UNITED STATES PATENT OFFICE.

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BASIC PROCESS FOR THE DEPHOSPHORIZATION OF IRON AND STEEL.

SPECIFICATION forming part of Letters Patent No. 272,085, dated February 13, 1883.

Application filed July 16, 1880. (No specimens.)

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 an Improvement in the Basic Process for the Dephosphorization of Iron and Steel; and I do hereby declare the following to be a full, clear, and exact description thereof.

The object of my invention is to secure the most favorable conditions for dephosphorization in the basic process.

For the manufacture of ingot iron and steel by the ordinary Bessemer process, metal was required which contained not more than one-tenth of one per cent. of phosphorus, and not less than two per cent. of silicon and two per cent. of carbon. The metal was blown in a silicious-lined vessel, and the acid formed by the oxidation of the silicon in the metal and by the wearing down of the lining passed into and imparted a highly-acid character to the slag, effectually preventing dephosphorization of the metal. Phosphorus cannot be readily or rapidly eliminated in the presence of any considerable quantity of an acid substance, and therefore in dephosphorizing operations it is necessary that the metal should be treated with large quantities of basic material to take up and neutralize the acid which may be formed. In the new basic process the metal is blown while in a basic-lined vessel and in the presence of a basic bath produced by basic additions or injections. In this operation dephosphorization does not take place to any considerable extent until after decarburization and desiliconization have been effected, and an after-blow is therefore necessary; but as the metal at this period contains but little caloric-producing substance, and as large quantities of basic materials are used, in some cases the converter is apt to chill and the slag is liable to form accretions at and partially choke up the neck and mouth of the converter. Therefore it will be readily understood that it would be an advantage to develop more heat during the after-blow, and to reduce the amount of basic material employed for the bath, if such changes could be effected. Large quantities of lime are used in the formation of the basic slag used in the process, the amount varying from ten to twenty-five per cent. of the weight of the metal, according to the manner of introducing the lime and according to the amount of silicon and phophorus present in the metal. After the metal has been dephosphorized the slag is emptied from the converter and becomes a waste product of the process. This waste involves great loss, as it is evident that the cost of the lime, its storage, and handling is a source of considerable expense. It is estimated, when the basic process is in regular and continuous operation, a waste of from ten to twenty thousand tons of lime per annum will occur at a single works.

Now, the object of my present invention is, first, to shorten the time of the first period of the blow by producing and blowing a pig metal low in silicon and high in phosphorus, so that a greater amount of calorific-producing material may be carried over to and utilized in the after-blow to prevent chilling and the formation of obstructions in the converter; secondly, to reduce the amount of basic material employed, which may be done, as the metal produced and blown will contain but little silicon, and but little silicic acid will be formed; thirdly, to utilize the material of the waste basic slag by the blast-furnace to produce a highly-phosphoretic metal low in silicon for use of the basic dephosphorizing process.

The components of the basic slag when drawn from the converter or open-hearth furnace, and which I propose to utilize in the production of a highly-phosphoretic non-silicious pig metal, will vary according to the amount of the various impurities which have been in the bath of metal operated upon; but the following analysis will indicate the components of any ordinary waste slag from the converter when operating by the basic process: lime, 50.21; oxide of manganese, 4.40; silicic acid, 11.10; phosphoric acid, 12.43; magnetic oxide of iron, (Fe_3O_4,) 11.25; magnesia, 9.84; and sulphate of calcium, 1.15, giving a total of 100.38. I find that the large amount of lime and magnesia oxide present renders the slag very valuable as a flux in the blast-furnace, and that the iron, manganese, and phosphorus will be taken up in the metal.

In the manufacture of the phosphoretic pig metal low in silicon I make use of the ordinary blast-furnace and conduct the smelting operation in the usual way, but do not select ores or stock low in phosphorus, taking care, however, that they are low in silica. An analysis of the fuel, ores, and limestone is taken, and in charging the furnace a sufficient quantity of the waste basic slag from the converter or open hearth is added to produce a metal having the required degree of phosphorus.

In conducting the smelting operation the amount of limestone in the charge may be decreased to a considerable extent on account of the large proportion of lime contained in the basic slag; but it is advisable that the total amount of lime in the furnace should be sufficient to thoroughly flux the materials and carry off the silica. It is preferable in general to regulate the charges to produce a metal having about two per cent. of phosphorus, which will develop sufficient heat during the overblow for ordinary treatment; but in certain cases where the metal will blow cold phosphoretic metal containing from two and one-half to five per cent. of phosphorus should be produced, so that when treated in the converter an additional amount of caloric may be developed during the after-blow to keep up the temperature and fluidity of the metal. After the pig metal has been produced it may be taken direct to the calcareous-lined Bessemer converter or open-hearth furnace; or it may be cast into pigs, remelted in a cupola, and run into the furnace or converter. The metal is then treated with a blast of air and with calcareous additions, or with calcareous injections, as described by me in Letters Patent No. 219,519, dated September 9, 1879, and it will be found the first stage of the process is shortened, as there is but little silicon in the metal and the carbon is consumed rapidly, and that sufficient caloric is developed by the oxidation of the phosphorus during the overblow to retain the temperature and fluidity of the metal, with but little, if any, oxidation of the iron.

The advantages of my invention are, first, a decreased amount of silicic acid is produced in the converter, and therefore a greater durability of the calcareous lining is insured; secondly, a large amount of caloric is developed during the overblow and the oxidation of the metal largely prevented; thirdly, the operation of dephosphorizing is rendered more rapid, regular, and efficient, thereby increasing the capacity of the plant and improving the quality of the product; fourthly, the utilization of the lime, phosphorus, manganese, and iron in the waste basic slags for the production of highly-phosphoretic pig metal low in silicon and, fifthly, by dephosphorizing a highly-phosphoretic non-silicious metal a highly-phosphoretic non-silicious slag is produced in the converter, especially adapted to produce such a grade of metal in the blast-furnace.

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

1. As an improvement in the basic process for the dephosphorization of iron and steel, the process herein set forth, which consists in charging the blast-furnace with fuel, iron ores, and limestone, together with sufficient quantities of the phosphoretic slag from the Bessemer converter or open-hearth furnace to produce a highly-phosphoretic metal low in silicon, and then heating the metal so produced in a calareous-lined vessel and in the presence of a highly-basic calcareous bath, substantially as and for the purpose herein set forth.

2. The method for securing the conditions for efficient dephosphorization of the metal by the basic process, which consists in smelting iron ores and limestone low in silica, together with a sufficient quantity or quantities of basic slag from the converter or open hearth in the blast-furnace, whereby a highly-phosphoretic metal low in silicon is produced, substantially in the manner and for the purpose set forth.

3. The method herein described of utilizing slag from the basic process, and of obtaining a metal high in phosphorus for use in the basic process, the same consisting in the addition of phosphoretic slag from the basic process to the blast-furnace charge, in lieu of a portion of the limestone commonly employed, substantially as specified.

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Witnesses:
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