

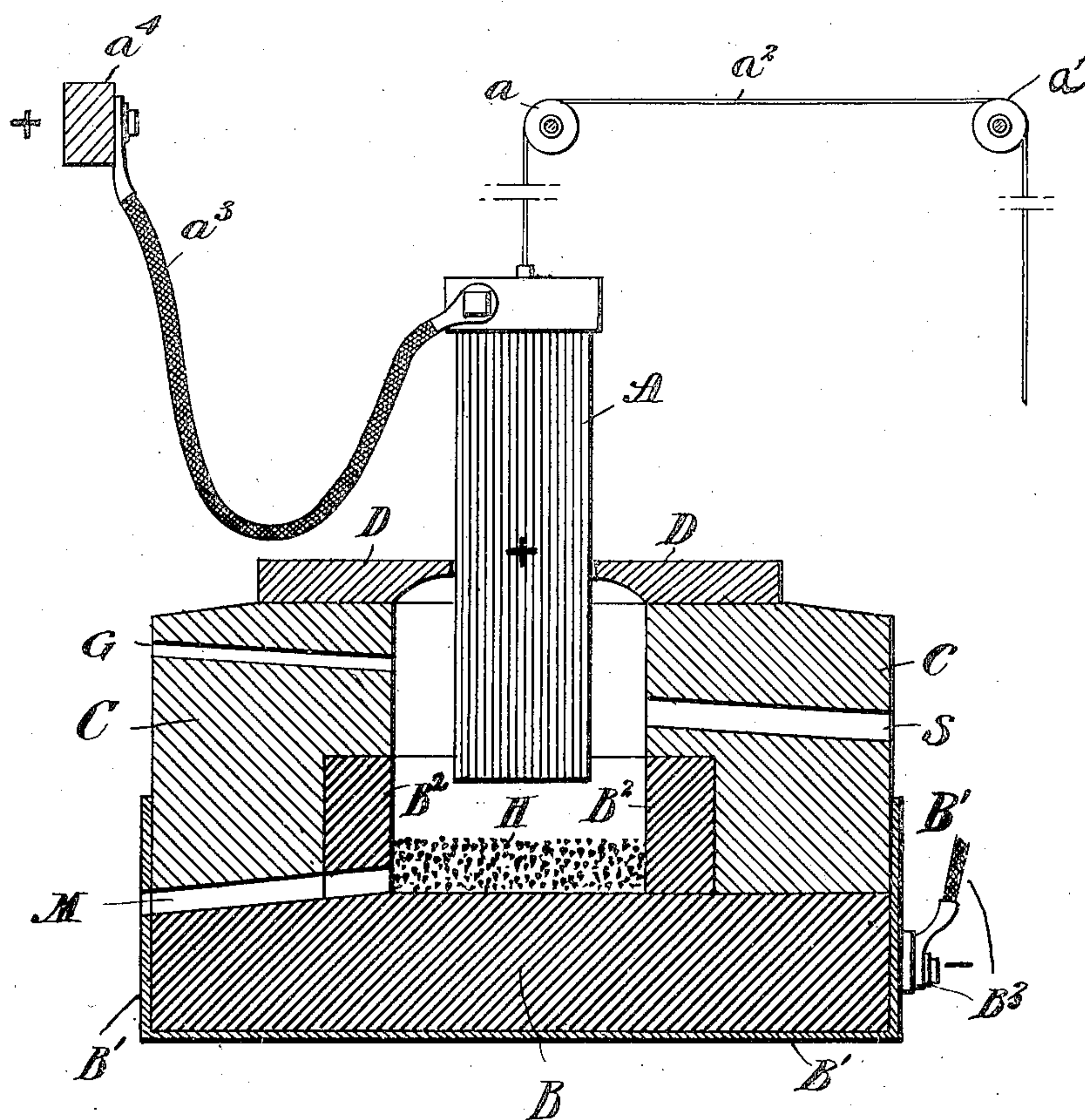
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A. J. ROSSI.

PRODUCTION OF STEEL CONTAINING TITANIUM.

APPLICATION FILED MAY 20, 1902.



Witnesses

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By his

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UNITED STATES PATENT OFFICE.

AUGUSTE J. ROSSI, OF NEW YORK, N. Y., ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, OF FORTY-TWO AND ONE-HALF ONE-HUNDREDTHS TO JAMES MACNAUGHTON, OF TAHAWUS, NEW YORK, AND FIFTEEN ONE-HUNDREDTHS TO PHILIP C. PECK, OF NEW YORK, N. Y.; JANET MACNAUGHTON EXECUTRIX OF SAID JAMES MACNAUGHTON, DECEASED.

PRODUCTION OF STEEL CONTAINING TITANIUM.

No. 822,305.

Specification of Letters Patent.

Patented June 5, 1906.

Application filed May 20, 1902. Serial No. 108,277.

To all whom it may concern:

Be it known that I, AUGUSTE J. ROSSI, a citizen of the United States, and a resident of the borough of Manhattan, city, county, and State of New York, have invented a certain new and useful Process for the Production of Steel Containing Titanium, of which the following is a specification.

My present invention relates to the production of steel containing titanium from cast or pig iron in a so-called "electric" furnace.

The object of my present invention is to produce a process whereby steel containing a desired proportion of titanium may be manufactured with requisite economy on an industrial scale, so as that it shall invariably contain only a definite, controllable, and intended percentage of carbon and likewise of titanium, the latter being not less than, say, two nor more than five per centum of the mass. I have secured this object by my said invention of the following process, in which I have used a so-called "electric" furnace, the details of construction and the operation of which are well understood. For the sake of clearness I have, however, shown in the accompanying drawing one form of such furnace adapted to the practice of my present process, said drawing comprising a vertical central sectional view of the furnace proper and its connections and a view in elevation of the movable electrode and its connections.

Referring to said sectional view of the furnace, B represents the base, constructed of material possessing electrical conductivity, preferably graphite, and constituting the floor of the hearth or crucible. B²B² represent a vertical lining or wall of similar material, the said floor and wall combining to make up a crucible possessing electrical conductivity. Said crucible is inclosed by a supporting-wall C C of any material sufficiently refractory to withstand the high temperature developed and having no electrical conductivity. D D represent a cover, which may or not be utilized, according to the special requirement of each case of the application of my said process. M and S are tap-holes, respectively, for the molten metal and for the slag, which are

plugged and unplugged, according to requirement, as is well understood by those skilled in the practice of the art. G is a gas-vent adapted to secure when required the requisite escape of gases generated during the application of the process. B' is a metallic casing, with which is connected in any convenient manner the negative electrode B³, thus constituting the said crucible the cathode of the electric circuit.

A is an electrode, composed, preferably, of carbon, and connected with the positive pole of the circuit through the flexible conductor a³, attached to the bus-bar a⁴, (shown in section,) which, it will be understood, is supported by any suitable means. The anode A is supported in any convenient manner and so as to provide for its movement vertically, as may be required—as, for instance, supported by the cord a², passing over the pulleys a a', the said cord and its supports being insulated or constructed of non-conducting material.

The furnace is operated as follows: The metal tap M being plugged, the charge H is introduced into the crucible in any convenient manner—as, for instance, through the aperture in the cover D when the anode A is lifted out of the aperture. The anode A is then moved downward again through said aperture until it attains the requisite proximity to the charge. The current being turned on passes from the anode through the charge and through the crucible or cathode, and the required temperature is thus developed. It will be understood that I do not confine myself to the particular form of furnace shown in the drawing. It will also be understood that the cover D is not in all cases essential. After the desired reactions have been accomplished the current is discontinued, the slag withdrawn through the slag-tap S and the molten metal through the metal tap M, the latter having been unplugged. The slag also may be drawn through the metal tap M, if desired, as will be understood by those skilled in the art. It will be observed that it is preferable that the maximum of temperature should be initially applied to the charge near the bottom of the crucible or hearth, so as to

insure the requisite reduction and liquefaction there at the inception of the operation. Into such a furnace I introduce and there support an ascertained quantity of pig-iron containing a determined quantity of carbon. The current is then turned on and the iron reduced to the molten state. To the molten mass still thus supported I add a determined quantity of titaniferous iron ore, preferably coarsely powdered or granulated, the amount of this addition being so calculated that the carbon of the pig-iron will reduce the oxides of iron and of titanium completely or only in part to iron and titanium, respectively, thus securing a product which will contain very little or such percentage of carbon as is desired in the resulting steel and also some titanium. On the addition of this ore and while the support of the mixture is still continued, as aforesaid, I increase the temperature thereof, as can readily be effected by regulating the intensity of the electric current, until it is brought to a point sufficiently high for the reduction of the oxide of iron and also of the titanate acid by the carbon of the pig-iron, or, say, to 3,200° to 3,500° Fahrenheit, or thereabout, which will result in the decarburizing of the iron, and simultaneously the resulting titanium will become incorporated in the steel, to which it will impart valuable qualities, and if the ore contain a high percentage of such titanate acid and the pig-iron sufficient carbon a special product—to wit, a titanate steel high in titanium and well adapted for seasoning other steel free from titanium—will be obtained.

It will be observed that by my said process no carbon is added to reduce the ore and that only the carbon contained in the cast-iron is depended upon for such reduction. The operation is very rapid, as at the temperature of fusion of cast-iron oxide of iron is readily reduced to the metallic state by carbon and but little material has to be reduced. One of the advantages of the electric current as applied as aforesaid in the practice of my process is found in the ease with which the temperature produced thereby can be controlled and adjusted to the different phases of the operation, being somewhat raised when the iron ore is added cold and lowered as soon as the reaction has taken place.

Those skilled in metallurgical arts will have little difficulty in calculating what should be the proportion of the constituents of the charge in any case, depending upon their composition. These proportions will necessarily vary in each case. Should carbon electrodes be used, some carbon will probably be derived from such electrodes; but in such cases by adding a slight excess of ore, readily ascertainable by practice, the carbon can be brought down, if desired, within a few hundredths of one per cent. of the quantity

first intended. The excess of ore added not reduced by the carbon of the pig-iron will in such case go into slag, with the gangue of that part of the ore added which has proved effective in removing the carbon from the pig-iron.

For a further and complete understanding of my invention I will now give a few examples of the application thereof. In one case the ingredients of my charge were as follows: The pig-iron contained silicon, 0.10; carbon, 3.85; phosphorus, 0.04; sulfur, 0.012; total, 4.002; or, say, iron, 96.000; total, 100.00. The iron ore used contained silica, 1.50; titanate acid, 15.00; alumina, 2.50; magnesia, 1.00; oxide of iron, (iron, fifty-six to fifty-seven per cent.) 80.00; total, 100.00. I assumed as close enough for practical purposes that the eighty oxide of iron was ferric oxide. I then added fifteen of such ore to a bath of one hundred of the preceding pig—that is, by weight, to one hundred of pig, silica, 0.225; titanate acid, 2.250; (corresponding to titanium, 1.35;) alumina, 0.375; magnesia, 0.150; oxide of iron, 12.000; (corresponding to iron, 8.40;) total, 15.000. Hence, as one carbon can reduce 3.333 titanate acid, or one titanate acid requires 0.30 carbon, the 2.25 titanate acid required $2.25 \times 0.3 = 0.675$ carbon, and the twelve oxide of iron $12 \times 0.225 = 2.700$ carbon. In all, 3.375 carbon out of the 3.85 of the pig-iron was thus to be expected to be theoretically effective, leaving 0.48 carbon to go in the product, and the steel might be expected to contain: iron from pig-iron, 96.00; iron from ore reduced, 8.40; titanium from ore reduced, 1.35; carbon, (not effective,) 0.48; total, 106.23—that is, titanium, 1.27 per cent.; carbon, 0.45 per cent. I found actually carbon 0.50 per cent.; titanium, 1.20 per cent. Again, with an iron ore of the following composition: silica, 2.50; titanate acid, 36.28; (corresponding to titanium, 21.768;) lime, 1.70; magnesia, 2.32; alumina, 3.44; oxide of iron, 53.76; (corresponding to iron, 37.632;) total, 100.00, and taking fifteen of such ore for one hundred of the same pig-iron containing 3.85 carbon there should be expected a steel containing, theoretically, titanium, 3.16; carbon, 0.38; In short, if titanium is desired in the steel to a given amount, the ore added to the bath of pig-iron to decarburize it should be either titaniferous ores alone, or a mixture of such ores with non-titaniferous ores, or may be even titanate-acid ore containing but a small percentage of iron, the *modus operandi* being similar in all cases and as described above.

The titanate-steel product resulting from my said process is characterizable as being fusible under substantially the same temperature as steel without titanium content and is therefore exceptionally available for imparting to ordinary steels while molten a desired lesser percentage of titanium.

I am aware that it has been suggested that powdered "titaniferous ores," also "titaniferous oxids" may be introduced through an air-blast into a body of molten iron in a converter in such a way as to be carried by the blast forward and upward into the said molten metal, and that thereby the titaniferous oxid may be reduced and titaniferous irons or steels thereby produced. Without admitting the possibility in practice of obtaining such a result by the process described, it is apparent that the decarburization of the iron by the oxygen of the blast must be so relatively extensive and so comparatively rapid as compared with the reduction of the said highly-refractory oxid as to exclude the possibility of thereby introducing into the molten iron any substantial amount or more than a trace of titanium, and therefore my claim hereinafter made is not to be understood as covering the aforesaid particular process of introducing the titaniferous oxid by means of an air-blast.

What I claim as new, and desire to secure by Letters Patent, is the following, viz:

The process of making steel containing more than one per cent. and less than five per cent. of titanium which consists in supporting in an electric furnace an ascertained quantity of molten cast-iron having an ascertained content of carbon and then, without the aid of an air-blast, introducing into said molten cast-iron so supported a predetermined quantity of oxids of titanium calculated to be sufficient to decarburize to the required extent the said iron, and then by regulation of the electric current raising and continuing the temperature sufficiently high until such decarburization is effected, and the reduced metallic titanium is incorporated into the resulting steel product.

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Witnesses:

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