UNITED STATES PATENT OFFICE.

ROBERT McKNIGHT, OF PITTSBURGH, PENNSYLVANIA.

PROCESS OF MAKING COMPOUNDS OF THE RARE METALS.

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To all whom it may concern:

Be it known that I, ROBERT MCKNIGHT, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a certain new and useful Process of Making Compounds of the Rare Metals, of which the following is a specification.

The invention relates to a process of making compounds of the rare metals such as tungsten, uranium, vanadium, molybdenum, and tellurium, with the various common metals such as iron, steel, copper, tin, lead, and all metals except the precious metals. It has been the practice heretofore to add the various rare metals to the common metals to impart certain characteristics and improve the qualities of the common metals, but the addition of the rare metals is accompanied by certain difficulties among which is the high temperature necessary before the desired combination can be accomplished when the rare metals are added in the usual form, such as ferro tungsten, ferro vanadium, and the like.

It is the primary object of the present invention to secure the incorporation of the rare metals with the common metals at much lower temperatures than have heretofore been required, and in fact at temperatures not substantially lower than the fusing point of the rare metal compound hereinafter described and not substantially higher than the fusing point of the common metal to which the rare metal is to be added. It is further the object of the invention to provide a process wherein the danger of injury to the common metal incident to the high temperatures heretofore required for the successful introduction of the rare metal into the common metal is reduced, and wherein the expense of the operation, by reason of the relatively lower temperature required, is reduced.

This composition is secured by melting together a salt of the rare metal with one of the haloid salts, preferably a chlorid, such as sodium chlorid, since this is the cheapest and most available haloid salt. The mixture or compound thus produced hardens into a cake which is subsequently incorporated into the common metal as hereinafter set forth. The mixture itself is described and claimed in my co-pending application, Serial Number 723,992, filed October 4, 1912, of which the present application is a division.

The salt of the rare metal may be produced in a number of ways. For instance, a concentrate containing the rare metal may be heated with sodium chlorid as set forth in the McKnight Patent No. 862,987, and placed in water in order to extract the soluble chlorid of the rare metal thus formed. Upon evaporating the liquid, a chlorid of the rare metal is secured in the form of a powder, which may be used in the formation of the cake or ingot comprising the salt of the rare metal. The chlorid of the rare metal may also be produced starting with an ordinary ore containing the rare metal, instead of with the concentrate. In this case the procedure is the same, sodium chlorid being heated with the ore to provide a chlorid which is soluble in water and which is secured as a powder by evaporating as above set forth. The salt may also be secured from an oxid of the rare metal such as tungstic oxid. This tungstic oxid (WO_3) is heated with sodium chlorid. The mixture is placed in water to secure the soluble chlorid of the rare metal and then evaporated, the resulting powder comprising a chlorid of the rare metal similar to that secured by the two processes above set forth.

The powder comprising the salt of the rare metal may contain an excess of free sodium chlorid, due to the fact that more sodium chlorid was used in the roasting process than was necessary, and the ingot or cake to be used in the common metal may be formed by merely melting the powder, the temperature required being substantially 800° C. The application of this temperature fuses the powder and the excess sodium chlorid, a slag being formed which floats on the surface of the liquid and consists largely of any impurities in the compounds and of the excess sodium chlorid. During the melting operation the slag constitutes a protection for the liquid beneath and restricts any vaporization or oxidization to a minimum.

In case the rare metal involved is tungsten and the haloid salt is sodium chlorid, the ingot or cake which is formed when the liquid cools comprises a hard semi-metallic cake or ingot which consists very largely of the rare metal.

In case the powder comprising the rare metal salt to be formed into an ingot con-

sists of a chlorid of the rare metal without any excess of free sodium chlorid, it is desirable to add sodium chlorid when the powder is melted to form the cake or ingot. Good results are secured by adding a quantity of sodium chlorid equal to about twenty per cent. of the powder. This mixture is melted as before at a temperature which need not exceed 800° C., and the procedure is as above described, a slag being formed protecting the liquid beneath and comprising to a large extent sodium chlorid, the liquid beneath being drawn off and cooled into a cake as heretofore set forth.

This compound is supplied to the common metal to be modified in quantities sufficient to give the quality desired for any specific purpose, such as for instance, the making of high speed tools where the common metal is steel and the rare metal is tungsten or molybdenum, the combination with the steel occurring at a temperature approximately that of the melting point of the steel. If desired the compound containing the rare metal might be supplied to the steel while in a molten state and without hardening into a cake, or the cake might be supplied to the steel before melting, although this is not as desirable a method of procedure. In some cases it might be desirable to add two or more of the rare metals to some common metal or to add one or more of the rare metals to a combination of the common metals, and it is to be understood that my invention comprehends these modifications, and that the method of procedure would be modified to secure the desired result. For instance, if it was desired to add tungsten and molybdenum to steel, the salts of these two metals, such as tungstic oxid and molybdenum oxid, would be melted with sodium chlorid to form a cake which would be incorporated into the steel as heretofore set forth. I have found that the metallic compound formed by melting the salt of the rare metal and the sodium chlorid together melts at a temperature considerably below the degree of temperature required for its formation, so that the compound is readily incorporated into those common metals having a relatively low fusing point, at the temperature of fusion, so that the common metal in any case does not have to be overheated. I also find that the incorporation of the rare metal occurs very rapidly.

The action of the sodium chlorid, or other chlorids, which might be employed, is believed to be in a measure catalytic, its presence (in addition to protecting the compound beneath it) facilitating the change in the melted salt of the rare metal without incorporating into it any substantial amount of the chlorid. The use of the compound with the common metal involves a very substantial saving over the processes heretofore used in that (1) there is a saving in time as the rare metal is incorporated within a few minutes, (2) the cost of fuel is reduced incident to the lower temperature required and the reduced period of time required, (3) the loss of common metal due to burning is entirely eliminated, and (4) the loss of the rare metal due to volatilization or oxidization is reduced to a minimum or entirely eliminated. Other advantages of the invention will be apparent to those skilled in the art.

Where several rare metals are to be added to a common metal, a single cake may be formed containing the plurality of rare metals. This may be done by melting the various salts of the rare metals together at the same time with sodium chlorid and allowing the mixture to harden, or by taking a plurality of cakes each containing a definite proportion of one of the rare metals and melting them together to form a single cake. This combination cake can then be supplied to the common metal to give the desired combination of the common metal with the plurality of rare metals. This result may also be accomplished by adding to the common metal separate cakes each of which contains a rare metal, the proportions being adjusted in any case to suit requirements.

What I claim is:

1. The process of making compounds of the rare metals such as tungsten, vanadium, uranium, molybdenum, and tellurium and common metals, which consists in melting together a salt of the rare metal and a chlorid of one of the alkali metals, and causing such mixture to combine with a molten common metal.

2. The process of making compounds of the rare metals such as tungsten, vanadium, uranium, molybdenum, and tellurium and common metals, which consists in melting together a salt of the rare metal and a chlorid of one of the alkali metals, and causing such mixture to combine with a molten common metal at a temperature approximating that of the fusing temperature of the common metal.

3. The process of making compounds of the rare metals such as tungsten, vanadium, uranium, molybdenum, and tellurium and common metals, which consists in melting together a salt of the rare metal and a chlorid of one of the alkali metals at a temperature approximating 800° C., and adding such mixture to a molten common metal.

4. The process of making compounds of the rare metals such as tungsten, vanadium, uranium, molybdenum, and tellurium and common metals, which consists in melting together a salt of the rare metal and a chlorid of one of the alkali metals at a temperature approximating 800° C., and caus-

ing such mixture to combine with a molten common metal at a temperature approximating that of the melting point of the common metal.

5. The process of making compounds of the rare metals such as tungsten, vanadium, uranium, molybdenum, and tellurium and common metals, which consists in melting together a salt of the rare metal and sodium chlorid without any substantial volatilization of the rare metal and causing such mixture to combine with a molten common metal.

6. The process of making compounds of the rare metals such as tungsten, vanadium, uranium, molybdenum, and tellurium and common metals, which consists in melting together a chlorid of the rare metal and a chlorid of one of the alkali metals, and causing such mixture to combine with a molten common metal at a temperature approximating that of the fusing temperature of the common metal and not substantially lower than the fusing temperature of the said mixture.

7. The process of making compounds of the rare metals such as tungsten, vanadium, uranium, molybdenum, and tellurium and common metals, which consists in melting together a salt of the rare metal and one of the haloid salts and causing such mixture to combine with a molten common metal.

ROBERT McKNIGHT.