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ALLOY

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The present invention relates to a new and useful alloy containing boron, titanium, tungsten and nickel, which is characterized by being responsive to thermal treatment for the improvement of physical properties.

An object of the present invention is to provide an alloy especially adapted for use as metal cutting tools, the cutting efficiency of which is superior to that of heretofore known high speed tools and other alloys. A further object is to provide an alloy which is free from or substantially free from carbon and which is readily amenable to thermal treatment by means of which the hardness, cutting efficiency, resistance to deformation and other physical properties and characteristics can be accurately controlled over a comparatively wide range.

I have found through experiment that by alloying or otherwise intimately combining boron, titanium, tungsten and nickel within the range boron 0.50% to 4%, titanium 0.25% to 7%, tungsten 2% to 30% and nickel substantially the balance that I obtain metallic compositions which are readily responsive to thermal treatment by means of which the physical properties and characteristics can be developed and controlled.

I have found that molybdenum or uranium may be used to supplant all or a portion of the tungsten of the alloy.

Alloys of this invention may be used in the cast condition for certain purposes, but approximate maximum values of hardness, resistance to deformation and certain other important physical properties can be developed only through thermal treatment or through mechanical working and thermal treatment. Bodies of the alloy which have been subjected to such treatment are particularly valuable for use as tools, dies and the like for the cutting or mechanical working of metals, as well as for many other industrial uses.

The present alloy is particularly responsive to thermal treatment for the development of precipitation hardening and I usually prefer to subject the alloy to such thermal treatment before using it for metal cutting tools, dies, etc. As an illustration, cast bodies of the alloy may have a hardness of from 50 to 57 on the Rockwall C scale and by subjecting the material to suitable thermal treatment such as heating to a temperature higher than approximately 1000° C., followed by rapid quenching, the hardness can be lowered to an approximate range of from 35 to 45 Rockwell C. The alloy can subsequently be subjected to a second thermal treatment, such as heating to a temperature lower than 1000° C. for one hour or more, followed by cooling at a normal rate by which the hardness can be increased to from approximately 58 to 70 Rockwell C. An important property of the alloy is that virtually all of the maximum hardness developed by thermal treatment is retained when the alloy is subjected to temperatures between 500° C. and 750° C. for long periods in various industrial operations.

Bodies of the alloy which have been subjected to a suitable thermal treatment are particularly resistant to abrasion at normal and elevated temperatures, and are also remarkably resistant to failure from sudden or repeated shock and to mechanical deformation. Consequently, cutting tools, dies and other articles composed of the present alloy retain an efficient cutting edge or working face for unusually long periods of time.

The more important distinctive advantages are apparently due to the presence of appreciable amounts of boron in the composition, in conjunction with the other components within the percentages specified herein.

I have found that chromium may be used as an essential component in the present alloy in an amount from 1% to 15%.

Specific examples of compositions within the scope of the present invention which I have found well adapted for numerous industrial applications are the following: Boron 1.75%, titanium 3.60%, tungsten 17%, nickel substantially the balance; boron 2.15%, titanium 1%, molybdenum 14%, nickel substantially the balance; boron 2.45%, titanium 1.50%, tungsten 4%, chromium 14%, nickel substantially the balance.

An object of the present invention is to provide an alloy having high hardness, valuable metal cutting properties, etc. which is free from or substantially free from carbon and thus eliminate all of the serious disadvantages associated with carbon containing alloys or compositions intended for metal cutting tools, etc. Although I prefer to have the alloys entirely free from carbon, in many instances I have found carbon present in the nature of an impurity incidental to manufacture. It is important, however, to restrict the carbon content to a maximum of about 0.15%, as I have found that the presence of higher percentages of this element not only act to embrittle the alloy but also inhibit or retard the desired or necessary reactions during thermal treatment. Furthermore, the presence of appreciable amounts of carbon decreases the red

hardness of the alloy when it is used as a metal cutting tool.

My investigations indicate that the preferred structure of a body of the present alloy, particularly after thermal treatment, comprises at least two principal constituents; one, a relatively hard intermetallic compound of boron with one or more of the other essential components; and two, a solid solution of two or more of the essential components which has a lower degree of hardness and functions as a matrix. The ratio of the constituents, as well as ratio of particle size in any body of the alloy may be accurately controlled and fixed over a wide range by means of thermal treatment.

By the term "balance nickel" in the foregoing and in the following claims I intend that the alloy of the present invention comprise all of the essential components, other than nickel, within the limits specified herein with the remainder nickel, except for substantially ineffectual amounts of impurities which may be present incidental to manufacture.

I claim:

1. A precipitation hardened alloy containing boron 0.50% to 4%, titanium 0.25% to 7%, metal selected from the group tungsten, molybdenum and uranium 2% to 30% and the balance nickel.

2. A precipitation hardened alloy containing boron 0.50% to 4%, titanium 0.25% to 7%, tungsten 2% to 30% and the balance nickel.

3. A precipitation hardened alloy containing boron 0.50% to 4%, titanium 0.25% to 7%, molybdenum 2% to 30% and the balance nickel.

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