

UNITED STATES PATENT OFFICE

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COPPER ALLOY AND PROCESS OF TREATING SAME

No Drawing.

Application filed February 16, 1929. Serial No. 340,651.

This invention relates to a process of treating alloys to impart desirable properties thereto and the product produced thereby. In particular, the invention relates to a class of alloys consisting principally of copper, tin and zinc, and characterized, when treated according to the process hereinafter disclosed, by properties giving them special utility when used in forming lubricated wearing surfaces, such, for example, as in bearings, bushings, pump cylinders, gears, etc.

The most important feature of the copper-tin alloys (tin bronzes) that causes them to be especially suitable for use in bearings and in similar situations where resistance to wear is desirable, is their peculiar structure in the cast state, which is characterized by the presence of a soft ground mass serving as a matrix for, and containing inclusions of, a second constituent,—the delta phase,—of considerable hardness, so forming a very desirable complex possessing good bearing qualities.

Other alloys used for bearings, or more specifically for bushings, are certain high zinc brasses composed of a high proportion of copper in alpha phase and a low proportion in beta or delta phase. These alloys, while they are cheaper than the high tin bronzes and can be hot worked with ease, since at high temperatures they transform into a uniform beta phase, are less satisfactory for bearing purposes than the tin bronzes, either because of insufficient hardness (too great a proportion of the softer alpha phase as compared with the harder beta phase) or because of the distribution of the harder phase in the softer ground mass in such a way as to present an excessive amount thereof at the wearing surface with consequent lack of ability to retain an adequate oil film thereon.

While alpha copper alloys are workable cold and to a slight extent when hot and the beta alloys are all workable hot, such alloys as are built up of mixtures of the alpha and beta phases, at any temperature below the freezing point, are not easily workable by pressure or tension either in the hot or cold state.

High tin bronzes are not exempt from the

action of this rule. The bronzes containing between 6 and 18% tin cannot be worked while hot. Such alloys containing above 18%, and up to 27%, tin are easily workable while hot, but are relatively expensive, and, what is more important, are at room temperatures too brittle and hard throughout their structure to be useful as structural materials or for bearings and bushings.

I have found that ternary bronzes can be made to behave much like complex brasses (alpha plus beta) in their ability to be hot worked when brought into the beta state and to retain a high strength with considerable ductility in the cold state. Also, they possess the property of high tin bronzes of being able to form a well distributed delta tin constituent of high hardness, which makes them good for wear resistance, not only because of the inherent hardness of such constituent, but also because the uniform distribution of the delta constituent in suitably sized particles throughout the ground mass or matrix imparts to a wearing surface prepared therefrom the ability to become covered with a substantial film of lubricant in the regions occupied by the softer alpha constituent of the matrix.

I have also found that such ternary bronzes can be markedly improved by structural changes resulting from a process of heat treatment.

Alloys coming within the present invention can be prepared within the following range of proportions:

	Per cent	
Tin 4.....	18	
Zinc 10.....	35	
Copper balance.		

The amounts of zinc and tin depend each upon the other. The more zinc the alloy contains, the less tin it may contain. Small amounts of nickel up to 10%, and preferably around to 3%, may be substituted for an equal amount of copper, and either a part of the tin or the zinc may be replaced by about half its weight of aluminum, aluminum preferably, however, not being added in amounts greatly exceeding 1% of the total. Iron and cobalt in amounts of from 0.3 to 2.0% may

also form useful but not absolutely necessary additions. These alloys may also contain small amounts of magnesium, phosphorus, silicon or manganese used as deoxidizers.

- 5 When aluminum is present amounts of manganese up to 4% may be added with very beneficial results.

These alloys can be used as cast or be hot worked by forging, rolling, or especially, by
10 extrusion; but to improve their structural features and ensuing properties it is necessary to subject them to heat treatment, as follows:

The cast or hot worked piece is heated up
15 to or above a point where the alloy forms a homogeneous beta phase or a mixture of the two betas possible,—650°–800° C., according to the composition,—and then quenched or air cooled. This brings it into a hard martensitoid or acicular form. It is next heated
20 to a point above the eutectoid point, or from 550°–625° C., and kept at this temperature for from one to six hours, or until the acicular structure is destroyed and the beta
25 phase divorces from the alpha; the first coalescing in the form of well-rounded dense grainlets sufficiently well spaced within the matrix of alpha to permit the formation of a lubricating film on the surface when in use.

30 The next step consists in lowering the temperature preferably to 450°–525° C., and not below 250° C., and holding such temperature for such time as to allow the beta phase to dissociate into alpha plus delta, the latter
35 forming very fine particles within each original grainlet of beta. When this condition is reached the structure will have become stabilized.

What I claim is:

40 1. Process of treating alloys containing 4–18% tin and 10–35% zinc, with the balance principally copper, to improve their properties for use as lubricated wearing surfaces, comprising heating the alloy to from 650°
45 to 800° C., and quickly cooling to produce a hard acicular structure, then reheating to from 550° to 625° C., maintaining the alloy at such temperature for sufficient time to destroy the acicular structure and produce
50 a structure characterized by the presence of beta crystals uniformly distributed throughout a matrix of alpha crystals, and finally gradually cooling the alloy at such a rate as to promote dissociation of the beta form into
55 alpha plus delta.

2. Process of treating alloys containing 4–18% tin and 10–35% zinc, with the balance principally copper, to improve their properties as lubricated wearing surfaces, comprising
60 heating the alloy for such time and at such temperature as to bring about a uniform beta state of the alloy constituents, then quickly cooling to produce a hard acicular structure, then reheating to a point above
65 the eutectoid transformation point for the

alloy to produce a structure characterized by the presence of beta crystals uniformly distributed throughout a matrix of alpha crystals, followed by slow cooling to produce stabilization.

3. Process of treating alloys containing
70 4–18% tin and 10–35% zinc, with the balance principally copper, to improve their properties for use as lubricated wearing surfaces, comprising heating the alloy to from 650°
75 to 800° C., and quickly cooling, then reheating to from 550° to 625° C., finally cooling to a point within the range 250°–525° C., and holding within such range until the beta phase constituent has dissociated into alpha
80 plus delta and the structure has become stabilized.

4. An article of manufacture consisting of an alloy containing 4–18% tin and 10–35% zinc, with the balance principally copper, and
85 characterized by a physical structure and properties such as are produced when an alloy of like composition is heated to from 650° to 800° C., quickly cooled, then reheated to from 550° to 625° C. and held at such
90 temperature for sufficient time to destroy the acicular structure and produce a structure characterized by the presence of a beta phase constituent uniformly distributed throughout a matrix of an alpha phase constituent,
95 and finally gradually cooled at such a rate as to promote dissociation of the beta form into alpha plus delta.

In testimony whereof, I have signed my name to this specification, this 11th day of
100 Feb., 1929.

MICHAEL G. CORSON.

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CERTIFICATE OF CORRECTION.

Patent No. 1,792,146.

Granted February 10, 1931, to

MICHAEL G. CORSON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, strike out the table between lines 85 to 89, and insert instead

Tin 4 — 18%

Zinc 10 — 35%

Copper balance.;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 17th day of March, A. D. 1931.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.