UNITED STATES PATENT OFFICE.

HENRI MOISSAN, OF PARIS, FRANCE.

PROCESS OF OBTAINING CAST TITANIUM.

SPECIFICATION forming part of Letters Patent No. 591,355, dated October 5, 1897.

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To all whom it may concern:

Be it known that I, HENRI MOISSAN, a member of the Institute of France, a citizen of the French Republic, residing at Paris, France, have invented certain new and useful Improvements in Processes of Obtaining Cast Titanium, of which the following is a specification.

Up to the present time titanium has been hardly more than a curiosity in laboratories and has never been produced commercially. The reason of this is the powerful affinity of titanium for nitrogen. Besides, it has never been possible to make cast titanium. Berzelius, by attacking fluotitanate of potash or chlorid of titanium with potash, has obtained a dark powder, becoming reddish by trituration. This powder, which Berzelius has considered as titanium, was only titanonitrogen. Woehler & Deville, using the same reaction in a current of hydrogen, have obtained a gray powder which decomposes the water at 100° and which they claim to be titanium, without, however, furnishing any analysis. Kern has prepared a gray powder which decomposed the water only at 500° and has done so in a china tube by the action of vapors of titanium upon sodium. These different samples of titanium are very impure. In fact, the alkaline metals alone have yielded, up to this time, by reduction of compounds of titanium, a gray powder not showing any trace whatever of fusion, tainted with sodium or potash with nitrogen and often with other impurities. Titanic acid has been considered, up to the present time, as irreducible by carbon. This is not so.

I have proved by numerous experiments that the oxids of uranium, of vanadium, of zirconium, and silicium, which were considered to be irreducible, can be reduced by carbon, provided the temperature be high enough. The same is the case with titanic acid which I find in nature or with that which can be prepared in a pure state. It can be reduced by carbon under conditions I am about to describe. If I melt in an electric furnace a mixture of rutile or pure titanic acid and carbon in the proportion of TiO_2 to 2C with an arc of four hundred amperes and eighty volts, I will obtain a melted mass, very hard, having yellow fractures and a reddish-brown aspect, which is a titanonitrogen compound containing from seventy-nine to eighty per cent. titanium and of a density of 5.02. If rutile or natural titanic acid be used, the product resulting from the treatment just specified will contain nitrogen and also small quantities of silicium and iron. Thus, employing the current furnished by a dynamo-machine of forty-five-horse power I obtain only a titanonitrogen compound.

In order to obtain genuine cast titanium, it is absolutely necessary that the temperature furnished by the electric arc exceed the point where titanonitrogen is decomposed by heat. In order that the preparation can be made, I need an arc of one thousand to two thousand amperes and sixty to seventy volts. Under those conditions the above-indicated mixture of rutile three hundred and thirty and carbon ninety-six, heated in a carbon crucible, will, after ten minutes, yield a mass the upper part of which will only be melted and which presents the following characteristics: Melted substance covered with a yellowish layer of oxid having bright white fractures of a metallic aspect. Under the hammer it can be reduced to a powder and can be attacked by diluted hydrochloric acid, while carburet (TC) and titanonitrogen (Ti_2Az_2) cannot be attacked. Cast titanium thus prepared by the direct reduction of titanic acid with carbon may be made to contain varying proportions of carbon as high, for example, as from two to six per cent. A product containing two per cent. of carbon is generally suitable for the purposes for which cast titanium can be employed industrially. If it is desired to have purer titanium, it will be sufficient to remelt that titanium, after having broken the same to pieces in the presence of titanic acid, by means of an arc of the same intensity. If the quantity of carbon added to the titanic acid is increased, I will obtain $TiC_2+3C=TiC+2CO$, a definite carburet which, according to the analysis, responds to the formula TiC. That compound is crystallized, the color is that of galena, and its density 4.3. This definite carburet, as well as the titanonitrogen compound above mentioned, when melted, will have many industrial applications. In those reactions with titanic acid I can substitute for the latter any

kind of oxid of titanium, a salt or other compound, or any kind of natural product containing titanium.

The oxid of titanium can be melted in an electric stove or otherwise in the presence of iron or all other metals and give alloys which possess new properties.

An alloy of titanium and iron or of titanium with nickel is soluble in iron, cast-iron, or steel in fusion. I have thus been able to easily produce titanium steel. I can also modify this mode of preparing in the following manner: I place in the crucible of an electric stove all or part of the quantity of metal I wish to alloy with titanium and I let it quietly go into fusion. I then add slowly agglomerates of oxid of titanium or rutile and carbon (or some suitable reductive) in proportions that must be determined according to the alloy to be made. These agglomerates are prepared with oxid of titanium, rutile, or other titanium ore and carbon mixed with some glutinous matter enabling the molding of the same into small masses, (in lozenges or cylinders of varying shape.) These lozenges are then dried with care.

In the above specification whenever the term "cast titanium" occurs it is meant in the same sense as the term "cast-iron" is used—*i. e.*, the metal titanium combined with a small quantity of carbon, as herein set forth.

I claim—

1. The process of making cast metallic titanium combined with carbon, consisting in subjecting an oxid or salt of titanium in presence of carbon to an electric arc produced by a current of from one thousand to two thousand amperes, and sixty to seventy volts, thereby fusing the titanium, which combines with the carbon forming masses of metallic titanium, substantially as described.

2. As a new composition of matter, a cast metallic substance consisting of titanium and a small proportion of carbon, and distinguished by a crystalline formation, by being corrodible by dilute hydrochloric acid, and by the other characteristics, herein set forth.

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

HENRI MOISSAN.

Witnesses:

CLYDE SHROPSHIRE,

CH. CASALONGA.