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HARD ALLOY

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1 Claim. (Cl. 75—136)

Experience has proved that the extra-rapid cutting of various steels, particularly very mild steels, cannot be accomplished as cheaply as possibly when the cutting tool employed is a sintered alloy consisting of tungsten carbide with cobalt or another ferrous metal. On the other hand, if weight by weight of small percentages of titanium carbide TiC is substituted for the tungsten carbides WC and W_2C, for instance, 5 to 30%, cutting tools are obtained which are much harder and which can hold the highest industrial speeds now used in the working of steel. Ternary alloys of tungsten carbides, of titanium carbide and cobalt or another metal of the same group have already been described.

It is also known that the tungsten carbides which are sintered together with alloys of the stellite type, such as cobalt, tungsten, with the optional presence of molybdenum, chromium, vanadium, manganese, iron and carbon, have made it possible to make particularly tough and very hard tools which are suitable for the working of castings regardless of whether the castings are chilled or otherwise. However, up to the present, the advantages, due to the sintering of the mixtures of tungsten carbides WC, W_2C and titanium carbide TiC with a metallic binder having a cobalt base, a tungsten base or other metal bases (the latter being optional), have been ignored. Such alloys have been described in the provisional Patent No. 339,540 of the applicant, for which an application was filed on September 5, 1932, and which is now French Patent 756,523, delivre September 25, 1933 and in the patent of addition whose provicional number is 31,372, for which an application was filed on November 25, 1932; now French additional Patent 43,192, delivre December 27, 1933 but these patents dealt with binders which could be hardened by means of a suitable heat treatment.

According to the present invention, the hard tungsten carbides and titanium carbides are sintered with hard, tough alloys, whose structural hardness is attained by virtue of their chemical composition and preparation, said hardness being independent of any additional heat treatment. These new alloys have among others the following characteristics:

(1) They permit the extra rapid machining of steels of any degree of hardness.

(2) Their toughness, which exceeds that of the alloys known heretofore, renders them suitable for the working of cast parts which have been improperly treated and whose hardness, which is altogether irregular throughout the parts, sometimes causes the breaking or the premature loss of the cutting edge in the case of the tools known heretofore.

In order to set forth clearly the invention, a few examples will be described.

Example 1.—The alloy may consist of the following ingredients:—

	Percent
Titanium carbide	8
Tungsten carbide	80
Tungsten	6
Cobalt	6

The tungsten carbides consist of a mixture of CW and CW_2, whose total carbon content may range between 5 and 6.1%. All the finely powdered constituents are mixed intimately in such a way as to obtain a frictional effect during the mixing. This can be brought about by the use of a ball mill. However, precautions should be taken to prevent oxidation of some of the constituents which are most likely to undergo changes, particularly tungsten and the carbide W_2C. After mixing, the uniform and homogeneous powder thus obtained is subjected to a load of 2 to 10 tons per sq. cm. The parts thus obtained are hardened by a heat treatment in a non-oxidizing atmosphere which may be neutral or reducing or a vacuum. The maximum temperature employed ranges from about 1500 to 1800 degrees C., the desired temperature level being held for 10 to 300 minutes, depending upon the hardness required. If desired, a first sintering at a lower temperature, for instance below 1200 degrees C. may be employed, in order that the parts may not attain their final hardness immediately, and so as to permit a certain rough finishing prior to the final hardening treatment. The cooling preferably should take place in a neutral or reducing medium, but in general any cooling rate may be employed because it does not noticeably affect the hardness, provided said hardening speed does not reach a point where conditions could occur in the material which would cause cracking as soon as the zone of rigidity is exceeded.

Example 2.—The proportions of one part of titanium carbide and ten parts of the mixture of tungsten carbides may be retained, and the sintering may be obtained by means of a more complex alloy consisting substantially of metal of the iron group and metal of the sixth group of Mendelejeff's periodic table of elements, for instance, iron-cobalt-tungsten in the weight proportions of 2, 4 and 6; or also cobalt-tungsten-chromium (for instance 6 : 5 : 1); or cobalt-molybdenum-tungsten-chromium (for instance 6 : 2 : 5 : 0.5); cobalt-tungsten-iron-vanadium (for instance 4 : 6 : 2 : 0.3), etc. In all these cases, the hardness and the duration of the final sintering are so regulated as to make the structure of the auxiliary alloy perfectly homogeneous.

Example 3.—The total carburization of the titanium involves some difficulties; most frequently one obtains a mixture (or perhaps a solid

solution) of the carbide TiC with a variable proportion of the nitride TiN. However, experience has proved that one can use, without trouble, these more complex products, provided the nitride content remains rather low, for instance, less than 20 per cent of the total weight of titanium carbide plus titanium nitride. Good results have been also obtained with the formula of Example 1, in which the carbide TiC is replaced partly by TiN containing 1.1% nitrogen.

Example 4.—It is also possible to manufacture the various alloys that are the subject of the invention by means of a sintering which may take place under simultaneous or alternate temperature and pressure effects, for instance, between 1350 and 1800 degrees C. at 50 to 200 kg./sq. cm. in the case of Example 1.

These various alloys hereinbefore disclosed are tough, the more so the lower the nitride content of the titanium carbide, and they permit working of steel at speeds which are much higher than in the case of tools made of tungsten carbide and cobalt or tools containing tantalum carbide.

To give an example, lathe tools made with alloys according to the method described in the preceding, have made it possible to machine a steel billet having a mechanical resistance of 100 kg./sq. mm. at the following mean industrial speeds:

Roughing:		
Feed per revolution	mm.	1.5
Cutting depth	mm.	2
Speed per minute in meters		40
Finishing:		
Feed per revolution	mm.	0.1
Cutting depth	mm.	0.5
Speed per minute in meters		250

It is obvious that the alloys which have been described in the foregoing are only given by way of examples and that they in no wise limit the scope of the invention. In general, the present invention covers alloys consisting substantially of titanium carbide TiC, tungsten carbide WC and a binding alloy with or without tungsten carbide W_2C and titanium nitride TiN. The binding alloy of which the alloy Co+W in substantially equal weights constitutes the simplest type is hard in itself without heat treatment. The respective proportions by weight of the extra hard constituents (carbides and nitride) on the one hand and of auxiliary alloy on the other hand may vary between about 97 and about 78 in the case of the first constituents and between about 3 and about 22% in the case of the auxiliary alloy.

Experience has proved that these alloys may likewise be prepared by fusion and casting, or also by impregnation of the extra-hard, sintered constituents by means of the auxiliary alloy which is brought to the liquid state at a high temperature.

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

A sintered composition consisting substantially of tungsten carbide, titanium carbide, titanium nitride, and a binder alloy for said carbides and nitride, said binder alloy consisting substantially of metal, of the iron group and metal of the 6th group of Mendelejeff's periodic table of elements and comprising about 3% to 22% by weight of said composition, the weight of the tungsten carbide being about ten times the combined weight of the titanium carbide and titanium nitride, and the weight of the titanium nitride being an appreciable amount but less than 20% of the combined weight of the titanium carbide and titanium nitride.

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