

UNITED STATES PATENT OFFICE.

JACOB REESE, OF PITTSBURG, PENNSYLVANIA.

PROCESS OF OBTAINING PURIFIED IRON IN THE BESSEMER BASIC PROCESS.

SPECIFICATION forming part of Letters Patent No. 279,596, dated June 19, 1883.

Application filed January 3, 1882. (No specimens.)

To all whom it may concern;

Be it known that I, JACOB REESE, a citizen of the United States, residing in Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a certain new and useful Improvement in Processes of Obtaining Purified Iron in the Bessemer Basic Process; and I do hereby declare the following to be a full, clear, and exact description thereof.

In the practice of what is known as the "Bessemer process" the necessary amount of caloric to keep the metal in a highly-fluid condition until the close of the blowing operation is developed chiefly by the oxidation of the various impurities in the metal, and in some degree by the oxidation of the iron itself as it remains at the close of the blow in an oxidized condition. The temperature developed in the converter therefore will depend on the amount of each of the various impurities present, upon the rapidity of their combustion, the nature of the chemical action which takes place during their combustion, and finally by the absolute heating-power of the various impurities in the metal. In the acid process silicon is relied upon as the principal caloric-producing element. Therefore not less than one per cent. should be present in order that the metal may be kept in a fluid condition, and not more than two and a half per cent. should be present, as an excess will cause the metal to work too hot and boil over. In ordinary practice it is desirable to have two per cent. of the weight of the whole charge. In the practice of the basic Bessemer process, however, it was soon discovered that it was desirable to use a metal low in silicon, as the silicic acid formed in the combustion of the silicon is destructive to the basic lining, requires basic conditions in relative amounts to the acid present, and also retards dephosphorization by robbing the phosphate of its base. The difficulties of dephosphorizing such a metal in the lime-lined converter are: it must be maintained at a highly-fluid condition, although it has been robbed of a large part of its chief caloric-producing agent, and is also robbed of a portion of its caloric by the large basic additions, and therefore in practice it was found that the

bath was liable to chill. In order to utilize a metal low in silicon and overcome these difficulties, it was then proposed to desiliconize an ordinary metal in an acid-lined converter, and run the highly-fluid metal into a lime-lined converter, exclude the acid slag, and subject the bath to an overblow. This plan met with better success, as the metal was run into the converter in a highly-heated condition, required but small basic additions, and because of the short duration of the overblow; but the plant is more expensive, time is lost in conveying the metal from one converter to another, and in some cases it is apt to work cold. In the operation of the acid Bessemer process, when ten gross tons constitute the charge and the metal contains two per cent. of silicon, it will be seen that there will be four hundred and forty-eight (448) pounds of silicon present in the metal, and as seven thousand eight hundred and thirty units centigrade of caloric are developed from each pound of silicon consumed we have three million five hundred and seven thousand eight hundred and forty units centigrade, or $7,830 \times 448 = 3,507,840$ units centigrade from the silicon in the charge. In the use of a metal containing but one-half per cent. (.5) of silicon by the basic process it will be seen that we only have one hundred and twelve pounds of silicon in a similar charge, and that only eight hundred and seventy-six thousand nine hundred and sixty units centigrade will be developed from the oxidation of the silicon; or, in other words, other things being equal, there will be two million six hundred and thirty thousand eight hundred and eighty (2,630,880) units of heat centigrade less developed on account of the absence of the one and one-half (1½) per cent. of silicon. Now, in order to secure the two million six hundred and thirty thousand eight hundred and eighty (2,630,880) units centigrade, I substitute a sufficient amount of phosphorus in the metal to develop that amount of caloric during the refining of the metal. The calorific power of phosphorus is 57.47 units centigrade, so that it will require (2.05) two and the one-twentieth of one per cent. of phosphorus to be substituted to furnish an equivalent of caloric for

that lost by reducing the silicon in the pig. When a metal is used containing but a trace of silicon, the amount of phosphorus required to produce an equivalent amount of caloric for that obtained from the oxidation of two per cent. of silicon may be readily computed, thus:

$$\frac{3,507,840}{57.47} = 611 \text{ pounds of phosphorus.}$$

$$\frac{611 \times 100}{22,400} = 2.73 \text{ per cent. nearly.}$$

In conducting my improvement the necessary amount of phosphorus may be had in the metal by smelting phosphoritic iron-ores with coke and limestone in a blast-furnace. In this case the ores should be as low in silica as economically possible, and the limestone additions should be in sufficient quantity to give the slag a more basic nature than in the usual practice; or ordinary non-silicious ores should be smelted together with coke and suitable charges of phosphoritic basic slag from the basic converter to flux the metal and charge it with phosphorus to the desired degree, in the manner described by me in a former application; or the metal may be produced in the manner described by me in Letters Patent No. 246,908; or ordinary metal may be used in connection with a ferro-phosphide, as described by me in a previous application. In the latter case it is obvious that a metal containing as little silicon should be used as can be conveniently had. When a metal containing the desired amount of phosphorus is produced, if it contains over one-half ($\frac{1}{2}$) per cent. of silicon, I prefer to desiliconize it in a silicious-lined converter and then finish its treatment in the basic converter. If it does not contain over one-half per cent. of silicon, it may be run direct into a lime-lined converter. The blast is let on, and the silicon becomes eliminated in from one to two minutes, when the second or decarburizing period commences. The length of this period will vary with the varying amounts of carbon and manganese in different charges, but will generally last from eight to twelve minutes, after which the phosphorus will be rapidly oxidized, the afterblow ranging from one to three minutes.

In this operation it will be found that the quantity of basic additions may be largely decreased, as but little silicic acid is formed, the lime-linings will last longer, the blow will be shortened, the metal will work better and more uniform in the overblow, a better and more regular product can be obtained, and the output will be increased as the use of the two vessels will be avoided.

One advantage of substituting phosphorus for silicon as a heat-producing agent is as follows: In the Bessemer process, when silicon is relied on as the chief caloric-producing agent, the greatest amount of caloric is developed

during the first period, while in the basic process it is absolutely necessary to maintain the metal at a very high temperature at the end of the blow, on account of the greater purity of the metal produced; and as phosphorus is not oxidized until the silicon and carbon are almost entirely removed it produces the greatest heat at the end of the blow, and maintains the metal in a highly-fluid condition while being deoxygenized, recarburized, and cast into the molds.

By the use of the term "non-silicious phosphoritic metal" I do not wish to be understood as limiting myself to a metal containing no silicon; but refer to a metal in which the silicon has been reduced so far below the normal standard that its presence will not seriously affect the lime-linings, and which contains a sufficient amount of phosphorus to give an increased number of caloric units over that lost by the reduction in the quantity of silicon, so that the metal may remain in a highly-fluid condition during the overblow.

It will be observed that a metal of high purity cannot be produced by the Bessemer acid process because of the impurity of the acid slag in which the metal is worked; nor, indeed, can this be produced by the basic process *per se*. For although the phosphorus may be eliminated, the metal would be so cold and sluggish at the end of the blow that more or less of the slag would be incorporated with the metal; but by diminishing the amount of the silicon and increasing that of the phosphorus the slag is kept more highly basic and pure, and the phosphorus is burned out after the silicon and carbon have disappeared, and this causes the metal to assume a highly-fluid state, so that the carbon, silicon, and phosphorus are entirely eliminated, the slag is separated, and a highly-purified metal is produced. So, it will be seen, that to secure the object of this invention by the use of the basic process it is necessary that the silicon should be reduced as low as possible, and that sufficient phosphorus should be present in the metal to compensate for the heat-units withdrawn by the reduction of silicon. Although the presence of silicon is injurious in any degree, yet if even two per cent. of silicon is present it can be entirely eliminated if sufficient phosphorus is present to develop the heat necessary to secure a highly-fluid overblow. Therefore, in the use of the term "non-silicious phosphoritic metal" I do not intend to limit my invention to a metal which contains no silicon, but rather to a metal containing less silicon than phosphorus. In the Bessemer acid process the metal contains more silicon than phosphorus.

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

The within-described process for obtaining

purified iron in the Bessemer basic process, which consists, essentially, in smelting phosphoric ores low in silicon, in the manner substantially as set forth, to obtain non-silicious phosphoric metal, and then subjecting
5 the resultant phosphoric metal, while held in a basic-lined converter and in presence of

a basic slag, to the action of an air-blast, substantially in the manner and for the purposes set forth.

JACOB REESE.

Witnesses:

JAMES H. PORTE,
WALTER REESE.