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COPPER-COBALT-TIN ALLOY

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The present invention is directed to copper-cobalt-tin alloys and to a process for treating such alloys to improve their physical and electrical properties.

It is one of the objects of the present invention to provide a relatively low cost alloy which in general may be substituted for phosphor bronze, i. e. a copper alloy containing about 6 to 12% tin. My process for improving the properties of the copper base alloys may be applied to alloys containing about 94 to 99.8% copper, 3 to 0.1% tin, and 3 to 0.1% cobalt. For best results I prefer to employ alloys which contain less than 3% tin and less than 3% cobalt, for example an alloy containing about 99% copper, 0.5% tin and 0.5% cobalt.

In carrying out my invention the alloy is fully precipitation hardened by heating it to a solution temperature. If the alloy contains about 0.5% tin and 0.5% cobalt with the remainder copper, this temperature will be about 950° C. and the alloy preferably should be held at that temperature for about one hour. It is then quenched in a suitable cooling medium such as water, reheated at about 550° C. for about two hours to effect precipitation and thereafter cooled in any suitable manner. The fully precipitation hardened alloy has a proportional limit of about 7000 pounds per square inch, a tensile strength of about 34,000 pounds per square inch, an elongation of 30%, a Rockwell B hardness of 7 and an electrical conductivity of 41%, referred to copper 100%.

If the fully precipitation hardened alloy is now cold reduced, for example reduced about 35% in thickness, the proportional limit is increased to 30,000 pounds per square inch, the tensile strength to 48,700 pounds per square inch and the Rockwell B hardness to 61. The electrical conductivity is reduced slightly to 40 and the elongation to 12. The recrystallization temperature of the cold worked alloy is in excess of 550° C. and the room temperature hardness of the alloy is unaffected by temperatures up to about 600° C.

Like improvements in properties may be obtained with similar alloys containing not more than 3% tin and not more than 3% cobalt, for example an alloy containing about 97% copper, 1% tin and 2% cobalt. When heated for about one hour at 950° C., water quenched, maintained at a temperature of about 575° C. for about two hours and then cooled, this alloy has a proportional limit of 13,500 pounds per square inch, a tensile strength of 30,000 pounds per square inch, an elongation of 4%, a Rockwell

B hardness of 50 and an electrical conductivity of 32. After cold working to effect a reduction of thickness of about 35% the alloy has a proportional limit of 34,000 pounds per square inch, a tensile strength of 60,500 pounds per square inch, an elongation of 2%, a Rockwell B hardness of 84 and a conductivity of 31.

While my process may be applied to copper-tin-cobalt alloys containing 3% tin and 3% cobalt with the remainder copper, the best results and lowest costs are obtained with alloys containing appreciably less than 3% tin and appreciably less than 3% cobalt. The preferred composition contains about 99% copper, with appreciable quantities of tin and cobalt, for example about 0.5% tin and 0.5% cobalt. Good results also have been obtained with alloys containing 0.1% tin to 3% tin, 0.1% cobalt to 3% cobalt and remainder copper.

The solution temperature employed in my process may vary from about 800 to 950° C. and the precipitation temperature from about 450 to 650° C. depending upon the composition of the alloy. Although the cold worked alloy which has been reduced about 35% in thickness gives entirely satisfactory results the invention is not limited to any specific amount of cold working. Satisfactory results may be obtained for example by employing a cold reduction of 20% or more than 70%. While the cold working effects a reduction in the percentage elongation this percentage may be improved if the alloy after cold working is subjected to a second aging treatment at an elevated temperature but not exceeding the precipitation temperature. The second aging step may be accomplished without appreciable reduction in either tensile strength or proportional limit. While these alloys also may be improved by cold working between the quench and the draw the greatest improvement is effected by cold working the fully precipitation-hardened alloys.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An alloy consisting of copper, cobalt and tin the cobalt and tin each comprising an appreciable quantity but less than 2% by weight of said alloy.

2. An alloy consisting of about 99% copper, 0.5% tin and 0.5% cobalt.

3. A precipitation hardened alloy consisting of about 0.1% to 3% tin and about 0.1% to 3% cobalt with the remainder substantially all copper.

4. A cold worked precipitation hardened alloy consisting of about 0.1% to 3% tin, about

0.1% to 3% cobalt with the remainder substantially all copper.

5. A cold worked precipitation hardened alloy consisting of about 99% copper, the remainder of said composition consisting of appreciable quantities of both tin and cobalt.

6. A cold worked precipitation hardened alloy consisting of about 99% copper, 0.5% tin and 0.5% cobalt.

7. The process for improving copper base alloys consisting of copper, cobalt and tin, the cobalt and tin content of the alloy each being an appreciable quantity but not more than 3%, which comprises precipitation hardening the alloy and thereafter cold working it.

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