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ALLOY

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The present invention relates to a new and useful alloy and relates particularly to an alloy containing as essential components metal from the group tungsten, molybdenum and uranium, boron, chromium, cobalt and iron.

An object of the present invention is to provide an alloy having certain physical properties and characteristics which can be developed and controlled by means of thermal treatment, and, further, to provide an alloy having certain characteristics which render it particularly suitable for manufacture in finished or semi-finished forms by means of centrifugal casting.

The alloy of the present invention, in the form of articles produced by means of centrifugal casting, has a combination of physical properties and characteristics which render it especially valuable for metal cutting tools and many other industrial purposes.

I have found through experiment that by alloying or otherwise intimately combining boron, tungsten, chromium, vanadium, cobalt and iron within the range of boron 0.25% to 5%, tungsten 5% to 30%, chromium 1% to 25%, vanadium 0.50% to 5%, cobalt 5% to 40% and iron substantially the balance, that I obtain metallic compositions which possess a combination of valuable physical properties and characteristics. An important essential characteristic of the present invention is that the alloy is adapted for the production of forms by means of centrifugal casting. Another advantage is that such cast forms are readily amenable to thermal treatment for the modification and control of important physical properties.

I have found that the presence of boron in the present composition has a marked and beneficial effect upon certain physical and mechanical properties. For example, the cutting efficiency of tools composed of the alloy is, in a large measure, directly dependent upon the percentage of boron in the alloy. The maximum degree of hardness which can be developed in the alloy can be regulated over a comparatively wide range by varying the boron content.

I have found that one of the most important and valuable effects of boron is that it renders the alloy highly resistant to deformation from impact or compression at both normal and elevated temperatures.

Ingots or other forms of the alloy disclosed herein cannot be economically forged or rolled. This characteristic is apparently due in part to the inherent resistance to deformation possessed by the alloy, and also to the fact that ingots, etc.,

have a relatively coarse structure which includes irregular shaped masses of a hard and brittle segregate. Investigation indicates that this segregate contains a relatively high percentage of boron, and that it is not amenable to reduction in size by forging or other mechanical means.

I have found that it is virtually impossible to dissolve all or an appreciable percentage of such boron containing segregates in the other constituent or constituents of the aggregate at a temperature lower than the approximate melting point of the hard segregate.

I have also found that it is virtually impossible to produce commercially satisfactory shapes or forms of the alloy by means of gravity casting. Such castings do not have the requisite density, nor do they have a uniform grain structure. In general the physical structure of castings produced by gravity methods is such that the alloys are not suitable for use as metal cutting tools.

I have discovered that by applying suitable pressure to the molten alloy while it is in the mold, that I can produce cast forms having a relatively high density and requisite physical structure. I have found that while various methods may be used for developing the necessary degree of pressure, that centrifugal casting offers an entirely satisfactory and economical means of manufacturing cast forms of the present composition. I have found that by means of centrifugal casting I can increase the density of cast forms of this alloy from 15% to 25% over the density values of forms cast by gravity methods. Another important advantage is that centrifugally cast forms have, in general, an unusually uniform physical structure and are quite free from massive segregates of hard and brittle constituents.

Cast bodies of the alloy produced by centrifugal casting may be utilized in the as cast condition. However, I usually prefer to subject the castings to a suitable thermal treatment before using them for metal cutting tools.

I have found by research that the preferred structure of an aggregate of the present composition comprises at least two principal constituents: (a) a relatively hard, intermetallic compound of boron with one or more of the other essential components; and (b) a solid solution of two or more of the essential components, which has a lower degree of hardness and functions as a matrix. For certain uses, an appreciable percentage of the intermetallic boron compound should be in the form of more or less finely

divided particles dispersed throughout the matrix. An aggregate having the preferred physical structure possesses a combination of essential physical properties superior to the properties of a cast aggregate which has not been subjected to thermal treatment. The present alloy is amenable to thermal treatment for the development of precipitation hardening.

A distinctive characteristic of a body of the alloy which has been subjected to a suitable thermal treatment is the combination of relatively high hardness, e. g., 63 to 70 Rockwell C, and high resistance to impact. Another important property is that virtually all of the values of hardness and resistance to impact developed by thermal treatment are retained when the alloy is subjected to temperatures up to approximately 600° C.

Although I usually prefer to have the alloy composed substantially of boron, tungsten, chromium, vanadium, cobalt and iron within the percentages specified herein, I have found that tungsten can be supplanted, in whole or in part, by molybdenum, uranium or both.

Specific examples of the compositions within the scope of the present invention, which I have found to be valuable for various industrial purposes, are the following: Boron 0.60%, tungsten 14%, chromium 3.80%, vanadium 1.00%, cobalt 16%, iron substantially the balance; boron 0.85%, molybdenum 12%, chromium 4%, vanadium 2%, cobalt 25%, iron substantially the balance; boron 0.95%, molybdenum 8%, tungsten 6%, chromium 3.50%, vanadium 1.60%, cobalt 30%, iron substantially the balance.

I prefer to have the alloys of the present invention as reasonably free from carbon as commercial manufacturing conditions permit. I have found that certain of the metals and alloys used in producing the present compositions generally contain varying amounts of carbon as an impurity and, consequently, the alloys of the present invention will usually contain small amounts of carbon in the nature of an impurity incidental to manufacture. It is essential to restrict the percentage of carbon so present to an amount which will not be adversely effective on the important physical properties. I have found that carbon may be present in amounts as high as approximately 0.70% without seriously affecting the value of the alloy for various uses.

Furthermore, various materials used in producing this alloy frequently contain other elements such, for example, as manganese, silicon,

etc., more or less in the nature of impurities. Therefore the alloy of this invention may contain small amounts of elements other than carbon in the nature of incidental impurities.

It will be understood therefore that the composition of the present invention comprises the following essential components; boron 0.25% to 5%, metal selected from the group tungsten, molybdenum and uranium 5% to 30%, chromium 1% to 25%, vanadium 0.50% to 5%, cobalt 15% to 40%, and the balance substantially iron except for minor amounts of incidental impurities in which carbon when present, will not exceed approximately 0.70%.

I claim:

1. As a new article of manufacture, a centrifugally cast form of an alloy comprising as essential elements boron 0.25% to 5%, metal selected from the group tungsten, molybdenum and uranium 5% to 30%, chromium 1% to 25%, vanadium 0.50% to 5%, cobalt 15% to 40%, the balance substantially all iron, except for minor amounts of incidental impurities in which carbon does not exceed approximately 0.70%; said cast form being characterized by a relatively fine and uniform grain structure, and being further characterized by being responsive to thermal treatment for the regulation of hardness.

2. As a new article of manufacture, a centrifugally cast form of an alloy comprising as essential elements boron 0.25% to 5%, tungsten 5% to 30%, chromium 1% to 25%, vanadium 0.50% to 5%, cobalt 15% to 40%, the balance substantially all iron, except for minor amounts of incidental impurities in which carbon does not exceed approximately 0.70%; said cast form being characterized by a relatively fine and uniform grain structure, and being further characterized by being responsive to thermal treatment for the regulation of hardness.

3. As a new article of manufacture, a centrifugally cast form of an alloy comprising as essential elements boron 0.25% to 5%, molybdenum 5% to 30%, chromium 1% to 25%, vanadium 0.50% to 5%, cobalt 15% to 40%, the balance substantially all iron, except for minor amounts of incidental impurities in which carbon does not exceed approximately 0.70%; said cast form being characterized by a relatively fine and uniform grain structure, and being further characterized by being responsive to thermal treatment for the regulation of hardness.

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