UNITED STATES PATENT OFFICE.

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TREATING TUNGSTEN.

1,011,708. Specification of Letters Patent. Patented Dec. 12, 1911.

No Drawing. Application filed July 2, 1906. Serial No. 324,392.

To all whom it may concern:

Be it known that I, AXEL O. APPELBERG, a subject of the King of Sweden, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Treating Tungsten, of which the following is a specification.

My present invention relates to a process of treating refractory metals and materials, whereby I am able to build up refractory conductors for lamps, furnaces, and the like, and then machine or otherwise work the conductors into complex forms. As a suitable refractory material I may use one of the high melting metals of that class of which tungsten is typical.

In carrying out my invention I treat the refractory material in a vacuum, and I so conduct the operation that at a certain stage I obtain a product which can be drilled, filed, planed and otherwise worked into complex forms such as tubes, cups, clamps, helices and the like.

The chemical reactions involved are probably of a complex nature, and it seems to me possible that various molecular changes occur simultaneously with the chemical changes, thus modifying the physical properties of the product, but whether this is true or not I have hereinafter described the steps of this method of treatment with such detail that a person skilled in the art will be able to reproduce the process and obtain the benefits resulting therefrom.

Various refractory metals such as tungsten are ordinarily obtained in the form of a dark powder, the particles of which do not cohere and cannot be welded together or agglomerated by methods applicable to low melting metals. Unless the material is subjected to some special treatment, solid conductors of complex form and good mechanical strength cannot be obtained. These difficulties are overcome by the process hereinafter described.

According to this process tungsten or other refractory powder is mixed with a small quantity of glucose or other suitable binding material and is then squirted or pressed by heavy pressure into rods, bars, or other bodies. A small quantity of tungstic oxid may be added to the mixture to serve as an oxidizing agent for carbon whether the latter is present as an impurity in the tungsten or comes from carbonization of the binder. The quantity of tungstic oxid is preferably just sufficient to remove all the carbon.

The squirted rods, produced as above described, are not strong mechanically, although they retain their shape and can be handled without difficulty. They do not work well under a cutting tool and tend to crumble away and disintegrate when subjected to the pressure of a drill, file or similar tool.

According to the next step in my operation, the squirted rod or bar is heated for an hour or two in a vacuum to a temperature of about 1300° C., whereby wonderful changes take place in the physical characteristics of the material. It is greatly increased in strength and tenacity and becomes much like artificial graphite in its mechanical properties. I have mentioned the temperature of 1300° C. as being a suitable one for this treatment, but I find that the best temperature depends somewhat on the percentage of carbon present in the original mixture; also on the percentage of tungstic oxid added to the mixture, and on the intensity of the pressure to which the mixture is subjected during the squirting operation. An excess of carbon lowers this critical temperature 100° or so, while an excess of tungstic oxid raises the allowable temperature about the same amount. I also find that if the squirting pressure has been low the temperature suitable for obtaining the desired result may be higher than that suitable when the pressure has been exceedingly heavy. Although I do not wish to be limited to any particular theory, I think the difference in result produced by a difference in pressure is due to the molecular distances in the material, or in other words, to the compactness of the material; a closely packed body requiring less heat than a loosely packed one.

The third step in my process consists in machining the refractory body into the desired shape. This may be done by drilling, sawing, filing, etc., the material being manipulated with the same ease as artificial graphite.

The fourth and last step in my process consists in heating the machined conductor to a high temperature and thereby driving out all impurities and rendering the conductor hard, strong, and refractory enough to resist disintegration at high temperatures. In general this last heat treatment should

reach a temperature above 1600° C. Except as regards temperature, this heat treatment need not be substantially different from the first. Its effect being produced through the action of heat upon the body, no special cooling or chilling is necessary in connection with it.

The final product may be made so hard that a file or drill will not work it. I am thus enabled to obtain in the desired form, the most complex structures that would probably ever be desired in electric furnace work or in other arts where a highly refractory material is desirable.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. The process which consists in forming a body consisting substantially of compressed refractory metal, heating said body to strengthen it and render it machinable, the heating temperature being well below the fusing point of the metal, machining said body to a predetermined shape, and subsequently heating said body to render it hard and strong.

2. The process which consists in compressing tungsten powder into a compact body, heating the same in a vacuum at a temperature well below its melting point to render it machinable, and subsequently heating to a higher temperature to render it strong and refractory.

3. The process which consists in forming a compact body consisting substantially of finely divided tungsten, heating the same in a vacuum to a temperature of about 1300° C., whereby it is rendered strong and workable, and subsequently heating to a temperature above 1600° C. to purify the material and render it suitable for use as a refractory conductor.

4. The process which consists in heating in a vacuum a body consisting substantially of finely divided tungsten to strengthen it, machining said body to a pre-determined shape, and subsequently heating the same to harden it.

5. The process which consists in mixing tungsten with a binder and a small quantity of oxid of tungsten pressing the mixture into a compact body, heating said body to a temperature of about 1300 degrees C. to render it strong and workable, machining said body into a predetermined shape, and subsequently heating said body to a temperature above 1600 degrees C. to purify the material and render it suitable for use as a refractory conductor.

6. The process which consists in forming a compact body consisting substantially of finely divided refractory metal, heating said body to a temperature of about 1300° C. so as to render it machinable, machining it, and subsequently heating it to a higher temperature to harden it.

7. The process which consists in forming a compact body consisting substantially of refractory metal powder, heating said body to render it machinable, machining said body to the shape desired, and then heating said body to a higher temperature to render it strong.

In witness whereof, I have hereunto set my hand this 30th day of June, 1906.

AXEL O. APPELBERG.

Witnesses:

EDWARD WILLIAMS, Jr.,

ARBA B. MARVIN, Jr.