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COPPER-BASE ALLOYS

Donald K. Crampton, Marion, Conn., assignor to The Chase Companies, Incorporated, Waterbury, Conn., a corporation

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This invention relates to copper-base alloys composed mainly of copper, aluminum, tin and zinc.

One object of the invention is to provide copper-base alloys of improved corrosion-resistance and other characteristics.

The foregoing and other objects will appear from the following description and appended claims.

One of the important uses for which my improved alloys are adapted, is for condensers and other uses where corrosion is encountered, especially corrosion resulting from exposure to saline waters. The more important types of corrosion attack are impingement attack, dezincification, especially plug-type dezincification, intercrystalline attack or corrosion, and general thinning.

Impingement attack usually causes a number of clean perforations extending through the metal.

Plug-type dezincification creates in the alloy isolated plugs of porous and sponge-like material extending ultimately completely through the wall of a tube, for instance, and hence renders such a tube brittle and pervious to fluids at such places, and often renders a tube useless even though less than 1/1000% of the tube has been attacked.

Intercrystalline attack or corrosion results in corrosion taking place at the grain boundaries, and in addition to causing complete penetration through a tube to permit seepage, it also decreases the strength of the metal by destroying the bond between the crystals.

General thinning, as its name implies, is a surface corrosion which decreases the thickness of the wall of a tube substantially uniformly.

It is known that the addition of a suitable percentage of aluminum to high copper brasses (70% Cu and upwards) serves to markedly increase the resistance of such copper-zinc alloys to impingement attack. But under certain conditions, such for instance as when an alloy is exposed to saline waters at temperatures above normal, the aluminum acts to markedly decrease the resistance of the alloy to dezincification, especially plug-type dezincification.

If a condenser tube is subjected to substantially uniform general thinning type of corrosion, the tube may still be serviceable even after as much as 40% of the metal of the tube has been dissolved, whereas in the case of impingement attack or plug-type dezincification or intercrystalline attack, the tube may be rendered useless even though only a very small per cent of the metal of the tube has been attacked. It is therefore obvious that impingement attack, plug-type dezincification and intercrystalline attack are very serious types of corrosion, whereas general thinning to a moderate extent, is comparatively harmless.

The inventor of Patent No. 1,874,617, granted August 30, 1932, set forth certain advantages of a copper-zinc-aluminum-nickel-tin alloy. But as shown by his Patent No. 1,815,071, granted on July 21, 1931 (but filed nearly a year after his Patent No. 1,874,617 was filed), he came to the conclusion that tin was highly undesirable as a constituent and in the Patent No. 1,815,071 stated, in lines 27 and 28 on page 1, that "in no case must there be any appreciable amount of tin present," and in lines 82 to 98 on page 1, stated:

"It was found that the freedom of the alloy from tin was particularly important in the manufacture of condenser tubes from ingots of the alloy by extrusion methods. When tin was present, even in small amounts, the ingot could not be extruded in a special tube extrusion machine of 900 tons capacity, unless the ingots were heated to a high temperature, for example, above about 950° C., at which the tin liquidated. By omitting the tin the alloy could be readily extruded at the customary temperatures and pressures of working.

"Also by omitting the tin the resistance to corrosion and oxidation at elevated temperatures was greater than when tin was present."

I have discovered, on the other hand, that alloys substantially free of nickel and containing copper, aluminum, tin and zinc possess a number of valuable properties. I have discovered that alloys substantially free of nickel and having approximately 75% to 95% copper, ½% to 4% aluminum, ¼% to 2% tin, and the balance mainly of zinc, have high resistance to impingement attack, dezincification, and intercrystalline attack. By the expressions "substantially free of nickel" and "substantially nickel-free," wherever used in the specification or claims, I hereby define and mean, that the alloy has so greatly less than the minimum 1.0% of nickel specified in Patent No. 1,874,617 that the resultant alloy possesses the herein described advantageous properties and is substantially free from the defects of the nickel and tin containing alloy stated in Patent No. 1,874,617. These nickel-free tin-containing alloys also can be worked into tubes with no greater difficulty than in the case of similar copper-aluminum-zinc alloys containing no tin. The presence of tin in my above alloys also results in greater fluidity of the alloy when molten, which

particularly helps in obtaining good castings free from inclusions of aluminum oxide. Aluminum oxide inclusions are very difficult to avoid with ordinary aluminum brass as the aluminum oxidizes very easily and the oxide so formed does not readily rise in the molten metal and free itself.

My foregoing copper-aluminum-tin-zinc alloys not only possess valuable corrosion-resistance properties, especially useful in condenser tubes and the like, but also are valuable for general structural and fabricating uses.

One of my nickel-free alloys containing 80% copper, 2% aluminum, 1% tin and 17% zinc, when subjected to a water-line test in dilute sea water of one-sixth its normal salt concentration for 35 days at 212° F., was subject to only slight general thinning and lost none of its original strength by corrosion and only 2% of its original ductility by corrosion.

My invention contemplates alloys of the nature, and possessing the characteristic properties, herein set forth, whether or not one or more additional elements are present.

I claim:

1. A substantially nickel-free alloy having not more nickel, if any, than an amount which is greatly less than 1% and comprising approximately: 75% to 95% of copper, ½% to 4% of aluminum, ¼% to 2% of tin, and the balance mainly of zinc.

2. A substantially nickel-free alloy having not more nickel, if any, than an amount which is greatly less than 1% and comprising approximately: 80% of copper, 2% of aluminum, 1% of tin, and the balance mainly of zinc.

3. A substantially nickel-free alloy comprising approximately: 75% to 95% of copper, ½% to 4% of aluminum, ¼% to 2% of tin, and the balance of zinc.

4. A substantially nickel-free alloy comprising approximately: 80% copper, 2% of aluminum, 1% of tin, and 17% of zinc.

DONALD K. CRAMPTON.