

# UNITED STATES PATENT OFFICE.

AUGUSTE J. ROSSI, OF NEW YORK, N. Y., ASSIGNOR OF ONE-HALF TO  
JAMES MACNAUGHTON, OF TAHAWUS, NEW YORK.

## ALLOY OF IRON AND TITANIUM.

SPECIFICATION forming part of Letters Patent No. 721,467, dated February 24, 1903.

Application filed October 30, 1902. Serial No. 129,402. (No specimens.)

*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 of New York, county of New York, and State of New York, have invented a certain new and useful Compound or Alloy of Iron and Titanium, of which the following is a specification.

The object of my present invention is the production as a new article of an alloy or compound of iron and titanium containing novel proportions of titanium, whereby is imparted to the alloy or compound qualities and capacities hitherto unpossessed by alloys of this class—to wit, the possession of a titanium factor or element in such preponderance as to render the same industrially important for various purposes, while nevertheless fusible under ordinary temperatures sufficient to melt iron or steel, whereby the said compound is utilizable for the seasoning with titanium of ordinary iron or steel with uniformity, ease, and the certainty of securing a homogeneous product, and such seasoning, so far as the iron-founder is concerned, becomes attainable by the use of my said novel compound without disturbing the usual conditions or procedures with which the average workman is now familiar—i. e., without any special or novel preparation or manipulation by him of ingredients or treatment thereof with any more than the present ordinary skill of his calling involved in, say, the familiar mixing of different grades of pig-iron in the cupola or in operations involving the production of steel in the converter or open hearth.

I have discovered that the alloys of titanium and iron for which United States Letters Patent No. 609,466 were granted to me August 23, 1898, and which alloys are characterized as containing not less than five per cent. of titanium, are practically infusible *per se* under the ordinary temperatures sufficient to melt iron or steel, and that in those cases in which my said last-mentioned alloys are employed for seasoning iron with titanium the latter becomes incorporated in the resulting product by dissolving at the temperatures mentioned in the bath of molten iron or in contact with it, analogously to the way in which platinum

(likewise infusible *per se* at such temperatures) is known to dissolve in a bath of molten iron or to fuse in contact with it, whereby may be produced an iron containing platinum. Therefore in order to insure success in the seasoning or titanizing of iron by the use of my said alloys containing above five per cent. of titanium, and likewise the desired homogeneity of the product, these alloys must preliminarily be reduced to the powdered state, or at least broken into small fragments, thus sometimes involving undesirable expense owing to their hard and refractory character, or, again, in certain cases—as, for instance, when operating in the ladle—stirring of the mixture becomes likewise requisite, all of which necessitates special preparation and treatment by the workman, involving some inconvenience, the exercise of perhaps more than his usual skill and attention, and thus more or less also undesirable expense, and this is especially the case when the operations involved are conducted upon moderate amounts of metal in the smaller foundries and plants. One of the causes contributing to render these manipulations necessary under the circumstances mentioned consists, doubtless, in the comparatively low specific gravity of the alloy of iron and titanium when high in percentage of titanium, the specific gravity of titanium being, for instance, 4.90, of an alloy containing ten per cent. of titanium 5.60, of cast-iron seven, and of iron 7.78.

My present invention comprises as its essential characteristic the production of an alloy of iron and titanium containing the latter in what my recent experiments and discoveries have demonstrated to be the required proportions for the purposes mentioned—that is to say, in excess of two and not to exceed five per centum of titanium. This new alloy I designate my “special titanic pig.” This I produce by processes described in my pending application for Letters Patent of the United States which have been recently allowed to me, Serial No. 96,453, filed March 3, 1902, viz: I produce my said novel alloy or compound by supporting a mixture of ingredients containing such proportions of titanic acid, of iron or of iron oxids, and of



carbon as to result in a pig-iron having the requisite proportion of titanium, as aforesaid, and subjecting the mixture until the requisite reactions have been thereby accomplished to the intense heat produced by the electric current—say a heat of 3,500° Fahrenheit—and it will be understood that the titanitic acid in the mixture above referred to may be introduced in any convenient form—as, for instance, as contained in titaniferous iron ore or as rutile.

Any form of electrical device capable of producing the results described may be employed—as, for instance, a Siemens furnace of the type described as early as 1879—or I have, for instance, used successfully for this purpose a graphite furnace or crucible properly insulated by an outside lining of refractory materials, such as magnesia bricks or the like, properly secured by means of tie-rods, buckstaves, and the like, the crucible being properly connected with one of the poles of the current by means of bus-bars, cables, or the like. Into this crucible was charged the mixture referred to, a more specific illustration of which will be given presently. Over this charge I lowered a large carbon or bunch of carbons constituting the anode properly connected with the positive pole of the current, the said anode being so disposed as to admit of its being gradually raised or lowered by any convenient mechanism for accomplishing that purpose. The current being turned on was passed through the materials to be reduced. The anode being of smaller diameter than the aperture of the crucible, additions could be made to the charge from time to time as the reduction proceeded and the level of the mixture sank in the crucible. After the charge, with its additions, has been sufficiently exposed to the action of the current and the resulting high temperatures my new alloy or special titanitic pig is cast into proper molds through a suitable opening provided at the bottom of the crucible and the slag run out thereafter analogously to the similar practice involved in the production of pig-iron in cupolas and blast-furnaces, after which the crucible or furnace is charged again as before and the operation repeated indefinitely. I have successfully produced my said special titanitic pig by using as one of the ingredients of the charge titaniferous iron ore containing on an average titanitic acid, fifteen; oxid of iron, eighty; silica, 2.50; alumina, 1.50; magnesia, one; lime, trace; phosphorus, 0.017; sulfur, 0.045 per cent. As this ore, however, contained nine per cent. titanium, being too large a percentage for the purpose of producing the special titanitic pig, I added in this instance a proper proportion of another non-titaniferous iron ore containing silica, 5.90; oxid of iron, eighty-five; alumina, 3.50; lime, 3.60; magnesia, 1.90; sulfur, 0.052; phosphorus, 0.07 per cent. As the titaniferous ore in this instance contained

fifty-six per cent. iron and no titanium, I mixed one hundred pounds of the former and two hundred and thirty pounds of the latter with the expectation of securing by the process above described and after allowing for losses, unavoidable in all metallurgical operations, a resulting pig containing some four per cent. of titanium—say, theoretically, 4.30 per cent., including carbon and silicon, in the pig-metal. The said ores properly pulverized were mixed with the requisite quantity of carbon, preferably in the form of charcoal powder, necessary to secure the reduction of the oxids of iron and titanium, or, say, about sixty-five pounds of charcoal, and were charged into the crucible or electric furnace, as above described, with about ten pounds of caustic lime added to the mixture, in lieu of which I might have added its equivalent in limestone.

The resulting pig metal produced by the treatment of the aforesaid mixture by the process above described contained silicon, 1.90; titanium, 4.09; carbon, 5.26; iron by diffusion, 88.75—total, one hundred per cent.

It will be observed that instead of using in admixture with the titaniferous ore an ore free from titanium, as above described, for the purpose of reducing the percentage of titanium in the mixture to the proper figure for the purposes of my special titanitic pig there might with equally beneficial results be substituted for the non-titaniferous ores and in the required proportions ordinary pig-iron free from titanium.

As further illustrating the entire practicability of regulating with certainty and exactness the percentage of titanium in the resulting pig by proportioning the respective ingredients of the charge upon a theoretic basis, I will add that in similar operations I have found that a mixture which would theoretically yield a titanitic pig containing 3.80 per cent. titanium, treated as above described, resulted in a pig-iron containing 3.68 per cent. titanium; also that on similarly treating another mixture which would theoretically yield a titanitic pig containing 4.38 per cent. titanium I obtained 4.28 per cent. titanium in the pig, and from another mixture which should have yielded 2.8 per cent. titanium I obtained 2.65 per cent. in the resulting pig-iron.

My new alloy or special titanitic pig is now ready to be used for the titanizing or seasoning of iron containing no titanium.

It is manifest that should my special titanitic pig contain, say, less than two per cent. of titanium it would prove scarcely available for the purposes in hand on any industrially economical basis, since, among other reasons, too great a bulk thereof would be required to produce the requisite seasoning, and I am therefore of the opinion that it is preferable in all instances that the percentage of titanium should be not less than four per cent. The seasoning required is accomplished by



introducing into the metal to be seasoned while either cold in the charge or in molten condition the requisite proportion of my special titaniferous pig which, among other things, owing to its percentage of titanium, as before explained, will under the ordinary and usual temperatures required for the melting of iron employed in foundry-work and without preliminary treatment or other manipulation melt with the same facility as the ordinary non-titaniferous pig-iron with which it is associated.

To secure the required titanizing of iron, for instance, my special titanic pig is charged solid into the cupola and in its original and unbroken form as pigs or ingots, (the same as any other pig-iron not titanic,) together with the pig-iron to be seasoned with titanium, care being taken to regulate the quantity of the titanic pig according to its percentage of titanium and the total mass of the mixture, so as to secure in the product the required percentage of titanium. The cupola is then run in all respects in the ordinary manner, including the employment of the same temperatures as in the case of ordinary iron, tapped as usual, the resulting product flowing out into the ordinary receiving-ladle, from which the pouring-ladles are filled for any purpose of casting whatsoever, or, if steel is to be made, the contents of the cupola—i. e., the molten titanized pig-iron—are run directly into the converter. Again, if my special titanic pig is desired to be used in the open-hearth furnace it is in the required quantity charged into that also, together with the non-titanic pig-iron, and the mixture treated in all respects according to the usual practices of such furnaces the same as though no titanic pig were being smelted.

I am aware that pig-iron produced from titaniferous ores under such temperatures as are attainable in the blast-furnace has been claimed to contain sometimes some titanium; but the proportion of the latter thus attainable has been invariably very small, hardly reaching a few hundredths of one per centum, more exceptionally a few tenths, and whenever, and abnormally and fortuitously only, such quantities as one, or even one and one-half per cent. of titanium in iron have been observed in the products of experimental work or even of the blast-furnace, the presence thereof has been due not to the direct reducing action of the carbon on the titanic oxid, since carbon cannot at the temperatures of the blast-furnace secure such reduction, which requires the intense heat of a powerful current, but to indirect causes, irregular, unreliable, dependent upon special or accidental conditions, such as are uncontrollable by the founder and which may often interfere with the proper and regular running of the furnace.

So far as I am informed, all efforts to introduce pure metallic titanium into iron in greater proportion than two per centum by the treatment of the ores in crucibles without the use of the electric current have failed. In fact, in many cases no trace of titanium has been discoverable by analysis in the so-called "titanic" product, and even when such a percentage has been supposed to have been observed the analysis has shown that the titanium was not present as pure metallic titanium, as in the case of my special titanic pig, but in combination with carbon and nitrogen as nitrid or cyano nitrid of titanium, being products which have long previously been mistaken for titanium, and the presence of which tends further to demonstrate that the reduction of the oxid of titanium at temperatures attainable in the crucible by a fire or even in the blast-furnace is not due to a direct action of carbon on the titanic oxid, but to some special, accidental, uncontrollable, uncertain, and unreliable conditions, it being notable that the percentage of titanium in the ore thus treated has no influence whatever upon the amount of titanium thus fortuitously found in the resulting pig. On the other hand, said Letters Patent of the United States No. 609,466 were granted to me August 23, 1898, for an article of manufacture consisting of a compound of iron and titanium containing iron in the proportion of not less than ten per centum of the mass and titanium in not less than five per centum of the mass. I do not wish, therefore, to be understood as claiming as any part of the invention hereby sought to be covered by Letters Patent either of the aforesaid compounds of iron and titanium in proportions differing from those to which my present claim is specifically limited, constituting a novel article unproduced and unsuggested, so far as I am aware, prior to my invention thereof and possessing the novel capacities and qualities, as compared with previous compounds of iron and titanium, which I have above pointed out.

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

As a new article of manufacture a compound fusible under ordinary temperatures sufficient to melt iron or steel, and characterized by containing an important quantity of iron, some carbon, and titanium in industrially important proportions but fusible at the said temperatures that is to say not less than two per centum and not more than five per centum of the mass.

AUGUSTE J. ROSSI.

Witnesses:

PHILIP C. PECK,  
G. G. MEASURES.