

UNITED STATES PATENT OFFICE.

JAMES HENDERSON, OF BELLEFONTE, PENNSYLVANIA.

ART OF MANUFACTURING IRON, STEEL, &c.

SPECIFICATION forming part of Letters Patent No. 278,013, dated May 22, 1893.

Application filed March 27, 1883. (No specimens.) Patented in England October 12, 1874, No. 1,267.

To all whom it may concern:

Be it known that I, JAMES HENDERSON, of Bellefonte, in the county of Centre 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 that the following is a full, clear, and exact description and specification thereof.

The object of this invention is to free crude iron of phosphorus by an economical operation; and to this end the invention consists of a process comprising the following operations, viz: first, the decarbonization of the crude iron, in whole or in part, by the action of air upon it while in a liquid condition; second, the treatment of the partially or wholly decarbonized iron, while in the liquid or molten condition, with a calcareous reagent and an oxide of iron, as more fully herein set forth.

In order that my invention may be fully understood, I will proceed to describe the best mode known to me in which the same may be practiced.

The crude iron to be treated is by preference melted in a cupola-furnace, such as is used for melting pig-iron in the manufacture of Bessemer steel. The melted iron is run into a Bessemer converter, which may be lined with the usual silicious lining, commonly called "ganister." The air is blown into the melted metal in the converter in the usual manner practiced in the Bessemer process for decarbonizing the metal. The operation is continued by preference to the end of what is called the "third period" or "after the boil," at which time the carbon in the iron is reduced to about one per cent.; but the operation may be continued to the "end of the blowing," when, practically, all of the carbon is removed. The decarbonized iron thus obtained is transferred to a ladle with a hole in the bottom, closed with a plug-stopper, and is permitted to run from the said hole into a spout which delivers it into the hearth of a reverberatory furnace which is capable of being heated to the melting-point of wrought-iron, or higher. The kind of reverberatory furnace which I prefer to use for this purpose is a gas-furnace constructed with a revolving movable hearth which is capable of being revolved upon an upright axis when in the furnace, and of being applied to and removed therefrom, the fuel used in said fur-

nace being preferably the gases evolved by the combustion of bituminous coal which is burned by means of jets of heated air. The metal is heated in said furnace in contact with the basic reagents for a short period—say from ten to thirty minutes—when the lime is in the condition of fluor-spar, depending upon the smaller or larger portion of carbon remaining in the iron at the time of its introduction into the furnace, after which a sufficient quantity of compounds of carbon, iron, and manganese—as spiegeleisen or ferro-manganese—is added to it for the purpose of recarbonizing the metal, as in practicing the Bessemer process. Then the metal is permitted to run from the furnace, and is cast into ingots in suitable molds.

The preferred mode of applying the reagents is to spread the compound of them upon the hearth of the furnace before the melted decarbonized metal is permitted to run into the furnace, and also to heat the compound until it becomes viscid; and I prefer that the hearth of the furnace should, previous to use, be lined with lime or other calcareous material, or with magnesia, or iron plates, as described in my English Patent No. 1,051 of 1870, and in my United States Patent No. 106,365. By thus protecting the metal and the reagents from contact with silica it is found that the work is accomplished better.

I prefer that the lime of the basic reagents shall be in the condition of fluor-spar, and that the oxide of iron shall be in the form of titaniferous iron ore, and that the relative proportions of the two shall be forty (40) parts, by weight, of fluor-spar to one hundred (100) parts, by weight, of titaniferous iron ore. The proportions of the reagents to be used may, however, be varied, and will depend upon the quantity of phosphorus present in the metal. If, for example, the phosphorus present is one per cent. of the metal, the amount of fluor-spar and titaniferous iron ore required will be about three (3) hundred-weight of the mixture of the two to one ton of steel, and if the phosphorus be present in less quantity the quantity of the mixture of the reagents may be correspondingly reduced.

The reagents above described may be replaced by their substitutes. Thus caustic lime or limestone may be substituted for fluor-spar weight for weight, and the titaniferous iron

ore may be replaced by rich magnetic oxides or hematites as free from silica, sulphur, and phosphorus as possible. The use of an oxide of iron in conjunction with fluor-spar or its equivalent is deemed preferable to either fluor-spar or oxide of iron separately. When combined in use the reaction will proceed more energetically, with a corresponding economy of time and saving in cost. The oxide of iron also protects the metal measurably from oxidation during the removal of the phosphorus.

The process above described is characterized by the dephosphorization of the iron after its decarbonization, and this is important because if lime in the form of fluor-spar should be introduced into the metal while in the converter before decarbonization, the fluorine of the fluor-spar, by combining with a portion of the silicon of the iron, and carrying it off in vapor or in gas would rob the metal of a substance (silicon) whose combustion by the blast is important for the purpose of keeping the melted metal at the requisite temperature, and the practical result would be the reduction of the temperature of the metal so low as to render the operation of casting it difficult. If, on the other hand, as above provided for, the metal be subjected to the action of the purifying reagent after the silicon has been consumed in the process of decarbonization, the temperature of the metal will not be reduced by the action of the purifying agent to any practical extent.

The additional heat applied to the melted metal in the reverberatory furnace during the treatment is advantageous. It obviates the risk of the metal becoming cooled by the too prolonged detention in the vessel in which it is treated, and also supplies the requisite heat to maintain the metal in a melted condition in

case the heat which is inherent in it previous to treatment is not sufficient for that purpose.

It is understood that the operation of decarbonization as carried on in a Bessemer converter by means of injected jets of air, as above set forth, is attended with the desiliconizing of the metal, whereby the metal is substantially free from silicon, silicates, silicic acid, the presence of which would seriously interfere with the succeeding dephosphorizing operation.

What is claimed is—

1. The improvement in the art of manufacturing iron and steel, which consists in first decarbonizing the metal, while in a molten condition, by means of jets of air, and afterward treating the decarbonized metal, while free from contact with silicious substances—such as the lining of the containing-vessel—with a calcareous reagent and oxide of iron to remove the phosphorus.

2. The improvement in the art of manufacturing iron and steel, which consists in first decarbonizing the metal, while in a molten condition, by means of jets of air, and afterward treating the decarbonized metal with a calcareous reagent and oxide of iron, while the metal is maintained in a liquid condition by the application of additional heat.

3. The improvement in the art of manufacturing iron and steel, which consists in first decarbonizing the metal, while in a molten condition, by means of jets of air, and afterward treating the decarbonized metal with a calcareous reagent and oxide of iron to remove the phosphorus.

JAMES HENDERSON.

Witnesses:

WILBUR F. REEDER,
CHARLES MCCAFFERTY.