UNITED STATES PATENT OFFICE.

JACOB REESE, OF PITTSBURG, PENNSYLVANIA.

PROCESS OF MANUFACTURING SOLID STEEL CASTINGS.

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To all whom it may concern:

Be it known that I, JACOB REESE, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in the Process of Manufacturing Solid Steel Castings; and I hereby declare the following to be an exact, full, and clear description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

My invention consists in a new and useful process for the production of tough, solid, and malleable steel castings low in silicon and free from blow-holes.

It is known that blow-holes in cast-steel are due to the formation and absorption of gases in the metal while fluid and to the imperfect emission of the gases when casting. Hard steel contains fewer blow-holes than soft steel, because it absorbs less gases and emits them again more perfectly, the fusion-point being lower and the steel remaining liquid for a longer time when cast and then solidifying suddenly. Soft steel, on the other hand, requires a higher temperature in melting, and on solidifying it passes through a pasty state, which prevents the free escape of the gases, and thereby causes an increased number of blow-holes in the interior of the casting. The formation and absorption of the gases principally take place during the ebullition and boiling of the metal, which is caused by the oxidation of the carbon. In the open-hearth process the metal does not commence to boil until the silicon in the metal is reduced down to about .020, at which point oxidation of the carbon commences.

Heretofore highly-carbonized steel has been used (on account of the reasons above stated) in the production of steel castings. These castings were then subjected to an annealing operation to reduce the carbon and impart the necessary degree of toughness and malleability. This operation is very tedious and costly, as the metal is placed in cast-iron boxes, packed with oxides, and heated and held at a high temperature from one to eight days, according to the thickness of the casting and the degree of toughness and malleability desired in the resultant product.

Now, the objects of my invention are, first, to prevent the production and absorption of gases in the metal when treated in an open hearth by preventing the metal from ebullition and boiling, and yet produce a casting low in silicon; secondly, to subject the metal to a "dead-melt" while at a state of perfect rest in the open hearth, to allow the free and gradual escape of its gases—that is to say, to prevent as far as possible the formation and absorption of the gases when the metal is being treated—and to aid as far as possible the emission of the gases previous to casting, and produce a strong, tough, malleable, solid steel casting, free from blow-holes and low in silicon, and which will not require the costly annealing operation above mentioned.

In the practice of my improvement I decarburize and desiliconize ordinary hot-blast silicious pig-metal in the Bessemer converter. The metal is then treated with a charge of ferro-manganese to remove the oxygen and partially recarburize it; and when this operation is finished it is treated with silicious pig to bring the carbon up to the degree required in the resultant product and to incorporate into and secure a determined and fixed amount of silicon in the metal. When the metal has siliconized to a sufficient degree to prevent ebullition and boiling during its after treatment, it is run into an open-hearth furnace, excluded as much as possible from oxides, and treated with a carburizing-flame, in order to give it a dead-melt and keep at a state of rest until ample time has elapsed for the free and gradual escape of the gases which then takes place. In other words, I produce a low Bessemer steel in the usual manner and then add silicious pig to the metal in the converter in sufficient quantities to prevent oxidation of the carbon during the time the metal is treated in the open hearth.

In order to secure economy and facility of operation, I prefer to use a plant which consists of a small converter of about one ton capacity and of a pair of open-hearth furnaces of about five tons each.

The operation is as follows: Hot-blast silicious pig-metal is melted in a suitable cupola and run into the converter, where it is blown until the carbon and silicon are entirely elimi-

nated. A charge of ferro-manganese is then added, and the metal is deoxygenized and partially recarburized, and as soon as this operation is finished the metal is treated with silicious pig, preferably containing about ten per cent. of silicon, and just sufficient carbon to bring the carbon in the metal up to the degree required in the resultant product of the process. The amount of silicon to be incorporated into the converted metal will depend upon the length of time of the after treatment of the metal. It is desirable that as little silicon should be used as will be sufficient to prevent the oxidation of the carbon during the time the metal is to be treated in the open hearth, as the percentage of silicon should be kept down in the castings in order to secure greater toughness and malleability. In ordinary practice .25 of silicon will be sufficient to hold the metal in a state of rest for one hour, and this amount may be lessened if the metal is treated only with a carburizing-flame and kept free from oxides, or if the time of after treatment is shortened. Ordinarily the metal should be charged with sufficient silicon to prevent oxidation of the carbon for about thirty minutes after the open-hearth furnace has been fully charged for the after treatment of the metal. After the charge has been siliconized in the converter it is run into the open-hearth furnace and treated with a carburizing-flame to keep down oxidation, and kept as free from oxides as possible, in order to keep it at rest and allow the free escape of the gases. As soon as the first blow has been treated and run into the open hearth another charge of metal is treated as in the preceding case and run into the furnace, and this operation is repeated until the first furnace is charged to its full capacity. The metal is then subjected to a dead-melt to allow further escape of the gases, the time of treatment generally lasting about one hour from the time of the introduction of the first blow of metal until the last blow is introduced, and then about thirty minutes longer for the further escape of the gases. When the first furnace has been fully charged the next five blows are run into the second furnace and treated as in the preceding case.

The principal object of treating a comparatively small amount of metal in the converter, and in the employment of open hearths of much larger capacity, is as follows: If at any time during the treatment of the metal it is found that the silicon is being reduced down to the boiling-point while sufficient time has not elapsed for the free escape of its gases, a fresh charge of partially-desiliconized metal may be added from the converter; or, if it is found that the percentage of silicon is too high after the metal has been treated for a sufficient time to allow the escape of its gases, a fresh charge of desiliconized metal from the converter may be run in, and in this manner the ebullition and boiling may be entirely prevented, and yet the proportion of silicon kept down in the metal and in the castings which are produced.

About five tons of steel per hour may be produced by the use of the plant which I have mentioned, about one hour being consumed in charging and one hour in treating the metal in and casting from each furnace. Hence the plant will produce about one hundred tons in twenty-four hours, leaving four hours for contingencies and repairs. The chief advantages of the plant when used by my method are low cost of apparatus, facility and economy of operation, and the cheapness with which the castings may be produced; and the chief advantages of the product of my invention are its solidity, freedom from blow-holes and porosity, and its toughness and malleability, thus obviating the necessity for the costly and tedious process of annealing heretofore in use.

When the metal is being treated in the converter it is preferable, but not necessary, to treat it first with ferro-manganese and afterward with the silicious metal; but the materials may be added in one charge as a ferro-silicate of manganese; and while I have described my improvement only as applicable to the manufacture of steel castings it is also applicable to the manufacture of solid ingots, free from blow-holes, for tool and other purposes, wherein the metal, after having been worked, requires to be tempered or hardened, in which cases blowing and cracking will be prevented, and the material will be uniform in texture and free from physical imperfections; but for these purposes metal of suitable grades must be used for the process.

I am aware that it has been heretofore proposed to treat a bath of cast and wrought iron in the open-hearth process by the addition of ferro-manganese and silicon to free the metal of oxides, and to retain it in a fluid condition for the escape of gases during the casting, and do not claim the same, as no provision is made for the elimination of any or all of the silicon so added, and steels lower in silicon than one-quarter of one per cent. (.25) were not contemplated or obtainable by such process; whereas by my process steel as low in silicon as one-fortieth of one per cent. (.025) can be obtained, and the essential difference of the process lies in this, that the molten metal, after the addition of the silicon, is submitted to a dead-melt under a neutral flame, which retains the heat and fluidity of the metal not only while the gases are escaping, but permits the oxidation of the larger portion of the silicon without decarburization of the bath, so that a steel casting practically free from silicon is obtainable.

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

1. The method herein described for obtaining solid cast-steel castings low in silicon, which consists, essentially, in the following steps: first, decarburizing and desiliconizing the molt-

en metal; secondly, adding carbon and silicon to the molten metal in such proportions as shall give definite per cents. of carbon and silicon to the molten metal; and, thirdly, subjecting the molten metal, after the addition of carbon and silicon, to a dead-melt under a neutral flame until the silicon shall be oxidized to the required degree, substantially as and for the purpose specified.

2. The method herein described for manufacturing solid cast-steel castings, which consists, first, in desiliconizing and decarburizing a portion of the metal; secondly, adding thereto a portion of metal which has been partially desiliconized and decarburized; and, thirdly, subjecting the molten mixture to a dead-melt under a neutral flame until the silicon added in the second step has been oxidized to the desired extent, substantially as and for the purpose specified.

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Witnesses:
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