

UNITED STATES PATENT OFFICE.

JACOB REESE, OF ALLEGHENY, PENNSYLVANIA.

PROCESS OF DEPHOSPHORIZING IRON IN AN OPEN-HEARTH FURNACE.

SPECIFICATION forming part of Letters Patent No. 284,233, dated September 4, 1883.

Application filed March 8, 1883. (No specimens.)

To all whom it may concern:

Be it known that I, JACOB REESE, a citizen of the United States, residing at Allegheny, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Processes of Dephosphorizing Iron and Steel in an Open-Hearth Furnace; and I declare the following to be a full, clear, and exact description thereof.

10 Previous to the discovery of this invention the open-hearth process was ordinarily conducted in a metal chamber which was lined with sand. Dephosphorization was not attained, and, indeed, was considered impossible
15 at such a high temperature as existed in such a furnace. In the course of my investigation of the subject I discovered that when phosphorus was removed from molten iron it was oxidized to phosphoric acid, (P_2O_5), which
20 united with a base oxide of iron or oxide of calcium, forming a phosphate, and as the sand lining was composed principally of silicic acid (SiO_2), the silicic acid possessing a greater affinity for the oxide of iron and oxide of calcium than phosphorus has, when silicic acid
25 was present in a free state, it robbed the phosphate of its base oxide of iron or oxide of calcium and the phosphorus went back into the metal, because it could not exist under the conditions, except as a phosphate in the slag or as
30 a phosphide in the metal. I therefore concluded to dispense with the acid lining, and in place thereof use a calcareous basic lining in order to secure a more perfect basic slag, so that the phosphate, when once formed, might
35 be held in the slag without coming in contact with the decomposing influence of silicic acid. In my further researches in this line I discovered that when carbonic oxide (C_0) passed
40 through a slag having a phosphate in it the carbonic oxide robbed the phosphate of its oxygen and the phosphide returned to the metal. I then conceived the idea of eliminating the carbon entirely, and then, in the absence of silicic acid and carbonic oxide, and
45 in the presence of a basic lining and a basic bath, dephosphorizing the metal and removing the phosphate with the slag, and I shall now describe and definitely limit the present
50 invention.

This invention relates to the basic process,

pure and simple, as practiced in the open hearth, and is conducted as follows:

The open-hearth furnace is furnished with its usual appurtenances—such as valves, regenerators, stack, and gas-producers—and having the metal chamber lined with a lime or magnesian-lime lining, the method of preparing, indurating, and putting the lining into the furnace being fully and clearly set forth in
55 patent issued to me November 15, 1881, No. 249,548, and pending application filed March 14, 1881, Serial No. 28,274, and application filed February 15, 1882, Serial No. 52,778. The lime should be burned at a high temperature, preferably so high that it is indurated, solidified, and hardened. It is then ground
60 and mixed with tar or other carbonaceous matter, and while in a semi-pasty condition it is placed in the furnace and the bottom made
65 by ramming the material in place.

I prefer to use lime-brick for the sides and roof of the metal chamber; but when this is not practical the furnace walls and roof may be made of other brick. In the latter case I
70 place a layer of coke-dust, plumbago, or other carbonaceous matter between the lime lining and the brick walls of the furnace, in order to prevent the lime and the brick from fluxing
75 each other; or instead of the carbonaceous matter the oxide of chromium or any other highly infusible basic material may be used.

It will be understood that I do not claim this particular construction of furnace as my
80 invention.

When the furnace has been thus lined and ready for use the fire is lighted and it is slowly dried. The heat is then increased gradually until the lining is glazed. When the furnace is thus prepared for work, it may be charged
85 with metal direct from a blast-furnace or cupola, or the metal may be charged in the form of pig or cast iron scrap, with ten to twenty per cent. of oxide of iron, and the temperature of the furnace kept up to a high point. As
90 soon as the oxide and metal have become thoroughly fused a chemical action takes place, the silicon of the metal attacking the oxygen of the oxide, the iron of the oxide going into the metal and the silicon going into the slag
95 as silicic acid, (SiO_2). This first chemical action, which I term the "silicon period," will
100

continue from three to five hours, according to the amount of silicon in the metal. During this silicon period but little gas is evolved, hence but little ebullition takes place, the metal being consequently in a comparative state of rest. When the silicon has been eliminated, the carbon is attacked by the oxygen of the oxide and carbonic oxide (C_0) is formed. This being a gas, it causes ebullition and the metal boils. This boiling-period, in which the carbon is being eliminated, will last from two to three hours, according to the percentage of carbon in the initial charge. When the boiling ceases and the carbon is eliminated, the slag should be tapped off, as it will then contain all the silicic acid resulting from the oxidation of the silicon of the metal. As soon as the slag is tapped off a fresh charge of about ten per cent. of fresh oxide should be charged. This may be oxide of iron alone, or a mixture of oxide of iron and lime. The oxygen of the oxide will then attack the phosphorus and oxidize it to phosphoric acid, (P_2O_5), which will unite with oxide of iron and abide in the slag as a phosphate. When the phosphorus has been thus eliminated, the phosphoritic slag should be tapped off and the metal deoxidized by the use of speigel, ferro-manganese, or silicon, as a silicious pig or a ferro silicide, and the metal then run into the ladle and molds; or the metal may (minus the phosphoritic slag) be run into the ladle and deoxygenated therein. In either case care should be taken to separate the metal from the phosphoritic slag before making the final charge for deoxygenating, as a portion of the carbon in the final charge will be changed to carbonic oxide, (C_0), which will reduce any phosphate there may be in the slag and cause the phosphorus to go back into the metal.

The time required to perform the aforementioned method will be about ten hours; but when scrap-iron or scrap-steel can be obtained to advantage the initial charge of cast-iron need not be more than three or four tenths of the whole weight per heat. In this case the oxide is omitted, and wrought-iron or steel-scrap (preferably heated) is put into the molten metal from time to time until the full charge is made. By this method, the scrap having no silicon and but little carbon in it, the average amount of silicon and carbon in the whole charge will be greatly reduced and the oxide coating of the scrap will rapidly desiliconize and decarburize the metal and expedite the practice, so that a heat may be made in this manner in much less time than when pig and ore only are used. When the heat formed of pig and scrap is thoroughly desiliconized and decarburized the silicious slag should be withdrawn and from five to ten per cent. of oxide charged and the metal dephosphorized, then removed from the slag and deoxygenized, as before explained.

Care should be taken that the metal shall be kept in a highly fluid condition during the

entire process, that the oxide employed should be as free from silica and phosphoric acid as possible, and that no carbonic oxide, and as little silicic acid as possible, shall be present during the dephosphorizing period, as both carbonic oxide and silicic acid will reduce the phosphate and cause the phosphorus to go back into the metal.

The metal-chamber should be carefully examined after withdrawing each heat, and where the lining has wasted away, either on the sides or the bottom, a portion of the mixture of tar and well-burned lime should be put in and well rammed on the old lining previous to charging a new heat.

When molten iron is kept in a highly fluid condition in the presence of a basic lining until the silicon and carbon have been eliminated, and then subjected to a highly basic bath, the phosphorus may be entirely removed from the metal to the slag, and the metal be thus converted into ingot iron or steel free from phosphorus.

In this application I do not claim any method of preparing and applying calcareous or calcareous-magnesian linings to furnaces, such linings and their preparation being covered by patents or pending applications for patents hereinbefore cited. Nor do I claim the process of desiliconizing or decarbonizing in a silicious-lined vessel and then conveying the iron into a basic-lined vessel and therein dephosphorizing it in presence of a basic bath, such process having been patented by me June 5, 1883, No. 278,738. Nor do I claim that the use of oxides of iron in connection with an open-hearth furnace in the process of purifying iron or steel is new; but

What I do claim is—

1. The within-described process for converting iron into steel, which consists in, first, charging the metal, together with suitable metallic oxides, into a lime-lined open-hearth furnace and there maintaining them at a high temperature until the metal is desiliconized, decarbonized, and dephosphorized, and, second, deoxidizing and recarburizing the metal after being separated from the slag, substantially as and for the purpose set forth.

2. The within-described process for converting iron into steel, which consists in, first, charging a lime-lined open hearth with iron and suitable oxides of iron and maintaining them at a high temperature until the silicon and carbon are eliminated; second, tapping off the silicious slag; third, adding a second charge of suitable oxides and heating until the phosphorus is eliminated; fourth, tapping off the phosphoritic slag; fifth, deoxidizing and recarburizing the metal apart from the slag, substantially as and for the purposes described.

JACOB REESE.

Witnesses:

J. M. ROURKE,
JAMES SIPPEY.