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UNITED STATES PATENT OFFICE.

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PROCESS OF MAKING STEEL INGOTS FREE FROM BLOWHOLES.

No Drawing.

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To all whom it may concern:

Be it known that we, ISAAC M. SCOTT and SAMUEL PEACOCK, both citizens of the United States, respectively residing at Wheeling, in the county of Ohio and State of West Virginia, and Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Processes of Making Steel Ingots Free from Blowholes; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a process of making purified cast steel ingots and has for its object to improve the procedures heretofore proposed.

With these and other objects in view, the invention consists in the novel steps and combinations of steps constituting the process, all as will be more fully hereinafter disclosed and particularly pointed out in the claim.

In order that the precise invention may be more clearly understood, it is said: It is well known that it is common to purify molten steel by adding ferro-silicon thereto, but it is also well known that in carrying out such practice it is found impossible to prevent the silicon from being absorbed to a greater or less degree by the molten metal, and thus often raising its silicon content to an objectionable degree. This absorption of the added silicon is particularly objectionable in those cases where the silicon content must be low, or when it must be constant, for there is no way to govern with exactness the amount of silicon absorbed, and there is no satisfactory way to eliminate the silicon after it is absorbed. In fact, even when there is provided in the bath a great excess of iron oxide, it is found impossible to oxidize all the silicon added and to thus prevent some of it from being absorbed into the final product, owing to the principles involved in the well known phase rule of Gibbs.

When it comes to ferro-manganese as a cleansing agent, it is also well known that while it is highly satisfactory under most conditions yet it does sometimes leave manganese sulphide in the steel. This said sulphide has a melting point of about 1600 de-

grees C., it does not readily separate out of the molten mass, and therefore in many cases it is left in the steel and later gives trouble.

Metallic aluminum is also frequently used as a cleansing agent, but like other agents it has its good and bad points which are well known. And it can be safely said that, however well ferro-silicon, ferro-manganese aluminum, or other cleansing agent may perform its function, in so far as we are aware, none of them except ferro-sodium, the one made the subject of this invention, have any efficiency in removing any hydrogen, or nitrogen, that may be occluded in the metal.

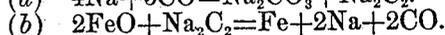
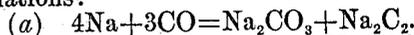
In carrying out this invention, we prefer to proceed as follows: We take pig iron containing say 3% to 4% carbon, and about 1% silicon. We melt this pig iron and admix therewith a predetermined proportion of iron oxide in the form of ore and raise the temperature to say 1300° C. when the iron carbides and compounds of silicon carried by the original pig iron will react with the iron oxide of the ore to form metallic iron, carbon monoxide, and silica. It, however, is not possible by this procedure to remove all the combined carbon and silicon present in the pig by this method, because if the ore is in sufficient excess to oxidize all the carbon and silicon, it is found that a considerable proportion of iron oxide from the ore enters the molten mass, which is undesirable. If, on the other hand, a less quantity of ore is used some of the original carbon and silicon remain in the molten bath, we next subject the bath to the reducing action of hot gases in the open hearth process or otherwise refine the molten metal according to the established practice. But instead of using a cleansing agent such as ferro-silicon, ferro-manganese, aluminum, etc., we add ferro-sodium to the ladle, or we place it in the ingot molds. The advantage of ferro-sodium over other cleansing agents for the molten mixture above disclosed resides in the following:

There is always a greater or less quantity of occluded hydrogen or nitrogen or both in a bath of molten iron as is well known, which injures the casting, and when these gases collect at particular points in the mass, they form blow holes. The sodium in the ferro-sodium on the other hand, at the tem-

perature of the molten iron, forms sodium
 hydride and sodium nitride with any free
 hydrogen and nitrogen with which it comes
 into contact, and this not only produces a
 5 more solid casting throughout, but it elim-
 inates any blow holes that may have formed.
 This hydride and nitride being volatile at
 the temperature of formation they readily
 pass out of the molten mass along with the
 10 other sodium compounds to be described.
 If any excess of iron oxide is present in
 the bath, as is frequently the case, or in fact
 if any iron oxide is present which is almost
 always the case, the sodium of the ferro-
 15 sodium readily reduces the same to form
 sodium oxide, and the same is true of any
 other oxygen compound. In the same way,
 the said sodium will unite with any silicon
 present to form a sodium silicide, or with
 20 any silica present to form a sodium silicate,
 and it will similarly unite with any other
 contaminating impurity usually found in
 baths of molten iron to cleanse the same.
 In all cases the melting points of the sodium
 25 compounds formed are far below that of the
 iron, and therefore all these sodium com-
 pounds readily rise to the top of the bath
 in the form of a slag or of a gas and are
 readily separated out in the usual manner.
 30 Another important advantage of ferro-
 sodium over other cleansing agents is found
 in the fact that it may be freely added in
 excess without injury to the product, for in
 such cases the sodium will not alloy with
 35 the metal to any appreciable extent, but will
 simply boil off as a vapor. In the case of

ferromanganese, ferrosilicon, or aluminum,
 on the other hand, an excess contaminates
 the product.

Again, the sodium present in ferrosodium 40
 will unite with any carbon monoxide oc-
 cluded in the metal to form sodium car-
 bonate which rises to the top in the form of
 a slag in accordance with the following
 equations: 45



It will thus be seen that one molecule of
 carbon monoxide is used up, or eliminated, 50
 for each molecule of sodium carbonate
 formed. In the case of a silicon compound
 on the other hand, the silicon combines with
 the oxygen of the CO, and precipitates the
 carbon in the metal which is undesirable.
 Ferromanganese and aluminum does not re- 55
 move occluded CO at all.

What is claimed is:

The process of producing steel ingots free
 from blow holes and contaminating oxides 60
 which consists in mixing iron oxide with
 molten pig iron to eliminate a portion of the
 carbides and any compounds of silicon pres-
 ent; refining the molten metal thus pro-
 duced by subjecting it to the action of re- 65
 ducing gases; and adding ferrosodium to
 the refined product in a quantity sufficient
 to remove all oxides and occluded gases
 present.

In testimony whereof we affix our signa-
 tures.

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