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COPPER-THORIUM ALLOYS

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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 a copper alloy of high electrical and heat conductivity, combined with suitable hardness.

Another object of the invention is to provide an alloy which, in the form of a casting, will have a very high electrical conductivity.

Further objects are to improve the cold working and crystallizing characteristics of the alloy.

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 the 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.

The invention relates to alloys consisting basically of copper and thorium, to which third elements are added to further improve the characteristics. While these alloys may vary in their physical characteristics, according to the specific compositions, they will generally be characterized by high conductivity and improved hardness. The alloys are further characterized by desirable electrical properties, such as being a material of low work function, which might be useful for special contacting purposes, or applications, such as neon sign electrodes, and similar applications where high electron emissivity is required.

It is contemplated that alloys may be produced according to the invention, having the ingredients combined in the following range of proportions:

	Per cent
Thorium-----	0.005 to 10
Elements of the 2nd group of the periodic system selected from the group consisting of cadmium, zinc, beryllium, magnesium, calcium, strontium, barium in the least useful amount to-----	30
Copper-----	Balance

It has also been possible to add small percentages of any one of the following ingredients

without changing materially the characteristics of our new alloy: aluminum, silicon, phosphorus, manganese, iron, cobalt, nickel and tin.

In alloys consisting predominantly of copper and thorium, it is found that additions of thorium to copper have very little effect on lowering the electrical conductivity. Alloys containing 1-1½% of thorium will have an electrical conductivity close to 90%, while alloys having as much thorium present as 5% will still have an electrical conductivity of 80%. With lesser amounts of thorium, higher values of electrical conductivity are obtainable.

We have found that alloys of copper and thorium apparently show what is generally known as an eutectic structure. With higher percentages of thorium present, such as 10-20%, a microscopic analysis shows a definite copper-thorium compound similar in structure to that noted in copper-thorium alloys of lower thorium content. This compound is one constituent of the eutectic.

It appears that it is due to the formation of this eutectic and the small amount of thorium, taken up in solid solution by the copper, which is responsible for the high electrical conductivity values. It is remarkable, however, to find that even with high thorium contents, the alloys remain easily workable and can be hot and cold worked.

The addition of elements taken from the second group of the periodic system and particularly the element cadmium, tend to improve considerably the cold worked characteristics of the copper-thorium alloy. By adding both cadmium and thorium to our improved copper alloy, it is possible to produce a material for electrical purposes, of outstanding merit. Similar results are obtained by adding the other materials contained in this group, such as magnesium or zinc. By adding a high enough amount of beryllium, alloys can be made susceptible to heat treatment, generally known as age hardening, and characterized by the fact that the heat treatment consists in two steps; namely, the quenching operation, followed by the aging operation, with or without cold working.

In carrying out the present invention, an alloy of copper and an element taken from the second group of the periodic system may be made according to the conventional alloy making procedure of the prior art, and then thorium may be added in any convenient form, such as cupro-thorium, pure thorium, or any other thorium alloy or compound. We have found it even possible to use ferro-

thorium, provided that impurities of iron are not objectionable for the specific application under consideration.

5 The great deoxidizing power of thorium can be judged from the heat of formation of the oxide. This heat amounts to 326,000 calories per gram atomic weight of metal. By comparing this with another material which is generally known as a good deoxidizer, such as manganese, superiority is
10 clearly shown. The heat of formation of the manganese oxide is only 91,000 calories per gram atomic weight of metal. This high heat of formation of oxides also points to the fact that if alloys of copper and thorium are to be made which
15 contain appreciable quantities of thorium, the molten bath must be free of oxides, particularly of copper oxides; otherwise a certain quantity of the thorium will be lost in reducing the copper oxide to pure copper with the resulting formation
20 of thorium oxide.

The presence in the alloy of small proportions of other ingredients which do not substantially alter its characteristics is contemplated as within the purview of the invention.

25 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 within the spirit and scope of the appended
30 claims.

What is claimed is:

1. An alloy consisting of copper and from 0.005% to 10% thorium, to which an element has been added, taken from the second group of the periodic system, the latter elements being present
5 in quantities from the least useful amount up to 30%.

2. An alloy composed of 0.005% to 20% thorium, from the least useful amount up to 30% of a material selected from the group consisting
10 of cadmium, zinc, beryllium, magnesium, calcium, strontium and barium, and the balance copper.

3. An electric current conducting member formed of an alloy composed of 0.005% to 20% thorium, from the least useful amount up to 30%
15 of a material selected from the group consisting of cadmium, zinc, beryllium, magnesium, calcium, strontium and barium, and the balance copper.

4. An electrical contacting member of the type
20 comprising resistance welding electrodes and the like formed of an alloy composed of 0.005% to 20% thorium, from the least useful amount up to 30% of a material selected from the group consisting of cadmium, zinc, beryllium, magnesium,
25 calcium, strontium and barium, and the balance copper.

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