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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 small amounts of silicon and beryllium. In addition to imparting other desirable physical properties to the alloys, silicon and beryllium function as anti-oxidants, preventing oxidation of the alloying constituents, particularly manganese, during the production of the alloy and during its subsequent remelting, beryllium being more useful in this respect than silicon.

The alloys of the invention, in its broad aspect, contain from 15 to 37.5% zinc, from 7.5 to 30% manganese, from 0.25 to 2%, and preferably from 0.25 to 1%, silicon, 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. In general, silicon in amount less than 1% increases the tensile strength and hardness of the alloy in a desirable manner, although at the expense of some loss in tensile elongation. In amount above 1%, silicon progressively increases the hardness but decreases the tensile strength and elongation.

Particularly useful alloys of the invention contain from 18 to 23% (preferably about 21%) zinc, from 15 to 20% (preferably about 18%) manganese, from 0.25 to 1% (preferably about 1%) silicon, from 0.01 to 0.2% (preferably about 0.08%) beryllium, and from not less than 52% up to about 67% (preferably from 56 to 60%) 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 0.25 to 1% (preferably about 1%) silicon, from 0.01 to 0.2% (preferably about 0.08%) beryllium, and from not less than 58% up to about 72% (preferably from 63 to 67%) copper.

In addition to increasing the tensile strength and hardness, silicon refines the grain structure of the alloy. Iron has an effect similar to silicon in these respects, but in the presence of silicon adversely affects the tensile strength. Hence,

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while the alloy may contain a small amount of iron, sometimes present as an impurity in the alloying elements, we prefer to limit the iron content of the alloys of the invention to 0.15% or less. Small amounts of lead, say from 0.1 to 3%, may also be included in the alloy without any substantial deleterious effect on the cast metal. Lead, as in ordinary brass, imparts to the alloy desirable properties with respect to machinability.

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 alloys of the invention, the silicon and beryllium are preferably introduced in the forms of copper-silicon and copper-beryllium hardeners or alloys. The copper and the copper-beryllium hardener (containing about 4% 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 and silicon (the latter as a copper-silicon hardener containing about 15% of silicon) are plunged into the melt, 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, 1% silicon, 0.1% beryllium, and the balance essentially copper has a melting temperature of about 825° C., and can be cast at temperatures from 850 to over 1000° C. The preferred temperature range for casting is 850 to 900° 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 $\frac{3}{16}$ 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 containing neither silicon nor beryllium becomes heavily coated with a brown oxide film identified as manganous oxide (MnO), and is very difficult to handle. The inclusion of the anti-oxidants in the alloys of the invention effectively inhibits surface oxidation of the alloy and loss of manganese on remelting.

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 may be readily machined. As hereinbefore mentioned, inclusion of lead, say from 0.5 to 3%, improves the machineability. For example, alloys of the invention in the form of bars for screw machine use may advantageously contain around 2% of lead.

The alloys of the invention are competitive with, and in some cases superior to, bronzes including both tin and aluminum bronzes. Thus, ship's propellers and marine fittings, such as steam valves and the like, can be advantageously made thereof.

I claim:

1. An alloy containing 15 to 37.5% zinc, 7.5 to 30% manganese, 0.25 to 2% silicon, 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, 0.25 to 1% silicon, 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, 0.25 to 2% silicon, 0.005 to 2% beryllium, lead not exceeding 3%, 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, 0.25 to 1% silicon, 0.01 to 0.5% beryllium, lead not exceeding 3%, and the balance substantially all copper but not less than 50%.

5. An alloy containing 18 to 23% zinc, 15 to 20% manganese, 0.25 to 1% silicon, 0.01 to 02.% beryllium, and not less than 52% copper.

6. An alloy containing 18 to 23% zinc, 15 to 20% manganese, 0.25 to 1% silicon, 0.01 to 0.2% beryllium, lead not exceeding 3%, and not less than 52% copper.

7. An alloy containing about 21% zinc, about 18% manganese, 0.25 to 1% silicon, 0.01 to 0.2% beryllium, and not less than 56% copper.

8. An alloy containing about 21% zinc, about 18% manganese, 0.25 to 1% silicon, 0.01 to 0.2% beryllium, lead not exceeding 3%, and not less than 56% copper.

9. An alloy containing 20 to 25% zinc, 7.5 to 12.5% manganese, 0.25 to 1% silicon, 0.01 to 0.2% beryllium, and not less than 58% copper.

10. An alloy containing 20 to 25% zinc, 7.5 to 12.5% manganese, 0.25 to 1% silicon, 0.01 to 0.2% beryllium, lead not exceeding 3%, and not less than 58% copper.

11. An alloy containing about 22% zinc, about 10% manganese, 0.25 to 1% silicon, 0.01 to 0.2% beryllium, and not less than 63% copper.

12. An alloy containing about 22% zinc, about 10% manganese, 0.25 to 1% silicon, 0.01 to 0.2% beryllium, lead not exceeding 3%, and not less than 63% copper.

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