United States Patent

Britton et al.

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[54] TREATMENT OF ALLOYS

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[58] **Field of Search** 148/11.5, 12.7, 13.2, 20, 20.6, 148/160, 32.5; 75/153

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[57] **ABSTRACT**

A process for the treatment of a beryllium-copper alloy to reduce or eliminate the distortion which occurs on precipitation treatment is provided in which the alloy is quenched in a medium providing a heat transfer coefficient of 150–750 B.Th.U/ft²h°F, said quenching being below the normal precipitation treatment temperature of said alloy.

The invention has utility in the production of an alloy which has little or no distortion on precipitation treatment as well as a predictable contraction.

6 Claims, No Drawings

TREATMENT OF ALLOYS

This invention relates to the treatment of beryllium-copper alloys by which term we mean a commercial beryllium-copper alloy which generally contains from 1.5 to 2.2 percent beryllium by weight with up to 0.5 percent cobalt and/or nickel.

This material is capable of precipitation hardening. In the fully precipitation-hardened condition, it has a high yield stress, which coupled with a low elastic modulus renders it particularly useful for the manufacture of springs. The hardening process consists of two stages: solution treatment followed by precipitation treatment. According to British Pat. No. 1420/65 the solution treated condition is defined as the condition obtained by subjecting a heat treatable alloy to a prescribed temperature and rapid cooling. In this case the temperature is in the region of 800° C and the usual method of cooling is by water quenching. Similarly, the precipitation treated condition is defined as the condition obtained by subjecting a solution treated alloy to reheating under prescribed conditions of temperature and time to increase its hardness and strength. The temperature for the alloy in question is 300°–350° C and the time normally 2 hours.

In the fully precipitation treated condition, the ductility of the material is negligible. It cannot therefore be formed in this condition. It is therefore necessary to form the material prior to the final precipitation treatment, that is to say in the solution treated condition. Simple shapes may be formed from material in the solution treated and cold worked condition. The material is subsequently precipitation treated as outlined above, so as to develop the required mechanical properties.

Unfortunately during this precipitation treatment considerable distortion of the parts occurs especially in the case of objects formed from flat stock e.g. strip, sheet, etc. Although a dimensional change is associated with the precipitation occuring during precipitation treatment there is also distortion, commonly of a twisting nature, which occurs in an apparently random and inexplicable manner.

It is of course apparent that this distortion on precipitation treatment is very considerable disadvantage since the precipitation treated article may have an entirely different shape from the shape in which it was formed. It is an object of the present invention to reduce or eliminate the random distortion which takes place when a beryllium-copper alloy of the type referred to is precipitation treated, for example by heating to a temperature of 300°–350° C. We have found that the distortion on precipitation treatment may be reduced or eliminated by introducing a particular quenching step after the alloy has been heated to the temperature prescribed for solution treatment referred to above.

This temperature prescribed for solution treatment is of the order of 800° C as indicated above. According to the invention, the material is quenched, by immersion in suitable medium such as a molten salt bath at a temperature below the normal temperature used for the precipitation treatment of the material which is as indicated above between 300°–350° C. A suitable temperature range for this quench is from 150° up to 300° C. The material thus treated shows a uniform contraction on precipitation treatment and not a random distortion as has previously been the case.

According to the invention there is provided a process for the treatment of a beryllium-copper alloy to reduce or eliminate the distortion which occurs on precipitation treatment in which the alloy is quenched in a medium providing a heat transfer coefficient of 150–750 B.Th.U./ft²h°F said quenching being below the normal precipitation treatment temperature of said alloy.

The quenching step provided by the invention forms part of the rapid cooling which is an integral part of conventional solution treatment. The advantages stem apparently from the fact that the quench is to a particular temperature and takes place in a material having a particular heat transfer coefficient. After the solution treatment the alloy may then be formed into a desired shape before the conventional precipitation treatment. If desired the alloy may be cooled to ambient temperature after the solution treatment and before forming but this is not necessary.

The invention also provides a shaped article of a beryllium-copper alloy which has been precipitation treated to develop the mechanical properties of the alloy and which has been formed after a solution-treatment in which the quench is effected in a medium providing a heat transfer coefficient of 150–750 B.Th.U./ft²h°F and at a temperature below the temperature used for the precipitation treatment of the formed alloy.

The preferred medium for the quench is a molten salt bath for example of a nitrate. The temperature used for the salt bath quench of the alloy may be varied within a wide range, but should be less than that for the precipitation treatment of the alloy. A preferred salt bath temperature is from 150–250° C.

The alloy which has been subjected to a salt quench according to the invention shows, as stated above, reduced or no distortion on precipitation treatment. There is, however, a uniform contraction which is substantially constant over of the material. The contraction which takes place on precipitation treatment can be varied by varying firstly the temperature of the solution treatment to which the material is subjected prior to the forming operation and secondly by varying the time and/or temperature of the salt bath quench. By varying these factors the possibility is provided for predictably controlling the dimensional change on precipitation treatment of a beryllium-copper alloy of the type referred to.

In order that the invention may be more fully understood, the following example is given by way of illustration only

Example

A copper-beryllium alloy containing 1.92 percent of Be (approx) was solution treated at 790° C and quenched into a salt bath at 190° C. The salt bath consists of sodium nitrite and sodium and potassium nitrates having an m.p. of 150° C such as that sold by I.C.I. and identified as Cassel T.S. 150. It was held in the salt bath for 1 minute. It was then cooled to room temperature. On precipitation treatment for 2 hours at 320° C a contraction of 0.14 percent in length was obtained. This did not vary by more than ±0.01 percent over the width of the strip.

We claim:

1. A process for the treatment of a beryllium-copper alloy containing from 1.5 to 2.2 percent beryllium by weight and up to about 0.5% cobalt and/or nickel, the balance being copper to reduce or eliminate the distortion which occurs on precipitation treatment in which the alloy is quenched in a molten salt bath providing a heat transfer coefficient of 150–750 B.Th. U/ft²h°F., until it has attained the temperature of said bath, said quenching being below the normal precipitation temperature of said alloy forming the alloy into a desired shape and subsequently heating the alloy shape to a temperature of from 300 to 350° C for a period of approximately 2 hours.

2. A process as claimed in claim 1 in which the quenching is effected at a temperature of from 150°–300° C.

3. A process as claimed in claim 1 in which the molten salt comprises a nitrate.

4. A process as claimed in claim 3 in which the salt bath is a mixture of sodium nitrite and sodium and potassium nitrates having a melting point of 150° C.

5. A process as claimed in claim 4 wherein said alloy contains approximately 1.92 percent beryllium and is solution treated at about 790° C and is quenched in said bath at about 190° C for about 1 minute and then cooled to room temperature.

6. A process for producing a precipitation hardened beryllium-copper alloy containing from 1.5 to 2.2 percent beryllium by weight and up to about 0.5 percent cobalt and/or nickel, the balance being copper which comprises the steps of: (a) heating the beryllium-copper alloy to a temperature of approximately 800° C; (b) quenching said heated alloy by immersion in a molten salt quench bath at a temperature of

150°–300° C providing a heat transfer coefficient of 150–750 B.Th. U./ft²h°F until it has reached about the temperature of said bath; (c) allowing said metal alloy to cool to ambient temperature; (d) forming the alloy into a desired shape and (e) heating the alloy shape to a temperature of from 300° to 350° C for a period of approximately 2 hours.

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