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TREATMENT OF LEADED BRASS ALLOYS FOR IMPROVING MACHINEABILITY AND PRODUCTS SO PRODUCED

Lewis E. Thelin, Waterbury, Conn., assignor to The Bristol Brass Corporation, Bristol, Conn., a corporation of Connecticut

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This invention relates to the treatment of copper base alloys, and more particularly to the treatment of leaded brass, or free-cutting brass, to improve machineability.

For many years, the leaded brass alloys in use have been considered as adequate for the machine tools in use. More recently, however, the development of machine tools with high peripheral and machine speeds have indicated deficiencies in the usefulness and adaptability of the available free-cutting brasses.

An important object of the invention therefore is to provide a leaded brass alloy having improved qualities for machining purposes.

A further object is in the provision of a leaded brass which will reduce abrasion to tool faces during machining operations thereby increasing tool life and decreasing tool wear.

Broadly speaking, leaded brass is a lead-copper-zinc alloy consisting essentially of 60–90% copper, 0.25–4.0% lead, and the balance of zinc. The commercially most important brass within this range comprises 60–65% copper, 0.25–4.0% lead, and the remainder zinc. Operations contemplated within the purview of this invention are those such as are performed in screw machines, drill presses, milling machines, turret lathes, embossers, and the like, and may include threading and knurling.

Of necessity, commercial brasses are made with a high proportion of scrap and remelt. Therefore, it is usually quite difficult to control the specific proportions of impurities within the alloy while still remaining within the A.S.T.M. standards of about .25% permissible impurities. Such elements as iron, tin, aluminium, nickel, cadmium, antimony, and silicon may be present in uncontrollable quantities. These impurities, including complex lead-copper-zinc oxides and other compounds, although sub-microscopic in size, seriously affect the machineability of leaded brasses. The impurities may exist on the surface or be disbursed throughout more particularly on the lead particles. Since it is well known that the lead is added as a chip breaker, the impurities existing on the lead particles are detrimental to the machineability. Moreover the machineability of leaded brasses does not necessarily conform to the standard properties, such as tensile strength, percent elongation, etc. Thus machineability cannot be adequately determined in this manner.

The present invention contemplates the use of very specific proportions of certain elements added to the leaded brass, for example, calcium, lithium and magnesium. Apparently lithium is most effective, with calcium next in effectiveness. The use of such metals has been known for the casting of copper oxide scavenger for improving the pouring and casting qualities. These additive metals usually substantially "boil off" in casting. Moreover, it has always been felt that the more added the better, with cost being the only consideration. Effectiveness of such additive elements as calcium-lithium, on cleaning lead when zinc is present, was unknown. Zinc itself has been acting as a scavenging agent for the casting and whether the additive elements react with the zinc and copper, and not the lead has been heretofore

undetermined. Furthermore, before machining, the leaded brass must undergo operations such as drawing to rod. The effect of such operations was not entirely clear, particularly since grain size and distribution is affected.

The addition of these elements must be controlled very carefully to the type of material being melted. Otherwise adverse properties will result. For example the present invention contemplates the use of a substantial portion of scrap. This is probably, but not necessarily, due to the formation of complex chemical compounds not removed before casting, which complex compounds, although sub-microscopic in size, seriously affect tool wear by abrasion. Excessive use of the additive elements would adversely affect machineability, as would insufficient use. The exact reason for this is not readily determined, but the following examples provide some evidence. Distribution, quality, and size of the lead particles may be a factor, and excessive addition of these elements may cause "too much" cleaning in one area, thereby reducing uniformity and consequently machineability. Moreover, for fine machining an excess would seem to increase the tendency of undesirable firecracking.

Example 1

A lot of free cutting brass billets for use as rod were cast at 2100° using the following charges:

	Pounds
Leaded brass alloy scrap	850
Copper	120
Zinc	82
Lead	8

The resulting analysis showed 62.03% copper, 2.95% lead, 0.15% iron and other impurities, and the remainder zinc. Alpha-beta structure was present in normal proportion. The billets were extruded to $^{15}/_{32}$" round rod, drawn to 0.406" round, annealed to between 800°–1100°, and again drawn to 0.328" round ($^{21}/_{64}$"). The resulting rod was all Alpha structure with normal lead distribution. The properties tested showed a tensile strength of 74,000 p.s.i., yield strength of 61,000 p.s.i., 10% elongation in 2 inches, with a consequent 48.7% reduction of area. On a subsequent machining operation the rod ran 34 hours before the high speed steel tools required sharpening to maintain the set machining depth. This was normal for free cutting, or leaded, brass.

Example 2

A lot of billets was cast at 2100° using proportions similar to Example 1, but before pouring the melt, calcium and lithium in equal proportions were added using a standard phosphorizer, at a ratio of 8 ounces of calcium and lithium per 1000 lbs. of brass melt. The resulting analysis showed 62.04% copper, 3.12% lead, 0.20% iron and the other impurities, and the remainder zinc. Again alpha-beta structure was present in apparently normal proportion. Extruding, drawing and annealing was conducted in the manner of Example 1 with the result being all Alpha structure and apparently similar lead distribution. Properties tested indicated 78,500 p.s.i. tensile strength, 61,200 p.s.i. yield strength, 10% elongation in 2" with consequent 45.2% reduction. Machining operations indicated a shearing off and a tendency to firecrack. The machine tools remained relatively sharp, since the shearing and firecracking were premature.

Example 3

The procedure according to Example 2 was followed except that the calcium lithium added was 2 ounces per 1000 pounds of leaded brass. Analysis disclosed a similar proportion of elements, with alpha-beta structure

present. Preparation of rod was as in the previous examples, and resulted in all Alpha structure. Tested properties were 73,500 p.s.i. tensile strength, 58,100 p.s.i. yield strength, 10% elongation in 2 inches with 46.9% area reduction. Results in machining were erratic, with some samples showing improved machineability and longer tool life, while other samples gave results similar to Example 1.

Example 4

The procedure according to Example 2 was again followed except that the calcium lithium ratio was 4 ounces per 1000 pounds melt. A similar proportion of elements again with alpha-beta structure present in normal percentages. After processing to rod as in the previous examples, apparently all Alpha structure was again the result. Properties were 70,600 p.s.i. tensile strength, 58,700 p.s.i. yield strength, 8.5% elongation in 2 inches with 41.1% area reduction. Machining was markedly improved, with tool life for the various samples being at least one third longer, with some samples as much as 200 percent longer. Neither shearing nor firecracking were evident, even with extremely thin walled machine parts.

Example 5

Samples of the rod prepared in Example 4 were relief annealed at 525° F. The mechanical properties were then 70,900 p.s.i. tensile strength, 61,300 p.s.i. yield strength, 11% elongation in 2 inches, with 44.4% area reduction. Results in machining were as good as Example 4, again with no firecracking in thin walled parts.

By using a typical comparative drill test, the superiority of the intermediate range was confirmed. The test consisted of a horizontal ⅛" drill acting on the specimen, with the drill mounted on a track and driven by a constant weight, the depth of drill in millimeters being measured over a constant time.

Using a drilling time of 60 seconds, to compare Examples 1 and 2, the following depth of drill resulted:

Example 1 (3 samples)	4.5–5.0–5.0
Example 2 (3 samples)	4.5–4.0–4.0

This indicates relative superiority of no calcium-lithium over the 8 ounce ratio.

Using a drill time of 30 seconds to compare Examples 1, 4 and 5:

Example 1 (3 samples)	2.0–2.0–2.5
Example 4 (2 samples)	3.5–3.5
Example 5 (2 samples)	3.0–3.0

Using a drill time of 30 seconds to compare Examples 1, 3 and 4.

Example 1 (3 samples)	3.0–3.0–3.5
Example 4 (3 samples)	3.5–4.0–3.5
Example 3 (3 samples)	4.5–3.0–2.5

Thus, example 4 exhibited regular superiority, while Example 3 was erratic, and suprisingly, Example 1 for drilling was superior to Example 2.

Having thus described certain details of my invention, I claim:

1. A method of treating brass to improve the machineability thereof which comprises adding to molten brass an additive selected from the group consisting of lithium and admixtures of lithium and calcium in an amount of from two to eight ounces of additive per thousand pounds of molten brass.

2. A method according to claim 1 wherein the brass consists essentially of copper, lead and zinc.

3. A method according to claim 2 wherein the additive is a mixture of equal parts by weight of lithium and calcium.

4. A method according to claim 2 wherein the additive is lithium.

5. Free-cutting brass having improved machining qualities containing an additive selected from the group of lithium and admixtures of lithium and calcium in an amount of from two to eight ounces of additive per thousand pounds of brass, said amount being determined by the addition of the said amount of additive to the brass when said brass is in a molten state.

6. Free-cutting brass according to claim 5 wherein the brass consists essentially of copper, lead and zinc.

7. Free-cutting brass according to claim 6 wherein the additive is a mixture of equal parts by weight of lithium and calcium.

8. Free-cutting brass according to claim 6 wherein the additive is lithium.

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HYLAND BIZOT, *Primary Examiner.*

ROGER L. CAMPBELL, DAVID L. RECK, *Examiners.*

D. L. REISDORF, R. O. DEAN, *Assistant Examiners.*