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TANTALUM CARBIDE ALLOY

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This invention relates in general to alloys, and has more particular reference to a novel and an improved alloy suitable for, but not limited to, the formation of tools and other implements.

For so much of the subject matter herein disclosed, which is also disclosed in either of my copending United States Letters Patent applications entitled Tantalum carbide alloy, Serial No. 439,227, filed March 26, 1930, and entitled Method of making hard alloys for cutting tools, Serial No. 439,228, filed March 26, 1930, the latter having since matured into Patent 1,937,185 dated Nov. 28, 1933, I claim the priority of said patent applications.

Among the objects of the invention is the provision of a novel alloy which, when used as a cutting tool, will be substantially non-cratering, that is, substantially free from undue wear or adherence between the chips from the work and the upper face of the tool when the tool is used for rapidly turning or cutting materials as difficult so to work as steel.

Among other objects of the invention are the provision of a hard alloy which includes as its predominant constituent, tantalum and carbon, substantially all of the carbon being in the form of a carbide of tantalum, and where desired, some of the tantalum remaining uncarburized after the formation of the carbide; the provision in such an alloy of an auxiliary metal or metals making up a minor percentage by weight of the entire alloy, and having a melting temperature less than that of the tantalum carbide; and the provision of a hard alloy including the tantalum, carbon, and the auxiliary material and having sufficient hardness, toughness, and strength to be suitable as a working portion for lathe tools and tools for other metal cutting or working machines, which working portion will retain such hardness, strength, and toughness even at the relatively high temperatures frequently developed in use.

Other objects and advantages of the invention will be apparent from the following description.

One of the best alloys, according to the invention, comprises tantalum and carbon in the proportion of from 93.8% to 95% by weight of tantalum, to from 6.2% to 5% by weight of carbon, substantially all of the carbon being combined with the proper amount of the tantalum to form tantalum carbide according to the formula TaC, and the carbon and tantalum together making up from 85% to 97% by weight of the entire alloy, which includes in addition to the tantalum and carbon, from 15% to 3% by weight of nickel.

A specific alloy within the purview of this invention comprises tantalum and carbon in the proportion of 94.25% by weight of tantalum to 5.75% by weight of carbon, substantially all of the carbon being combined with sufficient tantalum to form tantalum carbide according to the formula TaC, the alloy including in addition to the tantalum and carbon 10% by weight of nickel.

The invention is not limited to the precise percentages or proportions and the exact ingredients mentioned above, but contemplates that the tantalum and carbon together may range from barely a predominating amount by weight up to 97% by weight of the entire alloy, and that the proportion of tantalum to carbon may be so calculated that while substantially all of the carbon is used to form tantalum carbide, some of the tantalum remains uncarburized to promote toughness in the final alloy. Of course, this uncarburized tantalum may be provided for by having an excess of tantalum for that required to form the carbide, or it may be added as free metal after the carbide has been formed.

Furthermore, while nickel is specifically mentioned as the auxiliary metal in the examples given above, the invention contemplates the use of any other metal or metals which have a melting temperature less than that of tantalum carbide, and which will wet the carbide or will alloy, at least to some extent, with the carbide at relatively low temperatures as compared with the melting temperature of tantalum carbide. As examples of such metals for the auxiliary material, I may mention in addition to nickel, iron, cobalt, manganese, chromium, palladium, platinum, etc. For the sake of simplicity and convenience, I shall hereafter refer to these auxiliary metals as one or more metals from the class including nickel, chromium, and manganese.

One method which I have found suitable for combining the above mentioned ingredients is to start with tantalum carbide powder to which, where desired, tantalum is added or to start with a mixture of tantalum powder and carbon powder in the desired proportions to produce tantalum carbide according to the formula TaC with or without some free tantalum. Where the tantalum is first mixed with the carbon powder, the tantalum and carbon are combined by heat and degasified in order to remove or to exclude such embrittling impurities as oxygen from the tantalum carbide. In other words, the tantalum and carbon in finely divided form are degasified by a heat treatment in vacuo and the carbide powders are intermixed with one or more of the auxiliary metals from the class including nickel, chromium

and manganese in finely divided form. This mixture of tantalum carbide and the auxiliary metal with or without tantalum is pressed into workable bodies which are heat treated in vacuo to a temperature sufficient to form the alloy.

When these pressed bodies are heated in vacuo to a temperature at which the particular auxiliary metal or metals are molten or plastic, the auxiliary metal or metals from the class including nickel, chromium, and manganese, will bring about or will cause a shrinkage of the bodies into a sound solid alloy substantially free from porosity and voids. The temperature of the combining heat treatment will vary according to the amount of and the particular auxiliary metal or metals from the group including nickel, chromium and manganese employed in the alloy. Ordinarily, however, this temperature is less than the melting temperature of the added auxiliary metal, but not less than 1350° C. This vacuum heat treatment serves not only to combine the ingredients, but also serves to remove such embrittling impurities as oxygen, which may have been absorbed, occluded, or otherwise picked up by the fine powders during the preceding stages preliminary to the formation of the final alloy.

I have found that tools of my novel alloy when used for rapidly turning or cutting materials as difficult so to work as steel, are substantially free from that objectionable action known as cratering, or the undue wearing away of the tool material just back of the cutting edge of the tool, or adherence between the work chips and the tool material resulting in the removal of some tool material from the face of the tool.

Thus, an alloy of one or more metals of the class including nickel, chromium and manganese, and a refractory metal carbide is formed which has a homogeneous and substantially nonporous structure and which will be substantially free from cratering. This alloy retains the properties of sufficient hardness, mechanical strength and toughness for use in tools, even at the temperatures frequently developed in its use as a lathe, planing, or other cutting or metal working tool.

Illustrative of the advantages of this improved alloy, I have found that tools made thereof are extremely hard, and that in taking heavy cuts on a hard manganese steel, the tools did not heat so rapidly as other tools, and apparently offered a minimum resistance to the relative movement of the material being cut. In addition, the tools did not crater while operating under this exceedingly heavy duty.

While I have described as a preferred embodiment of my invention an alloy comprising tantalum carbide with or without free tantalum, it will be understood that the invention contemplates the use of other hard refractory metals and their carbides. In this connection I have particular reference to the refractory metal columbium and a carbide thereof. I do not, therefore, wish to be limited to the precise refractory metal or carbide thereof set forth, but contemplate that columbium carbide and/or columbium metal may replace tantalum carbide and/or tantalum, respectively, in whole or in part in my alloy, and I desire to avail myself of all such changes within the scope of the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. An imporous tool comprising an alloy consisting of deoxidized tantalum carbide predominating by weight therein, and a metal of the iron group united therewith.

2. An imporous tool comprising an alloy consisting of deoxidized tantalum carbide predominating by weight therein, and more than one metal of the iron group united therewith.

3. A hard and tough alloy comprising from 3% to 15% by weight of a metal of the iron group, and the remainder tantalum carbide having from 5% to 6.2% by weight of carbon.

4. A cutting tool comprising 10% by weight of nickel, the remainder tantalum and carbon in the proportion of 5.75% by weight of carbon to 94.25% by weight of tantalum.

5. A hard and tough alloy composed of from 3% to 15% by weight of nickel, and tantalum carbide making up the remainder of said alloy.

6. A hard and tough alloy comprising tantalum carbide, including tantalum and carbon in the proportion of from 93.8% to 95% by weight of tantalum to from 6.2% to 5% by weight of carbon, and having in addition thereto a metal of the iron group making up the remainder of said alloy and ranging from 3% to 15% by weight of the entire alloy.

7. A hard and tough tool having a low heat conductivity, comprising tantalum, carbon combined therewith in the proportion of from 93.8% to 95% by weight of the tantalum to from 6.2% to 5% by weight of the carbon, the tantalum and the carbon together making up not more than 97% by weight of the tool, but not less than a predominating amount by weight of the tool, and a metal of the iron group combined with the tantalum and carbon and making up from 3% to 15% by weight of the tool.

8. A hard and tough tool having a low heat conductivity, comprising tantalum, carbon combined therewith in the proportion of from 93.8% to 95% by weight of tantalum to from 6.2% to 5% by weight of the carbon, the tantalum and the carbon together making up not more than 97% by weight of the tool, but not less than a predominating amount by weight of the tool, and more than one metal of the iron group combined with the tantalum and carbon and making up from 3% to 15% by weight of the tool.

9. A hard alloy comprising from 85% to 97% by weight of tantalum carbide and from 15% to 3% by weight of an auxiliary metal having a melting temperature below the melting temperature of the tantalum carbide and adapted to combine with tantalum at a relatively low temperature as compared with the melting point of the tantalum carbide.

10. A hard alloy comprising from 85% to 97% by weight of tantalum carbide and from 15% to 3% by weight of nickel.

11. An alloy comprising a refractory metal from the group consisting of tantalum and columbium, carbon combined therewith in the proportion of from 93.8% to 95% by weight of said refractory metal to from 6.2% to 5% by weight of carbon, said carbon being combined with said refractory metal to form a carbide therewith, and from 3% to 15% by weight of nickel making up the remainder of the alloy.

12. A hard and tough alloy comprising from 3% to 15% by weight of one or more metals of the iron group and the remainder one or more carbides of a hard refractory metal from the group consisting of tantalum and columbium.

13. A sintered, hard, tough, metal composition consisting substantially of tantalum carbide and a binder material, said binder material contain-

CROSS REFERENCE SEARCH ROOM

ing an appreciable amount of nickel and being present in said composition in an appreciable but minor quantity.

14. A sintered metal composition consisting substantially of tantalum carbide and a metallic binder material therefor having a lower melting point than the carbide, said binder being present in said composition in appreciable but minor quantities.

15. A sintered composition containing about 3% to about 25% of a metallic binder material, the remainder of said composition consisting substantially of columbium carbide, said binder material having a lower melting point than said carbide and consisting mainly of metal of the iron group.

16. A sintered, hard, tough, metal, composition consisting substantially of tantalum carbide and nickel, the nickel comprising from about 3% to about 20% of said composition.

17. A sintered, hard, tough, metal composition consisting substantially of tantalum carbide and metal of the iron group, said metal of the iron group comprising from about 3% to about 20% of said composition.

18. A sintered, hard, tough, metal composition consisting substantially of tantalum carbide and cobalt, the cobalt comprising from about 3% to about 20% of said composition.

19. A sintered, metal composition containing about 3% to about 20% of a binder material, the remainder of said composition consisting substantially of tantalum carbide, said binder having a lower melting point than said carbide.

20. A sintered composition consisting substantially of hard, metal carbide particles and a metallic cementing medium therefor, one of the principal ingredients of said composition being tantalum carbide.

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