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METHOD OF MAKING ORDNANCE ALLOYS

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My invention relates to alloys, and more particularly to an alloy which is ideally adapted for use in ordnance, although it will be obvious to those skilled in the art that the alloy of my invention has many other uses.

Among the objects of my invention are: To provide an alloy ideally adapted for use for ordnance pieces; to provide an alloy highly resistant to mercury fulminate erosion and mercury corrosion; to provide an alloy of great strength that can be extruded and moulded into desired shapes; to provide an alloy plastic under heat and pressure; to provide an alloy having a high percentage of elongation and a high yield and tensile point; to provide an alloy of strength and grain structure comparable to that of forged steel, which can be moulded by extrusion processes, and to provide a beryllium-copper alloy having unique characteristics. It is also an excellent die-casting material due to its characteristic of deoxidizing at certain determined temperatures.

My invention possesses numerous other objects and features of advantage, some of which, together with the foregoing, will be set forth in the following description of my novel method.

My invention, in one aspect, broadly comprises the addition to a base material, such as beryllium-copper alloy, of aluminum, mercury and arsenic, to the end that the final alloy may be readily operated upon while in the plastic state, under heat and pressure, by extrusion moulding devices, without undesirable gasing and at high speed to produce a perfectly moulded, fine-grained, uniform part, comparable to a forging but with finished dimensions to accurate and close tolerances.

Another broad aspect is the formation of an alloy of a base material inoculated with mercury to prevent future corrosion or erosion by mercury or compounds thereof, sometimes in heated condition, and of sufficient strength to be used in ordnance.

The preferred alloy comprises the following ingredients:

Copper	Beryllium	Mercury	Aluminum	Arsenic
Per cent 60-94	Per cent 0.10-11	Per cent 1-5	Per cent 1-20	Per cent 0.10-2.00

The alloys within the above ranges are all especially suitable for gun barrel and ordnance uses, particularly because of the protection received by permanent inoculation of mercury in the alloy

which greatly reduces the affinity mercury fulminate has for gun barrels, as will be discussed later, because parts may be extrusion-moulded therefrom, and because they have sufficient strength to withstand modern gun chamber pressures.

When beryllium-copper is used as a base material, the base alloy is usually purchased as a concentrated product, and I add thereto pure copper to establish the correct percentage for the type of metal to be obtained, the following procedure being followed:

A small amount of pure copper is placed on the bottom of a melting pot, on top of which is placed the arsenic, and then more pure copper. The beryllium-copper concentrate is then added. The last portion of the pure copper is then placed on top of the entire combination. Powdered graphite is generally added to assist in cleaning these mixtures as they are being alloyed.

The heat applied to the mix is increased slowly at first, and when molten this mixture requires some agitation to accomplish the best interaction of the ingredients. The temperature may then be dropped to maintain the molten liquid at about 50° centigrade over the freezing point of the melt in preparation for the addition of a stable mercury alloy, the formation of which will next be described.

A cold mercury alloy is preferably made by placing mercury in contact with aluminum foil, for example, for at least twenty-four hours. Inasmuch as any excess mercury will pass out of the melt, there is no necessity of a careful proportioning of the mercury. The aluminum-mercury alloy is then added while cold to the melt and thoroughly mixed with the first alloy at the maintenance temperature to distribute the aluminum-mercury material throughout the melt.

Before the aluminum mercury amalgam is entirely melted the heat of the mix is preferably increased and held at a higher value for a period of time utilized as a deoxidizing period. This period of time and temperature will vary with the various alloys and conditions of the metal being processed. During this time mercury vapor and other gases, such as oxygen, representing the escaping oxides or oxygen, are expelled, leaving a particularly fine-grained metal free from oxygen or oxides, when cast. This metal is then cast into suitable bars for use in an extrusion moulding machine. This machine, however, is no part of the present invention. The final alloy produced is readily main-

tained in a plastic stage and is easily moulded at high temperatures and pressures.

The basic result of the use of mercury, and its addition to ordnance material, is that by inoculating the alloy of copper, beryllium and aluminum with enough mercury to provide a stable content of mercury therein, the affinity of mercury fulminates toward the metal is greatly reduced. It is well known that mercury fulminate leaves a condensate on the riflings and grooves of guns, as well as on the firing chamber and all other parts exposed to the explosion in an ordnance piece. This accumulation of mercury causes erosion due to additional wear resulting from the softening of the metal by the mercury amalgam formed on these various surfaces. When the metal utilized for gun barrels has previously been alloyed with mercury, affinity for additional mercury is greatly reduced. I have found that, regardless of temperature, mercury will remain in the melt after addition thereto when previously alloyed cold with another metal, providing the boiling point of the metal with which the mercury is alloyed cold, is not reached during subsequent operations. Actual tests have been made, showing that any form of mercury, including mercury fulminate, does not have nearly as great affinity for this inoculated metal as it does for a similar metal not inoculated.

The aluminum, is for most practical purposes, used only as a carrier, to allow the proper insertion of the mercury into the alloy, and inasmuch as the boiling point of the aluminum-mercury alloy is well above that of mercury, only the mercury free from aluminum-mercury alloy will be released during the melt. Consequently, the addition of mercury is usually in

proportion to the addition of aluminum in the various alloys in the final cast metal.

The presence of the aluminum, as such, in the final alloy also aids to make an excellent plastic, and somewhat improves the moulding properties of the alloy. It also serves to reduce the melting, plastic and semi-plastic temperatures. Aluminum, however, is only one example of a useful mercury carrier, and other materials alloying with mercury may be used, such as silver, for example.

Some of the arsenic sublimes and leaves a dark solid formation which serves as a cleaner in the pot, along with the powdered graphite added for the same purpose. I may, however, eliminate arsenic entirely and rely on the graphite alone.

I claim:

1. The method of making ordnance material exposed to mercury fulminate, which comprises making a cold alloy of mercury and aluminum, and mixing said cold alloy with beryllium-copper at a temperature not over the vaporization temperature of said cold alloy.

2. The method of making an ordnance alloy resistant to mercury fulminate which comprises melting copper and beryllium to form a basal alloy thereof, forming a cold alloy of aluminum in an amount providing 1% to 20% of the final alloy with mercury in excess of the amount forming a stable amalgam with said aluminum, and adding said mercury alloy to said beryllium copper melted at a temperature less than the vaporization temperature of the amalgam but more than the vaporization temperature of free mercury.

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