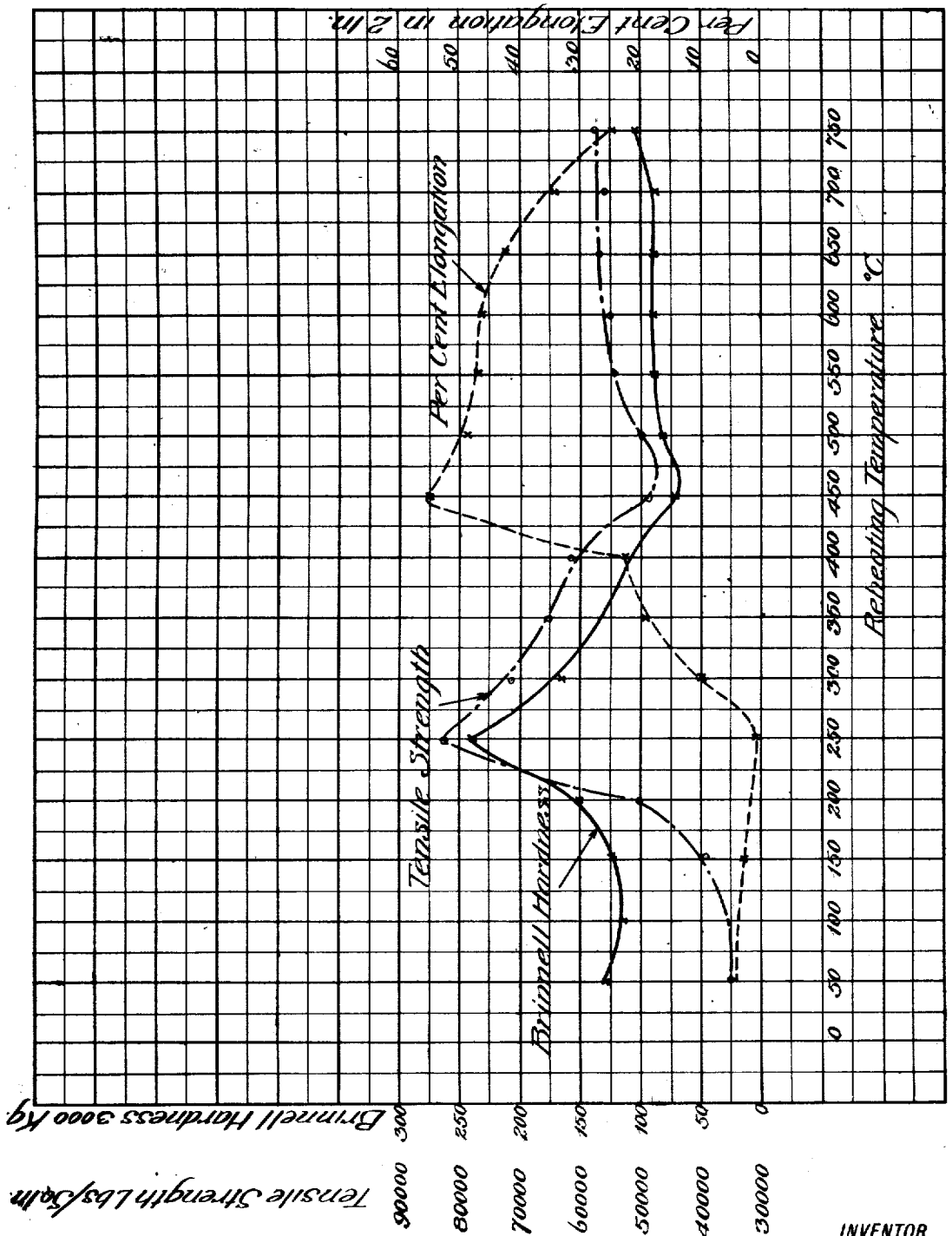
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METHOD OF TREATING COPPER ALLOYS AND IMPROVED PRODUCT

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METHOD OF TREATING COPPER ALLOYS AND IMPROVED PRODUCT.

Application filed January 30, 1924. Serial No. 689,504.

We have discovered a method of treating copper alloys, whereby it becomes possible to obtain products having definite predetermined characteristics of tensile strength, hardness or ductility, according to the result desired. The characteristic feature of our method is a double heat treatment with intermediate quenching, the first heat treatment being at a relatively high temperature, while the temperature of the second heat treatment is lower, but will vary with the characteristics desired in the finished product. Our process has been found particularly valuable for the heat treatment of brass such as 60-40 brass or Muntz metal, but it may also be applied to other brasses, ranging from 63% to 45% copper, and it may also be applied to other copper alloys, of which the temperature composition diagram resembles that portion of the brass diagram where Muntz metal is found. Portions of both the copper tin (bronze) and copper-aluminum diagrams have such resemblances.

Hereinafter, the term "brass" is to be understood to mean that range of copper-zinc alloys having 63% to 45% copper. The term "copper alloys" is to be understood to mean those alloys whose temperature-composition diagram resembles that portion of the copper-zinc diagram between 63% to 45% copper.

There may be present small percentages up to 10% or even more of other metals, such as lead, zinc, tin, aluminum, manganese, iron, nickel, cobalt, chromium, magnesium, tungsten, or non-metallic elements such as arsenic, phosphorus, sulfur. When these materials are added intentionally, it is for the purpose of improving the properties of the alloy.

The metal to be treated according to our invention may originally have been cast, rolled, drawn, extruded or spun and previously annealed or not.

The important thing is that our first heat treatment is at such a relatively high temperature as to be above the critical temperature at which the single solid solution exists. Those alloys to which the invention is applicable normally exist at room temperature made up of two components usually two solid solutions designated as alpha and beta. The alloys have the further property of transforming into a single solid solution called beta above a certain definite point called the critical temperature. If the alloy is allowed to transform into the beta condition and then is quenched quickly, substantially a single solid solution, beta, will be obtained at room temperature. In 60-40 brass for example, the critical temperature is above 775° C. or thereabouts, but it varies within limits for different alloys and for different compositions of copper alloys. Thus in an alloy with 52% copper, the temperature might be as low as 550° C. For copper aluminum alloys, the temperatures will vary from 550° C. to 1050° C. This temperature of the critical range is dependent on the composition and can be ascertained from the known diagram.

In practice we have found a temperature of 825° C. for a period of two hours to be suitable for this first heat treatment in the case of Muntz metal, but as the result at the end of this first treatment is in some measure a function of time and temperature, the latter may be varied somewhat by varying the length of this treatment.

This first heat treatment is followed by a quick quenching, preferably in cold brine, but other quenching media may be used.

The metal will now be in a condition of beta microstructure as the result of rapid cooling, although alpha may be found as a fringe at the grain boundaries. A second heat treatment at temperatures which we have determined will give a product having predetermined characteristics of strength, hardness or ductility. To start with the metal in the beta condition insures that results which are predetermined and reproducible will be obtained when the metal undergoes the second heat treatment. Heretofore, the properties of the alloy have been dependent on the condition of each piece and no definite heat treatment scheme or schedule has been possible.

For example, let us suppose that we wish to obtain a 60-40 brass of great tensile strength and hardness. We proceed as follows:—

Let us assume that the alloy is about 60 parts copper to about 40 parts of zinc, and containing, it may be also quite small percentages of other materials, such as lead, iron or manganese. We first subject this alloy to a temperature of over 775 degrees centigrade for a length of time, which may vary from half an hour to two hours, for example. We

have found that a temperature as high as 825 degrees centigrade, and a period of treatment as long as two hours have given good results.

These factors, temperature and time, may vary, the object being to heat for a time and not at a temperature which will substantially transform the alloy into a single solid solution.

At the end of this first heat treatment the metal is subjected to a quick quenching. Brine at a temperature of −8° C. may be used as the quenching medium. Any other medium will serve which will cause the piece to cool quickly enough to produce substantially pure beta solid solution at room temperature. The metal is now subjected to a second heat treatment, which is below that of the first heat treatment. In practice we have found that the best results for high tensile strength are obtained when the second heat treatment is somewhere in the neighborhood of 250° C., and the best results for ductility at about 450° C. The piece is kept at this reheating temperature until the single solid solution beta is transformed into alpha plus beta (or beta prime). This usually requires a shorter time than the primary heating. We have obtained good results with a temperature of about 250° C. for this second heat treatment and the length of the treatment half an hour. Thereafter for the production of high tensile strength and hardness the alloy metal is cooled in any convenient way, for we have found that the rate of this final cooling has no appreciable effect on the physical properties of the metal. This treatment will give an alloy which will be free from internal strains, a condition heretofore unknown with a brass of high tensile strength and hardness.

By the described process of double heat treatment we have obtained the copper alloy 60-40 brass with the remarkably high tensile strength of 82,750 pounds per square inch, with no elongation and a hardness of 240 (Brinell at 3000 kg.). The structure when examined microscopically was found to be made up probably of very fine alpha and beta or beta prime crystals uniformly distributed.

If on the other hand, a metal of high ductility is desired, the reheating temperature must be considerably higher, say up to 450° C. for the same length of time.

Attention is called to our co-pending application Serial No. 84,386, filed January 28, 1926 as a continuation in part of the present case. In that case, the claims which cover the heat treatment over the whole range of reheating temperatures are found and also specific claims for the heat treatment to obtain high ductility alloys. The claims in the present case cover the heat treatment to obtain alloys of high tensile strength and hardness and also product claims directed to new copper alloys of high tensile strength and hardness as disclosed herein.

The following table which is graphically illustrated in the diagrammatic figure of the accompanying drawing will serve as a guide to obtain any desired useful character of final product, although the temperatures in any given case may be varied slightly, especially if the normal period of half an hour for the second heat treatment be varied:—

Table.

Reheating temperature degrees C.	Brinell hardness		Tensile strength, lbs./sq. in.	Per cent elongation in 2 in.
	500 kg.	3,000 kg.		
50° C	97	126	35,000	4.0
150	100	123	38,750	3.0
200	136	149	52,500	1.0
250		241	82,750	0
300		163	71,250	9.0
350	130	131	65,000	19.0
400	119	111	61,250	22.0
450	69	68	48,750	55.5
500	74	82.5	50,000	49.0
550	74	85.5	55,000	47.0
600	76	87.1	55,000	47.0
650	79	88.7	56,750	42.5
700	85	88.7	55,750	34.0
750	96	107	57,000	24.5

In this way it is seen that given an alloy of a certain composition, it becomes possible to obtain by our double heat treatment a product of almost any desired physical properties from a low tensile piece with high elongation to one having high tensile strength with practically no elongation. These results are definite and can be predetermined by employing the appropriate reheating temperatures.

The figures in the accompanying table and drawing vary with the time and temperatures of operation, and the composition of the alloys being treated and are to be interpreted only as examples of the broad scope of the invention. Considerable modification in these factors is possible with no departure from the essential features of the invention.

We claim our invention:—

1. The method of treating those copper alloys whose composition is such that the particular alloy being treated falls within that portion of the temperature-composition diagram of its system which resembles the portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found which comprises heating the metal above the critical temperature to form a substantially single solid solution, beta; quenching to obtain the substantially single solid solution beta at room temperature; and thereafter reheating at a temperature below the critical point to transform the beta into finely divided alpha plus beta whereby an alloy of high tensile strength and hardness is obtained.

2. The method of treating brass whose

composition is such that the particular alloy being treated falls within that portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found which comprises heating the metal above the critical temperature to form a substantially single solid solution, beta; quenching quickly to obtain the substantially single solid solution beta at room temperature, and thereafter reheating at a temperature below the critical point to transform the beta into finely divided alpha plus beta whereby an alloy of high tensile strength and hardness is obtained.

3. The process of treating those copper alloys whose composition is such that the particular alloy being treated falls within that portion of the temperature-composition diagram of its system which resembles the portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found which comprises heating the alloy to a point above its critical temperature to obtain substantially a single solid solution; quenching quickly to obtain substantially a single solid solution at room temperature; and thereafter reheating at a temperature below the critical temperature to produce a structure of very finely divided crystals, corresponding to high hardness and tensile strength in the alloy body.

4. The process of treating brass whose composition is such that the particular alloy being treated falls within that portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found which comprises heating the alloy to a point above its critical temperature to obtain substantially a single solid solution; quenching quickly to obtain substantially a single solid solution at room temperature; and thereafter reheating at a temperature below the critical temperature to produce a structure of every finely divided crystals, corresponding to high hardness and tensile strength in the alloy body.

5. The method of treating brass whose composition is such that the particular alloy being treated falls within that portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found which comprises heating the metal above the critical temperature to form substantially a single solid solution; quenching quickly to obtain substantially the single solid solution at room temperature; and thereafter reheating at a temperature between 150 and 400° C.

6. The method of treating brass whose composition is such that the particular alloy being treated falls within that portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found comprising heating the alloy to a temperature above the critical point until there is formed substantially a single solid solution; quenching to obtain substantially the single solid solution at room temperature; and thereafter reheating to a temperature in the neighborhood of 250° C.

7. The method of treating Muntz metal which comprises heating the metal above the critical temperature to form substantially a single solid solution; quenching quickly to obtain substantially the single solid solution at room temperature; and thereafter reheating at a temperature between 150 and 400° C.

8. The method of treating Muntz metal comprising heating the alloy to a temperature above the critical point until there is formed substantially a single solid solution; quenching to obtain substantially the single solid solution at room temperature; and thereafter reheating to a temperature in the neighborhood of 250° C.

9. The method of treating Muntz metal comprising subjecting the alloy to a heat treatment of over 775° C. to obtain substantially a single solid solution, followed by quick quenching to obtain substantially the single solid solution at room temperature and then to a second heat treatment in the neighborhood of 250° C.

10. The process of treating copper alloys whose composition is such that the particular alloy being treated falls within that portion of the temperature-composition diagram of its system which resembles the portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found and which allow is made up substantially of a single solid solution, this process comprising heating the alloy at a temperature below the critical temperature to cause a crystalline transformation of the single solid solution into two solid solutions of very finely divided crystals uniformly distributed, corresponding to high hardness and tensile strength in the alloy body.

11. The process of treating brass whose composition is such that it falls within that portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found and which alloy is made up substantially of a single solid solution, this process comprising heating the alloy at a temperature below the critical temperature to cause crystalline transformation of the single solid solution into two solid solutions of very finely divided crystals uniformly distributed, corresponding to high hardness and tensile strength in the alloy body.

12. The process of treating brass whose copper content is approximately 60% and which is made up substantially of a single solid solution, the process comprising heating the alloy at a temperature between 150° C. and 400° C. to obtain in the alloy very finely divided crystals corresponding to

high hardness and tensile strength in the alloy body.

13. A copper alloy whose composition is such that the particular allow being treated falls within that portion of the temperature-composition diagram of its system which resembles the portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found, the copper alloy being characterized by high hardness and tensile strength and having these properties by reason of the presence therein of very finely divided crystals uniformly distributed.

14. A copper alloy whose composition is such that the particular alloy being treated falls within that portion of the temperature-composition diagram of its system which resembles the portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found, this alloy being characterized by high hardness and tensile strength and having these properties by reason of the presence therein of very finely divided alpha and beta crystals uniformly distributed.

15. A brass whose composition is such that the particular alloy being treated falls within that portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found, this brass being characterized by high hardness and tensile strength and having these properties by reason of the presence therein of very finely divided crystals uniformly distributed.

16. A brass whose composition is such that it falls within that portion of the copper-zinc temperature-composition diagram in which 60-40 brass is found, this brass being characterized by high hardness and tensile strength and having these properties by reason of the presence therein of very finely divided alpha and beta crystals uniformly distributed.

17. Muntz metal characterized by a tensile strength of over 75,000 pound per square inch and a Brinell hardness of over 200 and having these properties by reason of the presence therein of very finely divided crystals uniformly distributed.

18. Muntz metal characterized by a tensile strength of over 80,000 pounds per square inch and a Brinell hardness of over 220 and having these properties by reason of the presence therein of very finely divided crystals uniformly distributed.

In testimony whereof we have signed our name to this specification.

VICTOR O. HOMERBERG.
DEXTER N. SHAW.

CERTIFICATE OF CORRECTION.

Patent No. 1,680,046. **Granted August 7, 1928, to**

VICTOR O. HOMERBERG ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 7, strike out the word "not"; page 3, line 44, claim 4, for the word "every" read "very", and line 102, claim 10, for "allow" read "alloy"; page 4, line 4, claim 13, for "allow" read "alloy", and line 44, claim 17, for "pound" read "pounds"; same page, line 56, for the word "name" read "names"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of November, A. D. 1928.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.

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