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ALLOY

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1 Claim. (Cl. 148—32)

The present invention relates to a new and useful alloy containing boron, zirconium, chromium and cobalt, which is characterized by being responsive to thermal treatment for the improvement of physical properties. This application is a continuation in part of my copending application Serial No. 721,771 filed April 21, 1934.

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 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, zirconium, chromium and cobalt within the range of boron 0.50% to 4%, zirconium 0.25% to 5%, chromium 1% to 17% and cobalt 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.

Alloys of this invention may be used in the cast condition for certain purposes, but approximate maximum values of hardness, resistance to impact 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.

Numerous metallic compositions have heretofore been proposed as improvements on the known types of high speed tool steel, but all of such proposed compositions have disadvantages which render them unsuitable for general application as metal cutting or forming tools. One disadvantage of such compositions is that none of them are amenable to thermal treatment for regulation of physical properties, and consequently physical properties and characteristics are governed entirely by the chemical compositions of the alloy.

My alloy is particularly responsive to thermal treatment for the development of precipitation hardening, often referred to as age hardening. I prefer to subject the alloy to thermal treatment before using it for metal cutting tools, dies, etc. I have found that both the cast and forged materials are responsive to thermal treatment. As an illustration, cast bodies of this alloy may have a hardness of from 52 to 58 on the Rockwell 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 may be lowered to an approximate range of from 36 to 44 Rockwell C. The alloy can subsequently be subjected to a second thermal treatment, such as heating to a temperature lower than 1000° C. for a period of one hour or more, followed by cooling at a normal rate, by which the hardness can be increased to from approximately 58 to 66 Rockwell C. In the latter condition the alloy is valuable for many industrial uses.

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° and 750° C.

The alloy has a relatively high degree of hardness and resistance to abrasion at normal and elevated temperatures and is also remarkably resistant to failure from sudden or repeated shock. Consequently, tools and other articles made of the present alloy retain an efficient cutting edge, or working face, longer than similar equipment composed of heretofore known alloys.

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.

Specific examples of composition within the scope of the present invention which I have found well adapted for numerous industrial applications are of the following: boron 1.75%, zirconium 4.75%, chromium 7.50%, cobalt substantially the balance; boron 1.95%, zirconium 0.75%, chromium 15%, cobalt substantially the balance; boron 2.30%, zirconium 2%, chromium 12%, cobalt substantially the balance.

An objective of the present invention is to provide an alloy having high hardness, advantageous 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. Al-

though 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 embrittle the alloy, but also inhibit or retard the desired or necessary reactions during thermal treatment. The presence of appreciable amounts of carbon decreases the red hardness of the alloy; i. e., hardness at temperatures of approximately 550° C. and higher.

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 the ratio of particle size in any particular body of the alloy may be accurately controlled and fixed over a wide range by means of thermal treatment or mechanical working and thermal treatment.

By reason of the combined advantageous physical properties and characteristics possessed by the alloy of the present invention, tools and other articles composed of this alloy may be operated efficiently and economically under conditions which are impossible or uneconomical with tools, etc., composed of heretofore known alloys or metallic compositions.

By the term "the balance substantially cobalt" or the "balance cobalt" in the foregoing and in the following claim, I intend that the alloy of the present invention comprises boron, zirconium, and chromium within the percentage limits specified, with the remainder cobalt, except for ineffectual amounts of impurities which may be present incidental to manufacture.

I claim:

A precipitation hardened alloy containing boron 0.50% to 4%, zirconium 0.25% to 5%, chromium 1% to 17%, the balance cobalt.

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