June 27, 1939. F. R. HENSEL ET AL 2,164,065

COPPER CHROMIUM MAGNESIUM ALLOY

Filed Sept. 15, 1937

Fig. 1

HARDNESS VS. AGEING TIME

ELECT. CONDUCTIVITY VS. AGEING TIME

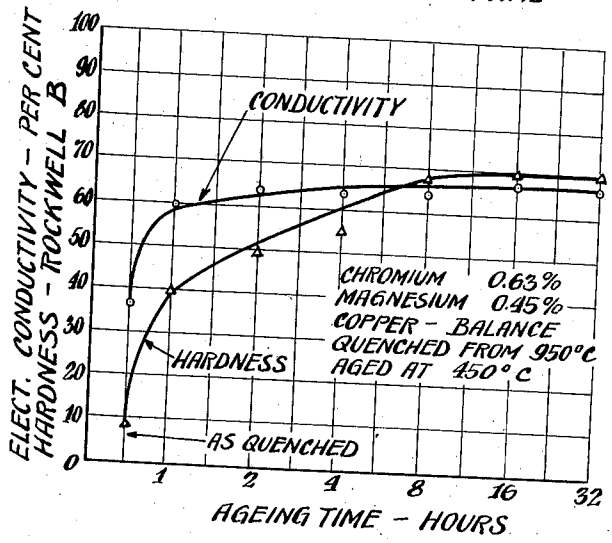


Fig. 2

HARDNESS VS. COLD WORKING

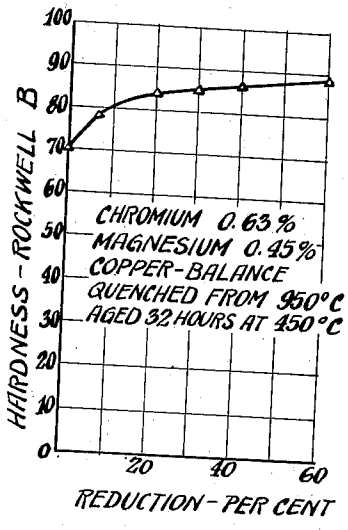


Fig. 3

HARDNESS VS. AGEING TIME

ELECT. CONDUCTIVITY VS. AGEING TIME

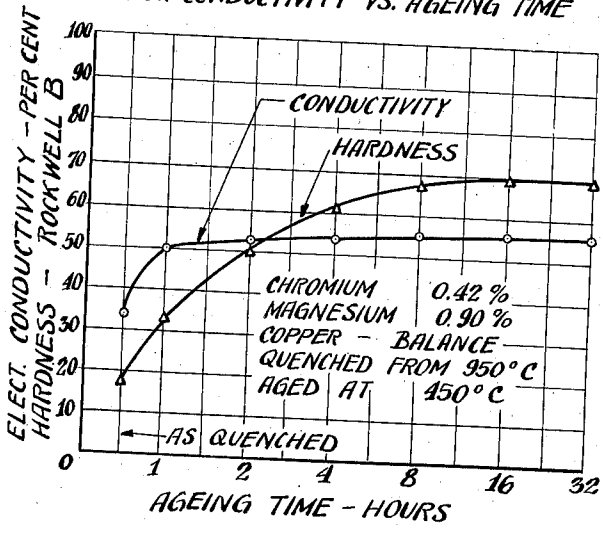
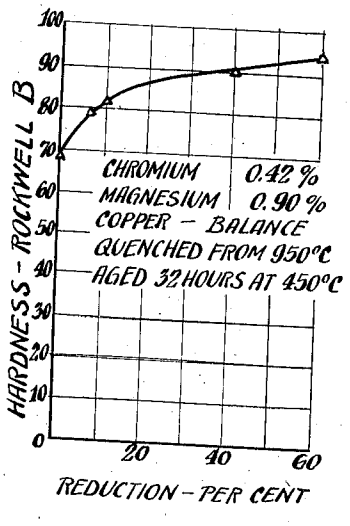


Fig. 4

HARDNESS VS. COLD WORKING



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COPPER CHROMIUM MAGNESIUM ALLOY

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3 Claims. (Cl. 75—153)

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 magnesium alloy, which is highly susceptible to age hardening and work hardening.

Another object is to provide an alloy of high hardness, coupled with improved electrical and thermal characteristics.

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

The present invention comprises the 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.

In the drawing:

Figures 1 and 3 are graphs showing curves illustrating the improvement in the hardness and electrical conductivity of alloys of the present invention during age hardening.

Figures 2 and 4 are graphs showing the effect of cold working on these alloys after age hardening.

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.

The invention relates to alloys of copper, magnesium and chromium. While these alloys may vary in their physical characteristics with the type of treatment received and the proportions of various ingredients, they will generally be characterized by high conductivity and hardness and by heat resistance.

According to the preferred method of carrying out our present invention, an alloy is made containing copper, magnesium and chromium in substantially the following proportions:

	Per cent
Magnesium	0.1–3
Chromium	0.1–3
Copper	Balance

It is possible, likewise, to improve the alloys consisting primarily of the alloy described above, but also containing small percentages of additional ingredients, such as silver, zinc, cadmium, calcium, lithium, silicon, titanium and beryllium.

In carrying out the present invention, a copper magnesium alloy may first be made according to the conventional alloy making procedure of the prior art, and the chromium may be added. It is also possible, however, to produce a copper chromium alloy first by melting down the copper and adding the chromium in the form of a hardener alloy which may contain anywhere from 5 to 50% of chromium. This hardener alloy can be either a pressed product or a pressed and sintered product or a melted product. In order to get the chromium completely in solution into the copper, it is necessary to keep the melt at an elevated temperature for some time. The magnesium is preferably added also in the form of a hardener alloy.

Magnesium will act, in addition to its function as an alloying ingredient, as a very strong deoxidizer and therefore with this new combination of copper magnesium chromium, it is possible to produce very sound castings.

After the alloy has been prepared according to such alloying methods as described above the heat treament may be carried out as follows: The alloy, in the form of a billet or a sand casting, or any other form, is raised in temperature to 700 degrees C. and preferably to a temperature in the order of 800–1000 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 and 600 degrees C. This heat treatment results in considerable improvement in the hardness of the alloy.

An example of an alloy of the present invention is one containing—

	Per cent
Chromium	0.63
Magnesium	0.45
Copper	Balance

whose characteristics are depicted in Figures 1 and 2. It may be noted that this alloy will have a Rockwell B hardness of 8 after quenching. After aging for 8 to 16 hours at 450° C. this hardness can be raised to 70 Rockwell B. Upon subsequent cold working the hardness is still further raised as shown in Figure 2, wherein it is indicated that the hardness may reach 88 Rockwell B after 60% reduction in thickness.

The characteristics of another alloy of the present invention containing—

	Per cent
Chromium	0.42
Magnesium	0.90
Copper	Balance

are shown in Figures 3 and 4. This alloy reached a hardness of 69 Rockwell B after 16 to 32 hours' aging and could be further hardened to 94 Rockwell B by cold working.

Excellent properties can also be obtained with alloys low in chromium content containing about ½ of 1% magnesium. For instance, an alloy of—

	Per cent
Chromium	0.25
Magnesium	0.42
Copper	Balance

reached a hardness of 66 Rockwell B after aging. With 25% reduction by cold working a Rockwell B hardness of 81 was obtained and after 65% cold work the hardness was further increased to 85 Rockwell B. At the same time the electrical conductivity was 70% of that of pure copper.

The effect of magnesium is very pronounced as far as its cold working is concerned, and with higher percentages of magnesium, higher ultimate hardness will be reached. This can not be accomplished with binary alloys containing only copper and chromium.

We have also found that these alloys are very well suited for treatments in which the various steps of heat hardening and work hardening are combined in various manners. For instance, the alloy may be quenched first, then cold worked, then aged and again cold worked.

Another remarkable effect of the heat treatment is the great improvement in the electrical conductivity. With some alloy combinations within the percentage range given above, conductivities ranging from 55–75% of that of pure copper can be easily obtained. The improvements in the conductivities of the first two example alloys are shown in Figures 1 and 3.

While it is possible to obtain a fairly good combination of hardness and conductivity in binary copper chromium alloys, provided that high enough percentages of chromium are added, we have found that by decreasing the chromium content and adding a larger percentage of magnesium, much higher hardnesses are reached than can ever be obtained in binary combinations.

The alloy, on account of these outstanding physical properties, is well suited for use at comparatively high temperatures, since the hardness and electrical conductivity are maintained for indefinite periods at the aging temperatures indicated.

The alloys prepared as indicated above are well suited for the manufacture of any type of castings, such as sand castings, chill castings and permanent mold castings. The alloys are further well suited for such manufacturing processes as extruding, rolling, drawing and forging. On account of the combination of high hardness, high electrical and high thermal conductivity, the material can be used for electrical parts of any description.

In addition, the high annealing temperature in connection with a Rockwell B hardness of above 90 Rockwell B, makes these alloys very suitable for applications where heat and pressure are applied at the same time, such as the case as in resistance welding electrodes. The alloys after cold working are also highly resistant to abrasion. They have high fatigue limits and good spring properties and can therefore be used for current carrying or heat carrying springs.

Another important use of these high strength alloys is in the manufacturing of cylinder heads, pistons and other parts of internal combustion engines, such as automobile engines, where high heat conductivity is 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 0.1–3% magnesium, 0.1–3% chromium, and the balance copper.

2. A hardened alloy composed of about 0.1–3% magnesium, 0.1–3% chromium and the balance substantiallly all copper, characterized by a combination of high hardness and high electrical and heat conductivity and the hardness and high conductivity of said alloy not being permanently affected to any substantial extent by temperatures in the order of 500 degrees C.

3. An alloy of high strength and electrical conductivity consisting of chromium and magnesium each 0.25–1 per cent by weight and the balance copper; the alloy being substantially free of other alloying constituents.

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