

UNITED STATES PATENT OFFICE.

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PROCESS OF PRODUCING STEEL FREE FROM PROTOXIDS.

937,486.

Specification of Letters Patent.

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No Drawing.

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To all whom it may concern:

Be it known that I, OTTO THALLNER, metallurgist, a subject of the King of Prussia, and resident of Bismarckhütte, in the Province of Upper Silesia, German Empire, have invented a new and useful Process for Producing Steel Free from Protoxids, of which the following is a specification.

This invention relates to a process for producing steel free from protoxids of iron or manganese and which has the acid properties of crucible steel.

It is already known to apply silicon for the deoxidation of steel and slag. In deoxidizing steel ferrosilicon has been added to the molten metal before or during tapping. In both cases the silicon effects deoxidation by reducing the protoxids of iron or manganese present. The silicon is not only used up in this action but there remains also a considerable quantity of the products of the reduction for instance silicic acid in such a fine state of division emulsified in the metal that it is not capable of separating out in the short time before pouring. The result is that only a small quantity of the pure silicon remains in solution in the steel and as this small quantity only acts for a short time it has practically no influence on the internal structure of the steel. On the contrary the fine emulsified silicic acid has a disadvantageous action on the internal structure. If it is desired to cause the silicon to act advantageously on the internal structure the metal must contain a greater quantity of the silicon and be subjected to the protracted action of the silicon at the melting temperature. It is known that in the Martin furnace a strong blowing action is obtained in consequence of the gases of combustion, that is to say, there is a constant excess of oxygen present in the slag and this oxygen has a constant blowing action on the metal bath below it. It is therefore impossible to obtain a constant percentage of carbon in the metal in a basic lined furnace of this kind as the carbon in contact with the slag which is rich in oxygen is subjected to constant changes as also is the manganese in the metal bath. This oxygen of course also affects the silicon as the silicon has a great affinity for the oxygen in the slag, and passes over into the slag as silicic acid. It appears therefore to be impossible to retain pure silicon dissolved

with a basic lined Martin furnace and it appears also impossible to obtain a favorable action of the silicon on the internal structure of the steel. There still remains the possibility of adding the silicon before tapping or in the ladle. Silicon of course always reduces the protoxid of iron and manganese out of the slag in a Martin furnace. The object aimed at however was difficult to obtain as the metal below the slag might still remain rich in oxygen and in addition very large quantities of silicon were necessary to bring about the permanent silicizing as the slag constantly took up oxygen from the combustion gases and this oxygen had to be continuously removed. The slag was therefore always more acid in its nature and increased in its tendency to give up oxygen to the metal bath. It may therefore be assumed as a practical impossibility to melt metal in a basic flame-heated furnace and still retain a reasonable proportion of silicon in solution.

I have discovered that the protoxids may be removed and pure silicon taken up in solution by the steel by treating blown steel in an electric furnace with a basic lining and heating the steel together with silicon in said furnace. The electric furnace with a basic lining in consequence of the high temperatures obtained retains the slag in a much more basic character than was at all possible in a Martin furnace. The consequence is that the slag is less liable to take up oxygen from the air as there is no oxidizing flame present in the electric furnace. The proof of this may be found in the fact that the metal may be heated for several hours in an electric furnace with a basic lining without altering the percentage of carbon and manganese in the metal. The proof is also to be seen in that the slag may be retained free of iron for several hours. This circumstance alone permits the carrying out of the following process.

The Martin steel or the melted product from any other blowing apparatus is passed into a basic electric furnace. Sufficient ferrosilicon is added either in the electric furnace or when tapping into the ladle to completely deoxidize the metal and so that a fixed amount of pure silicon remains in solution. When added in the electric furnace the ferrosilicon may be laid in the furnace and the metal poured thereon or the ferro-

silicon may be thrown on the top of the metal bath before the lime is added for forming the slag. It would of course also be possible to add part of the silicon to the metal before passing the same in the electric furnace and the other part after. The chemical action which results, is as follows: The product of the deoxidation which is emulsified in the metal has time during the melting in the electric furnace to separate out and this product passes in the form of silicic acid into the slag. The pure silicon held in solution is neutral as regards the basic lining. In consequence the basic lining of the furnace is not attacked whereas the excessive addition of silicon on a basic Martin furnace led to the formation of large quantities of silicic acid which attacked the lining of the furnace very severely. If the slag in the electric furnace still contains iron-protoid, the iron in the slag is gradually extracted by means of the silicon in the bath and this reduction takes place at the contact surface between the slag and the metal bath. The reduction further takes place until the whole content of silicon has been used up or until the slag is free of iron. In order to retard the loss of silicon it is necessary to accelerate the deoxidation of the slag. This may be effected by throwing on charcoal or the like or aluminium compounds or even pulverized ferrosilicon. It is to be mentioned that a part of the deoxidizing agent burns with the air while the deoxidizing means which act on the slag from below act without loss. When the deoxidation is complete in the slag it becomes white or falls to a powder when exposed to the cooling action of the air. When the slag becomes white or falls to a powder in the air, the metal bath below the slag may

be assumed as in a proper state for taking up pure silicon, and that the silicon remaining in solution in the metal will no longer be used up. In consequence if further additions of ferrosilicon are made, the silicon acts on the internal structure of the metal so that the resulting product is just as fine in grain and as tough as if the metal had been treated in an acid lined electric furnace or in a crucible. This is really the novel technical effect obtained by the invention, viz. to bring about the permanent action of the pure dissolved silicon on the internal structure of the steel in a basic lined furnace. The action of the silicon as a deoxidizing means for the slag from the lower surface upward that is to say from the metal bath upward, is also an important feature of the metallurgic action.

I claim:—

1. The process of producing steel free from protoxids, consisting in blowing the steel and passing it to a basic electric furnace, adding silicon to said steel and heating said metal in said furnace together with the silicon till the metal and slag are deoxidized.
2. The process of producing steel free from protoxids, consisting in blowing the steel and passing the blown steel to a basic electric furnace, adding silicon to said steel, heating said metal in said furnace together with the silicon till the metal and slag are deoxidized, and then adding further silicon.

In witness whereof I have hereunto set my hand in the presence of two witnesses.

OTTO THALLNER.

Witnesses:

HERMAN PLISCHKE,
MAX ZIERCHE.