UNITED STATES PATENT OFFICE.

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METHOD OF REFINING IRON.

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To all whom it may concern:

Be it known that I, PAUL SEJOURNET, a citizen of the Republic of France, residing in Paris, France, have invented certain new and useful Improvements in Methods of Refining Iron, of which the following is a specification.

By the known metallurgical processes for refining by oxidation cast iron and steel to obtain merchantable iron containing the minimum of carbon, the content of the metal in carbon can only be diminished within a certain limit; for example, 0.04 to 0.05 per cent. When such a metal, containing oxid, is cast in an ingot mold, it bubbles and heaves, in fact it does not remain tranquil after casting. This effect is due chiefly to the concentration of the oxid of iron and carbon, which react and liberate gases (an oxid or oxids of carbon). When the molten metal cools, crystals of ferrite (substantially pure iron) separate, and the liquid mass, forming a sort of mother liquor, becomes richer in foreign elements, notably in carbon. When the concentration of these elements has increased, the reactions, hitherto limited by the dilution, begin again. In an analogous manner occluded gases other than oxid of carbon are expelled physically or otherwise; at a given moment, which is the more quickly attained the more the metal in the ingot mold approaches pure iron, this expulsion becomes impossible, and the gases are confined. From this, many inconveniences arise.

The present invention obtains an ingot or other casting of steel or iron substantially without carbon and which remains tranquil after casting. By an extension of the process a product may be obtained which is also substantially free from iron oxid. By "substantially free" is meant containing either none whatever of the element in question, or only extremely small proportions thereof insufficient to have harmful effects. This new metal is obtained by manufacturing steel in the usual way so as to obtain, for example, extra soft steel which has not been deoxidized, and by cooling this steel in the furnace either by radiation or otherwise; for example, by the introduction of a certain proportion of suitable cold metal, such as that derived from previous operations. The cooling is proceeded with until the steel has at least in part solidified and bubbling has practically ceased. The solidification may be complete or may be continued until the mass is at a temperature lower than that of solidification. In the molten steel the oxid is usually in excess of the quantity necessary for combining with the carbon, and substantially all of the carbon will be eliminated by the concentration of the mother liquor and the chemical reactions above described. Thereupon the metal is remelted under conditions which will prevent its recarburizing. After the remelting the metal may be cast into ingot molds or the like, where it will remain tranquil. If it be deemed advisable the cooling may be conducted in a continuous manner or not, any particular stage of the cooling that is favorable being prolonged; the same remark applies to the reheating. Generally the operation is conducted in an electric steel furnace of any known kind in which the metal can be protected from all carburizing action. Such an electric steel furnace lends itself particularly well to the work, facilitating such variations as it may seem useful to make in the rapidity and the continuity or the discontinuity of the cooling or of the reheating. Once the molten iron is thus freed from carbon, it may be cast as it is; that is to say, containing a certain proportion of oxid. It may be cast in ingot molds, and it will remain tranquil therein provided that it does not come in contact with carbonaceous particles; if the molds are of cast iron, it is advisable, therefore, to line them first with a material free from carbon to prevent immediate contact of the metal with the cast iron.

The new metal thus obtained is useful for the manufacture of objects of pure iron, forged, laminated, or cast, and particularly applicable for the construction of electrical or mechanical apparatus.

If desired, the decarburized metal may be deoxidized by adding noncarburized deoxidants, such as aluminum; there is thus obtained a new metal decarburized and deoxidized which is equally applicable to the aforesaid uses.

It is obvious that by this process small proportions of oxid or of oxygen may be expelled from a carburized metal, the cooling being pushed to congelation; on the other hand, by adding oxid to a mother liquor rich in carbon so that reactions may occur uninterrupted by the dilution, the purification, by elimination of carbon, from an oxidized

metal may be achieved. If care is taken that the deoxidized steel is protected from fresh contamination, the metal may be cast, and will remain tranquil without deoxidizing addition.

It is well known that metal containing oxid of iron and carbon upon cooling gradually segregates the oxid of iron and a large proportion of the carbon. These elements in the original mass were diluted to such a degree as to avoid any reaction between them. When, however, they are segregated in the course of cooling the mass they become concentrated to such an extent that notwithstanding the lower temperature a reaction takes place between the carbon and the oxid of iron, generating carbon monoxid which is expelled as a gas. This is the familiar bubbling effect noticeable in the cooling of cast steel ingots. It is this reaction between the segregated oxid of iron and the carbon which is utilized by my invention. In my experiments I have carried this operation so far as to reduce the carbon in the steel or iron to 0.008 per cent.,—a practically negligible amount. It must be understood that the carbon and the oxid of iron co-exist in the molten metal without reacting upon each other as long as the entire mass is molten. It is after a partial solidification and the segregation and consequent concentration of the carbon and oxid that the reactions above referred to take place.

I claim as my invention:—

1. The process of obtaining decarburized iron, which consists in cooling low carbon steel from a molten condition until it is at least in part solidified, and the carbon therein has been oxidized by the contained oxygen and the oxid or oxids of carbon driven off, and remelting in the absence of carburizing conditions.

2. The process of forming ingots of decarburized iron, which consists in forming steel of low carbon and highly oxidized composition in molten condition, cooling it until it is at least in part solidified and the carbon therein has been oxidized by the contained oxygen and the oxid or oxids of carbon driven off, remelting in the absence of carburizing conditions, and casting into molds.

3. The process of obtaining decarburized and deoxidized iron, which consists in cooling low carbon steel from a molten condition until it is at least in part solidified and the carbon therein has been oxidized by the contained oxygen and the oxid or oxids of carbon driven off, and remelting in the absence of carburizing conditions and adding a deoxidant which is free from carbon to remove substantially all of the iron oxid, thus obtaining a product substantially free from carbon and free from oxid.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

PAUL SEJOURNET.

Witnesses:
T. W. MARTIN,
J. BLACHERÈ.