UNITED STATES PATENT OFFICE.

JACOB REESE, OF PITTSBURG, PENNSYLVANIA.

PRODUCTION OF FERRO-PHOSPHORUS.

SPECIFICATION forming part of Letters Patent No. 282,118, dated July 31, 1883.

Application filed September 27, 1881. (No specimens.)

To all whom it may concern:

Be it known that I, JACOB REESE, a citizen of the United States, residing in the city of Pittsburg, county of Allegheny, and State of Pennsylvania, have invented a new and useful Improvement in the Production of Ferro-Phosphorus; and I do hereby declare the following to be a full, clear, and exact specification thereof.

The object of this invention is the production of a metal composed chiefly of iron and phosphorus, and containing not less than ten (10) per cent. and not more than thirty-five (35) per cent. of phosphorus. This ferro-phosphide will be of great advantage in the production of ingot iron and steel by the basic process, as will be more fully explained hereinafter. It will also be useful for the production of phosphor-bronze and other metallic compounds in which phosphorus is an element. In the Bessemer acid process silicon is relied on as the principal caloric-producing agent. Hence standard Bessemer metal is required to contain from two (2) to three (3) per cent. of silicon, while in the practice of the Bessemer basic process silicon is avoided, as its combustion produces silicic acid, which is destructive to the basic linings, and otherwise retards dephosphorization, and as two or three per cent. of phosphorus may be as readily eliminated as one-tenth of that amount, and as phosphoric acid resulting from the oxidation of phosphorus is not destructive on the lining in the basic process, silicon is displaced and phosphorus substituted in its place in the metal as a calorific power as far as convenient. The amount of phosphorus required in order to supply the amount of caloric lost by the absence of silicon, and to meet other requirements, will be from one (1) to three (3) per cent., according to the conditions and amount of silicon withdrawn; and as the phosphorus is eliminated at the period known as the "overblow," it is exceedingly desirable that an exact and uniform amount of phosphorus may be present in each of a series of successive charges, in order that a definite relative amount of oxygen may be blown in, which will be just sufficient to oxidize all of the phosphorus, and that the overblow may be ended at that juncture, and thus prevent the oxidation of the iron, which would take place if the blow were prolonged after the phosphorus had disappeared.

Heretofore the pig metal made in the United States has ranged in phosphorus from .05 in all degrees to one and one-half per cent. and upward; and in order to utilize any and all of such metal in the manufacture of ingot iron and steel by the basic process, it is desirable that the amount of phosphorus in the initial charges should conform to a determined standard; and, in order to meet this requirement, I have produced a metal containing from ten (10) to thirty-five (35) per cent. of phosphorus, which I call "ferro-phosphorus."

The essential conditions for the production of ferro-phosphorus are bringing iron and phosphorus together while in a molten state in the presence of a silicious slag and a vapor of carbonic oxide, (CO,) or either of them. One means of securing these conditions is by smelting ores of iron and a phosphoritic slag in a blast-furnace. In such case as little lime should be used as consistent with the proper working of the furnace, so as to keep the slag highly silicious; or, when the ores contain sufficient phosphorus in themselves, the phosphoritic slag may be omitted. Another means of producing ferro-phosphide is by smelting cast-iron in a cupola provided with a hearth of sufficient capacity to hold the metal, and from six to twelve inches of slag below the line where the blast enters the cupola, and then melting phosphoritic ores or phosphoritic slag, and causing it to flow and rest upon the face of the metal. Then injecting into the metal or slag a vapor of hydrocarbon or carbonic oxide, whereby the carbon so injected will abstract the oxygen from the phosphate of the slag or ore and reduce the phosphate to a phosphide, which will immediately unite with the metal. In the latter case care should be taken to keep the ores or slag as highly silicious as consistent with their fluidity. In producing a ferro-phosphide by the cupola process, as just described, when a metal high in phosphorus is desired, I construct the cupola with a tymp or slag notch just below the blast-line, and continue to melt the phosphoritic slag until a sufficient quantity of phosphorus will be deposited in the metal, the excess of slag escaping out of the hearth through the tymp.

By this method I have been able to abstract phosphorus from puddle-furnace slag and produce a ferro-phosphide of a high grade. It is a well-known fact that the elements unite with each other in certain relative equivalents, and as a phosphide of iron consists of thirty-one (31) parts, by weight, of phosphorus, and fifty-six (56) parts of iron, it will be seen that if a ferro-phosphorus metal was a pure ferro-phosphide its composition would be phosphorus, 35.63 per cent.; iron, 64.37 per cent. It therefore follows that a ferro-phosphide cannot contain over thirty-five (35) per cent. of phosphorus, owing to a trace of other matter than iron.

In the production of ferro-phosphorus by means of the cupola, I line the cupola in the ordinary manner with a silicious lining, charge it with coke, and after it has become properly heated, pig-metal or scrap-steel is charged and melted. I prefer scrap-steel, as it is low in silicon. I then charge the phosphoritic slag from time to time, keeping up a brisk fire by blowing in the air-blast, and depositing the phosphorus in the metal by injecting the carbonaceous vapor into the bath. By this means I am able to produce a metal containing from ten (10) to thirty-five (35) per cent. of phosphorus, depending upon the quality of the slag and the time of treatment.

This ferro-phosphorus is designed to be used by mixing it with iron, which contains less than two per cent. of phosphorus, so as to bring up the average per cent. of phosphorus in the mixture to the requirement of the basic dephosphorizing process; and even where sufficient amount of metal containing from two to three per cent. of phosphorus is easily obtained, the ferro-phosphorus will be of great advantage, as a Bessemer works producing one hundred thousand tons of steel per annum will also produce twelve thousand tons of scrap in the form of "sculls," bloom ends, and rail ends; and as all this scrap is low in silicon, carbon, and phosphorus, it could not be used in the basic process unless it was admixed with a caloric agent. This I do by admixing such scrap with a sufficient amount of the ferro-phosphide and melting the mixture in the cupola and running it into the converter, or by throwing the scrap and phosphide into the converter, as is now done with scrap in the acid process. By the use of the phosphide all the scrap may thus be used and again put into serviceable ingots.

It is well known that phosphorus tends to make cast-iron very fluid, and by the admixture of a small portion of the ferro-phosphorus with pig metal in foundry practice, the iron will run more freely and smoother and finer castings can be produced. Phosphorus also tends to harden iron and strengthens it in the absence of concussive blows or sudden strains. The ferro-phosporus will, therefore, be of great service in producing phosphor-bronze, and all castings in which phosphorus is found to be desirable, as I purpose to furnish it as a regular article of manufacture, the same as ferro-manganese is now supplied.

In the basic dephosphorizing process as at present practiced, the duration of the overblow cannot be readily determined, owing to the varying content of phosphorus in the metal, and if the overblow is not continued sufficiently long, then the phosphorus is not sufficiently eliminated, and if it is continued too long, an extra portion of the iron is oxidized, and not only lost, but leaves an increased amount of oxygen in the metal. Consequently when it is deoxidized a less amount of manganese is left in the steel, and as it is of great importance to have no more and no less than the required amount of manganese in the resulting steel, the advantage of using the ferro-phosphorus will readily be seen, as by its use the amount of phosphorus may be definitely determined and the duration of the blow and amount of oxygen in the metal calculated, and I can thus produce steel free from phosphorus and containing a definite and desired percentage of manganese. For these reasons I conceive that the ferro-phosphorus will prove to be of great value in the practice of the basic dephosphorizing process.

In the production of ferro-phosphorus the more silicious the slag is the more readily the phosphorus will be deposited in the metal. Therefore but little lime, if any, should be used in the cupola, and when the calcarious phosphoritic slag is used, it should be admixed with silicious matter to as great a degree as it will remain in a fluid state while in the cupola; and in the use of phosphoritic ores I prefer to use those containing at least fifteen per cent. of silica.

This invention being the production of iron containing phosphorus in a larger degree than has hitherto been produced for commercial purposes by the processes herein set forth, I do not wish to confine or limit the processes to any form of apparatus referred to in my explanation of practice, and I do not herein claim the substitution of phosphorus instead of silicon in the basic process, nor the special use of phosphoritic metal with metal low in phosphorus to secure a definite duration of the overblow or for the utilization of scrap, as I have filed applications for said inventions.

I am aware that in the recovery of phosphorus from fossil phosphates and the manufacture of alkaline phosphates a phosphuret of iron has been produced by smelting a mixture of iron, silica, and the fossil phosphates, and do not herein claim such a process.

Having thus described the invention, what I claim, and wish to secure by Letters Patent, is—

1. The process herein described for the production of ferro-phosphorus, which consists in subjecting molten iron while in a cupola to the action of a phosphoritic and silicious slag and to the action of a carbonaceous vapor or

gas, substantially as and for the purposes specified.

2. As a step in the process for the production of ferro-phosphorus, covering molten iron with a phosphoritic slag, and then injecting into the molten metal or slag a carbonaceous vapor or gas, whereby the phosphate of the slag is reduced and the phosphorus is taken up by the metal, substantially as and for the purpose set forth.

JACOB REESE.

Witnesses:
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