Jan. 3, 1933. A. KROPF 1,893,144

ALLOY OF HIGH FUSION POINT

Original Filed Aug. 20, 1926

Fig. 1.

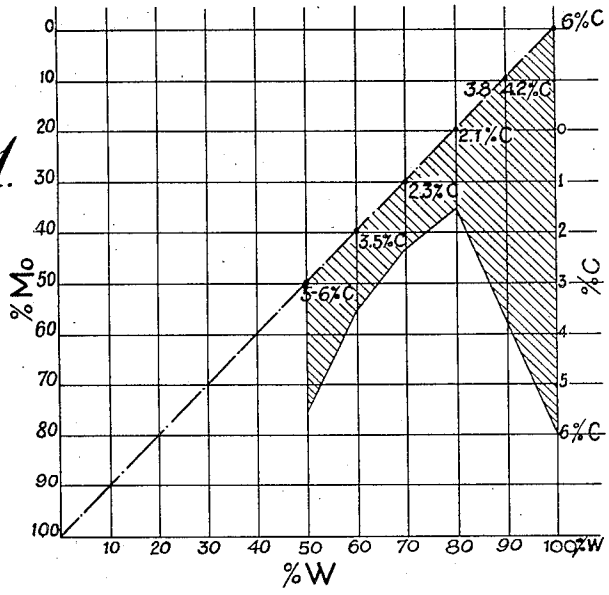


Fig. 2.

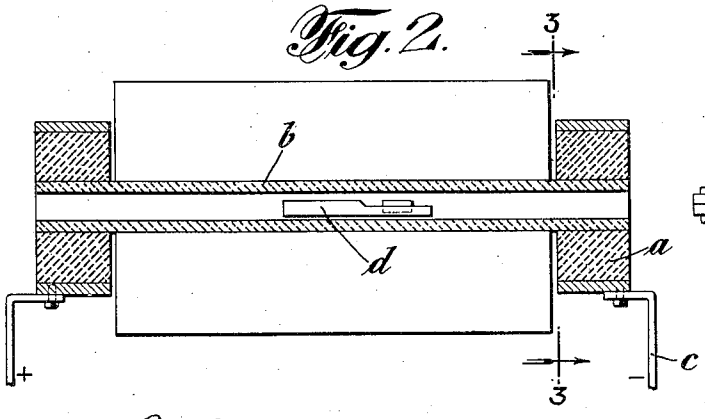


Fig. 3.

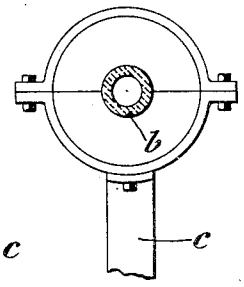


Fig. 4.

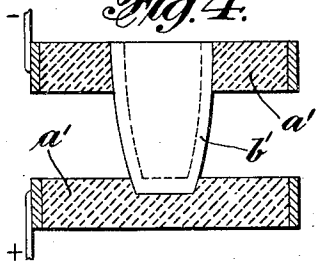
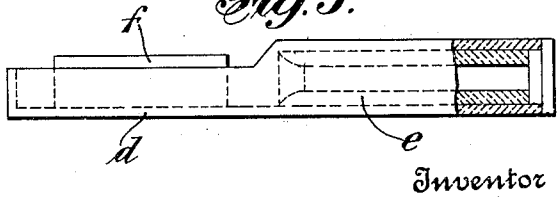


Fig. 5.



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UNITED STATES PATENT OFFICE

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ALLOY OF HIGH FUSION POINT

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My invention relates particularly to alloys of high fusing point containing metals of a high fusing point as well as the method of producing the same.

The object of my invention is to provide alloys of the above character, and particularly alloys containing metals of high fusing point, as, for example, molybdenum, tantalum, tungsten and chromium, all of which are of a kindred nature in the periodical system of chemical elements, and are obtainable on a commercial scale at a comparatively low cost. Furthermore, the object of my invention is to provide a convenient and effective method for producing such alloys. A further object of my invention is to obtain alloys of this kind comprising three or more metals.

The alloys so obtained show remarkable characteristics in regard to stress, extreme hardness, toughness, indifference against high temperatures and resistance against abrasion. These alloys are, therefore, of the highest usefulness in machining, etc., as, for example, where extremely hard substances have to be machined. These alloys are entirely effective for this purpose, where other alloys fail, owing to the qualities of the alloys referred to above. The alloys made in accordance with my invention receive and retain a keen cutting edge and will withstand very strong pressures in use.

While my invention is capable of being carried out in many different ways, for the purpose of illustration I shall describe only certain ways of carrying out the same hereinafter.

In the accompanying drawing, I have shown in addition to Fig. 1, containing the diagram above referred to, apparatus for use in carrying out the operation as follows:

Fig. 2 shows a carbon tube furnace comprising

a=graphite electrode
b=carbon tube
c=collecting bar
d=melting boat with casting mould;

Fig. 3 is a cross section of the same;

Fig. 4 shows a graphite crucible resistance furnace comprising

a'=graphite electrodes
b'=crucible resistance;

Fig. 5 shows a melting boat with casting mould comprising

d=melting boat
e=casting mould
f=pressed body of metal.

On account of its high melting point the alloy is produced in a carbon tube furnace b or in a graphite crucible b', the latter acting as a resistance furnace. See Figs. 1 and 2. The melting process itself is carried out in a boat d, to which is adjoined the casting mould e, the two being of one piece (Fig. 3). The pulverulent mixture of the metals and oxides for producing the alloy is composed as follows:

Example 1.—100 parts metallic tungsten, 60 parts metallic molybdenum (or the equivalent amount of dioxide).

It is more advantageous to use an equivalent quantity of the oxide of molybdenum instead of the metallic molybdenum.

Example 2.—100 parts of metallic tungsten, 10–30 parts of metallic molybdenum (or the equivalent dioxide), 20–50 parts of metallic tantalum.

Example 3.—100 parts of metallic tungsten, 10–30 parts of metallic molybdenum (or the equivalent dioxide), 20–50 parts of metallic tantalum, 10 parts of metallic chromium or cobalt.

The pulverulent mixture is divided in parts of 100 to 200 grams according to size and shape of the casting. They are filled into paper shells and pressed into suitable forms under high pressure. These forms are placed in the boat d and introduced in the melting zone of the furnace. As soon as the mixture melts it flows into the adjoining mould e, if the furnace is arranged vertically. After the mould is filled with metal, it is withdrawn from the furnace, the current having been interrupted previously. If the melting process is carried out in a horizontal carbon tube furnace, the current is interrupted as soon as the metals melt. Then the furnace is tilted into vertical position, so that the melt flows into the adjoining form e. The form e is at once removed from the furnace.

I have, thus, described the gases used, the

specific procedure for producing the alloy and the various eutectic points. It is to be added, however, that the invention is intended to apply to several other complex alloys with various other components.

I have found by experiments, that the tungsten molybdenum carbon alloys described above and the tungsten tantalum carbon alloys respectively may be materially improved, if both alloys are combined. This combination is valuable, because its physical properties vary according to the ratio of the principal elements, thus enabling me to adapt the various alloys to the individual purposes intended.

In certain cases an alloy of higher hardness is required, in other cases a softer alloy with high resistance against softening at high temperature appears preferable. These properties may be obtained, if the percentage of carbon is varied. This may be done by using varying percentages of molybdenum and tantalum. For example, a cutting alloy for the machining of extremely hard substances like manganese steel, which cannot be machined by stellite nor high speed steel, must be very hard and highly refractory. The hardness is dependent upon the percentage of carbon in combination with tungsten and molybdenum in form of carbides. According to the above, the percentage of carbon is controlled by molybdenum, but preferably by tantalum. The refractory qualities are inherent in the tungsten.

The most preferable alloy has the following composition:

Carbon=2.5%
Molybdenum=20–25%
Tantalum=10–15%
Tungsten=rest

This alloy is also remarkably adapted for the machining of hard rubber and fibre. The brittleness may be somewhat decreased—and to a certain extent the hardness likewise—by lowering the molybdenum contents and raising the tantalum contents, e. g.:

C =1.5–2%		C =1–1.5%
Mo=10%		Mo=10%
Ta =15–20%	or	Ta =25–40%
W =rest		W =rest

These are typical specimens how the alloy may be composed. There is furthermore the posibility of a wide variation according to the properties desired in the particular alloy. I only need vary the carbon contents, which—as stated previously—may be more readily attained by changing the tantalum contents than by changing the molybdenum contents. When using tantalum, the regulation of carbon is done so-to-say automatically, the addition of tantalum furthering the formation of an eutectic alloy in a metallurgical way.

In carrying out my invention, I have discovered, that the very high carbon content of the well-known tungsten-carbon alloy may be advantageously reduced by adding molybdenum or tantalum thereto, thereby obtaining the above advantageous qualities while avoiding the excessive brittleness of the tungsten-carbon alloy. Molybdenum and tungsten by themselves provide alloys for any ratio of proportions of the same, that is to say, from 1 to 99% of molybdenum with 99 to 1% of tungsten. However by the addition of carbon thereto it will be found, that for each percentage of carbon only one alloy with a fixed ratio of tungsten to molybdenum is possible which will have a minimum melting point. The tungsten-carbon alloy which has a minimum melting point itself contains about 4.5 to 5% carbon. However, when certain quantities of molybdenum are added in the production of this tungsten-carbon alloy, the saturation of the same with carbon takes place at a lower percentage of carbon than in the case of the pure tungsten-carbon alloy, provided certain conditions are followed while melting, such as: keeping temperatures as low as possible, i. e. not materially exceeding the melting point of the alloy; preventing the action of the carbon of moulds on alloy by using indifferent gases in the furnace, and by shortening the melting process as much as possible. The alloy thus obtained has a structure resulting from the absence of free carbon with the qualities above referred to, such as extreme hardness, toughness, etc. If the percentage of molybdenum is raised or lowered, the percentage of saturation of the same with carbon varies accordingly, also the toughness and hardness of the alloy. In these alloys the molybdenum content should preferably not be under 20%, tungsten from about 5 to 75%, carbon from 0.5 to 4%. For example, an alloy made in this way may be comprised of—

	Per cent
Molybdenum	30 to 40
Tungsten	55 to 65
Carbon	1.5 to 2.5

If part of the tungsten or molybdenum or the whole molybdenum is replaced by tantalum, the hardness of the alloy will be further increased. Besides, the presence of the tantalum is very advantageous as it favors the formation of alloys having a minimum melt point and in addition controls the saturation of the alloy with carbon. Consequently the addition of tantalum forms an easy method for regulating the amount of the carbon content. Tantalum, at its fusing point, does not form carbides and, accordingly, this quality enables this metal to be used conveniently for "diluting" the carbon in the alloy. Only by a reliable and easy method of this kind for regulating the carbon content, may these extremely hard alloys be made practical for the production of cutting tools inasmuch as, as above referred to, pure tungsten carbide

is too brittle for such purposes owing to its extremely high carbon content.

In preparing the alloys made in accordance with my invention, the melting of the metals is conducted as above explained in the presence of abundant carbon in order to insure the formation of carbides or alloys containing carbon which have a much lower fusing point than the pure metals, molybdenum and tungsten. If, however, the metals are in excess of the percentage necessary to form carbides containing a maximum of carbon, an alloy of lower carbon content is formed which has a lower fusing point. For example, such an alloy may be made by adding from 5 to 80% tungsten to from 60 to 20% of molybdenum having a carbon content of from 0.5 to 4%, and the carbon content may then be regulated by adding tungsten carbides, as, for example, from 20 to 50% of tungsten carbide containing 5% of carbon therein, or by the addition of other suitable carbonizing medium. If desired, certain quantities of tantalum may then be dissolved in this mixture without forming tantalum carbides. Even though the fusing point of tantalum is above the fusing point of this alloy, the tantalum is readily dissolved therein. This is also true in the case of the alloy, molybdenum, tungsten and carbon, which melts at a lower temperature than the metals therein. Such an alloy may, for example, be comprised of the following:

	Per cent
Tantalum	1 to 20
Molybdenum	10 to 40
Tungsten	40 to 65
Carbon	1 to 2.5

As pointed out above, if desired, the whole or part of the molybdenum or the tungsten may be substituted by tantalum, according to the hardness and heat resistance desired. The hardness is increased with the increase of the tantalum content. However, a molybdenum tantalum carbon alloy, though very homogeneous, is more brittle and more affected by high temperatures than the tantalum molybdenum tungsten carbon alloy.

Furthermore, the alloys of the above character are further improved in hardness and toughness by the addition of from 0.5% to 25% of the metals of the iron group, that is to say, chromium, nickel, cobalt, manganese, etc., or of the group, vanadium, titanium, zirconium, silicon, etc. Such addition may be of from 0.5% to 25% of one of these metals or two or several of them, the total quantity added, whether being of one or several of the metals, amounting to from 0.5 to 25%.

A base alloy of still a lower fusing point may be obtained by using a chromium tantalum base with the ratios of the tantalum and chromium varying according to the purpose desired, and to which there may be added the necessary amount of pure tungsten carbide or a tungsten molybdenum carbon alloy. The amount of chromium may be increased up to 40%, while the tantalum and tungsten or molybdenum may make up the remainder in the relative proportions mentioned in the examples given above. Such an alloy may, for example, be comprised of—

	Per cent
Chromium	1 to 40
Tantalum	1 to 40
Tungsten	60 to 10
Molybdenum	30 to 5
Carbon	4 to 0.5

While I have described my invention above in detail, I wish it to be understood, that many changes may be made therein without departing from the spirit of the same.

I claim:

1. An alloy of high fusing point containing from 1 to 2.5% of carbon, 40 to 65% of tungsten, 10 to 40% molybdenum and 1 to 20% of tantalum.

2. An alloy of the character described, containing 2 to 2.5% carbon, 40 to 65% tungsten, 15 to 25% molybdenum and 5 to 15% tantalum.

In testimony that I claim the foregoing, I have hereunto set my hand this 4th day of Aug., 1926.

ALFRED KROPF.