UNITED STATES PATENT OFFICE.

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IMPROVEMENT IN BESSEMER-STEEL INGOTS.

Specification forming part of Letters Patent No. **190,448**, dated May 8, 1877; application filed March 9, 1877.

To all whom it may concern:

Be it known that I, JACOB REESE, of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Manufacture of Bessemer-Steel Ingots; and I do hereby declare the following to be a full, clear, and exact description thereof.

This invention relates to a new and useful improvement in the manufacture of Bessemer ingots, thereby adapting the improved product to the manufacture of agricultural and other steels.

In order that the nature of the invention, and the advantages arising from it, may be the more fully understood, reference is had to qualities necessary in steel used for the manufacture of plows and other similar agricultural implements.

In the manufacture of plows there are three important considerations: first, cheapness; second, the least amount of frictional resistance offered to the plow during its passage through the soil; third, durability—that is to say, that it is desirable to secure the best plow at the least cost, and in so doing it is necessary that the plow should be durable, and also be of that fine model and texture offering the least amount of resistance to the draft.

That portion of the plow called the "mold-board" is made of steel. Practice has demonstrated the fact that the more highly the working surface of the mold-board is polished the less amount of frictional resistance will be exerted against the passage of the plow through the soil, and, consequently, less draft upon the horses will be produced.

In consequence of this fact a demand sprang up for plows having highly-polished mold-boards, and in order to obtain a steel capable of receiving a high polish manufacturers used a German steel of a close fine texture or grain; but a difficulty soon developed which rendered this class of steel unsuitable for the finer grades of plows. The polished surface of the mold-board soon became marred, and it rusted in spots by oxidation.

The demand then arose for excellence in mold-boards possessing the brightest polish, least wear, and least liability to oxidation. Under this demand German steel soon gave way to crucible cast-steel, and the cast-steel was finally made so hard, in order to obtain the qualities required to produce a steel not liable to become marred by the wear, and that a high polish might be obtained, that, in tempering, it would often crack and break in pieces. At this juncture what is now known as "iron-center cast plow-steel" was invented and put upon the market.

Iron-center cast plow-steel is manufactured as follows: A suitable cast-iron mold is prepared. This mold is generally about twelve inches wide, four inches thick, and two feet long (inside measurement). This mold is put together in two longitudinal sections, and bound with clamps. Slots are planed out on the inside of the mold, allowing a plate of fibrous metal to be inserted, thus dividing the mold into three sections, the iron occupying the middle one. When ready for casting, the plate of iron is heated red-hot and inserted into the mold, and the steel is "teamed" from two crucibles into the mold, thus forming an ingot with hard steel on each side and fibrous wrought-iron at the center. By this method a very hard surface is obtained, double elasticity, and sufficient toughness to withstand tempering, and the shocks incident to rough plowing; but with all the experience obtained in the manufacture of iron-center cast plow-steel, amounting to over six thousand tons per annum in Pittsburg alone, manufacturers have found it impossible to produce plow-steel without having soft spots in it, and where the soft spots existed oxidation would soon take place and injure the mold-board.

In investigating this subject I have discovered that the soft spots in the steel contained, previous to any apparent oxidation, a trace of oxide of iron, while the harder portions contained no trace and were free from oxide, and that this result was due to the presence of oxides in the molten metal. The only means of removing the oxide perfectly from the metal known to the trade is by the use of ferro-manganese or spiegeleisen.

In the crucible process the ferro-manganese or spiegeleisen is put into the crucible when it is cold, and as the melting operation usually consumes three or four hours, the process

of union is so slow that when the manganese has absorbed the oxygen the resulting compound (oxide of iron) rises and floats upon the surface of the molten metal, and is thus liable to become absorbed again by it, and also to become mechanically mixed with it during the operation of teaming. These are not the only defects incident to the crucible cast-steel process, as it is a matter of impossibility to remove the oxides in this process without the greatest danger of having the manganese combine with the steel to an undesirable extent, the presence of manganese in excess tending to produce brittleness, and having the effect of causing crystallization in large crystals divided by smooth cleavage-planes, such as characterize spiegeleisen.

From these facts it will be readily seen that any excess of manganese used in the crucible process for the purpose of removing all traces of oxide from the body of the metal would have the effect of causing great brittleness and a coarse granular structure in the resulting metal, which would disqualify it for agricultural use.

It will thus be seen that it is absolutely impracticable to thoroughly cleanse the fluid metal from oxide of iron in the crucible process, the process embodying inherent difficulties preventing the production of mold-boards of that high degree of excellence required by the trade.

By using the Bessemer process, however, I am enabled to use more manganese than can be used in others, and in this way remove all traces of oxide from the body of the metal. The reason why such is the case is that it is usual to carburize the metal, when in a molten condition, by the addition of ferro-manganese or spiegeleisen. In this process the fluid manganese compound is run into the molten metal, and the chemical action takes place immediately, causing violent ebullition, and the greater portion of the manganese passes off quickly in a gaseous state as an oxide of manganese.

It will thus be observed that a greater proportion of manganese may be used in this process without liability to injure the metal than could be used in the crucible method of making steel, as the greater portion of the manganese passes off quickly, and prevents any reaction by being absorbed by the steel.

Among other defects incident to the manufacture of crucible-steel are, first, on account of the manner in which it is necessary to "team" small ingots, steel cannot be produced without having a considerable amount of impurities formed upon the surface of the ingot, and when the ingot has been rolled into a plate suitable for the manufacture of agricultural shapes, the impurities produce blotches and spots upon its surface, injuring it and necessitating increased labor upon the part of the workman during the grinding and polishing operations. The second defect is known as "seaming," and is generally occasioned by the fluid metal enveloping air during the teaming operation. This defect is one of the most troublesome experienced by the manufacturer of cast-steel, and it is one that it is impossible to remedy, except at the loss of a considerable portion of the stock. In the manufacture of the finer grades of cast-steel, from fifteen to thirty per cent. of the stock is generally lost on account of this defect, and even in the manufacture of iron-center cast plow-steel great loss is sometimes occasioned from this defect.

I have discovered that Bessemer steel could be manufactured in such a manner that by its use spots would not be formed by oxidation upon the polished surface of the mold-board, such spots being primarily due to the presence of oxide in the metal, and that Bessemer metal thoroughly free from oxide would be especially adapted to the manufacture of agricultural shapes on account of many other advantages. The discovery I have applied to a practical purpose; but Bessemer metal high enough in carbon to be tempered hard enough to take a high polish, and not be liable to become easily marred by wear, is unfit for mold-boards on account of its excessive brittleness when tempered, and also because it is impossible to temper mold-boards of Bessemer metal high in carbon without cracking them. So that it will readily be seen that although Bessemer steel could be made free from the serious objections urged against crucible cast-steel, still it would be impossible to use it in the manufacture of agricultural implements successfully unless highly carbonized and practically free from metallic manganese. I cast iron or soft-steel center Bessemer ingots, and am enabled to utilize the production of the Bessemer plant, in the manufacture of the finest classes of agricultural implements, to produce a better steel, free from the objections to crucible-steel, at a greatly-reduced cost.

I will now proceed to describe my invention more fully, so that others skilled in the art to which it appertains may make and use the same.

I employ the ordinary Bessemer plant, and when the metal is thoroughly decarburized it is then charged with the ferro-manganese or spiegeleisen in such quantities as to thoroughly cleanse the metal of oxygen and charge it with 0.50 to 1.25 per cent. of carbon, as may be desired. The molds having been prepared with grooved sides, suitable bars or slabs are heated and inserted into the molds, and the molten metal is then teamed into them from the bottom in the usual manner of casting by that mode.

The space in which the ingots are formed, or the inside measurement of the molds, is generally about twelve inches wide by six inches through, and four or five feet long, thus producing an ingot of six inches thick, twelve inches wide, and of any length desired within the capacity of the mold. For ingots of this size the plate or slab of iron or soft steel should be of about two inches in thick-

ness when inserted in the mold; but as ingots of various size and thickness may be required, the thickness of the iron may be varied also to suit the change in the thickness of the ingot produced.

When small ingots are desired, three or four short heated bars or slabs are inserted, one on the other, in the grooved molds, and when the ingots are cold they may be broken at the points where the ends of the bars join each other, thus securing short ingots with all the economy of long ingots. The chief advantage of this method of making ingots is that the manufacturer will be enabled to produce short ingots and use the method of casting from the bottom in use at present, and that plow-steel manufacturers will be enabled to work the ingots without heating and cutting them in smaller sections, and consequently a saving of time and labor will be effected.

One of the greatest advantages arising from this invention is that in the manufacture of iron-center Bessemer steel I am enabled to use enough manganese to remove all oxide from the metal without producing the undesirable results that would be had if a proportionate amount of manganese was used in any other process known to me. But this result which I attain is not due to the usual method of manufacture by the Bessemer process, because Bessemer metal high in carbon, as it is at present manufactured, is neither absolutely free from oxide, nor from metallic manganese, and it is impossible to temper mold-boards of Bessemer metal when made of steel throughout. Mold-boards containing only 0.40 per cent. carbon crack badly in tempering, and often fall to pieces when let fall three or four feet onto the ground; but by my using a good fibrous iron or a soft-steel center I am enabled to charge the metal in any degree from 0.50 to 1.25 per cent. of carbon, and, when rolled and tempered, to make a flinty, hard, close-grained, tough, elastic, highly-polished mold-board, not liable to rust in spots on account of the presence of oxide in the metal.

Mold-boards made from Bessemer iron-center steel will be more uniform than those made from crucible cast-steel, as from five to seven tons of metal are converted at the same time. Thus the manufacturers of agricultural implements will be enabled to temper the mold-boards easily and uniformly. In the crucible process it requires two or three crucibles of steel to fill the ingot-mold. The crucibles do not always impart carbon uniformly to the charge, and, as it is practically impossible to secure uniformity of carbon in the stock before it is charged, it will readily be seen that the resulting metal will be very ununiform in carbon.

Mold-boards made from Bessemer iron-center steel will be free from seaming, and will not be liable to have blotches and blemishes upon their face, as those made from crucible cast-steel. This is due somewhat to the mode of casting from the bottom used in the manufacture of Bessemer steel, which mode obviates these defects, and also prevents any oxides floating upon the surface of the molten metal from mixing mechanically with the steel after it has been teamed. This would be a very expensive mode of teaming, however, if it was used in the crucible process of making steel, as the per cent. of loss in stock entailed by its use would be too high, if used for the formation of as small ingots as are usual in the manufacture of crucible-cast plow-steel. Nor could this difficulty be avoided in the Bessemer process, if short ingots were made; but by casting long ingots with sectional iron centers, and breaking them into short sections when cold, I am enabled to overcome all the difficulties incident to both processes when used for the manufacture of small ingots.

It will thus be seen that by my invention I am enabled to produce mold-boards, and all other shapes of agricultural steel, more perfectly free from soft spots, more uniform in texture and temper, freer from impurities, capable of receiving a uniformly high polish, not liable to rust in spots, and they may be manufactured at about one-half the cost of crucible iron-center cast-steel.

When the iron or soft center is inserted into the mold previous to teaming they may be put in cold, if desired. In such case the plates should be pickled and their surface so cleansed previous to their introduction into the molds. In practice I prefer to put them in hot, and thereby secure an even shrinkage of the ingot.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. An ingot having a center of iron or soft steel and faces of Bessemer steel, practically free from manganese, and containing from 0.50 to 1.25 per cent. of carbon, as and for the purpose set forth.

2. The ingot having the faces of hard steel and the sectional center of iron or soft steel, substantially as and for the purpose set forth.

In testimony whereof I, the said JACOB REESE, have hereunto set my hand.

JACOB REESE.

Witnesses:
JAMES I. KAY,
FRANK REESE.