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COPPER ALLOY

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My invention relates to the alloys of copper and more particularly to the copper base (over 50% copper) alloys of copper and zinc, commonly known as brasses.

The object of my invention is to provide improved brasses.

The copper-zinc alloys known as brasses may contain as much as 50% zinc, balance copper. The so-called alpha brasses have a one-phase structure and contain up to about 38% zinc. Various percentages of zinc within the range up to 38% are used for various purposes. Common compositions are 5% zinc, 10% zinc, 15% zinc, 20% zinc, 28% zinc, 30% zinc, 35% zinc, and 38% zinc. With higher zinc contents a two-phase structure is obtained. A 40% zinc content is found in the well known Muntz Metal. With 50% zinc the alloys are brittle enough to be pulverized. The pulverized 50% zinc-50% copper alloy is used as a brazing solder.

I have found that the common brasses are greatly improved by adding a relatively small amount of boron to the composition. This amount of boron may vary from .01% to 1.0%. The boron actually is alloyed with the brass. The zinc range may be from 0.1% to about 50% but preferably from 1% to about 45%.

The advantages gained from boron additions are decreased grain size for a given set of conditions, freedom of the metal from dross and oxides, improved casting, welding and brazing properties, and simplification of the mill practice in producing wrought forms.

The effect of the boron on grain size of two alpha brasses is shown in the following table. Four bars were cast in a chill mold and rolled to .060" gauge strip, the intermediate anneals being at a temperature of 650° C. All four bars were finished by cold rolling with a reduction in thickness of 8 Brown & Sharpe gauge numbers, or 60.5%. Bars 871 and 872 both contained 15% of zinc, and bars 873 and 874 contained 33% of zinc. Bars 871 and 873 also contained 0.10% boron, while bars 872 and 874 were free from boron. Samples of each of the four bars were annealed, 30 minutes at each of 3 temperatures after which the grain sizes were determined microscopically.

Diameter of average grain, mm.

Alloy	871	872	873	874
Percent zinc	15	15	33	33
Percent boron	0.10	0	0.10	0
Annealing temperature, °C.:				
450	.008	.015	.015	.030
650	.020	.075	.043	.150
850	.065	+.200	.065*	.190*

* Sample showed an alpha solid solution plus beta solid solution structure. Other samples contained none of the beta phase.

There are several advantages of a small grain size. For example the suppression by the boron of grain growth during annealing in operations in which cold working is very uneven, such as deep drawing, is a great advantage because metal in which the grain is coarse and ununiform has a rough surface on which it is difficult to produce a fine finish. Also a fine grained structure has greater fatigue resistance.

Boron has a great affinity for oxygen and, therefore, will reduce the oxides of zinc, nickel, and many other elements. When boron reduces the oxides of other metals it is itself oxidized to boric acid anhydride. As is well known, boric acid anhydride (at the melting temperatures of copper alloys) is a mobile liquid with great solvent power for other oxides. Thus this element not only reduces any oxide which may be present, but one of the reduction products, boric acid anhydride, acts as a flux. Thus the more dross the brass contains, the greater the fluxing action provided sufficient boron is present. This effect is of the greatest importance particularly where scrap is being remelted.

As a result of the complete deoxidation of the molten brass containing boron, the alloy has a low viscosity in the liquid state and gives castings which have exceptionally clean surfaces, and which also are sound internally. The same benefits are obtained in welding, brazing, die casting, or under any conditions where the brass must be melted. The soundness and freedom from dross in the internal structure is of great assistance in producing brass of high quality with greater strength, ductility, and fatigue resistance.

The simplification of the mill practice, resulting from boron additions, is due to the protection of the metal during annealing by the borate glass which forms on the surface when the boronized brass is heated in air and greatly reduces formation of scale.

One further advantage gained when boron is present in a copper alloy welding rod containing zinc is that it suppresses the fuming due to the evolution of zinc vapor from the weld pool and its subsequent oxidation to zinc oxide smoke.

In practicing my invention I alloy the metals, and scrap if used, in the customary manner and add the boron with stirring before pouring. I may add the element boron or a boron alloy. At present I prefer to use a 2% to 5% boron-copper alloy as a source of boron. I also may add the boron by one of the methods given in my copending application for a Process for producing boron-copper alloys, Serial Number 188,471. The melt is then poured or forced into a suitable mold and used in the cast form or rolled, drawn, swaged, forged, hammered, extruded, and otherwise worked to produce sheet, rod, wire, tube, profiles, forgings, and the like.

Frequently the common brasses are modified in

composition by adding one or more other elements. For example—some of the copper may be replaced by nickel to produce a stronger alloy of white or silvery color known as nickel silver. Lead is added to improve the machinability, aluminum to increase the corrosion resistance, and titanium to produce a heat hardenable alloy.

The benefits of boron in the binary alloys also extend to the alloys to which certain other elements have been added. Thus I may replace equivalent quantities of copper and zinc by:

	Per cent
Nickel	0 to 35
Manganese	0 to 10
Lead	0 to 10
Cadmium	0 to 5
Aluminum	0 to 10
Iron	0 to 5
Magnesium	0 to 5
Titanium	0 to 10
Vanadium	0 to 10
Zirconium	0 to 10

The improved alloys described herein may be used with advantage for any of the uses to which brasses without boron may be applied. They are particularly advantageous as welding rods and brazing solders, as base metals for welding and brazing, and as material for electrical contacts.

Having thus set forth the nature of my invention, what I claim is:

1. A copper base alloy comprising from 1 to 50 percent zinc, 0.01 to 1 percent boron, and balance copper.

2. A copper base alloy comprising zinc within the range of 1 to 50 percent, 0.01 to 1 percent boron, and balance substantially all copper, which is characterized by a finer grain structure and increased fatigue resistance over the alloy without the boron.

3. A copper base alloy comprising zinc within the range of 1 to 45 percent, boron from 0.01 to 1 percent, and balance substantially all copper.

4. A copper base alloy comprising zinc within the range of 1 to 50 percent, 0.01 to 1 percent boron, and balance substantially all copper, and which alloy is characterized by finer grain size, improved casting, welding and brazing properties, increased fatigue resistance and reduced formation of scale when annealed by heating in air, over the same alloy without the boron, and with amounts of other elements insufficient to affect the characteristics named.

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