No. 880,253. PATENTED FEB. 25, 1908.

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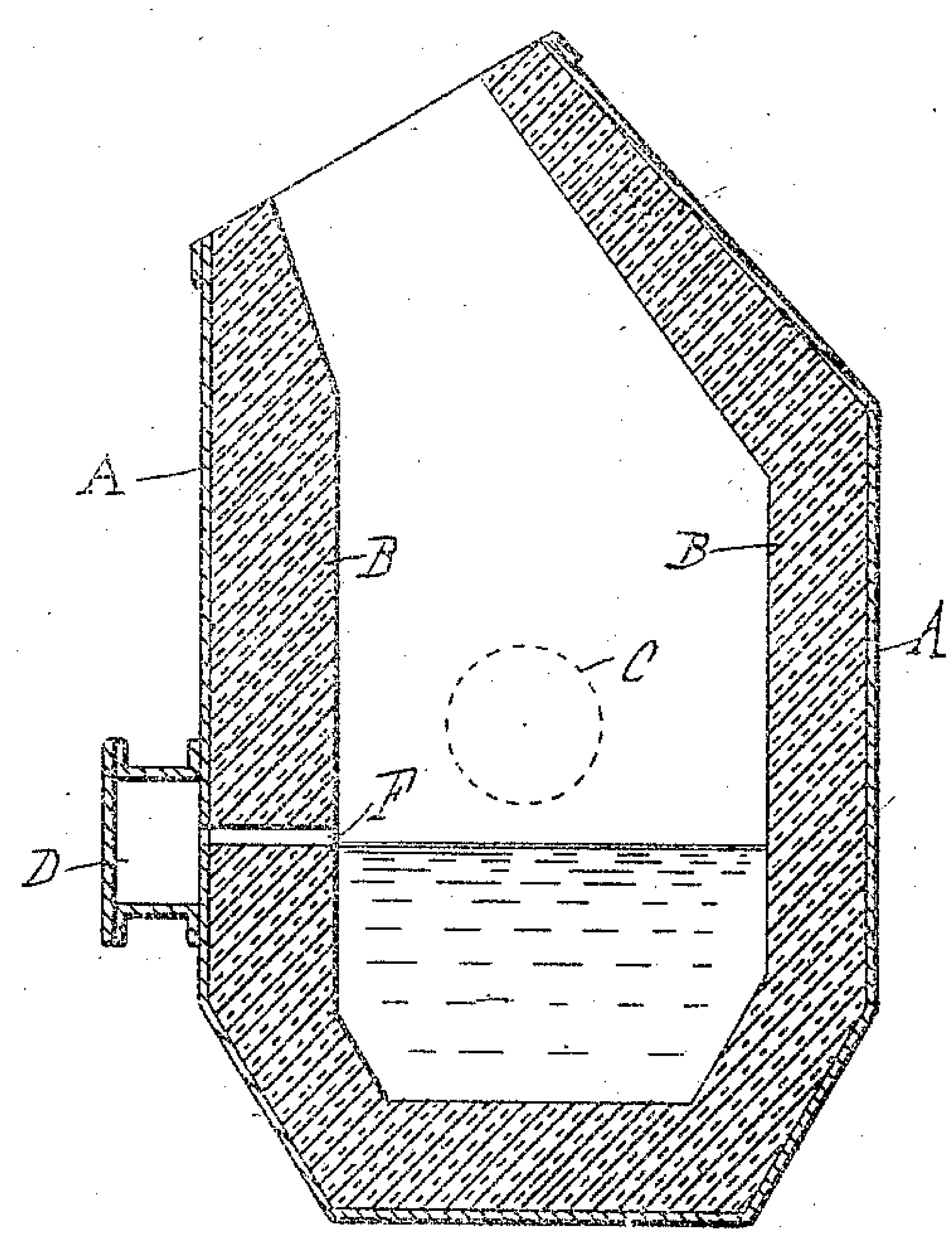
MANUFACTURE OF STEEL BY THE PNEUMATIC PROCESS.

APPLICATION FILED JAN. 29, 1907.



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MANUFACTURE OF STEEL BY THE PNEUMATIC PROCESS.

No. 880,253. Specification of Letters Patent. Patented Feb. 25, 1908.

Application filed January 29, 1907. Serial No. 354,694.

To all whom it may concern:

Be it known that I, ALEXANDRE TROPENAS, a citizen of the Republic of France, and a resident of Montelimar, in the Department of Drome, in the Republic of France, have invented certain new and useful Improvements in the Manufacture of Steel by the Pneumatic Process, of which the following is a specification.

It is generally understood that all known methods of making steel by the pneumatic processes are based on the elimination by oxidation of certain elements, such as carbon, silicon, manganese contained in the iron, by means of compressed air. This oxidation produces two distinct results. The first result is the elimination of the elements or part of the elements, carbon, silicon, manganese, contained in the pig-iron, and this transforms it into a new metal more or less malleable according to the degree of elimination attained. The second result is the great increase of the temperature of the metallic bath resulting from the reaction of the oxygen of the atmosphere on the elements eliminated. Among these elements, the silicon, for the acid method, the phosphorus for the basic method, are those which have the greatest influence on the increase of the temperature of the metallic bath. It is thus natural that the investigations of the inventors who have tried to solve the problem of manufacturing steel in small charges by the pneumatic process, have been directed towards these two constituent elements in pig-iron.

It is evident that when a small charge of metal is treated by the pneumatic process, the causes which operate to bring about cold steel, are much more in evidence than when larger charges are being dealt with. Special systems have been sought to prevent this cooling.

Some inventors have tried to increase the temperature of the final bath by mixing with the compressed air, solid or gaseous elements but the gain of temperature thus obtained has not been appreciable; others have used pure oxygen instead of compressed air; higher temperature has been reached thereby, but at too great an expense, and moreover the oxidation of iron and consequent waste have been so great that the method had to be discontinued as impracticable. In other experiments, with the view of obtaining high temperature in small charges, the percentage of silicon has been increased. In such case, the first period of the process, which comprises the time from commencement of the blow to the time carbon flame appears, has been much prolonged. The burning of this extra silicon wears away the lining, consequently any additional temperature that could be expected by the use of high percentage of silicon, becomes absorbed and lost by the melting of the lining. The inventors who, to my knowledge, have approached nearest to the solution of this problem, have treated by the pneumatic process in a vessel of small capacity, a charge of pig-iron containing the current percentage of silicon (1.50 to 2 per cent.). They blow such material up to the end of the blow in the usual way, and when the blow is finished, *i. e.*, when the flame drops due to carbon in the metallic bath having been exhausted, or practically so, then at this moment or a few seconds before or after the blowing is stopped a certain quantity of silicon (ferro-silicon or highly silicious pig-iron) is added to the bath, either red-hot or melted. The blowing is started again so as to oxidize or burn out this extra quantity of silicon which has been added. A sort of short glimmer produced by the last traces of carbon and by the smoke of oxid of iron is noticeable at the mouth of the vessel and the metallic bath increases rapidly in temperature during this special period of "over blowing", due to the effect of the combustion of the added silicon. A great temperature of the metallic bath is thus obtained, but then a great difficulty arises from the absence of real flame during this over-blowing, and this difficulty is the impossibility to stop the process with certainty at the precise moment when all the added quantity of silicon is eliminated. If the operation is stopped too soon, part of the extra or added silicon remains in the final steel which then contains too much silicon; if on the contrary, the operation is stopped too late, the metallic bath is over oxidized and it becomes impossible to make, with exactitude and certainty, the final addition of ferro-manganese and thus obtain a final steel of definite grade. To remedy this difficulty to a certain extent, it has been tried to sample the steel before the final addition, but when operating on a small charge there is no time to do this before pouring and the consequence is that the variations in the grade of steel obtained from different charges are such that the steel is not reliable.

Technicians know well enough that the only serious element that can be taken as a basis to determine the precise moment for stopping the blowing is observation of the flame of carbon; and in the method I have just described, there is no more carbon left in the metallic bath, and consequently no more flame (the dropping of the flame having taken place before the supplementary addition of silicon) and the process beginning afresh (but without flame this time), the operator possesses no certain sign for the final stoppage of blowing. He works blindly and has no possibility of obtaining with certainty a specified grade of steel.

The above explanation will now enable me to point out the novelty of the method, hereinafter described, relating to a process of manufacturing steel in small charges which I have discovered after various experiments, and by which, while getting a very high final temperature, the carbon flame remains visible up to the complete end of the process and allows steel to be easily manufactured even in very small charges, reliably hot and fluid and containing a determined and desired percentage of carbon.

I will now describe my method for the treatment of pig-iron in an acid-lined converter. To carry out this method, any suitable type of converters can be utilized. A converter may be used such as represented in the sectional view of the accompanying sheet of drawings, which is a vertical section; A being the wrought iron or steel shell, and B the refractory silicious lining. The vessel is mounted on trunnions C, and can turn upon them. A wind box D is connected with one of the hollow trunnions, through which comes the blast from the blowing engine; the general construction of the shell having no particular novelty and being of the type adopted for ordinary converters, it is not necessary to describe it in detail.

The bottom of the vessel or crucible is so designed that the metallic bath has considerable depth. The twyers, F, conveying the blast through the lining into the vessel, are placed so as to be just above the level of the metallic bath when the molten charge is in, before starting blowing.

In carrying out my improved process, I prefer to use hematite pig-iron containing as little silicon as possible. If this low silicious iron cannot be obtained, a mixture of pig-iron and steel scrap may be charged into the cupola so as to lower the percentage of silicon in the metal poured into the converter.

When the pig-iron or mixture of pig-iron and scrap has been melted in an ordinary cupola, it is poured as usual into the converter previously heated before the first operation. The converter is turned so as to bring the twyers just above the level of the metallic bath, and the blowing is started. On account of the low percentage of silicon in the metal, the first period, *i. e.*, the period without flame, is very short. As soon as the second period begins, *i. e.*, immediately following the appearance of the carbon flame at the mouth of the vessel, a small quantity of silicon, in the form of highly silicious pig-iron or ferro-silicon, varying with the initial percentage of the silicon in the metal charged in the vessel, is thrown into the converter without stopping blowing. If this addition of silicon be used cold, it should be thrown in almost as soon as the carbon flame appears. If the addition be thrown in hot, it may be added a little later but very soon after the appearance of the carbon flame. This addition does not generally exceed in weight five per cent. of the charge, but may be in certain cases, more or less. The blowing is continued without stoppage of any sort until the flame drops; this dropping is very characteristic and very clear. The final addition of ferro-manganese is made in the usual way and the steel is ready to pour into molds.

In starting the operation with a metallic bath of low percentage of silicon, the duration of the first period (without flame), is reduced to a minimum and the oxidation of iron and the wear of the refractory lining are likewise reduced to a minimum. By making the addition of silicon as soon as or immediately after the carbon flame has made its appearance at the mouth of the converter (not before or sometime after), all the silicon added for increasing the temperature of the bath is utilized under the best conditions. Experiments have shown that if the bath contains a high percentage of silicon, the first period, (*i. e.* without flame) is much prolonged and the greatest part of heat, produced by the oxidation of the silicon is absorbed by the melting of the refractory lining without increasing the final temperature of the metallic bath.

In starting, as specified, with low silicious iron and adding silicon only immediately after the appearance of the carbon flame, the added silicon is oxidized along with the carbon, and this gradually, while the silicon added, is transmitted in melting to the metallic bath. The added silicon moreover, becomes completely melted before the dropping of the carbon flame, and when the flame disappears, all the silicon added has been completely eliminated. The silicon being dissolved into the bath does not affect in the least the evolution of progression of the carbon flame which can be observed without any difficulty so that the operation can be stopped at the right moment with absolute certainty, while the temperature of the bath has been greatly increased. The steel contains no trace of the supplementary silicon which has been added, and is not over-oxidized; consequently it is then possible to make exactly the final addition of manganese, and to reach the percentage of carbon for a given grade or quality.

The experiments made in a great number of blows have shown that with the use of the process above described, it is possible with a converter of a half ton capacity to obtain always, the same given percentage of carbon and the same quality of metal without appreciable practical variation, and that the steel thus produced is sufficiently fluid to be carried in small ladles and poured into very small molds without waste and without the formation of skulls.

Experiments made in converters of small capacity of different systems with the view of obtaining steel always of the same required quality, hot and fluid enough to cast small articles, have shown (*a*) that an addition of silicon made before the appearance of the carbon flame retards, or prolongs, the time of its operation and produces a bad operation; (*b*) that an addition of silicon made near the end of the operation at about the moment of the dropping of the flame, a little before or after, deprives the operator of the reliable signs furnished by the flame for the stoppage of the operation at the right moment, and does not secure the accuracy needed in general practice to obtain the required grade of steel; (*c*) that only the addition of cold silicon made immediately after the appearance of the carbon flame, or which is the same, the addition of silicon made hot or melted and added a little later, but always a long time before the disappearance of the flame, gives a good result, certain and accurate.

I claim as my invention

As an improvement in the manufacture of steel by the pneumatic process, blowing the charge until the appearance of the carbon flame, adding a small percentage of silicon immediately after the appearance of such flame, and continuing the blow until the carbon flame disappears, all substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses.

ALEXANDRE TROPENAS.

Witnesses:

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MARIN VACHON.