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REFRACTORY METAL ALLOY OF HIGH DENSITY AND HIGH MELTING POINT AND METHOD OF MAKING THE SAME.

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My invention relates to useful alloys of refractory metals of high density and of high melting point combined with base metals of much lower density and lower melting point, and process for producing the same.

Such metallic bodies are very useful in the arts where the metal of the bodies is subjected to considerable wear such as bearings, electrodes for spot-welding, switchboard contacts, etc., and this is especially true when alloys of high electrical and heat conductivity and high density are desired, and which do not soften and disintegrate at high temperatures.

The metals, tungsten and tantalum, for instance, are well known to be refractory metals having these characteristics, and when alloyed with the base metals, nickel, silver, aluminum, copper, cobalt, etc., result in the production of the required metallic bodies useful for the purposes above stated.

In general the melting points of the alloys known in the art are lower than either of the melting points of their constitutents. The alloys, however, which I produce by my process are characterized by the fact that their melting points are higher than the melting points of the base metals alloyed with the refractory metal.

Alloys of these metals have heretofore been very difficult to produce by means known to the art for the reason that the heavy refractory metal has a tendency to settle to the bottom of the bath of molten base metal when introduced therein.

I have discovered that a more or less porous body of refractory metal of high density and high melting point, when brought into contact with a molten body of a base metal of much lower density and melting point for which it has an alloying affinity, it will absorb that base metal and thus produce an alloy which can be employed in the arts for many useful purposes.

In order to effect the alloying of the metals as described, such a physical structure of the compressed refractory body must first be determined so that it has the greatest possible absorbing power. It is necessary also to determine how to regulate the absorbing power of the body of refractory metal so as to produce alloys of various compositions. This, I have discovered, can be done by first adding small percentages of either boron or carbon to the powdered refractory metal, and then baking in an atmosphere of hydrogen at a temperature of approximately about 900 degrees to 1000 degrees centigrade. During this baking the additions partially combine with the hydrogen thus forming a porous body.

When the powders of tungsten or of tantalum are to be compressed, better results are obtained by the addition of small percentages of boron nitride or other refractory nitrides, such as titanium, tantalum, vanadium, chromium, silicon, etc.

During the baking operation to which these compressed bodies are to be subjected either in a vacuum or a reducing atmosphere, which will be hereinafter more specifically referred to, the nitrides partially decompose, thereby liberating nitrogen and thus adding to the porosity and absorbing power of the compressed body.

In the carrying out of my process, whether the refractory metal be tungsten or tantalum, and whether the base metal be any one of the base metals above specified, I proceed as follows:

In the interest of clearness the production of a tungsten-copper alloy will be described, but it is to be distinctly understood that an analogous procedure will produce an alloy of any other selected refractory metal and any other selected base metal.

My invention divides itself into two parts:

First: Production of a suitable porous refractory compressed body, and

Second: In the alloying of said body with lower melting point base metals by absorption in a molten bath of said metals in vacuum or a reducing atmosphere.

Describing then the production of tungsten-copper alloy, I first prepare a pure light or fluffy tungsten powder, preferably by reduction of the pure oxide with a mixture of hydrogen and ammonia, as well known in the art; or, in fact, I may use any pure light or fluffy tungsten powder which may be obtained in the market. The tungsten powder which is found most effective or most desirable to use should have a weight of about 35 to 45 grams per cubic inch. This powder is then sifted through a 200-mesh sieve and then thoroughly and uniformly mixed with .5% to .1% by weight

of carbon or of boron or boron nitride, or with the other refractory nitrides above specified. In order to obtain a uniform mixture of the powders, the mixture is ball-milled for twenty to forty hours and extreme care should be taken that the additions be free from oil and grease.

The resultant powder of the mixture is then compressed into bodies in a mold of such shape as may be needed for the specified purpose for which the resulting product is to be used. This pressure should preferably be as low as possible yet sufficient for the body to take the shape of the mold and to be subsequently handled without breaking, and a pressure of from two to five tons per square inch is usually amply sufficient for this purpose. The compressed bodies are then removed from the mold and baked at an initial temperature of from 700 degrees to 800 degrees centigrade, which temperature is preferably increased slowly for a period of approximately ten minutes to 1000 degrees centigrade, and continued at that temperature for another period of approximately ten minutes either in a vacuum or a reducing or inert atmosphere. The body is then allowed to cool in the same atmosphere. This baking step causes a partial decomposition of the admissions resulting in a porous body. When a refractory nitride is used, the liberated nitrogen adds to the porosity of the compressed body, and consequently to its power of absorption, while at the same time the baking of the body strengthens it so that it can be readily handled without danger of breaking.

It has been found that certain refractory nitrides, such as vanadium nitride and chromium nitride also have the additional function of toughening and hardening the final alloy.

After the compressed bodies are baked and cooled, as above described, they are immersed in a bath of molten copper, either in a vacuum or in a hydrogen or other reducing atmosphere, for a period of one hour, the molten copper being kept at a temperature as close to the melting point thereof as possible.

An effective means for immersing these bodies is to suspend them from supports of tungsten or other refractory wire so that when the period of alloying has expired they may be quickly lifted out of the bath by means of the supports and quickly cooled. The outer adhering film of copper on the body is then either machined off or removed by chemical means well known in the art.

As above stated, after the porous body has been immersed in the bath of molten base metal, it is permitted to remain in the said bath long enough for the molten constituents to seep through the porous refractory body and fill up the pores and alloy with the refractory constituents. While, as stated, the operation may be performed either in a vacuum or in a reducing atmosphere, either of hydrogen or mixtures of hydrogen and nitrogen, it is found preferable to operate in a vacuum because the vacuum draws the occluded gases out of the compressed refractory body.

When copper tungsten alloys are produced by either of the above methods, it is found that about 25 to 30% of copper by weight is absorbed, and that metallic bodies of uniform structure will result which have a density of 14 to 16 when either copper or nickel are employed, and that the alloying is uniform throughout the mass and that the resultant body is uniform and homogeneous.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. A metallic body comprising a porous compressed mass of tungsten and a decomposed nitride of refractory metals, and a base metal filling the pores of said mass.

2. A metallic body comprising a porous, compressed mass of decomposed tungsten and boron nitrides, and nickel or copper filling said pores.

3. A method of producing refractory alloys, which comprises absorbing molten metals in compressed bodies of tungsten interspersed with decomposed boron nitride.

4. A method of producing refractory alloys, which comprises abosrbing molten metals and molten alloys in compressed bodies of tungsten interspersed with decomposed refractory nitrides.

5. A method of making porous bodies of refractory metal, which comprises compressing said metal with a nitride of a refractory metal, and decomposing said nitride in said mass at a high temperature.

6. The steps in the production of an alloy of refractory metal with a base metal which consists in mixing with the refractory metal small additions of refractory particles decomposable at a high temperature, compressing said mixture into a shape, baking the same to partially decompose said additions to form a porous body.

7. The steps in the method of producing an alloy of refractory metal with a base metal which consists in mixing with the refractory metal small additions of boron nitride, compressing said mixture into a shape, baking the same to partially decompose said baron nitride to form a porous body.

8. The method of producing an alloy of refractory metal with a base metal which consists in mixing with the refractory metal small additions of boron nitride, compressing said mixture into a shape, baking the same to partially decompose said boron nitride to form a porous body, then immersing the porous body in a molten bath of a base metal.

9. A method of producing an alloy of tungsten and copper which consists of thoroughly mixing small percentages of refractory nitrides into a mass of tungsten powder, compressing said powder into a body of suitable shape, baking the compressed body at about 700 to 800 degrees centigrade, increasing said temperature to approximately 1000 degrees centigrade, then immersing said body in molten copper, removing said body from said bath and removing the copper from the surface of said body.

10. A method of producing an alloy of tungsten and copper which consists of preparing fluffy tungsten powder by reduction of a tungsten compound with a mixture of hydrogen and ammonia, sifting said powder through a 200-mesh sieve, uniformly mixing .5% to .1% of boron nitride with said powder, compressing said body into the shape desired, baking said body in a reducing atmosphere, immersing said body in a bath of molten copper in an inert atmosphere.

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