudson's '88	3.75
Improved Bay State	30.
Monarch	31.50
Oriole	4.00
Turntable	4.50
Victor	13.50
White Mountain	4 50
Rocking Table	4.25
Little Gem Corer and Slicer	3.70

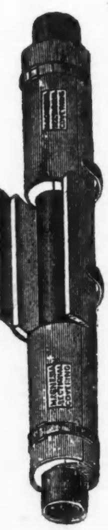


Rocking Table.

Pipe Covering.

Magnesia Sectional Covering.

For Wrought Iron Pipe. In Canvas Jacketed Sections, 36 inches in length.



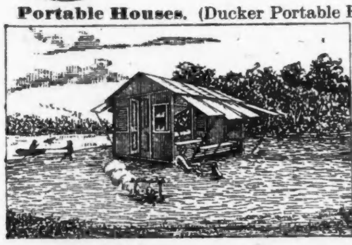
Inside dia. of pipe.	Weight of cover per lineal ft.	Price per lineal foot canvas jacketed.
½ in.	8 ozs.	$0.25
¾ "	9 "	0.25
1 "	10 "	0.25
1¼ "	12 "	0.25
1½ "	15 "	0.25
2 "	18 "	0.27
2½ "	20 "	0.31
3 "	24 "	0.36
3½ "	26 "	0.40
4 "	30 "	0.44
4½ "	38 "	0.47
5 "	40 "	0.50
6 "	48 "	0.60
7 "	55 "	0.65
8 "	65 "	0.75
9 "	75 "	0.80
10 "	85 "	0.90

Elb'ws.	Tees.	G Valv's.	Crosses.	Unions.
$0.20	$0.30	$0.25	$0.35	$0.30
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0·43	0.33
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.27	0.36	0.27	0.48	0.33
0.31	0.41	0.41	0.53	0.41
0.36	0.48	0.48	0.60	0.48
0.40	0.53	0.53	0.68	0.53
0.44	0.59	0.59	0.75	0.59
0.50	0.65	0.65	0.80	0.63
0.58	0.75	0.75.	0.90	0.67
0.65	0.90	0.90	1.00	0.77
0.83	1.20	1.20	1.10	0.90
1.00	1.35	1.35	1.20	1.00
1.10	1.50	1.50	1.35	1.10
1.25	1.75	1.75	1.50	1.25

Magnesia Plastic Covering (dry)—Prepared Carbonate Magnesia and Fiber, for Trowel Work per barrel, $8.00

Dis. 25%.

Portable Houses. (Ducker Portable House.



Weight, 450 lbs.

Price, $150.

Closes securely.

Dis., 10%.

Weight, 85 lbs. per section.

Price, $220.

Dis., 10%.

Weight, complete, 5600 pounds.

No. 10.—26 × 33 ft.. including veranda and rear extension. Main part, 19 × 26 ft. $500.00

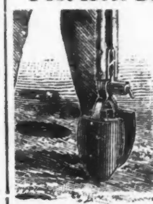
	No. 1. Veranda on side.	No. 2. Veranda on end.	No. 3. without veranda.
12 × 12, 1 door, 3 windows,	$120.00	$120.00	$105.00
12 × 14, 1 " 3 "	135.00	130.00	120.00
12 × 17, 1 " 3 "	155.00	150.00	135.00
12 × 19, 2 " 4 "	175.00	165.00	150.00
12 × 21, 3 " 5 "	190.00	180.00	165.00
12 × 23, 3 " 5 "	200.00	190.00	175.00
12 × 26, 3 " 5 "	220.00	205.00	190.00
14 × 21, 3 " 5 "	205.00	195.00	180.00
10 × 12, 1 " 3 "		100.00	90.00
10 × 14, 1 " 3 "		105.00	95.00
7 × 10, 1 " 2 "			65.00
7 × 12, 1 " 2 "			75.00
7 × 14, 1 " 2 "			85.00

Hunter's Cabins.

7 × 12, with 4 berths $80.00
7 × 14, " 4 " 90.00

Discount, 20%.

Post Hole Diggers.

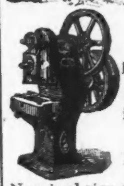


Chieftain Hay Rake Co.

Little Giant	$36.00 doz 11 cu ft.
Hercules	30.00 " " " "
New Champion	20.00 " " " "
Scheidler	36.00 " " " "

Dis. 40% f.o.b.New York or Boston.

Press.



Combined press for cutting, forming, horning and seaming.

Particulars of flat front presses, including beds, slides, bolsters, plates, etc.

Prices are net, delivered on steamers in New York, including insurance, etc.

Nominal size of press	41	42	43	44	450
Price, including et ceteras	$130	$200	$260	$420	$660
Weight, about ....lbs	600	1050	1900	3600	7200
Greatest diameter that can be wired ....ins	5	7	10	14	20
Greatest depth that can be wired ....ins	8	10	13	16½	20
Hole through bed—circle intersecting ....ins	4½	6	8½	12	17
Hole through back—width ....ins	8	9½	12	15½	20½
Width between die clamps—clear ....ins	8	11	15	20	27
Distance back from center of slide bar ....ins	4½	5½	7	9	12
Height to slide-bar, when up ..ins	5¼	6½	7½	8½	9
Stroke of slide-bar ....ins	1	1¼	1½	1¾	2
Adjustment of slide-bar ....ins	1	1¼	1½	1¾	2
Diameter of fly-wheel ....ins	20	26	32	38	44
Width of fly-wheel ....ins	3	4	5	6	7
Weight of fly-wheel, about ....lbs	125	250	420	725	1100
Speed per minute, about ....rev	120	110	100	90	80
Cubic feet boxed, about	30	40	50	60	70

Printers' Sundries.

Vanderburgh, Wells & Co.
And Liberty Machine Works.

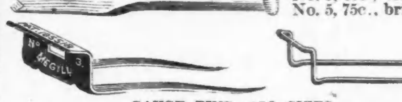
Wood rules, 12 cents per yard.
Wood rules, on end wood, 15 cents per foot.

EUREKA STAND.
12 full cases.

Price without cases $12.00
Boxing and cartage 1.25

SHOOTING STICKS.

Each.
No. 1, 75c.
No. 2, $1.
No. 4, 45c., black.
No. 4, 60c., bright.
No. 5, 60c., black.
No. 5, 75c., bright.



GAUGE PINS—ALL SIZES.

Brass, 40c. doz.	Steel, 60c. doz.
Wire, 25c. doz.	Golden, 40c. doz.

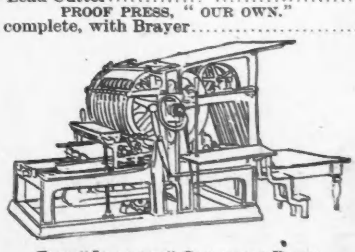
MITRE BOXES.
Regular size, 2 in., 50c. each.
Extra size, 3½ in., 75c. each.

LEAD CUTTER.

Curtis' Lead Cutter $2.00

PROOF PRESS, "OUR OWN."

9 × 32, complete, with Brayer $28.00



THE "LIBERTY" CYLINDER PRESS.
For Newspaper and Job Printing.

	Bed.	Form.	
No. 5	29 × 42	24 × 40	$1,200
6	33 × 47	28½ × 45	1,300
7	37 × 51	33 × 49	1,600

Dis., 20 and 5%.

THE "LIBERTY" JOB PRINTING PRESS.

Size of chase.

No. 2 — 7	× 11	$200
2a— 9	× 13	250
3 —10	× 15	300
3a—11	× 17	350
4 —13	× 19	400
5 —14½	× 22	500

Dis., 12% and 5%.

Two sizes built extra strong for boxmakers, embossing, etc.

No. 3a—11 × 17 .... $375
4 —13 × 19 425

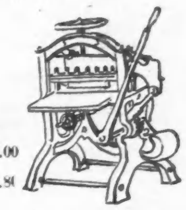
Dis., 12 and 5%.

Fountains, either size, $25 extra, if ordered with press.
Steam fixtures, either size, $15 extra.

THE AMERICAN CARD AND BILL HEAD PRESS.

No. 5—4 × 6 .... $16
7—6 × 9 36
8—8 × 12 60

Dis., 20% and 5%.



THE "LIBERTY" PAPER CUTTER.

Cuts 30 inches $140.00

Extra knife 18.80

Dis., 12% and 5%.

THE "LIBERTY" IMPOSING TABLES

Marble top.

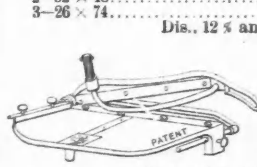
No. 1—24 × 36 .... $24
2—32 × 48 38
3—26 × 74 44
4—36 × 43 48

Dis., 12% and 5%.

Slate Top.

No. 1—24 × 36 .... $18
2—32 × 48 25
3—26 × 74 32

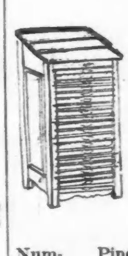
Dis., 12 % and 5%.



Kelsey & Co.,

The Eagle Card and Paper Cutter, 24½ inch, $12 each, $100 per doz.

THE "LIBERTY" TYPE CABINETS.



Number of cases.	Stained. Flat. $	Stained. Galley.* $	Grained. Flat. $	Grained. Galley.* $
12⅔	12.00	14.50	14.00	17 00
16⅔	15.00	17.50	17.00	20.00
18⅔	16.50	19.00	18.50	21.50
20⅔	18.00	20.50	20.00	23.00
12¾	15.00	17.50	17.00	20.00
16¾	18.00	20.50	20.00	23.00
18¾	19.50	22.00	21.50	24.50
20¾	22.00	24.50	23.00	26.00
12 full	18.00	20.50	20.00	28.00
16 "	22.00	24.50	24.00	27.00
18 "	24.00	26.50	26.00	29.00
20 "	26.00	28.50	28.00	31.00

Number of cases.	Pine. Flat. $	Pine. Galley.* $	Cherry. Flat. $	Cherry. Galley.* $	Napanoch. Flat. $	Napanoch. Galley.* $	Walnut. Flat. $	Walnut. Galley.* $
12⅔	18.00	21.00	20.00	23.00	22.00	25.00	23.00	26.00
16⅔	22.00	25.00	24.00	27.00	26.00	29.00	27.00	30.00
18⅔	24.00	27.00	.....	.....	.....	.....	.....	.....
20⅔	26.00	29.00	28.00	31.00	30.00	33.00	31.00	34.00
12¾	21.00	24.00	23.00	26.00	25.00	28.00	26.00	29.00
16¾	25.00	28.00	27.00	30.00	29.00	32.00	30.00	33.00
18¾	27.00	30.00	.....	.....	.....	.....	.....	.....
20¾	29.00	32.00	31.00	34.00	33.00	36.00	34.00	37.00
12 full	24.00	27.00	26.00	29.00	28.00	31.00	29.00	32.00
16 "	28.00	31.00	30.00	33.00	32.00	35.00	33.00	36.00
18 "	30.00	33.00	.....	.....	.....	.....	.....	.....
20 "	32.00	35.00	34.00	37.50	36.00	39.00	37.00	40.00

*Furnished with galley top and extra drawer for copy.
Dis., 20 and 5%.

THE "LIBERTY" CASE STANDS AND RACKS.

Stands.

Single, without racks $3.75
" with racks for 8 full cases 4.00
Single, with racks for 10 full cases 4.25
Single, with racks for 12 full cases 4.50
Single, with racks for 14 full cases 4.75
Double, without racks 4.25
" with racks for 8 full cases 4.50
Double, with racks for 16 full cases, and gal. rest 6.25
Double, with racks for 20 full cases and gal. rest 6.50
" " " " 24 " " " 6.75
" " " " 24 ⅔ cases 5.25
" " " " 8 full and 8 ⅔ cases 5.00
" " " " 8 " " 8 ¾ " 5.25
" " " " 10 " " 12 ⅔ " 5.50
" " " " 12 " " 16 ⅔ " 5.75
" " " " 12 " " 16 ¾ " 6.00

Stands with closed ends, extra 2.00
Extra slides for stands, each .... .05

Case Racks.

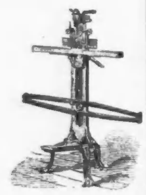
Cases.	Inches High.	Price.	Inclosed Back and Sides.	Cases.	Inches High.	Price.	Inclosed Back and Sides.
12	41	$6.00	$8.50	30	84	$10.00	$13.50
16	50	7.00	9.50	32	51	12.50	16.00
20	60	8.00	11.00	40	60	14.00	17.50
24	70	9.00	12.00	60	84	18.00	23.00

Dis., 20 and 5 %.

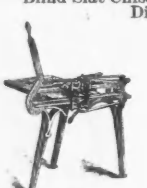
W. F. & J. Barnes Co.
Scroll and Circular saw Combined.
Combined Machines.

Combined circular scroll saw and boring attachment—2 circular saws, 12 assorted scroll saws, boring attachment, and self-centering drill chuck $50.00
Combined circular and scroll saw—2 circular and 12 scroll saws 40.00
Circular saw—1 extra rip and 1 cross-cut saw 35.00
Scroll saw—12 assorted scroll saws 32.00
Counter shaft for steam power 10.00
Dis., 35%.

Foot Power Former.
$20.00; Knives extra, $1.00 each.
Dis., 35%.

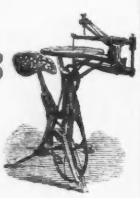


Mortising Machine.
$22.00; Chisels, $1.00 each.
Dis., 35%.
Blind Slat Chisels, 3 set bits, $5.00.
Dis., 20%.



Tenoning Machine,
Price, $25.
Dis., 35%.

Velocipede Scroll Saw,
Without boring attachment $20.00
With " " 23.00
1 doz. saw blades, } Included.
1 3-16 bit.
Dis., 35%.

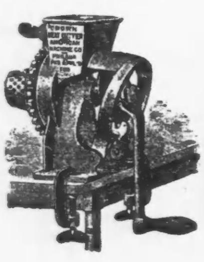


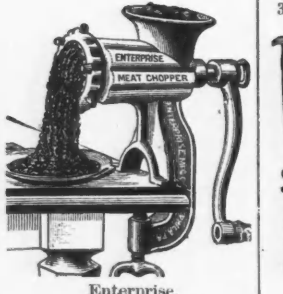
Lathe.
3 centres, 1 spur, 2 tool rests and sockets, 1 turned face-plate, $35.
Dis., 30%.

Lathe.

One turned face-plate, two pointed and one spur center, two rests, with sockets and plate for hand tools, slide rest-wrench, belting, etc., $40.
Dis., 25%.

Meat Cutters.





American.					Enterprise.					
	1	2	3	4		10	12	22	32	42
each,	$5.00	7.00	10.00	25.00	each,	$3.00	2.50	4.00	6.00	15.00
Dis., — —.					Dis., 30%.					

Motors (Water).
Size No. 8, for Sewing Machines, etc , $18 each.

No. 9, ⅛ horse-power (30 lbs. pressure), ¼ h. p. (50 lbs.), ½ h. p. 100 lbs.), ¾ h. p. (150 lbs.), 1 h. p. (200 lbs.), $30.

No. 10, ¼ horse-power (30 lbs. pressure), ½ h. p. (50 lbs.), 1 h. p. (100 lbs.), 1½ h. p. (150 lbs.), 2 h. p. (200 lbs.), $50.

No. 10½, ½ horse-power (30 lbs. pressure), 1 h. p. (50 lbs), 2 h. p. (100 lbs.), 3 h. p. (150 lbs.), 4 h. p. (200 lbs.), $75.

No. 11, 1 horse-power (30 lbs. pressure), 1½ h. p. (50 lbs.), 3 h. p. (100 lbs.), 4½ h. p. (150 lbs.), 6 h. p. (200 lbs.), $100.

No. 12, 2 horse-power (30 lbs. pressure), 3 h. p. (50 lbs.), 6 h. p. (100 lbs.), 9 h. p. (150 lbs.), 12 h. p. (200 lbs.), $175.

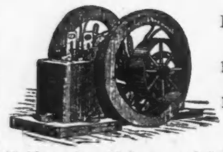
No. 13, 3 horse-power (30 lbs. pressure), 5 h. p. (50 lbs.), 10 h. p. (100 lbs.), 15 h. p. (150 lbs.), 20 h. p. (200 lbs.), $285.
Dis., 40%.

Governors for 11 and 12, $25 extra; for No. 13, $35 extra.

Mining Machinery.

N. B.—Special attention is invited to the goods advertised and illustrated in the advertising pages of the ENGINEERING AND MINING JOURNAL, quotations and discounts upon which would only mislead buyers.

Price-lists and other information may be obtained by addressing the advertisers direct, or by writing to the ENGINEERING AND MINING JOURNAL.



Concentrating Machinery.
Fort Scott Foundry & Machine Works Co.

Blake Improved Crusher: 10x7, weight 7,500; $410.00.

Blake Improved Crusher: 15x9, weight 9,000; $580.00.
Discount 25%.

Cornish Crushing Rollers: 20 diameter, 10 face, weight 5,400; $450.00.

Cornish Crushing Rollers: 20 diameter, 14 face, weight 6,000; $500.00.

Cornish Crushing Rollers: 22 diameter, 14 face, weight 9,500; $625.00.

Cornish Crushing Rollers: 27 diameter, 14 face, weight 13,000; $750.00.

Cornish Crushing Rollers: 30 diameter, 14 face, weight 15,000, $850.00.

Discount 25%.

Complete Sizing Arrangement, consisting of Revolving Screens of Steel Sheet and Hydraulic Classifier.

For Concentrator, 25 tons capacity, $250; 50 tons capacity, $350; 75 tons capacity. $450; 100 tons capacity, $800. Discount, 10 per cent.

Automatic working Jig Machines, all complete, woodword included, with slidemotion: 2 sieves, $3.0; 3 siev. s, $360; 4 sieves, $450.

With Eccentric Motion, all complete, woodwork included: 1 sieves, $200; 2 sieves, $270; 3 sieves, $320; 4 sieves, $330.

Automatic working Double Jig Machines, all complete, woodwork included: 4 sieves, $210; 6 sieves, $335; 8 sieves, $425. Discount, 25 per cent.

Single Rittinger Percussion Tables, all the iron parts, $350; Double Rittinger Percussion Tables, all the iron parts, $500. Discount, 10 per cent.

Improved Rotary Tables, all the iron parts and pipes, $2.0. Discount, 25 per cent.

Mouse Traps.

The Cyclone Mouse Trap, per gross, $4.05.

The Idea Mouse Trap per gross, $8.25.

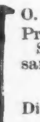
Slayer Rat Traps, per gross, $10. Net prices

Nails and Tacks.

Swedes. Tacks.

Per doz.	½	¾	1	1½	2	2½	3		
½ wt..	35	40	46	50	55	60	65	75	
	6	8	10	12	14	16	18	20	24 oz.
	85	1.00	1.20	1.40	1.60	1.75	1.85	2.15	2.55
Doz. full	½	¾	1	1½	2	2½	3	4	
weight	60	70	80	90	1.00	1.10	1.20	1.40	
	6	8	10	12	14	16	18	20	24 oz.
	1.60	1.90	2.30	2.70	3.10	3.40	3.80	4.20	5.00
lb., bulk	½	¾	1	1½	2	2½	3	4	
or paper	1.60	1.25	1.00	80	66	58	52	46	
6	8	10	12	14	16	18	20	24	
36	32	31	30	29	28	28	28	28	

Discount, 67½, 10 and 2%.



O. H. Swedes.
Price, same as Swedes.
Swedes steel tacks same list price as iron.

Upholsterers.

Discounts, 72½, 10 and 2%.

Price, same as Swedes.

Cut Tacks. Price per dozen ounces.

	1	1½	2	2½	3	4	6	8	10
¼ wt	..	..	..	..	35	40	45	50	55
	12	14	16	18	20				
	60	70	80	90	1.00				
½ wt	1	1½	2	2½	3	4	6	8	10
	45	50	50	55	60	65	70	80	95
	12	14	16	18	20				
	1.10	1.25	1.40	1.55	1.70				
Full wt ..	1	1½	2	2½	3	4	6	8	
	80	90	90	1.00	1.10	1.20	1.30	1.50	
	10	12	14	16	18	20			
	1.80	2.10	2.40	2.70	3.00	3.30			

Discount, 70, 10 and 2%.

Carpet Tacks, flat and oval heads.

Blued, doz. oz.	4	6	8	10	12	14	16	18	20
¼ wt.	35	40	45	50	55	65	5	85	95
	22	24							
	1.05	1.15							
" ½ wt.	4	6	8	10	12	14	16		
	65	70	80	95	1.10	1.25	1.40		
	18	20	22	24					
	1.55	1.70	1.85	2.00					
Tinned, doz. ¼ wt.	4	6	8	10	12	14	16		
	50	55	60	75	85	1.00	1.10		
	18	20	22	24					
	1.20	1.35	1.45	1.60					
Tinned, doz. ½ wt.	4	6	8	10	12	14			
	95	1.05	1.15	1.40	1.60	1.85			
	16	18	20	22	24				
	2.10	2.35	2.60	2.85	3.10				

Discount, 72½, 10 and 2%.

Finishing Nails.

Inch....	⅜	3½-8	4-8	4½-8	⅝	5½-8	6-8	7-8	1
Per lb...48	40	32	28	26	24	22	20	18	

1⅛ and larger.
16
Discount, 60, 10 and 2%.

Chair Nails.
Doz. ½ wt. ; doz. full wt.; pound B. or P.

Inch..	⅜	3½-8	4-8	4½-8	⅝	5½-8	6-8	7-8
Per lb.	51	43	35	31	29	27	25	23
	1	1⅛						
	21	19						

Discount, 60, 10 and 2%.

Common and patent brads.

inch.	Price per doz. ½ wt.	Price per doz. full wt.	Price per lb. in papers or bulk.
2-8	.50	1.00	1.25
3-8	.60	1.20	.80
4-8	.65	1.30	.58
5-8	.72	1.44	.48
6-8	.80	1.60	.36
7-8	.90	1.80	.30
1	1.00	2.00	.26
1⅛	1.12	2.24	.25
1¼	1.26	2.52	.24
1½	1.82	3.64	.22
1¾	2.25	4.50	.20
2	2.43	4.86	.18

Dis. 60, 10 and 2%.

Oils.

LUBRICATING.—Fiske Bros.
Lubroleine A cylinder oil 50 in. barrels.
Lubroleine D cylinder oil 40 in. barrels.
Lubroleine A machine oil 45 in. barrels.
Lubroleine B machine oil 35 in. barrels.
Lubroleine A engine oil 50 in. barrels.
Lubroleine B engine oil 40 in. barrels.
In cases 5c gal. extra.

Crescent Axle Grease.—Barrels, 3c per lb; 100-lb. kegs 3½c lb.; 2-lb. decorated tins, $12, gross less 5 per cent.

Texas Star Axle Grease.—Barrels, 2½c per lb.; 100-lb. kegs, 3c per lb.

Oil Stones.

Best White Washita.

Green Paper Brand, 8 × 2 × 1⅛ inches	per lb.	.32
Oil stone, No. 1, " "	"	.22½
" Extra, " "	"	.30
High rounds, " "	"	.30
Round edge slips, Nos. 1, 3½ to 5, in boxes 10 lbs. upwards	"	.40
Round edge slips, extra, in boxes 10 lbs. upwards	"	.50
Pen knife pieces, ass't 3 to 5 × 1 × 1⅜, in boxes 10 lbs. upwards	"	.50
Needle pieces	per hundred.	$5.00
Wheels, 1½ to 5¾ in. thick	per inch.	.40

Good Washita,

Oil Stone No. 1, 8x2x1⅛	per lb.	.15
" " 2, "	"	.12
Axe Stone, assorted sizes	"	.10
Round Edge Slips, assorted sizes	"	.25

Arkansas.

Oil Stone No. 1, 4 to 6 in. long x2x¾ to 1 in.	per lb.	$1.35
Oil Stone No. 1, 6 to 9 in. long x2x¾ to 1 in.	"	1.75
Oil Stone No. 2, 4 to 9 in. long x2x¾ to 1 in.	"	.75
Round Edged Slips, assorted sizes	"	2.00
Square File Slips, 3 to 4 inches long	per doz.	1.75
Diamonds, 3½ to 4 inches long	"	3.00
Triangulars, 3½ to 4 inches long	"	3.00
Flat Files, 3 to 4 inches long	"	2.00
Beveled Files, 3½ to 4 inches long	"	2.50
Knife Blades, 3 to 4 inches long	"	3.00
Points, extra long, 3 to 3½ inches	"	2.00
Points	"	1.50
Pen Knife Pieces, assorted sizes	per lb.	2.00
Needle Pieces	per hund.	8.00
Wheels, 2 to 4 inches, ½ inch thick	per inch	1.25
Oil Stone Powder	per lb.	15

10, 10 and 2½ dis.

Oil Stoves.

Burns 8 hours; holds 1 quart oil.

Nickel plated crown plate, per doz., $12.

Packing.

SELDEN'S PATENT.
For Steam, Air, Water and Ammonia.
With Rubber Core, 60 cents per lb.
Dis., 25 and 5%.
With canvas core, 50 cents per lb.
Dis., 30 and 5%.
Hline & Robe tson.
Eureka, 75c. per lb. Dis., 40%.
Soapstone—Standard, 8c. per lb.
XX. 11c. per lb.
Crown—No. 1, 23c per lb.
No. 2, 26c. per lb.
Climax, 9c. per lb.
Net.

Paints.

For Assorted Cans of 1, 2, 3 and 5 pounds. 100-lb. cases.

No.		lb. c.	No.		lb. c.
533.	Scotch yellow	18	583.	Black	18
534.	Lead color	18	584.	Dark blue	25
536.	Brown	18	585.	Chrome yellow	30
537.	Light drab	18	586.	Vermilion	30
539.	Buff	18	587.	Indian red	25
542.	Warm drab	18	588.	Bronze green	25
544.	Dark green	25	589.	Quaker green	25
581.	Light green	18	546.	Inside white	15
582.	Norway red	18	547.	Outside white	18

Discount 50 per cent.

Ordinary shades. Per gal. | Per gal.
One to 5 gallon cans.. $1.90 | Half gallon cans $2.00

Tuscan Red, Green and Yellow.
Per gal. | Per gal.
One to 5 gallon cans.. $3.10 | Half gallon cans $3.30

Vermilion.
Per gal. | Per gal.
One to 5 gallon cans.. $5.00 | Half gallon cans $5.20
Discount 40 per cent.

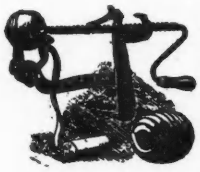
The list in barrels, half-barrels and kegs (of 5 gallons or larger) will be 10c. a gallon less than in gallon cans. Kegs of less than 5 gallons will be charged at gallon price. One-quarter gallon cans not put up. Special shades made to order.
Special cash discount for large orders.

Parers and Corers.

SAML. LEES & CO.

List, $9 per gross.

APPLE.



Little Gem.

Rocking Table.

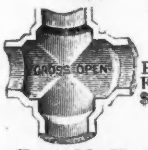
	Per doz.
Advance	$4.75
Baldwin	5.25
Champion	7.25
Hudson's '88	3.75
Improved Bay State	30.
Monarch	31.50
Oriole	4.00
Turntable	4.50
Victor	13.50
White Mountain	4 50
Rocking Table	4.25
Little Gem Corer and Slicer	3.70

Pipe Covering.

Magnesia Sectional Covering.
For Wrought Iron Pipe. In Canvas Jacketed Sections, 36 inches in length.

Inside dia. of pipe.	Weight of cover per lineal ft.	Price per lineal foot canvas jacketed.
½ in.	8 ozs.	$0.25
¾ "	9 "	0.25
1 "	10 "	0.25
1¼ "	12 "	0.25
1½ "	15 "	0.25
2 "	18 "	0.27
2½ "	20 "	0.31
3 "	24 "	0.36
3½ "	26 "	0.40
4 "	30 "	0.44
4½ "	38 "	0.47
5 "	40 "	0.50
6 "	48 "	0.60
7 "	55 "	0.65
8 "	65 "	0.75
9 "	75 "	0.80
10 "	85 "	0.90

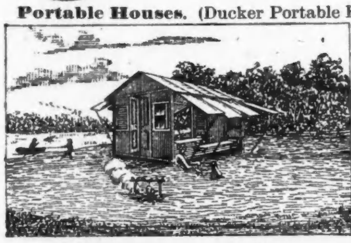
Elb'ws.	Tees.	G Valv's.	Crosses.	Unions.
$0.20	$0.30	$0.25	$0.35	$0.30
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.25	0.33	0.25	0.43	0.33
0.27	0.36	0.27	0.48	0.33
0.31	0.41	0.41	0.53	0.41
0.36	0.48	0.48	0.60	0.48
0.40	0.53	0.53	0.68	0.53
0.44	0.59	0.59	0.75	0.59
0.50	0.65	0.65	0.80	0.63
0.58	0.75	0.75	0.90	0.67
0.65	0.90	0.90	1.00	0.77
0.83	1.20	1.20	1.10	0.90
1.00	1.35	1.35	1.20	1.00
1.10	1.50	1.50	1.35	1.10
1.25	1.75	1.75	1.50	1.25



Magnesia Plastic Covering (dry)—Prepared Carbonate Magnesia and Fiber, for Trowel Work per barrel, $8.00

Dis. 25%.

Portable Houses. (Ducker Portable House.

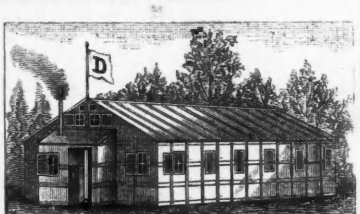


Weight, 450 lbs.

Price, $150.

Closes securely.

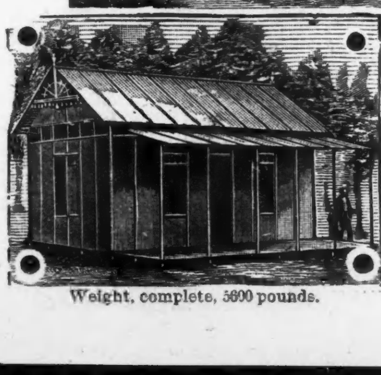
Dis., 10%.



Weight, 85 lbs. per section.

Price, $220.

Dis., 10%.



Weight, complete, 5600 pounds.

No. 10.—26 × 33 ft.. including veranda and rear extension. Main part, 19 × 26 ft. $500.00

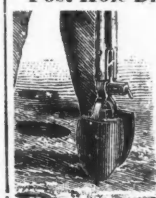
	No. 1. Veranda on side.	No. 2. Veranda on end.	No. 3. without veranda.
12 × 12, 1 door, 3 windows,	$120.00	$120.00	$105.00
12 × 14, 1 " 3 "	135.00	130.00	120.00
12 × 17, 1 " 3 "	155.00	150.00	135.00
12 × 19, 2 " 4 "	175.00	165.00	150.00
12 × 21, 3 " 5 "	190.00	180.00	165.00
12 × 23, 3 " 5 "	200.00	190.00	175.00
12 × 26, 3 " 5 "	220.00	205.00	190.00
14 × 21, 3 " 5 "	205.00	195.00	180.00
10 × 12, 1 " 3 "		100.00	90.00
10 × 14, 1 " 3 "		105.00	95.00
7 × 10, 1 " 2 "			65.00
7 × 12, 1 " 2 "			75.00
7 × 14, 1 " 2 "			85.00

Hunter's Cabins.

7 × 12, with 4 berths $80.00
7 × 14, " 4 " 90.00

Discount, 20%.

Post Hole Diggers.

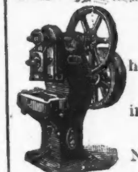


Chieftain Hay Rake Co.

Little Giant	$36.00 doz	11 cu ft.
Hercules	30.00 "	" " "
New Champion	20.00 "	" " "
Scheidler	36.00 "	" " "

Dis. 40% f.o.b. New York or Boston.

Press.



Combined press for cutting, forming, horning and seaming.

Particulars of flat front presses, including beds, slides, bolsters, plates, etc.

Prices are net, delivered on steamers in New York, including insurance, etc.

Nominal size of press	41	42	43	44	450
Price, including et ceteras	$130	$200	$260	$420	$660
Weight, about ...lbs	600	1050	1900	3600	7200
Greatest diameter that can be wired ...ins	5	7	10	14	20
Greatest depth that can be wired ...ins	8	10	13	16½	20
Hole through bed—circle intersecting ...ins	4½	6	8½	12	17
Hole through back—width ...ins	8	9½	12	15½	20½
Width between die clamps—clear ...ins	8	11	15	20	27
Distance back from center of slide bar ...ins	4½	5½	7	9	12
Height to slide-bar, when up ...ins	5¼	6½	7½	8½	9
Stroke of slide-bar ...ins	1	1¼	1½	1¾	2
Adjustment of slide-bar ...ins	1	1¼	1½	1¾	2
Diameter of fly-wheel ...ins	20	26	32	38	44
Width of fly-wheel ...ins	3	4	5	6	7
Weight of fly-wheel, about ...lbs	125	250	420	725	1100
Speed per minute, about ...rev	120	110	100	90	80
Cubic feet boxed, about	30	40	50	60	70

Printers' Sundries.

Vanderburgh, Wells & Co.
And Liberty Machine Works.

Wood rules, 12 cents per yard.
Wood rules, on end wood, 15 cents per foot.

EUREKA STAND.
12 full cases.

Price without cases $12.00
Boxing and cartage 1.25

SHOOTING STICKS.

Each.
No. 1, 75c.
No. 2, $1.
No. 4, 45c., black.
No. 4, 60c., bright.
No. 5, 60c., black.
No. 5, 75c., bright.

GAUGE PINS—ALL SIZES.

Brass, 40c. doz. | Steel, 60c. doz.
Wire, 25c. doz. | Golden, 40c. doz.

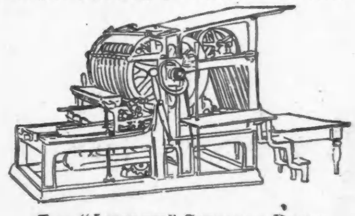
MITRE BOXES.
Regular size, 2 in., 50c. each.
Extra size, 3½ in., 75c. each.

LEAD CUTTER.

Curtis' Lead Cutter $2.00

PROOF PRESS, "OUR OWN."

9 × 32, complete, with Brayer $28.00

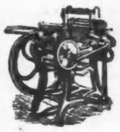


THE "LIBERTY" CYLINDER PRESS.
For Newspaper and Job Printing.

	Bed.	Form.	
No. 5—	29 × 42	24 × 40	$1,200
6—	33 × 47	28½ × 45	1,300
7—	37 × 51	33 × 49	1,600

Dis., 20 and 5%.

THE "LIBERTY" JOB PRINTING PRESS.



Size of chase.

No. 2 — 7 × 11 ....$200
2a— 9 × 13 250
3 —10 × 15 300
3a—11 × 17 350
4 —13 × 19 400
5 —14½ × 22 500

Dis., 12% and 5%.

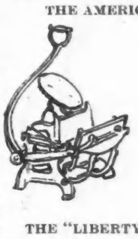
Two sizes built extra strong for boxmakers, embossing, etc.

No. 3a—11 × 17 ....$375
4 —13 × 19 425

Dis., 12 and 5%.

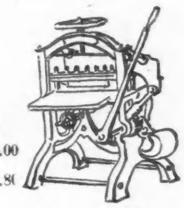
Fountains, either size, $25 extra, if ordered with press.
Steam fixtures, either size, $15 extra.

THE AMERICAN CARD AND BILL HEAD PRESS.



No. 5—4 × 6 ....$16
7—6 × 9 36
8—8 × 12 60

Dis., 20% and 5%.



THE "LIBERTY" PAPER CUTTER.

Cuts 30 inches $140.00
Extra knife ....18.8[illegible]

Dis., 12% and 5%.

THE "LIBERTY" IMPOSING TABLES

Marble top.

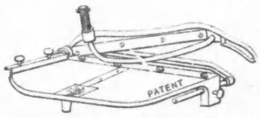
No. 1—24 × 36 ....$24
2—32 × 48 38
3—26 × 74 44
4—36 × 48 48

Dis., 12% and 5%.

Slate Top.

No. 1—24 × 36 ....$18
2—32 × 48 25
3—26 × 74 32

Dis., 12% and 5%.

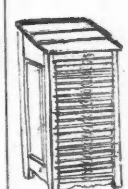


Kelsey & Co.,

The Eagle Card and Paper Cutter, 24½ inch,

$12 each, $100 per doz.

THE "LIBERTY" TYPE CABINETS.



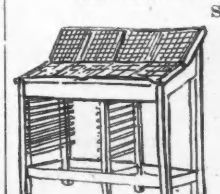
Number of cases.	Stained. Flat. $	Stained. Galley.* $	Grained. Flat. $	Grained. Galley.* $
12⅔	12.00	14.50	14.00	17 00
16⅔	15.00	17.50	17.00	20.00
18⅔	16.50	19.00	18.50	21.50
20⅔	18.00	20.50	20.00	23.00
12¾	15.00	17.50	17.00	20.00
16¾	18.00	20.50	20.00	23.00
18¾	19.50	22.00	21.50	24.50
20¾	22.00	24.50	23.00	26.00
12 full	18.00	20.50	20.00	23.00
16 "	22.00	24.50	24.00	27.00
18 "	24.00	26.50	26.00	29.00
20 "	26.00	28.50	28.00	31.00

Number of cases.	Pine. Flat. $	Pine. Galley.* $	Cherry. Flat. $	Cherry. Galley.* $	Napanoch. Flat. $	Napanoch. Galley.* $	Walnut. Flat. $	Walnut. Galley.* $
12⅔	18.00	21.00	20.00	23.00	22.00	25.00	23.00	26.00
16⅔	22.00	25.00	24.00	27.00	26.00	29.00	27.00	30.00
18⅔	24.00	27.00	.....	.....	.....	.....	.....	.....
20⅔	26.00	29.00	28.00	31.00	30.00	33.00	31.00	34.00
12¾	21.00	24.00	23.00	26.00	25.00	28.00	26.00	29.00
16¾	25.00	28.00	27.00	30.00	29.00	32.00	30.00	33.00
18¾	27.00	30.00	.....	.....	.....	.....	.....	.....
20¾	29.00	32.00	31.00	34.00	33.00	36.00	34.00	37.00
12 full	24.00	27.00	26.00	29.00	28.00	31.00	29.00	32.00
16 "	28.00	31.00	30.00	33.00	32.00	35.00	33.00	36.00
18 "	30.00	33.00	.....	.....	.....	.....	.....	.....
20 "	32.00	35.00	34.00	37.00	36.00	39.00	37.00	40.00

*Furnished with galley top and extra drawer for copy.
Dis., 20 and 5%.

THE "LIBERTY" CASE STANDS AND RACKS.

Stands.



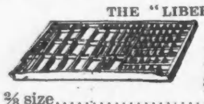
Single, without racks $3.75
" with racks for 8 full cases 4.00
Single, with racks for 10 full cases 4.25
Single, with racks for 12 full cases 4.50
Single, with racks for 14 full cases 4.75
Double, without racks 4.25
" with racks for 8 full cases 4.50
Double, with racks for 16 full cases, and gal. rest 6.25
Double, with racks for 20 full cases and gal. rest 6.50
" " " " 24 " " " " " 6.75
" " " " 24 ⅔ cases 5.25
" " " " 8 full and 8 ⅔ cases 5.00
" " " " 8 " " 8 ¾ " 5.25
" " " " 10 " " 12 ⅔ " 5.50
" " " " 12 " " 16 ⅔ " 5.75
" " " " 12 " " 16 ¾ " 6.00
Stands with closed ends, extra 2.00
Extra slides for stands, each 05

Case Racks.

Cases.	Inches High.	Price.	Inclosed Back and Sides.	Cases.	Inches High.	Price.	Inclosed Back and Sides.
12	41	$6.00	$8.50	30	84	$10.00	$13.50
16	50	7.00	9.50	32	51	12.50	16.00
20	60	8.00	11.00	40	60	14.00	17.50
24	70	9.00	12.00	60	84	18.00	23.00

Dis., 20 and 5%.

THE "LIBERTY" TYPE CASES.



Name.	Outside Measurements.
Full size	32¼x16½x1 9-16
Rooker size	28½x14¼x1 9-16
¾ size	26x16½x1⅜
⅔ size	22⅜x16½x1⅜
Enlarged size	32¼x23x2 3-16
Wood type "	32¼x23x1 9-16
Mammoth "	44x23x1 9-16

Cabinet case sides extend 1½ to 3 inches. In ordering cabinet cases, state whether high or low fonts are wanted.

	Without Pat. Clasps.	With Pat. Clasps.
News, full, per pair	$1 60	$1.75
" Rocker, "	1.60	1.75
" ¾ "	1.50	1.60
" ⅔ "	1.40	1.50
German, full, "	1 60	1.75
Music " "	2 00	2.20
Job " "	.90	1.00
Job, full size, California	.90	1.00
" Rooker	.90	1.00
" full, Yankee	.90	1.00
" ¾ Regular	.80	.90
" ⅔ Yankee	.75	.85
" " Boston	.75	.85
" " California	.75	.85
" " improved	.90	1.00
" full size, Middletown	1.20	....
" " Paterson	.90	....
" " New York	.90	1.00
Quadruple, full size	1.20	....
Double lower, "	1.20	....

Name.	Without pat. clasps.	With pat. clasps.
Galley lower, full size	$1.10	
Enlarged Yankee job	2.20	
Enlarged German	2.20	
Founder's sort case	2.20	
Half-cap	.50	
L. S. lead, full-size	1.00	
" rule "	1.15	$1.25
" " ¾ size	.95	1.05
" " ⅔ "	.80	.90
Improved, ⅔ "	90	1.00
Space and quad, full-size	1.00	
Slug "	1.00	
Figure "	.90	
Triple "	.90	1.00
Improved triple "	.90	1.00
Triple, ¾ size	.80	.90
Blank, full-size	.65	
" ¾ size	.55	
" ⅔ size	.50	
Script, full-size	.90	
" ¾ size	.80	
" ⅔ size	.75	
Wood type, 23x32¼	1.10	
Mammoth, 23x44	1.30	
Metal furniture, full-size	1.25	
Border "	1.25	
" ⅔ size	1.00	
Leader, ⅔ size, per pair	1.40	
Butler jobs, full-size, per pair	3.00	
For pulls on cabinet cases add per case		.10
For rollers " " "		.30

Dis., 25 and 5%.

THE "LIBERTY" GALLEYS.
All brass "indestructible."

Single, 3¾ x 23¾ inside	$2.50
" 3¾ x 15¾ "	2.00
" 3¾ x 11¾ "	1.75
Medium, 5 x 23¾ inside	2.75
Double, 6¼ x 23¾ inside	3.00

Dis., 33⅓%.

SMOOTH LINED NEWS GALLEYS.

	Half-lined.	Full-lined.		Half-lined.	Full-lined
Single col.	$1.75	$2.00	Double col.	$2.00.	$2.50

Dis., 20% and 5%.

SCREW GALLEYS.

	Unlined.	Half-lined.	Full-lined.
Single column	$1.25	$1.50	$1.75
Double column	1.50	1.75	2.00

Dis., 20% and 5%.

SMOOTH LINED JOB GALLEYS.

Size.	Unlined.	Full-lined.	Size.	Unlined.	Full-lined.
6 × 10	$1.25	$2.00	12 × 18	$2.50	$3.50
8¼ × 13	1.50	2.50	14 × 20	3.00	4.00
9 × 14	1.75	2.75	15 × 22	3.50	5.00
10 × 16	2.00	3.00	18 × 25	4.00	5.50

Dis.. 20% and 5%.

RULED GALLEYS.

These have a rule laid out on one of the rims, divided into quarter inches, by which to set advertisements. Cost of ruling extra, 25 cents.

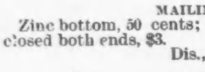
Dis., 20% and 5%.

MAILING GALLEYS.

Zinc bottom, 50 cents; brass bottom, 90 cents. Brass closed both ends, $3.

Dis., 20% and 5%.

GALLEY RACKS.
From $3 up.

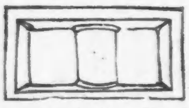


LEAD CUTTERS,
From $2 up.
Dis., 20% and 5%.

THE "LIBERTY" STEEL SHOOTING STICKS.
Bright, $1 each.
Nickelplated, $1.25 each.
Dis., 10%.

STANDARD METAL FURNITURE
25c. a pound.
In fonts of 25, 50, 75 and 100 lbs.
Dis., 15%.

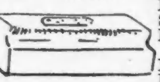
THE "LIBERTY" MALLETS.



Hickory, small	$ .20
" medium	.25
" large	.30
" iron bound	1.00
Lignum Vitæ, No. 4	.30
" " No. 3	.40
" " No. 2	.50
" " No. 1	.70

Dis. 20 and 5%.

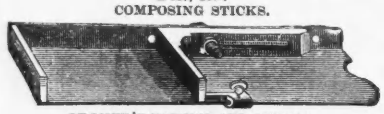
THE "LIBERTY" PLANERS AND PROOF PLANERS.



Midget planer	10c.
Small Maple	20c.
Large "	25c.
" b'ked with leather	30c.
Midget " " "	12c.
Proof planer, faced with cloth,	50c.

Dis., 40%.

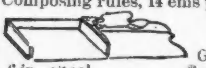
COMPOSING STICKS.



GROVER'S PATENT AND UNION.

		Screw or News.
6 in.,	1.10	$ .90
8 "	1.20	1.10
10 "	1.40	1.20
12 "	1.60	1.40
14 "	1.80	1.60
16 "	2.00	1.80
18 "	2.20	2.00
20 "	2.40	2.20

Composing rules, 14 ems pica and under, 25 cents.



THE "LIBERTY" COMPOSING STICKS.

Grover.

6 in., Steel	$ .90	16 in., Steel	$1.80
8 "	1.00	18 "	2.00
10 "	1.20	20 "	2.20
12 "	1.40	Extra Clasp	.10
14 "	1.60	Extra Knee	.40

Screw.

6 in., Steel	$ .75	16 in., Steel	$1.45
8 "	.80	18 "	1.60
10 "	1.00	20 "	1.75
12 "	1.15	Extra Knee	.30
14 "	1.30	" Screw and Nut.	.10

Dis., 40%.

Yankee.

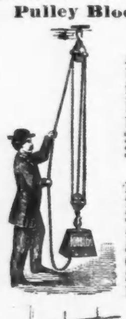
6-in., Steel	$ .75	12 in., Steel	$1.15
8 "	.80	Extra Knee	.30
10 "	1.00	" Clamp and Screw	.15

Other Sizes to Order.
Dis., 40%.

Albion.

6-in., Steel	$1.00	6-in, German Silver	$1.50
8 "	1.10	8 " " "	1.75
Extra Knee	.40	Extra Screw and Nut.	.10

Pulley Blocks.

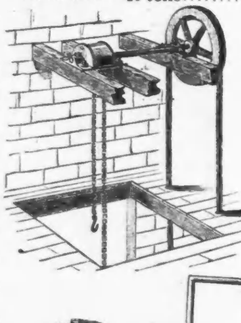


WESTON DIRECT.

	Each.
⅛ ton	$10
¼ ton	13
½ ton	15
1 ton	20
1½ tons	25
2 tons	30
3 tons	40

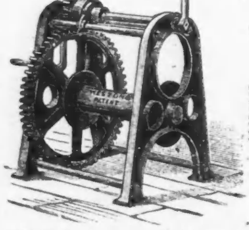
Geared.

1 ton	35
2 tons	45
3 tons	60
4 tons	80
5 tons	110
6 tons	150
8 tons	210
10 tons	275



DOUBLE LIFT HOISTS FOR HATCHWAYS, ETC.

500 lbs.	$25.00
1000 "	50.00
1500 "	65.00
2000 "	80.00
500 "	30.00



WESTON CRAB SAFETY BRAKE, HANDLES CANNOT FLY BACK.

	Each
21	$35.00
22	45.00
23	65.00
25	100.00

Pumps. Rumsey & Co.
Prices on all pumps include cylinders.

No.	Dia. Cyl.	Suction.	Cap. stroke.	Price Iron.	Price Brass cyl.
0	2 in.	1 in.	1-15 gal.	$3.50	.....
1	2¼ "	1 "	1-12 "	4.00	$6.00
2	2⅜ "	1¼ "	1-11 "	4.50	7.00
3	2½ "	1¼ "	1-10 "	5.00	8.00
4	3 "	1¼ "	1-6 "	5.50	10.00
5	3¼ "	2 "	1-5 "	6.50	14.00
6	3½ "	2 "	1-4 "	8.00	18.00
7	4 "	2½ "	1-3 "	12.00	20.00

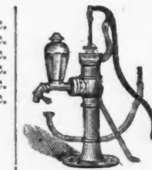
Dis., 65%.

No.	Dia. Cyl.	Suction.	Cap. stroke.	Price Iron.	Price Brass cyl.
1	2½ in.	1¼ in.	1-10 gal.	4.25	.....
2	3 "	1¼ "	1-7 "	4.75	.....
3	3½ "	1¼ "	1-5 "	5.25	.....
4	4 "	1½ "	1-4 "	5.75	.....
5	4½ "	1½ "	1-3 "	6.25	.....

Dis., 70%.

Standard and Cylinder for 1½ in. Iron Pipe, $16.00.

Dis., 55%

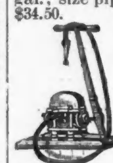


No. 6½, sta and cylinder, 1¼ in. pipe, $13.00.
No. 7½, standard and cylinder, 1¼ in. pipe, $15.00.
No. 8½, standard and cylinder, 1½ in. pipe, $18.00.
With hose and discharge pipe, add $3.00 to list price.

Dis. 55%.

No. 1, diam. cyl., 2½ in.; cap. stroke. 1-8 gal.; size pipe, 1¼ in. Price, iron, $12.50; brass cyl., $17.50.
No. 2, diam. cyl., 3 in.; cap. stroke, 1-6 gal.; size pipe, 1¼ or 1½ in. Price, iron, $14.50; brass cyl., $18.50.
No. 3, diam. cyl., 4 in.; cap. stroke, 2-5 gal.; size pipe, 1½ or 2 in. Price, iron, $23.50; brass cyl., $34.50.

Dis., 55%.



No. 1, diam. cyl., 3 in.; suction, 1¼ in. cap. stroke, 3-10 gal. Price, iron, $28.00; brass cyl., $58.00.
No. 2, diam. cyl., 4 in.; suction, 1½ in.; cap. stroke, 1-2 gal. Price, iron, $32.00; brass cyl., $60.00.
No. 3, diam. cyl., 5 in.; suction, 2 in.; cap. stroke, 6-7 gal. Price, iron, $35.00; brass cyl., $90.00.
No. 4, diam. cyl., 6 in.; suction, 2½ in.; cap. stroke, 1 1-5 gal. Price, iron, $45.00; brass cyl. $120.00.

Dis., 45%.

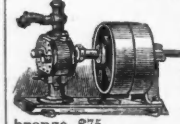
No.	Diam. cyl.	Cap. stroke.	Stroke.	Pipe.	Price.
0	2 in.	1-11 gal.	7 in.	1 in.	$21.50
00	2½ "	1-7 "	7 "	1¼ "	23.00
1	3 "	1-5 "	7 "	1½ "	25.25
2	3½ "	1-3 "	7 "	1½ "	27.25
3	4 "	4-10 "	7 "	2 "	30.50
3½	4½ "	1-2 "	7 "	2 "	37.50
4	5 "	8-10 "	10 "	2½ "	44.00
4½	5½ "	1 "	10 "	2½ "	47.00
5	6 "	1 1-5 "	10 "	3 "	50.00

Dis., 40%.

No.	Diam. cyl.	Cap. stroke.	Diam. pipe.	Price Iron.	Price Br's cyl.
1	2 in.	1-5 gal.	1 in.	$39	$51
2	2½ "	1-3 "	1¼ "	41	56
3	3 "	1-2 "	1½ "	45	62
4	3½ "	6-7 "	2 "	51	81
5	4 "	7-8 "	2 "	63	114
6	4½ "	1 "	2 "	80	155

Dis., 40%.

With Tight and Loose Pulleys.



No. 1, cap. per rev., 1-6 gal.; size of pipe, 1¼ in.; price, iron, $26; bronze, $45.
No. 2, cap. per rev., 1-5 gal.; size of pipe, 1½ in.; price, iron, $31; bronze, $55.
No. 4, cap. per rev., 1-3 gal.; size of pipe, 2 in.; price, iron, $48; bronze, $75.

Pulleys on Nos. 1 and 2 are 8 in. diam., 2½ in. face; on No. 4, 12 in. diam., 3½ in face.

Balance wheels for above pumps. $1, $2, and $3, according to size. Dis., 45%.

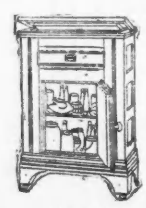
No. 2, ½ to 2 gal. per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, ¾ in.; discharge, ⅜ in.; price, $9.
No. 3, 1 to 4 gal per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, 1 in.; discharge, ⅜ in.; price, $11.
No. 4, 2 to 8 gal. per min.; length of drive pipe, 25 to 40 ft.; calibre of pipes, drive, 1½ in.; discharge, ½ in.; price, $14.
No. 5, 3 to 14 gal. per min.; length of drive pipe, 25 to 40 ft.; calabre of pipes, drive, 2 in.; discharge, 1 in.; price, $22.
No. 6, 4 to 25 gal. per min.; length of drive pipe, 30 to 40 ft.; calibre of pipes, drive, 2½ in.; discharge, 1¼ in.; price, $40.
No. 7, 8 to 60 gals. per min.; length of drive pipe, 30 to 40 ft.; calibre of pipes, drive, 4 in.; discharge, 2 in.; price, $75.
No. 8, 12 to 120 gal. per min.; length of drive pipe, 30 to 50 ft.; calibre of pipes, drive, 6 in.; discharge, 2½ in.; price, $125.

Dis., 45%.

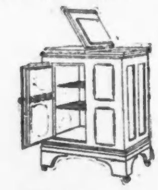
Refrigerators.

Indurated Fibre and Stoneware-Lined.

Cordley & Hayes.

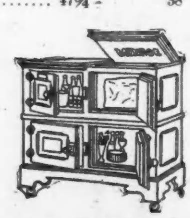


No. 35.

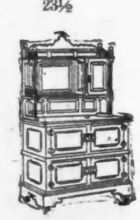


Nos. 75, 85.

No.	High.	Wide.	Deep.	Price.
35	46¼	28¾	20¼	$20.00
75	44¼	33¼	23½	28.00
85	47¾	38	23½	34.00



No. 2.



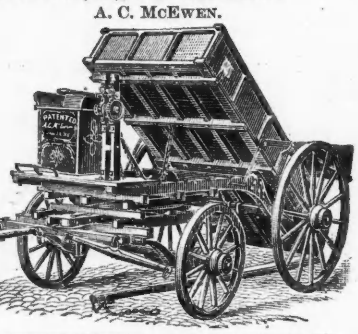
No. 6.

No.	High.	Wide.	Deep.	Price.
2	41	46	26	$36.00
6	84	46	26	60.00

Mirror 16 by 18 in. Dis., 30 and 5%.

Railroad Dumping Cars and Carts.

A. C. McEwen.



Cars.	Gauge.	Cap.	Net	Cap.	Net	Cap.	Net
Side Dumping	24″	1 c. y.	$55	2 c. y.	$65	3 c. y.	$75*
End "	"	"	55	"	65	"	75*
Revolving "	"	"	70	"	80	"	90*
Bottom "	"	"	80	"	90	"	100*
Tunnel.......	"	"	55	"	65	"	75*
Mine.......	"	"	50	"	60	"	70*
Plantation....	30″		43				
Logging......	36″		170				
"	4′ 8½″		185				
Hand	36″		45				
"	4′ 8½″		50				
Push	36″		40				
"	4′ 8½″		45				
R.R. Construction	36″		60				
"	4′ 8½″		65				
Carts.							
Plantation and Railroad.........			45 to 75				
Wagons.							
McEwen Patent Dumping....	....	1 "	175	1½ "	200		

*These cars built of any gauge from 18″ to 56½″ and of any capacity from ½ to 6 cu. yd.

Sash Chains.

No. A. "Giant" metal, 15c. pr. ft., wts. not over 125 lbs.
No. 1. "Giant" metal, 12c. pr. ft., wts. not over 75 lbs.
No. 2. "Giant" metal, 10c. pr. ft., wts. not over 40 lbs.
No. 0. "Giant" metal, 8c. pr. ft., wts. not over 25 lbs.
No. 1. Red metal, 10c. pr. ft., wts. not over 40 lbs.
No. 2. Red metal, 8c. pr. ft., wts. not over 30 lbs.
No. 0. Red metal, 6c. pr. ft., wts. not over 15 lbs.
No. 1. Steel, 8c. pr. ft., wts. not 75 lbs.
No. 2. Steel, 6c. pr. ft., wts. not over 30 lbs.
No. 0. Steel, 4c. pr. ft., wts. not over 15 lbs.
No. 1. Steel, black enameled, 9c. pr. ft., wts. not over 75 lbs.
No. 2. Steel, black enameled, 7c. pr. ft., wts. not over 30 lbs.
No. 0. Steel, black enameled, 5c. pr. ft., wts. not over 15 lbs.

Fastenings for hanging a window of 2 sashes for Nos. 1 and 2 chains, consisting of 4 hooks, 4 rings, 4 sash irons, a set, 18c. per set.

Fastenings for hanging a window of 2 sashes for No. 0 chains, 14c. per set.

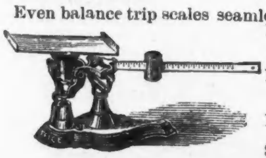
Dis. on "Giant" metal chain	40	10	10%	
" " Red metal chain..............	40	10	10	10%
" " Steel " "	40	10	10	10%
" " Fastenings..................	40	10	10%	

Scales.—Discount on all scales 50 per cent.

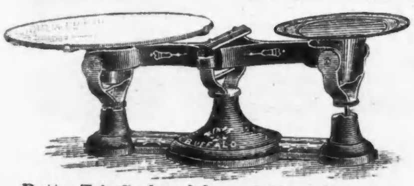
Postal scales.

No. 1, capacity ½ to 9 oz. $3.00.
No. 2, capacity ½ to 12 oz., $4.00.
No. 3, capacity ½ to 34 oz. $6.00
No. 4, capacity ½ oz. to 4 lbs., $8.00

Even balance trip scales seamless scoop, with weights.



No. 1, capacity ½ oz. to 2 lbs., tin scoop, $5.50 brass scoop, $6.50.
No. 2, capacity ½ oz. to 4 lbs., tin scoop, $6.50; brass scoop, $7.50.
No. 2½, capacity ½ oz. to 18 lbs, tin scoop, $11; brass scoop, $12.50.



Butter Trip Scales, slab, weights and scoop.

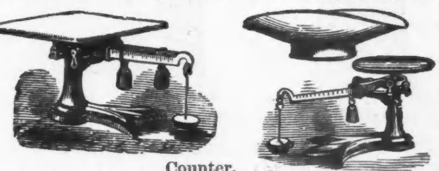
No. 7, ½ oz. to 10 lbs., 10 in. slab, without side beam	$10.50
" " " " " " with "	11.50
" 8 " " 20 lbs., 12 in. " without "	12.50
" " " " " " " "	13.50

Tea Scales—All Seamless Scoops.

Capacity.	Scoop.		Capacity.	Scoop.	
¼ oz. to 10 lbs.	Tin	..$8.00	¼ oz. to 10 lbs.	Brass	.. 9.00

Druggists.

Capacity.	Scoop.		Capacity.	Scoop.	
1-16 oz. to 8 lbs.	Tin	..$10.00	1-16 oz. to 8 lbs.	Brass	..$11.00



Counter.

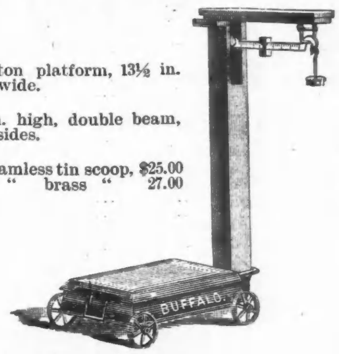
Capacity.	Scoop.		Capacity.	Scoop.	
½ oz. to 36 lbs.	Tin	..$10.00	½ oz. to 36 lbs.	Brass	..$12.00

Grocer.

Capacity.	Scoop.		Capacity.	Scoop.	
½ oz. to 62 lbs.	Tin	...$12.00	½ oz. to 62 lbs.	Brass	..$14.00

Meat or Butter Scales, with Slab.

½ oz. to 62 lbs., with Single Beam..................$14.00
" " " " Double " 15.00



Patent Boston platform, 13½ in. long by 10 in. wide.

Pillar, 18 in. high, double beam, marked both sides.

With large seamless tin scoop, $25.00
" " " brass " 27.00

Platform scales. Without Wheels.

No.	Capacity.	Platform.	Price.
1............	400 lbs.	21½ by 15 inches.	$23.00
2............	600 lbs.	25 by 16 "	30.00
3............	800 lbs.	25 by 17 "	34.00
4............	1,000 lbs.	26 by 17 "	39.00
5............	1,200 lbs.	28 by 20 "	45.00
6............	1,600 lbs.	29 by 21 "	55.00
7............	2,000 lbs.	32 by 23 "	70.00

With Wheels.

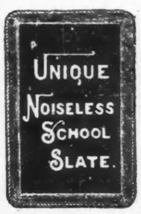
No.	Capacity.	Platform.	Price.
1............	400 lbs.	21½ by 15 inches.	$26.00
2............	600 lbs.	25 by 16 "	33.00
3............	800 lbs.	25 by 17 "	38.00
4............	1,000 lbs.	26 by 17 "	43.00
5............	1,200 lbs.	28 by 20 "	49.00
6............	1,600 lbs.	29 by 21 "	60.00
7............	2,000 lbs.	32 by 23 "	75.00

Brass sliding poise at same price if so specified in order.

With Wheels and Drop Lever.

No.	Capacity.	Platform.	Price.
4............	1,000 lbs.	26 by 17 inches.	$51.00
5............	1,200 lbs.	28 by 20 "	59.00
6............	1,600 lbs,	29 by 21 "	70.00
7............	2,000 lbs.	32 by 23 "	82.00
8............	2,500 lbs.	33¼ by 24¾ "	94.00
9............	3,000 lbs.	38 by 30 "	125.00

School Slates.



Noiseless School Slates.

Winsboro Cord Bound.

Size.	Doz. in case.	Price per case.
5 by 7.............	18	$18.00
6 by 9.............	12	15.00
7 by 11.............	10	14.40
8 by 12.............	8	14.00
9 by 13.............	6	12.00

Dis., 50 and 2½%.

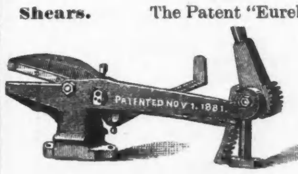
"D" School Slates.

Winsboro Oval Round Corner

Size.	Doz. in case.	Price per case.
4 by 6.............	24	$10.80
5 by 7.............	18	9.00
6 by 8.............	12	8.20
6 by 9.............	12	8.64
6½ by 10.............	12	9.00
7 by 10.............	10	7.70
7 by 11.............	10	8.00
8 by 12.............	8	8.00
9 by 13.............	6	7.20

Dis., 200 case lots, 50 and 2½%.

Shears. The Patent "Eureka



No. 1 cuts round metal up to ¼ in. steel to ⅛, $12.

No. 2 cuts round metal up to ½ in., steel to 3-16, $20.

Discount, 25%.

Steel Wire Mats.

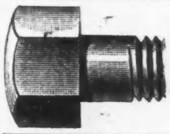
Hartman Mfg. Co.

Galvanized Steel Wire. (Style A) "Hartman Flexible."

No. 2.	Size 16x24.	Each	..$1.50
No. 3.	" 18x30.	"	.... 2.00
No. 4.	" 22x36.	"	.... 3.00
No. 5.	" 26x48.	"	.... 4.50
No. 6.	" 30x48.	"	.... 5.25
No. 7.	" 36x48.	"	... 6.50
No. 8.	" 36x60.	"	.... 8.00
No. 9.	" 36x72.	"	....10.00

Brass mats "list" double the price of galvanized (Style A) for similar sizes.
3 doz. lots, dis. 33 1-3%.
6 doz. lots, dis. 40%.
12 doz. lots, dis. 40 and 5%.

Screws.



STEEL SCREWS ADD 50% TO LIST.

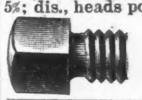
Prices are per 100.

Hexagon Cap Screws.

Heads on Steam-tight Screws not polished, unless so ordered. Can make these 12 inches long.

Diam. head.	7-16	½	9-16	⅝	¾	13-16	⅞	1	1⅛	1¼	1⅜
Length head.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
Diam. screw.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞		1⅛
L'gth under head. ¾..	3.00	3.25	3.75	4.40	5.50	7.00					
1 ..	3.25	3.50	4.00	4.70	5.70	7.00	9.50				
1¼..	3.50	3.75	4.25	5.00	6.00	7.50	9.50	12.20			
1½..	3.75	4.00	4.50	5.30	6.30	8.00	10.00	12.20	16.00		
1¾..	4.00	4.25	4.75	5.60	6.60	8.50	10.60	12.80	16.60	21.20	
2 ..	4.25	4.60	5.05	5.95	7.00	9.10	11.20	13.40	17.20	22.30	29.00
2¼..		5.00	5.40	6.35	7.50	9.70	11.90	14.10	17.90	23.60	30.50
2½..			5.80	6.80	8.00	10.40	12.70	14.90	18.80	25.10	32.30
2¾..				7.30	8.60	11.20	13.60	15.90	20.00	26.90	34.40
3 ..					9.30	12.10	14.70	17.00	21.80	29.00	37.00
Thread to in.	20	18	16	14	12	12	11	10	9	8	7
Add for each ¼ in.	30	40	50	60	80	1.00	1.30	1.60	2.00	2.40	3.00

Dis., heads ground, 60%; dis., heads black, 60 and 5%; dis., heads extra finish, 50%; dis., heads case-hardened, 5%; dis., heads polished after hardening, 45%.



SQUARE CAP SCREWS.

Diam. head.	⅝	7-16	½	9-16	⅝	11/16	¾	⅞	1⅛	1¼	1⅜
Length head.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
Diam screw.	¼	5-16	⅜	7-16	½	9-16	⅝	¾	⅞	1	1⅛
L'gth under head. ¾	2.40	2.75	3.20	3.80	4.40	5.75					
1	2.60	2.95	3.40	4.00	4.70	5.75	7.70				
1¼	2.75	3.10	3.65	4.20	4.95	6.05	7.70	10.50			
1½	2.90	3.30	3.85	4.45	5.25	6.35	8.25	10.50	14.00		
1¾	3.05	3.50	4.10	4.70	5.55	6.65	8.80	11.10	14.80	18.00	
2	3.25	3.70	4.35	4.95	5.90	7.05	9.40	11.80	15.70	19.00	22.50
2¼		4.00	4.65	5.25	6.30	7.55	10.10	12.60	16.70	20.20	24.00
2½			5.00	5.60	6.75	8.15	10.90	13.50	17.80	21.50	25.80
2¾				6.00	7.25	8.85	11.80	14.60	19.10	23.10	27.90
3					7.80	9.65	12.80	15.90	20.60	25.00	30.50
Thread to in.	20	18	16	14	12	12	11	10	9	8	7
Add for each ¼ in.	25	35	45	55	65	90	1.20	1.50	1.80	2.30	3.00

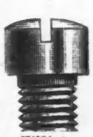
Dis., heads ground, 65%; dis., heads black, 65 and 5%; dis., heads extra finish, 55%; dis., heads case harden ed, 60%; dis., heads polished-hardened, 50%.

MILLED HEADS, COLLAR SCREWS

Diameter of Collar.	¼	11/32	7/16	½	⅝	11/16	13/16	15/16	1	1¼
Diameter of Screw.	⅛	3/16	¼	5/16	⅜	7/16	½	9/16	⅝	¾
Length under Head to Point. ¾	2.50	2.80	3.10	3.75	4.40	5.00	6.25			
1	2.80	3.10	3.40	4.05	4.70	5.30	6.60	8.25		
1¼	3.10	3.40	3.70	4.35	5.00	5.60	7.00	8.60	11.25	
1½	3.45	3.70	4.00	4.70	5.30	5.95	7.40	9.00	11.90	15.00
1¾		4.05	4.35	5.05	5.65	6.35	7.80	9.45	12.60	15.60
2			4.70	5.45	6.25	6.85	8.40	10.00	13.35	16.25
2¼				5.95	6.85	7.40	9.00	10.60	14.15	17.10
2½					7.50	8.10	9.60	11.25	15.00	18.00
2¾						8.75	10.30	11.90	15.90	19.00
3							11.00	12.60	16.85	20.00
Threads to inch	40	30	20	18	16	14	12 or 13	12	11	10
Add for each ¼ inch	30	40	50	60	80	1.00	1.30	1.60	2.00	2.40

Dis., 25%.

MILLED FROM SOLID BAR.



Fillister.

Bevel Head.

Button Head

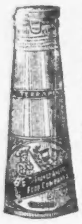
Diam. Head	3-16	¼	⅜	7-16	9-16	⅝	¾	13-16	⅞	1
Length Head	⅛	3-16	¼	5-16	⅜	7-16	½	9-16	⅝	¾
Diam. Screw	⅛	3-16	¼	5-16	⅜	7-16	½	9-16	⅝	¾
Length under Head. ¾	2.00	2.25	2.50	3.00	3.50	4.00	5.00			
1	2.25	2.50	2.75	3.25	3.75	4.25	5.30	6.60		
1¼	2.50	2.75	3.00	3.50	4.00	4.50	5.60	6.90	9.00	
1½	2.75	3.00	3.25	3.75	4.25	4.75	5.90	7.20	9.50	12.00
1¾		3.25	3.50	4.00	4.50	5.00	6.20	7.50	10.00	12.50
2			3.75	4.35	5.00	5.50	6.75	8.00	10.75	13.00
2¼				4.75	5.50	6.00	7.25	8.50	11.50	13.75
2½					6.00	6.50	7.75	9.00	12.00	14.50
2¾						7.00	8.25	9.50	12.75	15.25
3							8.75	10.00	13.50	16.00
Threads to inch.	40	30	20	18	16	14	12	12	11	10

Head on Bevel and Button Head Screws, 1-16 larger in diameter than above specifications.

Price, according to size of head.

Discount, 50%; case hardened, 45%; case hardened and polished, 35%.

Soups (French). Franco-American Brand



Per dozen.	In Cans—Quarts.	In Cans—Pints.	In Glass. 1½ pt.
Green turtle	$8.00	$4.32	$9.00
Terrapin			
Chicken	3.75	2.25	
Mulligatawny			
Mock turtle			4.50
Ox tail			
Consommé			
Tomato			
Julienne			
Printanier	3.50	2.10	
French bouillon			None in glass.
Mutton broth			
Vegetable			
Beef			
Pea			
Packed in cases of	2 doz.	4 doz.	1 doz.

Regular Assorted Cases. In Cans—Quarts.
2 Chicken, 1 Mulligatawny, 3 Mock Turtle, 3 Ox Tail, 2 Consommé, 2 Tomato, 3 Julienne, 1 Printanier, 1 Mutton Broth, 1 Vegetable, 1 Beef, 2 French Bouillon, 2 Pea. Per doz., $3.55.

In Glass.
11 Chicken, 1 Mulligatawny, 2 Mock Turtle, 1 Ox Tail, 2 Consommé, 2 Tomato, 1 Julienne, Printanier, 1 Mutton Broth.

Terms cash Discounts: 5% for lots of 10 cases, 10% for lots of 25 cases. 15% for lots of 50 cases.

Slate Roofing.

F. o. b. New York. Stowage allowed.
Purple and Green, per 100 feet sq.......$4.50
Dark blue, per 100 feet sq.......4.10
Sizes, 24 × 12 = 115 to sq., 650 lbs. weight.
Sizes, 20 × 10 = 170 to sq., 650 lbs. weight.

Spades and Shovels.

The D. F. Jones Mfg. Co., of Gananoque (Ld.).
JONES'
Patent plain black solid cast-steel shovels and spades.

Patent solid steel shovel.

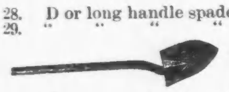
No.		No.	Per Doz. Black.	Per Doz. Pol's'd
20.	D. or long handle sq.-point shovels.	2	$15.50	$16.50
21.	" " " " "	3	16.25	17.25
22.	" " " " "	4	17.00	18.50
23.	" " " " "	6	17.50	19.00
24.	" " " " charcoal.	8	20.50	22.00

Pt. plain back solid cast steel shovel.

25.	D or long handle round-point shovels.	3	16.25	17.25

Patent solid cast steel spade

28.	D or long handle spades	2	16.00	17.00
29.	" " " "	3	16.50	18.00



Patent plain back solid cast steel.

26.	Long round joint shovel No. 2		15.50	16.50
27.	" square " " No. 2		15.50	16.50
32.	D. handle square-point molders' shovels	2	.....	17.00
33.	D. handle square point railroad, extra heavy	2	15.75	
34.	D. handle round point railroad, extra heavy	3	16.50	
35.	L. handle round point shovel, with foot cap	2	16.00	17.00

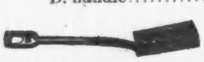
GRAY'S CAST.
Patent plain back solid-steel shovels and spades.

50.	D. or long handle sq.-point shovels.	2	$12.00	$13.00
51.	" " " " "	3	12.75	14.00
52.	" " " round point "	3	12.75	14.00
55.	D. handle spades	2	12.25	13.25
56.	" " "	3	13.00	14.25

Patent solid corrugated cast steel scoop.

SCOOPS.
Jones' patent plain back solid corrugated cast steel scoops.

90.	D. or long handle solid cast steel	2	$13.50	$14.50
91.	" " " " "	4	14.50	15.50
91½.	" " " " "	6	16.50	17.50
	Jones' riveted scoops.			
92.	Cast steel D. or long handle	2	13.50	14.50
93.	" " " "	4	14.50	15.50
94.	" " " "	6	16.50	17.50
				Half polished.
95.	" " "	8		$20.00
96.	" " "	10		22.50
97.	" " " Locomotive or coal (heavy)	6	17.50	
98.	" Long or D. handle for salt (heavy)		17.50	
99.	" D. handle flour and house furnace		10.50	
100.	" D. handle r'd-pt. for coal (extra heavy)	6	20.00	
				Polished.
101.	" ash pit, furnace L. handle	2		13.00
102.	" " " 32 in. D.	2		13.50
103.	" " " 42 " iron D. handle	2		14.00



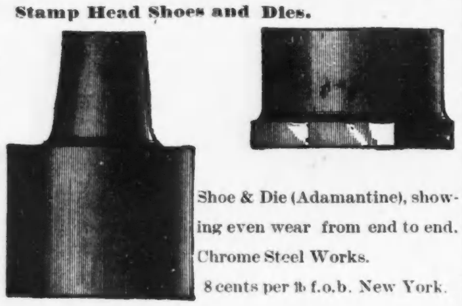
Ditching spade.

124.	D handle ditching (flat)	18.00	19.50
125.	D handle post hole (concave)	18.00	19.50
126.	D handle Alcock (for clay and brick)	16.00	17.00

Discount on shovels and spades, 50 and 10.
" " scoops, 50.
Boxed f.o.b. New York, Boston or Montreal.

The solid shovels, spades and scoops are made from cast steel bars by a recently patented process, the blade and strap being in one piece, not welded. All goods are American patterns.

Stamp Head Shoes and Dies.



Shoe & Die (Adamantine), showing even wear from end to end.
Chrome Steel Works.
8 cents per lb f.o.b. New York.

Stencil Inks.

S. H. QUINT & SON.

Black.

No.	Per can.	Per cake.	No.	Per can.	Per cake.
1	7 cents	3 cents	3	20 cents.	12 cents
2	10 "	5 "	4	30 "	20 "

Blue.

No.	Per can.	Per cake.	No.	Per can.	Per cake.
1	10 cents	6 cents	3	30 cents.	22 cents
2	15 "	9 "	4	50 "	40 "

Red and Green.

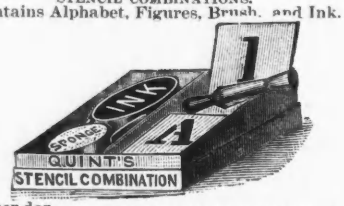
No.	Per can.	Per cake.	No.	Per can.	Per cake.
1	12 cents	8 cents	3	50 cents.	42 cents
2	20 "	15 "	4	90 "	80 "

Per doz. cans or cakes, net, per gross, 10% less.

Indelible Ink.

Small bottles per 100.......$2.75
" " 500.......12.00
" " 1,000.......20.00

STENCIL COMBINATIONS.
Contains Alphabet, Figures, Brush, and Ink.

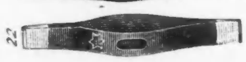


½ inch, per doz	$5.00
¾ " "	5.40
1 " "	5.75
1¼ " "	7.50
1½ " "	8.40
2 " "	10.00
2½ " "	15.00

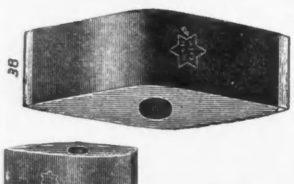
Dis., 10%.

Tools. ARTISANS.

Chisel (Mason).
Stone, 5 and 8c. lb., net.



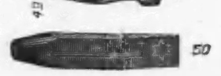
Mill Picks.
Cast steel, 2 to 3 lbs., $22 per doz.
Dis., 60 and 5%.



Stone Axes. Cast Steel.
All sizes, 50c. per lb.
Dis., 70 and 10%.

Five lbs. and over, 40c.; with teeth, 45c.; 3 to 5 lbs., 45c.; with teeth, 50c.; under 3 lbs., 50c.; with teeth, 55c.
Nos. 40 and 41, spalling or stone hammer, 5 lbs. and over, 36c.; 3 to 5 lbs., 40c.; under 3 lbs., 45c. per lb.
Nos. 40 and 41, spalling hammers, 9 to 20 lbs., steel face, per lb., 17c. Dis., 70 and 10%

Ship or Top Mauls, Steel Face. 4 to 8 lbs., 28c. per lb.
Dis., 50, 10 and 5%.



Steel Wedges, wood, 1st qual., 5c. lb.

Cooper Froes.

8 in. ⅌ doz.	$13.00
10 in. ⅌ doz.	13.50
12 in. ⅌ doz.	14.00
14 in. ⅌ doz.	14.50
16 in. ⅌ doz.	15.00

Discount, 60%.
60 days, 2% 10 days.

Vise.

No 1. Solid Box Vises.

	Each.
No. 25, 3⅜ in. Jaw	$12.00
" 30, 3½ "	11.00
" 55, 3⅞ "	10.00
" 40, 4 "	10.50
" 45, 4¼ "	11.00
" 50, 4½ "	11.50
" 55, 4½ "	12.00
" 60, 4¾ "	13.00
" 65, 4¾ "	14.00
" 70, 5 "	15.00
" 75, 5 "	16.00
" 80, 5¼ "	17.50
" 85, 5¼ "	18.50
" 90, 5½ "	20.00
" 95, 5¾ "	21.00
" 100, 6 "	22.00
" 105, 6 "	23.00
" 110, 6¼ "	24.00
" 115, 6½ "	25.00
" 120, 6½ "	26.00
" 125, 6¾ "	27.50
" 130, 6¾ "	29.00

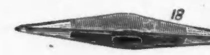
	Each.		Each.
No. 135, 6¾ in. Jaw	$31.50	No. 170, 7¼ in. Jaw	$44.50
" 140, 7 "	33.00	" 180, 8 "	47.00
" 145, 7 "	35.00	" 190, 8 "	53.00
" 150, 7 "	36.00	" 200, 8 "	56.00
" 160, 7¼ "	41.50		

Dis., 60 and 10%.

MINERS.

Adze Eye Coal Picks.
Same list and dis. as No. 16.

Anthracite Coal Picks.
Same list and dis. as No. 16.



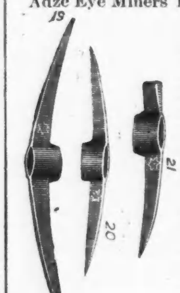
Stone Picks, per doz.
No. 18, 6 to 7 lbs...$16.50.
No. 18, 7 to 8 lbs... 17.50.
No. 18, 8 to 9 lbs... 18.50.
Dis., 60 and 5%.

Coal Picks.

No.		Per doz.
16,	Weight, 2 lbs	$8.50
16,	" 2½ "	9.00
16,	" 3 "	9.50
16,	" 3½ "	10.00
16,	" 4 "	10.50
16,	" 4½ "	11.00
16,	" 5 "	11.50
16,	" 5½ "	12.00
16,	" 6 "	12.50
16,	" 6½ "	13.00
16,	" 7 "	14.00

Packages charged at cost. Dis., 60%.

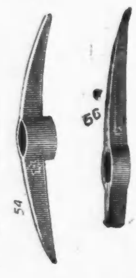
Adze Eye Miners Picks—Surface, Drifting and Poll.



No.			per doz.
19,	Surface.	No. 1, 4 lbs	$14.00
19,	"	No. 2, 4½ "	15.00
19,	"	No. 3, 5 "	16.00
19,	"	No. 4, 5½ "	17.00
19,	"	No. 5, 6 "	18.00
19,	"	No. 6, 6½ "	19.00
19,	"	No. 7, 7 "	20.00
20,	Drifting,	No. 1, 3 "	12.50
20,	"	No. 2, 4 "	14.00
20,	"	No. 3, 4½ "	15.00
20,	"	No. 4, 5 "	16.00
20,	"	No. 5, 6 "	17.50
21,	Poll.	No. 1, 3½ "	15.00
21,	"	No. 2, 4 "	16.00
21,	"	No. 3, 4½ "	17.00
21,	"	No. 4, 5 "	18.50
21,	"	No. 5, 6 "	20.00
21,	"	No. 6, 6¾ "	21.50

Dis., 60, 10 and 5%.

No. Ore Picks.



54, Adze Eye, 5 to 6 lbs.....⅌ doz. $12.00
54, " 6 to 7 " ..... " $13.00
54, " to 8 " .... " $14.00

56, Steel Lake Superior Mining Pick*
(Special Price and Quality.)
Dis, 60 and 10

Tamping Picks.

Adze eye, 6 to 7 lbs., per doz., $17.
Adze eye, 7 to 8 lbs., per doz., $18.
Adze eye, 8 o 9 lbs., per doz., $19.
Hunt eye, 6 to 7 lbs., per doz., $17.
Hunt eye, 7 to 8 lbs., per doz., $18.
Hunt eye, 8 to 9 lbs., per doz., $1[illegible].
Dis., 60 and 10%.

Steel Face Hammers.

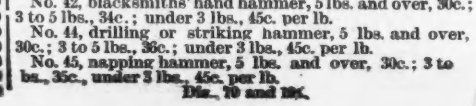
No. 43, hand drilling hammers, 2 to 5 lbs.; No. 45, napping hammers, 2 to 5 lbs.; No. 39, mason hammers, 3 to 8 lbs.; No. 42, smiths' hand hammers, 2 to 5 lbs.; No. 44, smiths' striking hammers, 2 to 5 lbs., all steel face, per lb., 26c. Dis., 70 and 10%.

Steel Face Sledges.

No. 34. Smiths' sledges, 6 to 30 lbs., steel face, 17c. per lb.
No. 35. Stone sledges, 6 to 30 lbs., steel face, 17c. per lb.
No. 36. Striking sledges, 6 to 30 lbs., steel face, 17c. per lb.
No. 37. Coal sledges, 5 to 10 lbs., steel face, 18c. per lb.

Cast Steel Sledges.

No. 34. Blacksmiths' sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 35. Stone sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 36. Striking sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 37. Coal sledge, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.



No. 43, hand drilling hammer, 5 lbs. and over, 36c.; 3 to 5 lbs., 40c.; under 3 lbs., 45c. per lb.
Dis., 70 and 10%.

Cast Steel.

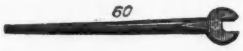
No. 42, blacksmiths' hand hammer, 5 lbs. and over, 30c.; 3 to 5 lbs., 34c.; under 3 lbs., 45c. per lb.
No. 44, drilling or striking hammer, 5 lbs. and over, 30c.; 3 to 5 lbs., 36c.; under 3 lbs., 45c. per lb.
No. 45, napping hammer, 5 lbs. and over, 30c.; 3 to 5 lbs., 35c., under 3 lbs., 45c. per lb.
Dis., 70 and 10%.

RAILROADS.

Railway Track Punch

Round Point.
15c. lb., net.

Track Wrench.



7¾c. lb., net.

Rail Fork.

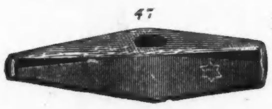
9c. lb., net.

Crow Bars.
Wedge Points,
3½c. lb., net.
Pinch Point,
3 ½c. lb., net.

65 Tamping Bar,
6c. lb., net.

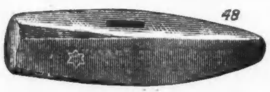
66 Claw Bar,

7c. lb., net.



Railroad Spike Mauls
6 to 16 lbs., Steel Face
18c. lb.

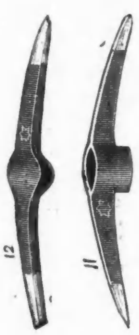
Dis.. 50, 10, and 5%.



Steel Track Chisel,

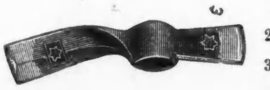
15c. per lb., net.

Railroad or Clay Picks.

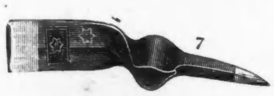


No.		Per doz.
11, Adze eye,	4 to 5 lbs.	$11.00
11, "	5 to 6 "	12.00
11, "	6 to 7 "	13.00
11, "	7 to 8 "	14.00
11, "	8 to 9 "	16.00
11, "	9 to 10 "	18.00
12, Hunt eye,	4 to 5 "	11.00
12, "	5 to 6 "	12.00
12, "	6 to 7 "	13.00
12, "	7 to 8 "	14.00

Dis., 60 and 10%.



Mattocks—Price per doz.
2, Adze Eye, Long Cutter, 6 lbs., $16.00.
3, Adze Eye, Short Cutter, 5½ lbs., $15.50.
2, Adze Eye, Long Cutter, Light, $15.00.
3, Adze Eye, Short Cutter, Light, $15.00.
4, Hunt Eye, Long Cutter, 6 lbs., $16.00.
5, Hunt Eye, Short Cutter, 5½ lbs., $15.50.



Adze Eye Pick
Mattocks..........$16.

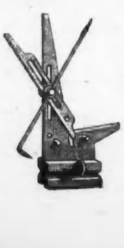
Hunt Eye Pick
Mattocks.........$16

Dis., 60 and 10%.

Grub Hoes.

Western Pattern, No. 0, 3 lbs., ℔ doz., $10.50.
Western Pattern, No. 1, 3½ lbs., ℔ doz., $11.
Western Pattern, No. 2, 4 lbs., ℔ doz., $11.50.
Western Pattern, No. 3, 4½ lbs., ℔ doz., $12.
Baltimore Pattern, No. 1, 3½ lbs., ℔ doz., $11.
Baltimore Pattern, No. 2, 4½ lbs., ℔ doz., $11.75
Baltimore Pattern, No. 3, 5 lbs., ℔ doz., $12.75.
Baltimore Pattern, No. 4, 5¾ lbs., ℔ doz., $13.75.
Dis., 60 and 10%.

MACHINISTS'.

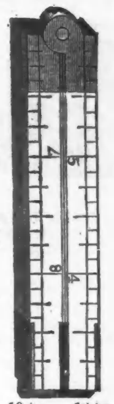


Combination Square, Bevel and Surface Gauge.

Price complete..............................$3.00

Dis., 20, 10 and 5%.

Tools, Carpenters'.



BOXWOOD RULES.

Two feet, four-fold, 1 inch wide.

Plate.	Middle.	Edge.	Bound.
Round joint..........	$4	...	...
Square "	5	$7	$15
Arch "	6	8	16

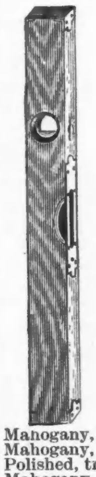
Two feet, four-fold, 1⅜ inches wide.

Plate.	Middle.	Edge.	Bound.
Square joint..........	$7	$9	$18
Arch "	9	11	20

Two feet, two-fold, 1½ inches wide.

Square joint.	Arch.	Arch Bound.
$5	$7	$16
12	14	24
		Gunter's Slide.

Dis. 80, 10 and 10%.



LEVELS.

	10 to 16 in.	18 to 24 in.
Arch top plate, 2 side views..	$9.00	$12.00

PLUMBS AND LEVELS.

Arch top plate, 2 side views.

	12 to 18 in.	18 to 24 in.	24 to 30 in.
Polished..................	$14.00	$16.00	$18.00
Mahogany..............	....	16.50	22.50
Mahogany tp'd and lp'd	27.00	.....	.....
Polished and l pped.....	.....	.....	24.00
Polished and tipped.....	.....	.....	28.00
Polished, lip'd and tip'd	.....	.....	35.00

	in.	
Mason's level, 2 plumbs, polished,	36,	$30.00
Mason's level, 2 plumbs, p'd and t'd,	36,	36.00
Mason's level, 2 plumbs, polished,	42,	36.00

PATENT ADJUSTABLE PLUMBS AND LEVEL.

Arch Top plate, 2 side views	26 to 30 in.
Polished and lipped....................	$27.00
Polished and tipped....................	30.00
Polished, lipped and tipped............	39.00
Mahogany..............................	27.00
Mahogany, lipped..............................	33.00
Mahogany, lipped and tipped....................	48.00
Polished, triple stock, lipped and tipped..........	48.00
Mahogany " " " " "	60.00
Rosewood, lipped and tipped....................	90.00

Dis., 70, 10, 10%.

POCKET LEVELS.

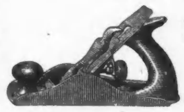
Iron top, Japanned..................................	2 50
Brass top.................................. ...	3.00

Dis., 70, 10, 10%.

SCREWDRIVERS.

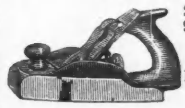
Varnished handles, pat. metallic fastening.
Size 1½, $1 per dozen; 2, $1.50; 3, $2; 4, $2.50; 5, $3; 6, $3.50; 7, $4; 8, $4.75; 10, $6; 12, $8.
Dis., 75%.

PLANES, BAILEY'S PATENT IRON.
With pat. lateral adjustment.



Smooth, 8 in. × 1¾ in., $3; 9 in. × 2 in., $3.25; 10 in. × 2⅜ in., $3.75 each.
Jack, 14 in. × 2 in., $3.75.
Fore, 18 in. × 2⅜ in., $4.75
Jointer, 24 in. × 2⅜ in., $6.50 each.
Dis., 40, 10 and 10%.

BAILEY'S PATENT WOOD PLANES.



Smooth.		Handle smooth.
9 × 8¾ in.	8 × 2 in.	9 × 2 in.
$2	$2	$2.50 each
Jack.	Fore.	Jointer.
15 × 2½ in.	20 × 2⅜ in.	26 × 2⅜ in.
$2.50	$2.75.	$3.25 each

Dis., 40, 10 and 10%.

STANLEY IRON BLOCK PLANES.

3½ × 1 in.
20c.

5½ × 1¼ in.
40c.

7½ × 1¾ in.
60c. each.

ADJUSTABLE.

5½ × 1¼ in.
60c.

7½ × 1¾ in.
85c. each.

Dis., 40, 10 and 10%.

STANLEY'S BEADING, RABBET, SLITTING AND MATCHING PLANE.

Eighteen Tools, Bits, etc.

X $8 each. Dis., 20, 10 and 10%.

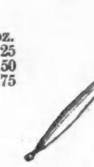
STANLEY "ODD JOBS."

Embraces in combination with ordinary Carpenters' Rule:

010 Try square.
020 Mitre square.
030 T——— square.
040 Marking gauge.
050 Mortise gauge.
060 Depth gauge.
070 Mitre level.
080 Spirit level and plumb.
090 Beam compass.
0100 Inside square for making boxes and frames.

Price 75 cents.
Dis., 20, 10 and 10%.

TACK HAMMERS.



	Doz.
Magnetic, small...............	$1.25
Medium............	1.50
Large............	1.75

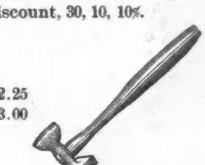
Discount, 30, 10, 10%.

MALLEABLE IRON.

Inlaid Handle.

Per Doz..........................$2.50

Discount, 30, 10, 10%.



STEAK HAMMERS.

Japanned.....................	$2.25
X Plated....................	3.00

Discount, 30, 10, 10%.

Trucks.

New York Pattern.

Size.	Length of hdles. Ft.	In.	Width at nose. Inches.	Width at upper bar. Inches.	Size of wheel. Inches.	Price.
No. 0	3	6½	12	13¼	6½ × 1¾	$4.50
No. 1	4	1	13⅞	15⅝	6½ × 1¾	4.85
No. 2	4	5	15	16½	7¾ × 1⅞	6.00
No. 3	4	8	16	17¾	8¾ × 2¼	7.00
No. 4	5	0	16¼	17¾	9¾ × 2¼	8.00
No. 5	5	4	17¼	18⅞	10¾ × 2¾	9.50

Discount 50%.
Special net prices on quantity orders.

Tuyeres.

No. 2.	No. 4.
$25.00	$35.00 per doz.
	20 % dis.

Valves. Brass Globe and Angle Valves.

Size, inches..........	⅛	¼	⅜	½	¾	1
Star globe and angle valves..........	$0.80	$0.85	$0.90	$1.20	$1.55	$2.00
Star globe and angle valves, heavy patterns........ ...	...	...	...	1.50	1,95	2.80
Extra heavy Star and Lion patterns. ...	...	...	...	2.00	2.60	3.60
All brass, yoke top. ...	...	...	...	....	....	3.75
Cross valves.......... ..	...	1.15	1.25	1.50	2.00	2.50
Star check valves..	.70	.70	.75	.95	1.20	1.65
do. heavy pattern. ..	...	...	...	1.15	1.50	2.00
Crescent globe and angle valves......	.60	.60	.75	1.00	1.35	1.80
Crescent hose valves ..	...	...	...	...	...	...
check valves. .	...	.50	.60	.85	1.15	1.55
Vertical check v'lv's .	...	.50	.60	.85	1.15	1.55
Jenkins globe and angle valves	...	1.10	1.25	1.60	2.20	2.80
Jenkins check valv's ..	...	1.10	1.20	1.30	1.90	2.60
Gate valves, Chapman....	...	...	...	1.30	1.75	2.25
Gate valves, other makes............... ..	...	...	1.00	1.20	1.75	2.5[illegible]
Brass safety valves. ..	...	2.00	2.25	2.75	3.50	5.00
Brass butterfly v'lv's ..	...	...	...	...	...	3.50

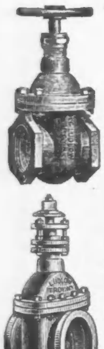
Size, inches......................	1¼	1½	2	2½	3
Star globe and angle valves.	$3.00	$4.00	$6.50	$12.50	$19.00
do. heavy pattern.	3.95	5.30	8.35	14.00	22.00
Extra heavy Star and Lion patterns......................	5.40	7.20	10.80	18.20	28.60
All brass, yoke top...........	5.00	7.00	10.00	18.00	30.00
Cross valves.................	3.50	5.00	8.00	16.00	24.00
Star check valves............	2.50	3.25	5.00	11.00	15.00
do heavy pattern..	3.00	4.00	6.50	12.50	17.00
Crescent globe and angle valves......................	2.80	3.90	5.90	11.25	16.00
Crescent hose valves.........	4.00	5.50	7.00	10.00	....
" check valves.......	2.30	3.25	5.20	10.00	14.00
Vertical check valves........	2.30	3.25	5.20	10.00	14.00
Jenkins globe and angle valves......................	4.00	5.50	8.00	15.75	22.00
Jenkins check valves	3.60	5.00	7.50	13.50	20.50
Gate valves, Chapman.......	3.25	4.25	6.25	11.50	16.00
" " other makes....	3.50	5.00	7.50	15.00	22.00
Brass safety valves	7 00	8.50	12.00	20.00	30.00
Brass butterfly valves.......	4.50	5.50	8.00	11.00	16.00

Pressure Regulating.

Mason Regulator Co.

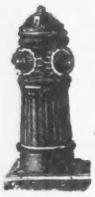
Size pipe.	Price.	Size pipe.	Price.	Size pipe.	Price.
1 inch,	$22.	1¼ inch,	$28.	1½ inch,	$35.
2 "	44.	2½ "	57.	3 "	72.

Ludlow Valve Co.
Double Gate Brass Valves.
Gland in packing box.



Size.	Screw socket.	Flange.	Diameter of Standard Flange.	Face to face of Screw socket	Face to face of Flanges.	Extra for slide stem and lever subject to discount.
In.	$	$	In.	In.	In.	
½	1.25	.....	....	2¼	....	$1.00
¾	1.65	.....	....	2½	....	1.00
1	2.15	.....	....	2⅞	....	1.00
1¼	3.15	.....	....	3⅜	....	1.00
1½	4.25	.....	....	3¾	....	1.00
2	6.25	11.50	6	4⅛	4⅝	1.00
2½	11.50	18.00	6½	4 13-16	5⅜	1.25
3	16.00	22.00	7	5	6¼	1.25
3½	21.00	31.00	7½	....	....	1.25
4	35.00	43.00	9	....	7 1-16	1.25
5	52.00	64.00	10	....	....	1.25
6	78.00	90.00	11	....	9	1.25
8	.....	.....	....	....	....	......
10	.....	.....	....	....	....	......
12	.....	.....	....	....	....	......

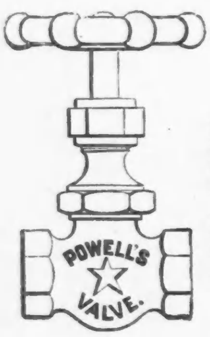
Rubber-Faced Slide Gate Fire Hydrant.



Diameter of pipe connection.	Diameter of stand pipe.	Diameter of seat ring.	One 2½ nozzle.	Two 2½ nozzles.	Three 2½ nozzles.
Inches.	Inches.	Inches.			
3 or 4	4½	3	$28	....	....
3-4-6	5¾	4	31	$33.00	$35.00
4 or 6	7	5	....	38.50	40.50
6 or 8	8	6	....	49.00	51.00
8 or 10	10	8			

Four 2½ nozzles.	Six 2½ nozzles.	One steamer nozzle.	One steamer and one 2½ nozzle.	One steamer and two 2½ nozzles.	Frost case, standard length.
......	......	......	......	......	$4.50
......	......	$33.00	$35.00	$37.00	5.00
......	......	38.50	40 50	42.50	6.50
$53.00	......	49.00	51.00	53.00	7.50

or each 6 inches more or less than standard length of stand pipe, add or deduct from list.	For each 6 inches more or less than standard length of frost case, add or deduct from list.	Extra charge for hub.	Independe't nozzle gates each.
$0.60	$0.44		
.75	.50	6 in. $0.50	$3.50
.85	.70	No ch'ge	3.75
1.00	.90	8 in. $1.25	3.75
....	....		4.50



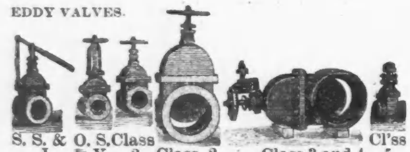
Star Radiator Valves, with Brass T Handles or Wood Wheels.

Size, inches.....	½	¾	1
Plain brass....	$1.60	$2.00	$2.50
Plated trim'gs.	1.80	2.25	2.80
Rough & Plat'd	2.00	2.45	3.05
Finish'd & P'l't.	2.50	3.00	3.65

Size, inches....	1¼	1½	2
Plain brass.....	$3.60	$4.80	$7.50
Plated trim'gs.	3.95	5.20	8.00
Rough & Plat'd	4.20	5.50	8.50
Finish'd & P'l't.	4.95	6.50	9.75

Dis., 40, 10 and 5%.

EDDY VALVES.



S. S. & L. O. S. & Y. Class 2. Class 2. Class 3 and 4. Cl'ss 5.

	Class 2.		Class 3.	Class 4.	Class 5.		
	Iron, brass mounted.		All ir'n for gas. Hub. ends.	Water works valves. Hub ends.	Quick opening valves with rack and pinion stem. Iron, brass mounted.		
Size.	Screw, or flange ends.	Add for S S&L			Hub ends.	Screwed.	Flanged.
2	$7.00	$1.00	$8.00	$10.00	$10.00	$9.00	$9.00
2½	10.50	1.30	....	....	15.00	14.00	14.00
3	13.00	1.40	10.00	15.00	20.00	17.00	17.00
3½	16.50	1.50	.. ....	....	25.00	21.00	21.00
4	18.00	1.70	15.00	18.00	30.00	25.00	25.00
4½	22.00	1.80	....	....	....	....	....
5	25.00	2.00	20.00	25.00	35.00	31.00	31.00
6	31.00	2.30	25.00	31.00	40.00	37.00	37.00
7	37.00	2.70	30.00	37.00	....	....	....
8	45.00	3.00	35.00	45.00	55.00	55.00	55.00
10	60.00	3.50	48 00	60.00	....	....	....
12	80.00	4.00	65 00	80.00	..	.. ..	....

All Iron Valves, Classes 2 and 5, 10 per cent. less than Brass Mounted.

Varnish.

Edward Smith & Co.
For Finishing Coats.

	gal.
Wearing body varnish	$5.50
Medium drying body...............	5.50
One coat coach varnish.............	4.50
Wearing carriage......................	4.50
Heavy gear varnish..................	4.00
Coach body "	4.05
No. 1 coach "	2.2

For Under Coats.

Hard drying body.....	$4.50	Black rubbing varnish.	$4.00
Rubbing body varnish.	4.00	Priming (1st coat).....	2.50
Quick rubbing "	3.50	Filling (2d coat)	2.50
		Rough stuff...........	2.50

For Inside Work.

Best flowing varnish..	$4.50	Hard oil finish-light ..	$2.75
Best polishing " ..	4.50	" dark...	2.25
Cabinet " ..	3.00	White copal....... ...	4.00

Dryers.

Japan gold size.... ..	$3.50	Brown japan...........	$1.25
Coach japan...........	1.75	Liquid dryer..........	1.25

Discount, 40 per cent, f.o.b. N. Y.

Preservative Coatings.

Spar coatings..........	$4.00	Exterior car coating..	$4.00
I. X. L. No. 1..........	2.50	Interior car coating...	3.25
I. X. L. No. 2..........	4.00	Locomotive coating....	4.00
Floor finish...........	2.50		

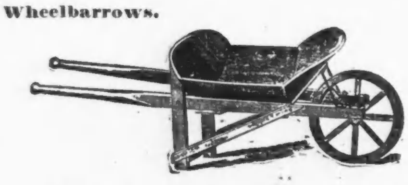
Discount, 35 per cent, f.o.b. N. Y.

Wagons, Carts, Etc.

D. F. Sargent & Son.

No. 0. Cart, top and fenders.......................... $150
No. 1. Cart, top and fenders.......................... 90
No. 2. Cart, one man cart, open........................ 65
No. 2. Cart, one man, top. 86
No. 2. Cart, one man, top and fenders............. 90
No. 3. Cart, two man, open............................. 60
No. 3-H. Cart, two man, open........................... 54
No. 4. Cart, two man, top. 86
No. 5. Cart, two man, top and fenders........................... 90
No. 6. Cart, two men, top and fenders.................. 90
No. 7. Two man combination cart.................. 110
Wide track 5 feet.
Narrow track 4 feet 8 inches.
Discount 33⅓ per cent. off.

Wheelbarrows.



Climax Bolted Barrow, with Wood Wheel per doz. $22.50.
1½ tire of iron,
Common Nailed Barrow per doz. $18.50.
" Bolted " " " 18.75.

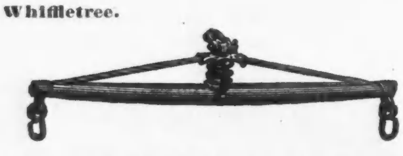
Lansing's Patent Iron-Bolted Barrow,	per	doz.,		$25.50
Capital Patent Bolted Dirt	"	"	"	30.00
Red oak or Government	"	"	"	40.50
Wharf	"	"	"	72.50
Mortar	"	"	"	30.00
Bent Handle Stone	"	"	"	48.00
Coal or Ore	"	"	"	31.50
Pig Metal or Casting	"	"	"	40.50
Brick Yard 20 inch Iron Wheel	"	each		10.50

Globe Patent Bolted Garden Barrow, Box 30 by 24 by 12 deep, wood wheel } per doz., 42.50.

Capita Patent Barrows
With Iron Tray, A, per doz., ...$39.00
" " " B, " " 42.00

The Leader Iron and Steel Barrows.
Gas-pipe Legs and Handles in one price.
No. 1 Tray of 16 iron, capacity 3 cu. ft. of earth, each $12.
No. 2 " " 14 " " 5 " " " " or 250 lbs. of coal.......................... " 15
3 Galvanized 18 iron, capacity same as No. 2..... " 15

Whiffletree.

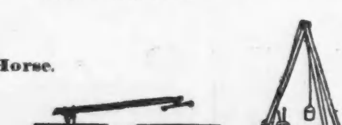


Willson spring (Jeffery Manufacturing Company).

	Single.	Double.
No. 1, 34 or 36 inches long..............	$1.25	$2.50
No. 2, " " "	1.40	2.75
No. 3, " " "	1.50	3.00
No. 4, " " "	1.65	3.25

Including either steel hooks or rings
Discount, 45 and 5%.

Whims—Horse.

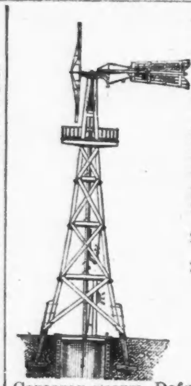


Common-sense Steel.

F. O. B...$125

Dis., 25%, in car lots.

Windmills.



A. J. CORCORAN.
Patent Storm Defying Pumping Mills.

Wheel.	Weight, boxed.	Cubic feet.	Price.
8½ ft.	650 lbs.	55	95.00
10 "	700 "	75	120.00
12 "	900 "	95	150.00
14 "	1,350 "	135	250.00
16 "	1,850 "	195	375.00
18 "	2,150 "	250	450.00
20 "	3,500 "	335	600.00
Dis., 25%.			
25 "	5,400 lbs.	450	775.00
Dis., 20%.			
30 "	9,500 lbs.	795	975.00

Boxing for export extra.

Corcoran Storm Defying Geared Windmills for Driving Machinery.

Price includes upper set of Bessemer steel gears, one length of shaft.

Dia.	H. P.	Weight.	Cu. ft.	Price.
16 ft.	2½	1,900 lbs.	209	$400.00
20 "	5	3,600 "	340	650.00
25 "	6½	5,400 "	355	850.00
30 "	8	9,600 "	816	1,150.00
36 "	10	12,000 "	856	1,500.00
40 "	12	14,500 "	896	2,000.00
50 "	30	16,500 "	956	3,500.00
30 "	40	20,000 "	1,015	4,500.00

Dis., 25%.

10 ft. pumping.... $75
12 ft. " 95
14 ft. " 140
16 ft. " 225
} Plus cost of packing.

Dis., 50 per cent.

EMMERT & LAMB.

"Stover" Pumping Windmills (no tower).

Size wheel.	Wt. packed.	Cubic ft.	Price.
10 ft.	650	50	$80.00
12 ft.	750	58	100.00
"Zenith" Pumping Windmills (no tower)			
10 ft.	650	48	85.00
12 ft.	750	57	110.00
Dis., 50 per cent.			
14 ft.	1,400	108	160.00
16 ft.	1,600	114	250.00
Dis., 45 per cent.			
20 ft.	2,950	220	400.00
25 ft.	4,225	280	600.00

Dis., 40 per cent.

"Zenith" Geared Windmill (no tower).

Prices include upper set of Gears and about 5 feet vertical extra heavy shaft in windmill head.

14 ft.	1,550	178	260.00
16 ft.	1,780	198	300.00
20 ft.	3,170	216	500.00

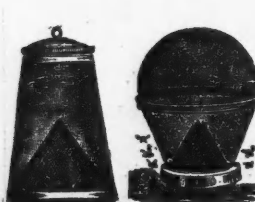
Dis., 40 per cent.

Wire Cloth.

Brass and Copper Wire Cloth.

No. Mesh.		Price per foot.	No. Mesh.		Price per foot.
2	from No. 10 wire....	$2 50	20	from No. 26 wire....	$.80
3	" 11 "	2.50	22	" 27 "	.80
4	" 12 "	2.50	24	" 28 "	.80
5	" 13 "	2.50	30	" 30 "	.65
6	" 14 "	2.50	40	" 32 "	.70
8	" 16 "	2.50	50	" 34 "	.75
10	" 18 "	2.00	60	" 35 "	.78
12	" 19 "	2.00	70	" 37 "	.70
14	" 22 "	1.10	80	" 38 "	.90
16	" 24 "	.80	90	" 39 "	1.10
18	" 25 "	.80			

Dis., 60%.



Wire Goods.

Fly Traps. Per gross.
Paragon....... $18.00
Balloon... ...... 15.00

Dis., 10%.