UNITED STATES PATENT OFFICE.

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METHOD OF DEPHOSPHORIZING CRUDE CAST-IRON.

SPECIFICATION forming part of Letters Patent No. 246,398, dated August 30, 1881.

Application filed April 26, 1880. (No model.)

To all whom it may concern:

Be it known that I, LOUIS G. LAUREAU, of the city and State of New York, have invented a new and useful Improvement in the Method of Dephosphorizing Crude Cast-Iron, of which the following is a specification.

A brief statement of the known dephosphorizing processes, such as the Bell and the Krupp, will be necessary to the thorough understanding of my invention.

In the processes alluded to the impurities of the crude cast-iron usually known as "pig"—such as silicon, manganese, phosphorus, sulphur, &c.—are oxidized at a low temperature in a revolving refining-furnace by means of oxides of iron. The operation continues until the carbon shows signs of oxidation. It must then be stopped, partly on account of the reducing action of the carbonic oxide on the phosphates formed and partly because the iron must retain all or nearly all its carbon to keep it fluid for transfer from the refining-furnace to the steel-furnace; but it is found that silicon and manganese are much more quickly oxidized than phosphorus, for while mere traces of the former elements remain in the bath a considerable portion of the latter is yet present at the time when the operation must be stopped. For instance, a pig containing phosphorus, 2.50 per cent., with the usual amounts of silicon and manganese, will retain practically no silicon or manganese; but as much as 0.75 per cent. of phosphorus will yet be in the bath when, according to the Bell-Krupp method, the refined pig-iron must be transferred.

My improvement consists in treating the bath in such a manner that after the Bell-Krupp process has been performed a new refining operation may be carried on in the same furnace, by which nearly all the phosphorus will be removed, even when the most highly phosphoric pigs are employed, thus making them available for the manufacture of fine steels. In order to attain this result I commence the operation in the usual manner as performed in the Bell-Krupp process. I prefer, however, a revolving to a rocking refining-furnace as more convenient in practice and more efficacious in its working. Having conducted the operation to its end as now performed—*i.e.*, when carbonic oxide begins to burn—I preferably draw off the slag. This removes with the slag all the phosphorus that has been oxidized and eliminated from the iron. Then, instead of drawing off the charge at this moment, as Bell and Krupp do, I add into the furnace a certain amount of oxidizable materials, such as silicon and manganese, in a melted state.

I have found that in basically-lined vessels silicon has a decided effect in the removal of phosphorus when added at the proper time—*i. e.*, after a part of the phosphorus has already been removed. Its addition to the bath at this period, on account of its greater affinity for oxygen, retards the formation of carbonic oxide, which, having a strong reducing action on the phosphates in the slag, would cause a reabsorption of phosphorus into the iron if the operation were not immediately stopped. Manganese has also, to a lesser degree, the same effect, and as, moreover, its effect on basic linings is less deleterious than that of silicon, it may be employed with advantage in connection with it for the purpose mentioned, in order to temper the strong cutting action of silicon and to add to the fluidity of the slag, which, as it must be thoroughly separated from the refined pig, should be as liquid as possible. I so proportion the additions that after they are in the bath the metal has nearly the same composition as when first run into the furnace, with the exception of phosphorus, a notable quantity of which has been removed by the first operation. The hearth is then revolved rapidly for a period extending from two to eight minutes, and the operation is stopped as soon as the flame shows that the carbon in the iron is beginning to burn.

I prefer to use for additions such compounds of iron and silicon, or of iron, silicon, and manganese, as may be found among the pig-irons of commerce. These, of course, may vary in composition, the main object being to introduce a certain amount of silicon in all cases and a certain amount of manganese when judged necessary. Any silicious pig-iron may be used, with or without the addition of a small quantity of ferro-manganese.

The compound of silicon, manganese, and iron, known under the name of "ferro-silicon," may also be used advantageously.

To better explain the operation, I will suppose that the pig to be treated contains phosphorus, 2.50; silicon, 1.00; manganese, 0.50. I first place it in a furnace lined with oxide of iron, as in the Bell-Krupp method, and carry the operation to its usual termination as practiced in this method—*i. e.*, when carbon begins to burn. The pig then contains traces of silicon and manganese, and about 0.75 per cent. phosphorus, which renders it unfit for the manufacture of steel, although the Bell-Krupp method has been carried out to its full development. I then, by preference, draw off the slag if it appears to have accumulated on top of the bath in a dangerous quantity, (instead of drawing off the charge and transferring it to the steel-making furnace, as in the Krupp or Bell processes,) and immediately run in the necessary additions, as aforesaid, to remove the remaining phosphorus. As the greater part of the phosphorus has already been oxidized, it is not necessary to add to the bath as much silicon as it originally contained. For that reason the additions may consist of a certain quantity of silicious pig, sufficient to give to the charge in the furnace from 0.20 to 0.50 in silicon, and, especially if the lining seems loose or worn, a small quantity of ferro-manganese to give the charge about 0.25 per cent. in manganese. The same amount of these ingredients may be introduced in the form of ferro-silicon, as before mentioned. The composition of the metal in the furnace will be phosphorus, 0.75; manganese, 0.25, and silicon, 0.20 to 0.50. The purifying operation is continued, and the silicon and manganese will preserve the carbon from oxidation, and an additional quantity of phosphorus will be removed from the iron before the reducing action of carbonic oxide can take place. I revolve the furnace, and when the carbon begins to burn I stop this second operation and draw off the charge. The metal will then have about the following composition: phosphorus, 0.05 to 0.12; silicon and manganese, traces; and it can be used for the manufacture of steel in the open-hearth furnace. It is evident that this additional operation can be performed several times successively, if necessary, each successive operation removing more phosphorus. It can be applied to comparatively pure pigs when it is desirable that a greater quantity of phosphorus should be removed.

I am aware that ferro-silicon and silicon and manganese have been used before in the manufacture of the so-called "Terrenoire" phosphorus steel, and also in making solid steel castings; but they have never been employed as a second charge in a basically-lined vessel to retard or avoid the reducing action of carbonic oxide in the elimination of phosphorus from a melted bath of crude iron, and to prevent the reducing back into the iron of the oxidized phosphorus retained in the slag.

In the steel-making processes before named, where silicon and manganese are used, their action is intended to neutralize the phosphorus which is present in the steel; but it does not remove it.

My process is not, primarily, for making steel, (although the principle on which it rests may be used in the manufacture of steel from phosphoric pig in basically-lined hearths,) but it is for further treating and purifying a bath of impure crude cast-iron and preparing it thoroughly for the manufacture of steel.

I do not claim the first stages of my process, as those have been used, my invention only relating to the complete process, including the second stages.

I claim as my invention—

The process specified for treating iron for the removal of phosphorus and other impurities and the production of pure cast-iron, consisting in introducing the melted metal upon a basic-lined hearth, and allowing the principal portion of the impurities to become oxidized in the form of slag, the carbon remaining unacted on, or nearly so, and then adding silicon or manganese, or equivalent easily-oxidized material, while the iron is still on a basic hearth, for combining with or facilitating the separation of the remaining impurities, and then separating the iron and slag before the carbon of the iron is burned, substantially as specified.

Signed by me this 20th day of April, A. D. 1880.

L. G. LAUREAU.

Witnesses:

A. L. HOLLEY,

GEO. T. PINCKNEY