

UNITED STATES PATENT OFFICE.

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THIRTY ONE-HUNDREDTHS TO WALTER D. EDMONDS, OF BOONVILLE, NEW YORK.

METHOD OF PRODUCING ALLOYS OR COMPOUNDS OF TITANIUM AND COPPER.

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No Drawing.

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To all whom it may concern:

Be it known that I, ISADOR LADOFF, a citizen of the United States, and a resident of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Methods for Producing Alloys or Compounds of Titanium and Copper, of which the following is a specification.

Alloys or compounds of metals whose chemical properties are the most dissimilar are often the most useful in the arts on account of their idiosyncratic properties rendering them comparable to new elements. Such products are, however, the most difficult to produce. Heretofore such alloys or compounds have been produced principally in one of the two following ways, viz:—The metals have been melted together in certain proportions at requisite high temperature. It will be observed that by this process in certain cases extremely high temperatures are required—as, for instance, where alloys with titanium are involved. Also, that in certain cases the proportions of the respective metals in the resulting product are limited. Another process of production has been to mix the metals together in powdered state and apply thereto a pressure sufficiently high to effect the production of a resultant alloy at ordinary temperature.

The high pressure method last referred to is preferable to the high temperature method above described because avoiding the aforesaid limitation as to proportions of the respective metals in the resulting product and also avoiding oxidation and volatilization in the case of certain metals such as copper, occlusion of gases, etc., often characteristic of the molten metal method. But the pressure method, on the other hand, is too expensive for application on an industrial scale.

The object of my present invention is to provide a more economical, certain, safe, and universal method of producing specifically the alloy of titanium with copper hitherto I believe produced with great, if not prohibitory, difficulties attributable to the wide difference in properties of the respective metals in their oxygenated as well as in their metallic state, the highly refractory character of the oxid of titanium, its comparatively enormous heat of formation, and the extremely high melting point of that

metal being well known, likewise the instability, in the atmosphere, of molten copper, the formation of alloys of these metals by the molten method presenting therefore exceptional difficulties, and their production by the compression method being also at present difficult if not impossible owing to the hitherto difficulty, if not impossibility, of procuring metallic titanium in sufficient quantity or at such cost as to justify manufacture industrially of said alloys so produced.

My researches have enabled me to attain my object by the process and method of production hereinafter described. Such researches have demonstrated that the alloy of copper with titanium or an alloy comprising in substantial amounts copper and titanium may be produced at a temperature below the melting point of the alloying metals provided the oxids of the metals, preferably suitably powdered and mixed, are, in the presence of a reducing agent, or, so to speak, in a "reducing atmosphere", raised to a temperature sufficiently high to inaugurate the reduction of the oxid of one of the metals, in this instance the oxid of copper, thus utilizing the catalytic action of the oxids in process of reduction, with the further result that the pure metals, *i. e.* copper and titanium, being brought into each other's presence in their nascent state, are susceptible of alloying or compounding with each other in proportions which I believe to be unprecedented in former processes—as for instance the above referred to molten metal method.

My novel process may, generally speaking, be practised as follows, viz:—Oxid of titanium, say rutile, TiO_2 , is preferably preliminarily reduced to powdered state. Oxid of copper, preferably cupric oxid (CuO) is, preferably, likewise reduced to similar condition, and the two powdered oxids are then preferably thoroughly mixed together in such proportions as are desired for the metals in the alloy to be produced. It will be understood, however, that the pulverization and thorough mixing referred to is not absolutely essential to the production of the alloy by my method, although speed is thereby promoted, and possibly a more homogeneous product secured. The mixture may then, if desired to produce the alloy in any particular form, be moistened by water, or, if preferred, a binding material such as oil,

and charged into molds of any desired form or proportions, and therein subjected to a pressure sufficient to impart coherence to the mass.

5 The oxids thus brought into each other's presence are then, at a temperature of say from 600° C. to 800° C., and while excluded from air, as in an ordinary gas furnace, subjected to the action of a reducing agent, 10 preferably carbon monoxid gas. The requisite reducing atmosphere is preferably obtained by packing the coassembled oxids in powdered coke. The temperatures referred to are then maintained in the furnace 15 until the oxids are reduced, the resulting metallic product being an alloy of copper with titanium. It will be observed that by my said process the reduction of the oxid of titanium and the production of the resulting alloy or compound of titanium and copper 20 has been accomplished at temperatures immensely below those heretofore regarded as indispensable for such results and that thus, incidentally also, the electric furnace, 25 or aluminum as a reducing agent, may be dispensed with in reducing such a refractory oxid as that of titanium, and in producing its combination with copper in metallic form. Also the temperatures employed, being 30 below the melting point of copper, obviate risks incident to the undesirable behaviors of that metal when in molten state, to say nothing of the difficulties to be expected when copper is subjected to the temperatures required to melt titanium. Those 35 skilled in the metallurgical art will of course understand that it is desirable after the aforesaid reduction to continue exclusion of air from the product until it has been cooled down sufficiently to avoid undue oxidation 40 from the atmosphere. It will also be understood that a so-called gas furnace is not essential to securing the required reactions since these may be produced as aforesaid on any scale and in any apparatus or inclosure 45 capable of imparting the requisite temperature and meanwhile excluding access of oxygen, as in the atmosphere, to the charge.

Having now described my invention, what 50 I claim as new and desire to secure by Letters Patent is the following, viz:—

1. The method of producing an alloy of copper and titanium which comprises subjecting the coassembled oxids of copper and

titanium, in a reducing atmosphere, to temperature below the melting point of copper 55 but sufficiently high to inaugurate, and maintaining such temperature sufficiently long to insure, reduction of said oxids.

2. The method of producing an alloy of 60 copper and titanium which comprises heating coassembled oxid of copper and oxid of titanium, in a reducing atmosphere, sufficiently long, and at temperature sufficiently high, to reduce said oxids without melting 65 the resulting metals.

3. The method of producing an alloy of copper and titanium which comprises heating coassembled oxid of copper and oxid of titanium, together with carbon, sufficiently 70 long, and at temperature sufficiently high, to reduce said oxids without melting the resulting metals.

4. The metallurgical method which comprises bringing oxid of copper and oxid 75 of titanium into presence of a reducing agent and subjecting them to temperatures below the melting points of said metals but sufficiently high to insure reduction of the oxid of copper by said agent. 80

5. The metallurgical method which comprises bringing oxid of copper and oxid of titanium into presence of carbon monoxid and subjecting them to temperatures below 85 the melting points of said metals but sufficiently high to insure reduction of the oxid of copper by said carbon monoxid.

6. The method of producing an alloy or compound of copper and titanium which 90 comprises subjecting the coassembled oxids of copper and titanium, in a reducing atmosphere, to temperatures of from 600 degrees to 800 degrees centigrade and maintaining such temperatures sufficiently long 95 to insure reduction of said oxids.

7. The method of producing an alloy or compound of copper with titanium which 100 comprises subjecting the coassembled oxid of copper and oxid of titanium together with carbon to temperatures of from 600 to 800 degrees centigrade and maintaining such temperatures sufficiently long to insure reduction of said oxids.

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Witnesses:

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