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COPPER ALLOY

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This invention relates to alloys and more particularly to copper alloys of improved characteristics.

An object of the invention is to produce an improved copper base alloy.

Another object is to produce a copper-cadmium-cobalt alloy, having a high wear resistance.

Other objects of the invention will be apparent from the following description taken in connection with the appended claims.

The present invention comprises a combination of elements, methods of manufacture and the product thereof, brought out and exemplified in the disclosure hereinafter set forth, the scope of the invention being indicated in the appended claims.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure and the combination of elements without departing from the spirit of the invention. In our co-pending application, we have described the advantages of copper-cobalt-cadmium alloys, such advantages consisting primarily in making the alloys more stable at elevated temperatures, producing a material of high resistance against atmospheric corrosion and electrical erosion, and producing a material with comparatively high hardness, high electrical conductivity and low contact resistance.

According to the present invention, these alloys can still further be improved by the addition of acid forming elements, such as silicon, phosphorus, beryllium or aluminum, which tend to produce an intermetallic compound with the base forming element present in the alloy; namely, cobalt. By means of the formation of an intermetallic compound, the ternary copper-cobalt-cadmium alloys can be made of greater hardness, which hardness is also being retained at high temperatures.

According to the preferred method of carrying out the present invention, an alloy is made containing copper, cadmium and cobalt, plus a compound forming element in the following proportions:

	Per cent
Cadmium	0.1 to 10
Cobalt	0.1 to 10
Elements selected from the group consisting of silicon, phosphorus, beryllium and aluminum	0.01 to 5
Copper	Balance.

It is possible likewise to improve the characteristics of other copper-cadmium-cobalt alloys containing small percentages of additional ingredients, by the addition of the above mentioned compound forming elements. Thus copper-cadmium-cobalt alloys, containing small proportions of silver, zinc, tin, calcium, lithium, iron, nickel and manganese, can be improved by the addition of compound forming elements, taken from the group of silicon, phosphorus, beryllium and aluminum in substantially the proportions indicated above.

The alloy can be made according to standard alloying methods. Thus an alloy of copper and cobalt may be prepared by melting first the copper and then adding the cobalt in the form of rondelles or compressed cobalt-copper slugs or any other form. Afterwards, the cadmium may be added in the form of stick cadmium, or in the form of a cadmium-copper powder mixture or any other suitable form. Finally, the compound forming element may be added and the melt may then be poured into either billets or sand castings. The billets can then be further worked down by hot extruding or forging or any other similar means. After the alloy has been prepared according to these standard methods, the heat treatment may be carried out as follows:

The alloy is raised in temperature to above 700 degrees C. and preferably to a temperature in the order of 800 to 1000 degrees C. The alloy is then quenched from this high temperature and subsequently aged at a temperature below 700 degrees C. and preferably in the range between 400 to 600 degrees C. This heat treatment results in a considerable improvement of hardness in the alloy and hardness values can be reached exceeding 95 Rockwell B. Another remarkable effect of the heat treatment is a marked improvement in the electrical conductivity. With some alloy combinations within the percentage range given above, a conductivity of 65% of that of pure copper has been obtained.

This alloy is therefore well suited for use at comparatively high temperatures, since the hardness and electrical conductivity are maintained for indefinite periods at the aging temperatures indicated above. Heat treated alloys, with or without cold working, will retain their properties at a temperature of 450 degrees C., almost indefinitely.

Alloys which are intended for casting purposes have a preferred cadmium content of from 0.5 to 5%, while in alloys which are intended for further cold or hot working, the maximum cadmium content should be 1.5%. The material in the cast condition has a fairly high hardness of 40

to 60 Rockwell B. This hardness can be increased by the aging treatment described above. Instead of giving both treatments to the casting, it is also possible to eliminate the quenching treatment, because the material usually gets partly chilled during the casting process and all that is necessary is to apply the second heat treatment, which is generally known as the aging treatment. The materials made in accordance with the present invention, were tested for contact resistance after being operated as contactor contacts. It was found that the contact resistance remained very low during long periods of operation, the combined presence of cadmium and cobalt being responsible for the oxide of low resistivity, while the compound forming element produced a mechanical hardness which gave the material a wear resistance superior to that of the ternary alloy of copper, cobalt and cadmium, described in our co-pending application.

The tensile properties of alloys containing cadmium, ranging from 0.25 to 1%; cobalt, from 0.5 to 5% and compound forming elements ranging from 0.3 to 1%, will reach values of 90,000 to 110,000 p. s. i., with an elongation of 10% or better, measured in 2 inches. The alloys also have very fine grain structure, which improves the physical properties.

With regard to the addition of the compound forming elements, we have found that they may be added either separately or in the following combinations:

Silicon plus phosphorus
Silicon plus beryllium
Beryllium plus aluminum.
Phosphorus plus aluminum.

The alloys prepared, as indicated above, are well suited for the manufacture of castings, such as commutator segments or collector rings for electric machines. In addition, these alloys are suitable for welding electrode tips and welding wheels.

Another important use of these high strength alloys is in the manufacture of a material which must be resistant to atmospheric corrosion and to electrical erosion. The materials can also be used for parts where high thermal conductivity with high strength, are needed.

While the present invention as to its objects and advantages has been described herein, as carried out in specific embodiments thereof, it is not desired to be limited thereby, but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. An alloy containing about 0.1 to 10% cobalt, about 0.1 to 10% cadmium, about 0.01 to 5% silicon and the balance copper.

2. An alloy containing 0.25 to 1% cadmium, 0.5 to 5% cobalt, 0.3 to 1% silicon and the balance copper, said alloy having high tensile strength and fine grain structure.

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