

# UNITED STATES PATENT OFFICE.

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## PROCESS OF MANUFACTURING IRON AND STEEL.

SPECIFICATION forming part of Letters Patent No. 429,638, dated June 10, 1890.

Application filed September 12, 1883. Serial No. 106,339. (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 made an invention of a new and useful Improvement in the Art of Manufacturing Iron and Steel; and I do hereby declare the following to be a full, clear, and exact description thereof.

10 The object of the invention is to produce dephosphorized ingot iron and steel by the thorough decarburization and desiliconization of the crude metal and the subjecting of this refined metal to the action of a basic  
15 bath while in a basic-lined vessel and maintained at a temperature above the fusion-point of wrought-iron, as more fully herein-after set forth.

In reducing my invention to practice it is  
20 absolutely necessary to secure the following conditions for dephosphorization: First, the metal must be subjected to the action of an oxygen-yielding blast or to the action of oxidizing agents, while maintained at a temper-  
25 ature above the fusion-point of wrought-iron, in order that the phosphates of iron formed thereby may be able to float up through the bath and enter into the slag; secondly, the carbon is eliminated before the metal is  
30 treated for dephosphorization in order to prevent the formation of carbonic oxide during the after treatment, as this gas reduces the phosphate of iron and causes the phosphorus to enter again into the metal; third, the metal  
35 is desiliconized in its first treatment in order to prevent the formation of silicic acid during the second stage of the process, for if silicic acid were then formed it would attack the phosphate and reduce it, forming silicate of  
40 iron, and the phosphorus would again enter the metal; fourth, the metal must be treated in the presence of a highly basic slag, in order that any silicic acid which has been formed may be provided with a base which  
45 will be capable of holding it as silicates, and thereby prevent its decomposition of the phosphate, as above stated; or, in other words, the metal must be subjected to oxidation in the absence of carbonic oxide and of  
50 free silicic acid, and in the presence of basic

additions, while contained in a basic-lined vessel and maintained at a temperature above the fusion-point of wrought-iron. To secure the first condition, resort must be had either to the Bessemer converter or the open-hearth  
55 furnace. The invention cannot be reduced to practice in any apparatus from which the product would be delivered in a solid, semi-solid, or spongy state. The second and third condition—namely, decarburizing and desili-  
60 conizing previous to after treatment—are most economically obtained by the use of an acid-lined Bessemer converter, but may also be had by the use of an acid-lined open  
65 hearth. The fourth condition necessitates the removal of the acid lining, its replacement with a hard durable lime lining, and the use of basic additions.

In carrying the invention into practice it is proposed to decarburize and desiliconize  
70 molten metal by subjecting it to the action of an air-blast or by exposure to an oxidizing flame or gas in the usual manner. This decarburized and desiliconized metal is then transferred, minus its acid slag, into a lime-  
75 lined open-hearth or Bessemer converter, and subjected to oxidation, while covered with a basic calcareous slag, until the phosphorus is eliminated from the metal, and the phosphate so formed enter into the slag. The resulting  
80 molten dephosphorized metal is then treated with deoxygenating, or deoxygenating and recarburizing, agents to produce the grade of ingot iron or ingot steel that may be desired.

In the operation referred to the phosphorus  
85 is not removed from the metal by any action of the lime upon it. It is present in the metal either as a phosphide or simply as phosphorus, more probably in the former state. In either case a phosphate of iron results from  
90 the exposure of the metal to oxidation. In the first the phosphide would be oxidized to a phosphate. In the second the phosphorus would be oxidized to phosphoric acid, which would instantly combine with oxide of iron,  
95 (present throughout the metal at this stage,) and thereby form the phosphate of iron. This phosphate of iron then passes upward unattacked and enters the slag in the form of phosphate of iron, as carbonic oxide and free  
100



silicic acid are then absent from the bath. The lime has nothing to do with this action of the blast. Its functions are to supply an excess of base for any silicic acid present to  
5 combine with, so that it will not be free to decompose what phosphates are formed, and to act as a slag to retain the phosphates after the phosphorus has been eliminated from the metal. The basic bath may contain enough  
10 oxide of iron to flux the lime sufficiently to cause the latter to form a fluid or semi-fluid slag. The amount will vary, of course, with the varying infusibility of the lime employed.

The entire process may, if desired, be conducted in a basic-lined converter, in which  
15 case the metal is run into it. Lime additions of from twenty to thirty per cent. of the weight of the metal are then added, and the bath is then subjected to the action of an air-  
20 blast until decarburization, desiliconization, and dephosphorization have been effected; or the entire process can be conducted in like manner in a basic-lined open hearth, and in the presence of a highly-basic slag, by sub-  
25 jecting the metal to the action of an oxidizing flame or agent, and maintaining it at a temperature above the fusion-point of wrought-iron until decarburization, desili-  
30 conization, and dephosphorization have been effected.

Pending applications filed February 1, 1882, Serial No. 51,606; February 3, 1882, Serial No. 51,788; August 31, 1883, Serial No. 105,256; September 12, 1883, Serial No. 106,340, and  
35 September 15, 1883, Serial No. 106,548, describe a somewhat similar process; but in neither of them is the metal treated in a basic

bath composed of oxide of iron and calcareous matter.

I do not now claim hard, durable, indurated, 40 refractory lime linings or replacing acid linings therewith; nor do I now claim the formation of a basic slag by the use of lime linings and lime additions; nor dephosphorizing in the absence of free silicic acid; nor dephos- 45 phorizing in the absence of carbonic oxide; nor dephosphorizing by means of an over-blow.

What I claim, and desire to secure by Letters Patent, is— 50

1. The improvement in the art of manufacturing ingot iron and steel, which consists in first decarburizing and desiliconizing the metal while in a molten condition by subject- 55 ing it to the action of an oxidizing agent and afterward treating the decarburized metal, while free from contact with silicious substances, with a calcareous reagent and oxide of iron, and maintaining the bath at a temperature above the fusion-point of wrought- 60 iron until dephosphorization is effected.

2. The improvement in the art of manufacturing ingot iron and steel, which consists in first decarburizing the metal while in a molten condition by subjecting it to the action 65 of an oxidizing agent, and then treating the decarburized metal with a calcareous agent and oxide of iron while maintained at a temperature above the fusion-point of wrought-iron.

JACOB REESE.

Witnesses:

C. C. LEE,  
WALTER REESE.