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3,054,671

HARDENING OF COPPER ALLOYS

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This invention relates to a process for hardening copper alloys and to a novel copper alloy having superior mechanical properties.

The hardening of copper alloys in accordance with conventional quenching techniques has proved to be unsuitable. These alloys when subjected to the high temperatures employed in such techniques become soft and retain their softness even after quenching. In a further attempt to produce hardened copper alloys, specially formulated quenching baths have been suggested and, to a limited degree, produce alloys which exhibit high tensile strengths. However, the presently available high tensile strength copper alloys lack the high electrical and thermal conductivity characteristics necessary for use in high conductivity applications.

It is the primary object of this invention, therefore, to circumvent the above described deficiencies of the prior art by providing a new and improved copper alloy and a process for producing the same.

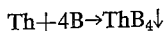
Another object of this invention is to provide a copper alloy having superior tensile strength properties together with high electrical and thermal conductivity characteristics.

A further object of this invention is to provide a copper alloy particularly adapted for use in high conductivity applications.

Other objects, advantages, and features of this invention will become readily apparent to those skilled in the art upon consideration of the following detailed disclosure thereof.

It has been found in accordance with this invention that the above objects are accomplished by a melting and casting technique in which a fine dispersion of thorium boride particles is produced in molten copper at which time the liquid copper is chill cast to its solid state in order to retain a uniform dispersion of the particles throughout the solid copper. The thorium boride particles neither settle nor float because the density thereof approximates that of copper.

In a more specific aspect, the process for producing the novel copper alloys of this invention involves the following procedure. Pure copper is melted in a graphite crucible. Boron is then added to the molten copper and the liquid alloy is homogenized by stirring. Preferably the boron is added in the form of a copper-boron master alloy, however, if desired, the boron may be added as a single constituent. Thorium, either as pure thorium or as a copper-thorium master alloy, is then added to the liquid melt and the resulting mixture is stirred in order to allow the following reaction to occur in the molten copper.



The bar under the symbols for thorium and boron indicates that these two elements are in solution in the molten copper and the arrow, following the symbol for thorium boride, indicates that the thorium boride is precipitated as individual solid particles uniformly dispersed throughout the molten copper. The resultant alloy is then chill cast in a cast iron mold to retain the particles in the dispersed state previously produced in the liquid copper. The thorium and boron are added in stoichiometric quantities such that the final alloy contains from about 1 percent to 4 percent thorium boride.

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The following table further illustrates the principles of this invention by presenting specific examples of the copper alloys together with an indication of their mechanical properties in the hot rolled condition at a temperature of 750° C. These alloys contain from 1 percent to 4 percent thorium boride with the balance being substantially all copper.

Composition		RT Hardness	Tensile Strength	
Percent ThB ₄	Percent Cu		Temp., °C.	Str., p.s.i.
1-----	Balance---	44.6	RT	38,000
			700	9,100
			800	5,240
			900	4,310
2-----	do-----	64.3	RT	43,300
4-----	do-----	59.3	RT	44,000
			800	8,970
			900	5,970
			975	5,820

As can be seen by the above data, the dispersion hardened copper alloys of this invention are characterized by greater strength than that exhibited by pure copper at both room and elevated temperatures. In addition, the thermal and electrical conductivity of these alloys is considerably higher than other high conductivity copper alloys of comparable strength. The superior heat conductivity of these alloys together with their increased strength makes them especially amenable for use in the fabrication of heat absorbing shield material. The combined elevated temperature strength properties and high electrical conductivity of these copper alloys make them useful in the manufacture of various electrical components such as switches as well as welding electrodes which carry high electric currents.

Unless otherwise indicated, the term percent, as used in the instant specification and appended claims, refers to percent by weight based on the final alloy weight.

Although the present invention has been described with particular reference to specific embodiments thereof, the invention is not to be considered as limited thereto, but cludes within its scope such modifications and alterations as come within the appended claims.

What is claimed is:

1. A process for hardening copper alloys comprising the steps of introducing thorium and boron into a mass of liquid copper to produce a molten solution thereof, stirring said molten solution in order to effectuate a reaction between said thorium and boron, precipitating thorium boride particles as a product of said reaction, dispersing said precipitated particles throughout said liquid copper in a uniform manner, cooling said liquid copper to a solid state in order to retain said precipitated particles in a uniform dispersed manner.

2. A process in accordance with claim 1 wherein said thorium and boron are introduced in stoichiometric quantities such that said solid copper contains from about 1 percent to 4 percent precipitated thorium boride particles.

3. An improved copper alloy having superior tensile strength properties and high thermal and electrical conductivity characteristics consisting essentially of from about 1 percent to 4 percent thorium boride particles uniformly dispersed throughout said alloy with the balance of said alloy being substantially all copper.

4. An improved copper alloy having superior tensile strength properties and high thermal and electrical conductivity characteristics consisting essentially of about 1 percent thorium boride particles uniformly dispersed throughout said alloy with the balance of said alloy being substantially all copper.

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5. An improved copper alloy having superior tensile strength properties and high thermal and electrical conductivity characteristics consisting essentially of about 2 percent thorium boride particles uniformly dispersed throughout said alloy with the balance of said alloy being substantially all copper.

6. An improved copper alloy having superior tensile strength properties and high thermal and electrical conductivity characteristics consisting essentially of about 4 percent thorium boride particles uniformly dispersed throughout said alloy with the balance of said alloy being substantially all copper.

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Notice of Adverse Decision in Interference

In Interference No. 93,911 involving Patent No. 3,054,671, G. J. London and S. Zirinsky, Hardening of copper alloys, final judgment adverse to the patentees was rendered Sept. 16, 1964, as to claims 1, 2, 3, 4, 5 and 6.

[*Official Gazette October 27, 1964.*]

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[*Official Gazette October 27, 1964.*]