

UNITED STATES PATENT OFFICE.

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TREATMENT OF ALLOYS TO ALTER THEIR COMPOSITION.

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To all whom it may concern:

Be it known that I, ISAIAH L. ROBERTS, a citizen of the United States, residing at New York, in the county of Kings, State of New York, have invented a certain new and useful Treatment of Metallic Alloys to Alter Their Composition, of which the following is a specification.

In various arts it is frequently found desirable to remove part or all of one or more constituents from an alloy, mixture, or compound. For example, in certain processes of extracting metal from ores the metal is obtained in a crude state—that is, containing one or more other substances. As an instance of such a case crude copper may be noted, which usually contains a certain amount of iron. If pure metal is desired, it therefore becomes necessary to get rid of the impurities in the crude product, and for this purpose a great number of methods have been devised. In other instances it may be desirable to substitute another metal, or metals for the impurities in the crude product. As an example of this case I may mention the manufacture of "chrome steel," "nickel steel," &c. Here it is advantageous for economical reasons to produce the steel direct from the crude iron by removing the undesirable impurities, proportioning the amount of carbon by removal or addition, and adding the proper quantity of the alloying metal. In still other cases it may be at times desirable to remove part or all of a constituent from an artificial alloy to alter its quantitative composition, or to substitute a foreign metal for one already present in the alloy to vary its qualitative composition.

The object of my present invention is to provide a method by which such removals or substitutions may be effected, and it will therefore be seen that my invention has a wide range of application.

In practicing my method I add to the molten metal, alloy, or compound in which the desired change is to be made a molten compound containing a substance which has a greater affinity for the constituent which is to be removed than have the other constituents of the alloy or compound in which the said constituent exists. The compound which I use with the material to be treated may be a salt, a mixture of salts, an oxid,

or a mixture of one or more oxids and one or more salts. I prefer to use fluorids for this purpose, for the reason that they can stand high temperatures without being volatilized; but chlorids and bromids may be used, if desired, and also other salts provided the non-metallic element of the salt has a greater affinity for the element to be removed from the given material than the said non-metallic element has for the substance with which it is already combined, or stated otherwise, the metal of the salt must be less basic than the element to be removed from the given crude metal, alloy, or compound. Under certain circumstances oxids may be employed, depending on the particular object to be attained; as will appear more clearly hereinafter.

A suitable flux must be provided to form a slag in which the new compound, produced by the substitution, may float, and for this purpose I prefer to use a mixture of calcium and sodium fluorids. The flux also serves as a solvent for the oxids or salts which are used as the reagents in the various applications of my process. It will of course be understood that other fluxes may be employed, depending upon the conditions in a particular case; but the flux mentioned is not only comparatively inexpensive, but its constituent salts are extremely stable, and therefore with the possible exception of a very few cases will remain unchanged in the various applications of my method—that is to say, the sodium (or potassium, which is equivalent thereto) and calcium fluorids are not affected by the material treated, and vice versa, and therefore they are not a source of impurity for the final product. The fluorids are preferable for the additional reason that they can stand a higher temperature without volatilizing than the bromids or chlorids; but where the temperature necessary to keep the materials molten is low the flux may be composed of bromids, chlorids, or other salts, if desired. As a rule a flux should be chosen which fuses at the temperature at which the metal to be treated becomes molten. The fusibility of the flux depends upon its quantitative composition; but as the differences produced by varying the proportions of the ingredients of the flux are well understood they need not be recited here. In general it

may be said that the more mobile the flux the more rapid the reactions will be. The total quantity of flux used is largely immaterial; but sufficient should be used to dissolve the reagent and take up the compound produced thereby from the material under treatment. A quantity of flux in excess of such amount does no harm, though more heat will be required to fuse it and keep it molten than where a smaller quantity is used.

In the practical application of the invention I prefer first to melt the alloy or compound which is to be treated and then add the flux containing the oxid or salt required to effect the desired result. Instead of following this procedure all the materials may be melted together or one added after another. In general they may be brought together in any convenient way and in any convenient apparatus. During the process samples may be taken from the mixture, by which the progress of the operation may be determined. The time required for the completion of the process will of course vary with the nature of the material under treatment and also the quantities used. The reactions will be facilitated by occasional or constant agitation, as will be readily understood. It will, as a rule, be found advisable to use more of the reagents than is called for by the valences of the substances which react to insure that substantially all of the substance to be taken from the material treated will be removed, where such complete removal is desired.

Having now explained my invention in broad terms, several of its practical applications may now be described. One instance in which it will be found of value is the purification of raw or crude copper. As previously stated, this product frequently contains iron in greater or less quantities, an impurity which may be readily removed by my process.

The operation is as follows: The copper is melted in a suitable crucible, and the flux mentioned above, containing a sufficient quantity of copper fluorid, is then added, and the whole agitated. The amount of copper fluorid used depends upon the amount of iron to be removed; but if all the iron is to be eliminated, as will usually be the case, the fluorid should be in excess of that necessary to provide fluorin sufficient to take up all the iron. The result is that the iron, being more basic to fluorin than copper is, or, stated otherwise, the fluorin having a greater affinity for iron than for copper, the copper in the fluorid contained in the flux is released and iron from the crude copper takes its place. Zinc, cadmium, and any other metal for which fluorin has a stronger affinity than for copper may be removed in the same way, either singly or simultaneously. An oxid of copper may be used instead of the fluorid, if

desired, or a mixture of oxid and fluorid. The iron, zinc, &c., will then be removed as oxids or as oxids and fluorids.

The application of the invention to the purification of crude or impure metals is of course not limited to copper or to zinc and cadmium as impurities, nor are metals the only substances which can be removed in this way. Carbon, phosphorus, and sulfur may be removed by my method; but these elements, and also arsenic, can be removed only by oxidation, and the reagent must therefore be an oxid of a metal for which oxygen has less affinity than for the particular element or elements to be eliminated. The metal with which the oxygen was first in combination will then take the place of the carbon, sulfur, &c. If this metal of the reagent is not the same as that which is to be purified, the product will of course be a mixture or an alloy of the two.

My invention will also find an important application in the manufacture of nickel steel—for example, by melting common cast-iron with a suitable flux (such as that previously mentioned) containing an oxid of nickel such substances in the iron, as carbon, sulfur, phosphorus, arsenic, &c., will be oxidized by oxygen from the nickel oxid and will be taken up by the flux, while the metallic nickel thus freed will alloy with the iron. In the same way chromium, titanium, manganese, tungsten, and other metals may be substituted for other substances in the iron. The product is then nickel steel, chrome steel, &c., as the case may be, the amount of carbon therein being regulated by removing more or less from the quantity thereof present in the iron.

If it is desired to remove sodium from an aluminium-sodium alloy, it may be effected by using aluminium fluorid in a suitable flux—as, for example, that described hereinbefore—composed of a mixture of calcium and sodium fluorids. Then the fluorin in the aluminium fluorid will take up the sodium from the aluminium-sodium alloy, releasing the aluminium with which it was in combination, or if fluorid of magnesium is used to remove the sodium the product will be an alloy of aluminium and magnesium, since the sodium and magnesium will exchange places. If it is desired to remove sodium from an alloy with zinc, the fluorid of magnesium may be used, and the product will be an alloy of zinc and magnesium with the sodium in the flux as a fluorid. The same is true in the case of an alloy of copper, aluminium, zinc, and sodium—that is, the magnesium in the fluorid will be released and the sodium taken up.

The alloy of aluminium and magnesium mentioned above is known as "magnalium." It possesses many valuable properties, but at the present time, however, it is costly, since the method heretofore employed for making

it requires the use of metallic magnesium, which is an expensive substance; but in my method, as stated above, the magnesium is furnished by a salt of that metal—as, for example, magnesium fluorid, which is comparatively cheap. This salt is added to a molten bath of aluminium and some other element which has a greater affinity for fluorin than magnesium has. Whereupon the magnesium and the said other metal change places, leaving magnalium as the product. If the aluminium as produced for the purpose does not contain this other metal or not enough of it to release the desired amount of magnesium from the fluorid, then the necessary amount of the more basic metal must be added to the aluminium. Sodium being both cheap and very effective, I prefer to use it for this purpose; but other metals may be employed—as, for example, potassium.

It will now be seen that by my method a great variety of alloys may be made without the necessity of first having the constituents thereof all in the metallic form. If the metallic ingredient or ingredients of the alloy (as the copper, iron, aluminium, &c., mentioned in the preceding examples of the application of my invention) do not contain a metal more basic than that which is to be substituted therefor, such a more basic metal must be added to the metallic ingredient, whereupon the more basic metal just added, which if it remained would be an impurity in the product, will change places with the metal which is to be one of the constituents of the alloy and which is supplied by an oxid or salt thereof in the flux. As a further example, the alloy of iron and nickel may be again referred to. If the iron does not contain enough carbon, sulfur, or other impurities to combine with so much oxygen of the nickel oxid as is necessary to release the amount of nickel desired for the alloy, it is necessary to supply the iron with what might be called an "artificial impurity," which of course must be more basic (to the non-metallic component of the nickel compound used) than nickel itself is. For instance, aluminium is very convenient for such purpose, especially in the present example, since it has great affinity for oxygen, and its oxidation also liberates a considerable quantity of heat, thus effecting a saving of fuel. The aluminium being added to the iron, the carbon and aluminium will both be removed by the liberating of the desired amount of nickel. The product will then be the desired alloy of iron and nickel. Instead of using oxid of nickel in this case—that is, where aluminium is added—the fluorid may be used; but if the carbon is to be removed some oxid of nickel must also be used, since carbon can be removed only by oxidation.

Carbon itself may be added as the artificial impurity; instead of aluminium; but the quantity of aluminium required is small and inexpensive and produces more heat in the process, so I prefer that metal. Sodium and potassium, possessing extraordinary affinity for the halogens—in fact, greater affinity therefor than is possessed by almost all other metals—are very effective for the purpose of liberating the metal of an oxid or halogen salt in my process, and by the use of either as explained a great variety of alloys may be cheaply and easily made.

What I claim is—

1. The method of varying the composition of a metallic alloy or mixture, which consists in treating the same in the molten state with a flux composed of fluorids and containing a compound of a metal less basic than the element to be removed from the alloy or mixture, as set forth.

2. The method of varying the composition of a metallic alloy or mixture, which consists in treating the same in the molten state with a flux composed of salts of sodium and calcium and containing a compound of a metal less basic than the element to be removed from the alloy or mixture, as set forth.

3. The method of varying the composition of a metallic alloy or mixture, which consists in treating the same in the molten state with a flux composed of fluorids of sodium and calcium and containing a compound of a metal less basic than the element to be removed from the alloy or mixture, as set forth.

4. The method of removing a metal from an alloy or mixture and substituting another and less basic metal therefor, which consists in reducing the alloy or mixture to the molten state, and treating the same with a compound of the metal to be substituted, in a flux composed of salts of sodium and calcium as set forth.

5. The method of making an alloy of aluminium and magnesium, which consists in treating, with a flux containing a salt of magnesium, a molten mixture of aluminium and a substance more basic than magnesium, as set forth.

6. The method of making an alloy of aluminium and magnesium, which consists in treating a molten mixture of aluminium and sodium with a flux containing a salt of magnesium, as set forth.

7. The method of making an alloy of aluminium and magnesium, which consists in treating a molten mixture of aluminium and sodium with a flux containing magnesium fluorid, as set forth.

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Witnesses:

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