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ALLOY

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This invention relates to alloys and particularly to brass-type alloys of zinc, copper and manganese, and has for its object the provision of improved alloys of this type.

The alloys of the invention generally resemble brass or bronze and may aptly be called white brasses or bronzes. The base of the alloys is made up of zinc, copper and manganese, and their characteristic new and improved properties are due to the presence of a small amount of beryllium. In addition to imparting other desirable physical properties to the alloys, beryllium functions as an anti-oxidant, preventing oxidation of the alloying constituents, particularly manganese, during the production of the alloy and during its subsequent remelting.

The alloys of the invention, in its broad aspect, contain from 15 to 37.5% zinc, from 7.5 to 30% manganese, from 0.005 to 2%, and preferably from 0.01 to 0.5%, beryllium, and the balance (up to 77%) substantially all copper but not less than 50% and except for the possible inclusion of lead as hereinafter explained. These alloys are characterized by excellent physical properties such as tensile strength, tensile elongation and hardness. Particularly useful alloys of the invention contain from 18 to 23% (preferably about 21%) zinc, from 15 to 20% (preferably about 18%) manganese, from 0.01 to 0.2% (preferably about 0.08%) beryllium, and from not less than 53% up to about 67% (preferably from 57 to 61%) copper. Other very useful alloys of the invention contain from 20 to 25% (preferably about 22%) zinc, from 7.5 to 12.5% (preferably about 10%) manganese, from 0.01 to 0.2% (preferably about 0.08%) beryllium, and from not less than 59% up to about 73% (preferably from 64 to 68%) copper.

Small amounts of lead, say from 0.1 up to 3%, may also be included in the alloys without any substantial deleterious effect on the cast metal. Lead, as in ordinary brass, imparts to the alloy desirable properties with respect to machineability.

The alloys of the invention are preferably manufactured and handled in clay-carborundum and carbon-carborundum crucibles. Steel crucibles may be used for remelting purposes without excessive iron contamination, but should be avoided in the manufacture of the alloy. Crucibles made of refractory oxides, such as alumina and magnesia, may also be used.

In manufacturing the alloy, the copper and the beryllium, the latter in the form of a copper-beryllium hardener or alloy containing 4% of

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beryllium, are first melted together and brought to a sufficiently high temperature so as not to freeze when the other alloying constituents are later added. The manganese is then added in small lots until all of the addition has dissolved. At this stage, it is expedient to add a small amount of borax to clear up any oxide on the surface of the molten metal (melt). The amount of borax is preferably less than required to form a continuous molten cover, the ideal condition being to have beads of molten borax which dissolve or flux any surface oxide and then gather near the crucible wall leaving a clear center portion through which other additions may be made. After the borax has thus cleared up the surface of the melt, the zinc is added and the entire melt is stirred to produce a uniform composition. The melt is then allowed to stand for a few minutes to permit entrained oxides to reach the surface, and is then skimmed and poured.

Electrolytic copper cathode sheet, or any other good commercial grade of copper, may be used in the manufacture of the alloys of the invention. The zinc is preferably high grade metal containing 99.99% zinc. Electrolytic manganese is the preferred form of that constituent. While metals of high purity are thus preferably used, alloys of satisfactory properties may be made of metals or alloys of good commercial purity.

The alloys of the invention melt at temperatures between about 800 and 950° C., depending largely on the copper content, the higher the copper content the higher the melting temperature, and are highly castable. For example, the alloy of 21% zinc, 18% manganese, 0.1% beryllium, and the balance essentially copper has a melting temperature of about 850° C., and can be cast at temperatures from 875 to over 1000° C. The preferred temperature range for casting is 875 to 925° C. This alloy can be sand cast quite easily in the standard green sand mold common to the foundry industry, using casting and molding practices common in the industry. The alloy has a high shrinkage during solidification, as have many commercial sand casting alloys, and means for handling such alloys are well understood and available in commercial foundry practice. The pattern shrinkage allowance for the alloy is $\frac{1}{8}$ inch per foot. The density is 0.296 pound per cubic inch. A notable advantage of the alloy in sand casting is that the sand does not adhere to the casting and can be removed easily by shaking or by blowing. Most commercial foundry alloys must be sand blasted to remove sand burned to their surfaces. In addition to sand casting, the

alloys of the invention may be chill cast or die cast.

Alloys of the invention display excellent retention of composition during manufacture and remelting. An alloy of zinc, manganese and copper without beryllium becomes heavily coated with a brown oxide film identified as manganous oxide (MnO), and is very difficult to handle. The inclusion of beryllium, as an anti-oxidant, in the alloys of the invention effectively inhibits surface oxidation of the alloy and loss of manganese on remelting. This is illustrated by the following example:

Four and one-half pounds of an alloy of synthetic composition 60% copper, 21% zinc, 18.5% manganese and 0.5% beryllium were prepared. The alloy was prepared by melting the copper and a 0.2% beryllium-copper hardener together. The melt was lowered to 950° C. and zinc was added. The temperature was lowered to 900° C., and a 2" x 4" x 1/4" slab, pigs, and water-pour were cast. The pigs were remelted, raised to a temperature of 900° C. and water-pour and pigs were cast as before. This was repeated until the alloy had been remelted a total of four times. Following are the analytical data:

Analysis

Condition	Copper	Manganese	Beryllium	Remarks
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	
As prepared.....	61.7	13.9	0.08	Clean and white.
First remelt.....		13.8		Slightly oxidized.
Second remelt.....		13.6		More oxidation.
Third remelt.....		13.3		Do.
Fourth remelt.....		12.7	0.01	Definitely oxidized but considerably cleaner than corresponding copper-zinc-manganese alloy without beryllium.

The alloys of the invention have desirable corrosion resistant properties. Thus, the alloys withstand the effects of sea water, dilute acids and alkalies better than many of the heretofore available types of brass and bronze.

The alloys of the invention are competitive with, and in some cases superior to, bronzes including both tin and aluminum bronzes. The alloys may be rolled or otherwise mechanically worked. The alloys containing from 15 to 25% zinc and from 10 to 20% manganese (more particularly 18-23% zinc and 15-20% manganese) resemble nickel silver, and when rolled may be fabricated in much the same manner as nickel

silver, as, for example, in the manufacture of tableware, which may be electroplated with silver.

I claim:

1. An alloy containing 15 to 37.5% zinc, 7.5 to 30% manganese, 0.005 to 2% beryllium, and the balance substantially all copper but not less than 50%.

2. An alloy containing 15 to 37.5% zinc, 7.5 to 30% manganese, 0.01 to 0.5% beryllium, and the balance substantially all copper but not less than 50%.

3. An alloy containing 15 to 37.5% zinc, 7.5 to 30% manganese, 0.005 to 2% beryllium, 0.1 to 3% lead, and the balance substantially all copper but not less than 50%.

4. An alloy containing 15 to 37.5% zinc, 7.5 to 30% manganese, 0.01 to 0.5% beryllium, 0.1 to 3% lead, and the balance substantially all copper but not less than 50%.

5. An alloy containing 18 to 23% zinc, 15 to 20% manganese, 0.01 to 0.2% beryllium, and not less than 53% copper.

6. An alloy containing 18 to 23% zinc, 15 to 20% manganese, about 0.1% beryllium, and not less than 53% copper.

7. An alloy containing 18 to 23% zinc, 15 to

20% manganese, 0.01 to 0.2% beryllium, 0.1 to 3% lead, and not less than 53% copper.

8. An alloy containing about 21% zinc, about 18% manganese, 0.01 to 0.2% beryllium, and not less than 57% copper.

9. An alloy containing 20 to 25% zinc, 7.5 to 12.5% manganese, 0.01 to 0.2% beryllium, and not less than 59% copper.

10. An alloy containing 20 to 25% zinc, 7.5 to 12.5% manganese, 0.01 to 0.2% beryllium, 0.1 to 3% lead, and not less than 59% copper.

11. An alloy containing about 22% zinc, about 10% manganese, 0.01 to 0.2% beryllium, and not less than 64% copper.

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