UNITED STATES PATENT OFFICE.

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PROCESS FOR PRODUCING ALLOYS OF TITANIUM WITH OTHER METALS OR THE LIKE.

986,505. Specification of Letters Patent. Patented Mar. 14, 1911.

No Drawing. Application filed May 6, 1910. Serial No. 559,657.

To all whom it may concern:

Be it known that I, AUGUSTE J. ROSSI, a citizen of the United States, and resident of Niagara Falls, in the county of Niagara and State of New York, have invented certain new and useful Improvements in Processes for Producing Alloys of Titanium with other Metals or the Like, of which the following is a specification.

My present invention relates to processes for producing alloys of titanium with other metals, as for instance with iron, copper, zinc, tin, lead, aluminum, tungsten, molybdenum, etc., or with metalloids, as for instance silicon, and has for its object the prevention, more efficiently and economically than heretofore, of oxidation, volatilization, or other undesired alterations of the metals so alloyed or combined, including the said titanium, during the production of said alloys. In producing the said alloys more or less difficulty has been encountered, due to such oxidation, volatilization, etc., resulting not only in undesired loss of the metals themselves, but also, in some instances, as for example where copper is involved, the production of fumes deleterious to the operator. The losses and other undesirable incidents referred to occur particularly when the said alloys with titanium are produced in an electric furnace of the type known as an "open" furnace, but are also undesirably encountered during the formation of the alloys in any other electric or other apparatus in which sufficient or equivalent requisite temperature may be developed.

It will be understood that in the formation of the aforesaid alloys with titanium the latter is usually supplied to the charge in the form of its oxid, and that the chemical combinations resulting in the volatilizations, losses, etc., above referred to are usually between constituents of the forming alloy and of the atmosphere, and therefore requiring for the prevention of such combinations interposition between such alloy and atmosphere of a coating of molten material normally impervious by the atmosphere.

My present invention may be practiced as follows:—Taking for example the production in an electric furnace of an alloy of iron and titanium known as ferro-titanium, there is charged into such furnace a predetermined quantity of iron intended to be alloyed with the titanium. Such iron has been previously melted or is melted in the said furnace so as to produce a bath of molten iron. Onto the surface of said bath is then charged preferably lime (CaO), the said charge so added being in quantity sufficient to constitute, when melted, a complete covering or coating for the exposed surface of the underlying molten iron bath. After the lime has melted, or while it is melting, there is next superimposed thereon a charge of a mixture of titanic acid and carbon, preferably comminuted or agglomerated in briquets, the carbon of the said last mentioned mixture being so proportioned as to be in sufficient quantity to reduce both the said titanic acid and the lime. In lieu of titanic acid a titanate might be employed as for instance preferably a titanate of lime (CaO,TiO_2), the titanium content of which shall be such as to impart to the resulting alloy the desired content of titanium. In such case the said titanate is similarly mixed with carbon, the proportion of the latter being sufficient to reduce both of the constituents of the titanate as well as the lime previously added, or, in certain cases, it may be found desirable to substitute for both the lime and the titanic acid the said titanate of lime from which may be derived the required amount of titanium and also the required amount of lime for combination with the carbon.

The temperature of the charge being raised sufficiently to secure reduction of the titanic acid under the conditions mentioned, there is formed by the resulting reactions metallic titanium, which, passing through the lime, dissolves in the bath of molten iron to produce the desired alloy of titanium and iron, and there is also formed, superimposed and maintained above the said alloy during its formation, a coating of calcium carbid, which, possessing reductive properties, promotes reduction of said oxid of titanium and simultaneously effectually protects the said metals constituting the bath of said molten alloy from substantially all alterations by oxidation, volatilization, or otherwise. It is preferable to add on the surface of the said melted carbid of calcium, toward the close of the operation, an additional covering or blanket of carbon in order to insure a reducing atmosphere throughout

the furnace. The said reactions so occurring may be expressed by the following formulæ:

$$CaO + C_3 = CaC_2 + CO$$
$$TiO_2 + C_2 = Ti + 2CO.$$

The resulting alloy may be tapped in any approved manner and into any desired receptacle, the supernatent molten carbid of calcium running out simultaneously therewith and forming on the alloy, while the latter is cooling, a protective coating.

When, as above noted, a mixture of carbon and of a titanate of lime is employed, the final reactions will be similar as when lime and titanic acid are employed, *i. e.* as per the formulæ.

$$CaO,TiO_2 + 5C = CaC_2 + 3CO + Ti.$$

I have also found it advisable in many cases to add carbon in excess of the quantity strictly required by the said formulæ, said surplus of carbon being not only to guard against possible contingencies, but also in order to insure, in cases in which lime is used for the covering, decomposition of any accidentally formed titanate of lime, which compound, however, would nevertheless, even were it to remain intact until the end of the operation, be evacuated with the carbid of calcium with no greater detriment to the success of the operation or to qualities of the resulting alloy than a possible small, though undesired, loss of titanic acid. It is obvious that the amount of such excess of carbon will be readily determined according to the requirements of each case by those skilled in the metallurgical art. It will also be appreciated that in the production of ferro-titanium, as well as alloys of any other metal to be alloyed with titanium, a concentrate of titanic acid and oxid of iron, or of titanic acid and the oxid of the other metal may be employed instead of titanic acid pure and simple and with equivalent results, a proper amount of carbon being, in such case, however added sufficient to reduce also the oxid of iron, or of the other metal present, and the resulting iron, or other metal, passing into the original bath of molten metal together with the titanium.

The foregoing formulæ should enable those skilled in the metallurgical art to calculate the proportions of carbon required to secure the reduction of the lime, titanic oxid, or other oxids employed as the case may be; also the amount of carbon required in cases in which instead of titanic acid alone titanic acid and the oxid of the other metal to be alloyed with the titanium are employed. Furthermore those so skilled will readily understand the various proportionings of titanic acid, or other titanic material, employed to furnish to the metallic bath the required percentage of titanium.

It will be observed that in cases in which metals, or metalloids other than iron, are desired to be alloyed or combined with titanium, my process is substantially the same as above applied to production of ferro-titanium, in such case such other metal, or metalloid, being substituted for the iron and the oxid of such other metal, if employed, for the oxid of iron.

By means of said process, metals heretofore alloyed with titanium with difficulty, loss, and danger, as for instance copper, are, as likewise the titanium, retained substantially intact without loss or other undesired alteration and without production of fumes injurious to operators.

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

1. The method of producing an alloy or compound of titanium with other metal, which comprises superimposing over a bath of such other molten metal a coating of molten oxid of calcium, superimposing above said oxid of calcium oxid of titanium and carbon, and imparting to the whole a temperature sufficient to insure reduction of the said oxids under the conditions specified.

2. The method of producing an alloy or compound of titanium with copper which comprises superimposing over a bath of molten copper a coating of molten oxid of calcium, superimposing above said oxid of calcium oxid of titanium and carbon and imparting to the whole a temperature sufficient to insure reduction of said oxids under the conditions specified.

3. The method of producing an alloy or compound of titanium with other metal which comprises producing on the surface of such other molten metal a covering comprising oxid of titanium, carbon, and a chemical compound of calcium, and imparting to the whole a temperature sufficient to insure reduction of the said oxid of titanium under the conditions specified.

4. The method of producing an alloy or compound of titanium with copper which comprises producing on the surface of a bath of molten copper a covering comprising oxid of titanium, carbon, and a chemical compound of calcium, and imparting to the whole a temperature sufficient to insure reduction of the said oxid of titanium under the conditions specified.

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