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TUNGSTEN NICKEL ALLOY OF HIGH DENSITY

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Fig. 1.

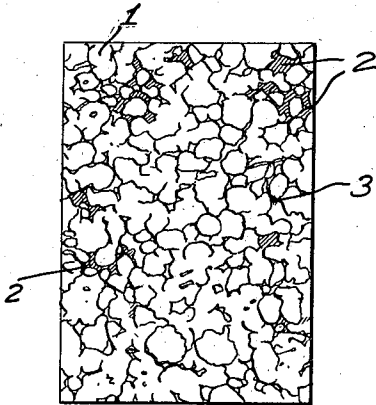


Fig. 2.

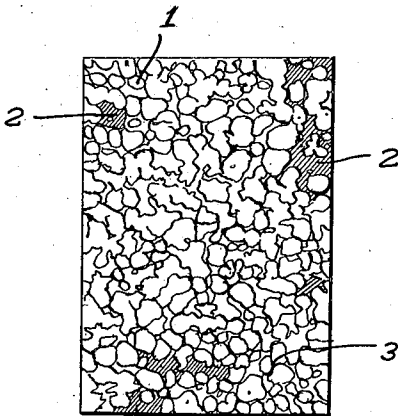
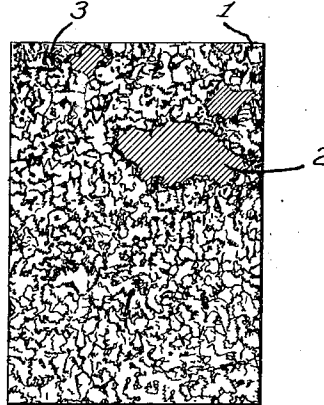


Fig. 3.



Fig. 4.

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TUNGSTEN NICKEL ALLOY OF HIGH DENSITY

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3 Claims. (Cl. 75-176)

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The present invention relates to a tungsten alloy which has a density approximating the theoretical density of pure hot swaged tungsten and which has greater machinability and workability than such pure tungsten.

It has been a matter of great interest to metallurgists to produce tungsten alloys that have the desirable mechanical properties of pure tungsten and greater machinability, but such alloys as have been produced are generally considerably below the theoretical density of the pure hot swaged tungsten and consequently lack the desirable mechanical properties.

It is the object of the present invention to produce an alloy mainly of tungsten having a density approximating that of pure hot swaged tungsten and having greater machinability and better mechanical properties than pure tungsten.

Attempts have been made to form an alloy consisting of large grains of tungsten cemented together by copper or nickel. Such alloys, however, have not been of value for if copper alone is used no alloying takes place between the tungsten and copper and the resulting product is not a true alloy. The tungsten grains do not increase in size or shape but remain in their original condition, being merely cemented together in a porphyritic structure. Furthermore, the copper does not fill all the intergranular voids and the product is of low density and lacks the desirable mechanical properties.

On the other hand, if nickel alone is used, a true alloying takes place between the nickel and tungsten grains. The alloy so formed, nevertheless, does not permeate the entire body but much of the nickel gathers in large pools, leaving many of the tungsten grains unalloyed and a large number of intergranular voids among these grains. This product is also of low density and deficient in mechanical properties.

It has, however, been proposed to form an alloy of tungsten with both nickel and copper and this has been more successful since a nickel-copper-tungsten alloy is formed that fills substantially all the intergranular spaces between the tungsten grains. The alloy so formed, however, while much superior to that formed with copper alone or nickel alone, has a density of only slightly more than 16 grams per c. c. as compared with the theoretical density of pure hot swaged tungsten of 19.3 grams per c. c. and is still somewhat lacking in the desirable mechanical properties. The structure shows very large grains, there being less than 1500 grains per square millimeter.

I have discovered that by the addition of very

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small percentages of platinum, platinum family metals, or gold, to an alloy of tungsten and nickel without any copper, a very remarkable increase in density can be attained. The platinum family metals here referred to are palladium, iridium, osmium, ruthenium and rhodium. This is a very remarkable phenomenon in view of the fact that the amount of such added metals need not be more than 0.1 per cent. and should be within the range of 0.05 and 1.0%. Larger amounts produce no greater benefit and merely add to the cost. In his Patent No. 2,183,359, Smithells discloses that an alloy of 95% tungsten and 5% nickel has a density of less than 14. Applicant has found that by replacing 0.1% tungsten by 0.1% of platinum, thereby forming an alloy consisting of 94.9% tungsten, 5% nickel and 0.1% of platinum, he can obtain an alloy having a density of 18.3.

According to the method of the present invention, purified tungsten powder having a particle size of from 1 to 25 microns is thoroughly mixed with nickel in proportion of from 85-95% tungsten, to 5-15% nickel, and platinum to an amount of from 0.05 to 1.0% is added.

The platinum is preferably added in the form of an aqueous solution of chlor-platinic acid to the mixture of the tungsten-nickel powders. This mixture, after the platinum addition, is dried with constant stirring to assure a uniform distribution of the platinum in the dried mixture of powders. The mixture is then placed in a suitable container and then put through a furnace under hydrogen atmosphere to remove any traces of oxidation that might have taken place during the platinum addition. The reduced powders are then sieved, ball-milled, pressed into ingot form and sintered at a temperature of about 1500° C. for about one hour. Likewise, other water soluble salts of the platinum group metals can be added in the same amounts as specified for platinum. These metals include palladium, iridium, rhodium, osmium and ruthenium. Gold also may be used in the same amounts.

The resulting body shows a very considerable increase in grain size and a marked alloying of the tungsten and nickel evidenced by the rounded form of the grains. In the drawings, Fig. 1 shows a structure resulting from an alloy containing 94.9% tungsten, 5% nickel and 0.1% platinum; Fig. 2 shows the structure obtained with 95% tungsten, 5% nickel and no platinum. It will be observable that in Fig. 1 the grain structure has been greatly modified from the original sharp angular condition of the grains before sintering. In Fig. 2 the grain structure is hardly modified

at all and the grains are small, sharp and angular. The grain count of Fig. 1 shows about 2500 grains to the square millimeter and there are only very small pools of nickel observable, while in Fig. 2 very large pools of nickel are present. Intergranular voids are almost entirely absent in Fig. 1, while in Fig. 2 voids are observable in considerable number amongst the grains. In both drawings the indicating numeral 1 indicates the tungsten alloy grains, 2 indicates the nickel pools, and 3 10 the intergranular voids.

The invention will be more clearly understood from the drawings in which

Fig. 1 is a representation of a sample of the alloy of the invention containing 94.9% tungsten, 5% nickel and 0.1% platinum;

Fig. 2 is an alloy not of the invention containing 95% tungsten, 5% nickel and no platinum;

Fig. 3 is an alloy of the invention containing 89.9% tungsten, 10% nickel and again 0.1% platinum; and

Fig. 4 is an alloy not of the invention but corresponding to Fig. 3, containing 90% tungsten and 10% nickel, with no platinum.

The figures are enlarged by 300 diameters.

The alloy shown in Fig. 1 has a density of 18.3, although its composition differs from the 95% tungsten 5% nickel alloy of Smithells (which has a density of 14) only in the fact that there is 0.1% of platinum added. The grain count is much larger and the alloying much more consistent throughout. This alloy has a hardness on the Rockwell A scale of 66 to 66.5.

With a larger nickel content of about 10%, similar phenomena are observable. For instance, the alloy shown in Fig. 3, consisting of 89.9% tungsten, 10% nickel and 0.1% platinum, shows similarly formed rounded alloy grains with a somewhat larger number of nickel pools, but practically no intergranular voids, a density of 17.3, a grain count of 3000 to the square millimeter, and a hardness on the Rockwell A scale of 66, while on the other hand the alloy of Fig. 4, with 90% tungsten and 10% nickel, without any platinum, shows a structure very similar to that of Fig. 2, the grains being sharp and not much altered from their original condition. Large pools of nickel are also observed throughout. The structures shown in Figs. 1 and 3 have good machinability despite their high density and hardness. 50

The density of these alloys can be materially increased without noticeable loss of mechanical properties by enlarging the time during which the sintering takes place. The structures shown in Figs. 1 to 4 were sintered at about 1500° C. for a period of about one hour, and if this period is extended to five hours or somewhat more, there will be an increase in grain size and somewhat fewer pools of nickel.

The illustrations above given are specific to platinum as the added metal. However, if 0.1% of gold or of any of the other platinum family metals mentioned above are substituted for platinum, the results will be approximately the same. The amount of these added metals is so small that it is desirable to add them as solutions of water soluble compounds so that they may be evenly distributed throughout the tungsten and nickel powders by stirring, after which they are reduced to metal. Aqueous solutions of chlorplatinic acid, gold chloride, palladium chloride, etc., may be used.

Having thus described my invention, what I claim is:

1. Tungsten nickel alloy having a density of more than 17 grams per cubic centimeter consisting of 84 to 94.95% of tungsten, 5 to 15% of nickel and 0.05 to 1.0% of a metal of the group consisting of platinum family metals.
2. Tungsten nickel alloy of high density and good machinability consisting of 84 to 94.95% of tungsten, 5 to 15% of nickel and 0.05 to 1.0% of platinum, and having a density of more than 17 grams per cubic centimeter.
3. Tungsten nickel alloy of high density and good machinability consisting of 94.9% of tungsten, 5% of nickel and 0.1% of platinum and having a density of 18.3 grams per cubic centimeter.

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The following references are of record in the file of this patent:

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