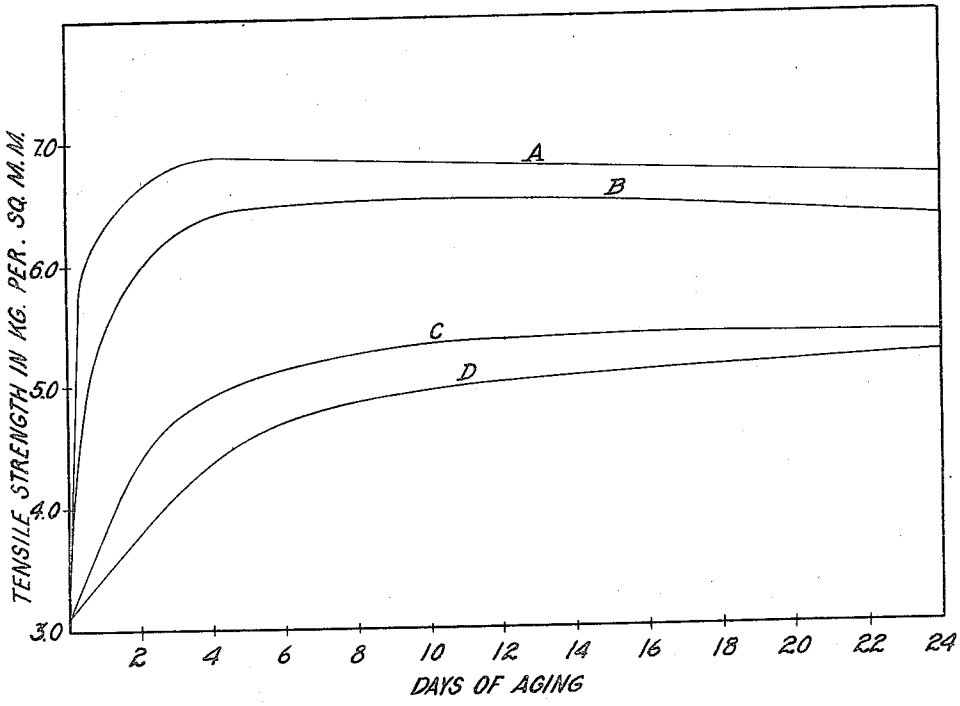
June 26, 1928. 1,674,959

R. S. DEAN

HARDENABLE ALLOY

Filed Jan. 23, 1926



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Patented June 26, 1928. 1,674,959

UNITED STATES PATENT OFFICE.

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HARDENABLE ALLOY.

Application filed January 23, 1926. Serial No. 83,177.

This invention relates to hardenable alloys, and more especially to methods of producing the same.

The object of the invention is to provide a practical and efficient method for producing age hardenable alloys having different degrees of hardness.

One method embodying the invention consists in controlling the rate of cooling of the alloy subsequent to its heat treatment, and more specifically consists in utilizing cooling media which more or less inherently control the rate of cooling.

The copending application, Serial No. 690,716, filed February 15, 1924, of R. S. Dean and W. E. Hudson, discloses that by adding to lead matter which will be soluble in lead and having a solubility which will vary with a change in temperature, the lead alloy can be treated by a process to enhance its properties to produce a product which is resistant to corrosion, is plastic, but has a greater hardness, toughness, tensile strength and resistance to abrasion and related mechanical properties.

The copending application above referred to also discloses that the proper length of time and temperature of the heating or solution forming step, quenching or supersaturating step, and aging step of the process wherein the alloy is allowed to assume a more stable state, together with the proper proportions of the lead and antimony, would vary depending upon the properties desired in the alloy and also depending upon the uses to which the alloy is put. The present invention is based on further experiments in which solid lead-antimony alloys have been allowed to become supersaturated in cooling media having different heat absorption properties than water at room temperature, the specific quenching medium defined in the foregoing application. Results obtained from these experiments establish the fact that by controlling the rate of cooling of the alloy the degree of hardness may likewise be controlled. Also by determining the proper cooling medium the period required for the alloy to obtain a more stable state may be readily controlled.

A better understanding of the invention may be had from the following description when taken in conjunction with the accompanying drawing, which shows a set of representative curves determined by plotting tensile strength in kilograms per square millimeter as ordinates and days of aging as abscissa, when a lead-antimony alloy having 2½% antimony treated in accordance with the method outlined in the previously referred to copending application is quenched or cooled in different media.

As outlined in the foregoing copending application, the proper proportions of lead and antimony are combined to form a solid solution thereof which is reduced to a substantially supersaturated solid solution following which the resulting alloy is allowed to assume a more stable state. More specifically, the process outlined in the foregoing copending application consists in adding to lead a greater percentage of antimony than is soluble at room temperature, but not substantially more antimony than is soluble at a temperature slightly below the eutectic fusing temperature. The alloy produced by the addition of the proper proportions of lead and antimony is heated to a temperature slightly below the eutectic fusing temperature, which is not appreciably greater than 240° C. until a substantially homogeneous solid solution is formed. The alloy is then quenched to reduce the solid solution to a supersaturated solid solution and the alloy finally permitted to age during which period the solution assumes a substantially stable state. The present invention contemplates securing a supersaturated solid solution by a slow cooling, the result being to change the resultant characteristics of the alloy, dependent upon the nature of the cooling step.

When it is desired to obtain an alloy having a maximum degree of hardness and it is also desired to produce an alloy in which the hardness is attained in a relatively short period of time, the alloy resulting from the mixture of lead and antimony, as clearly set forth in the previously referred to copending application, is quenched in water producing an alloy having the characteristics represented by graph A of the group of curves illustrated in the single figure of the drawing. A study of this graph shows that by quenching the alloy in water which is at substantially room temperature, an age hardenable alloy is produced having great tensile strength as compared with the same alloy when cooled slowly, as by cooling the alloy in different

media represented by graphs B, C and D, as will be later described more in detail. It should also be noted that the alloy attains its maximum tensile strength in a comparatively short period of time.

Referring to graph B which illustrates the behavior of the alloy when cooled in a substance or solution, such as glycerine, in this case the alloy does not attain as high a tensile strength as the alloy quenched in water nor does it attain its maximum tensile strength in the same period of time. In other words, the time required for the alloy to attain its maximum tensile strength is longer than in the case of the alloy quenched in water. It is, of course, advantageous to produce alloys having various degrees of hardness or tensile strength which are particularly suitable for different uses. By the proper selection of the cooling media the degree of hardness and the rate of attaining the hardness, as is clearly evident from the curves illustrating the behavior of the alloy in the different cooling media, may be readily controlled.

A still different condition is produced when the alloy is reduced to a supersaturated solid solution and allowed to assume a substantially stable condition when cooled in air at room temperature. This particular condition is illustrated in graph C of the set of curves shown in the single figure of the drawing. Here again the maximum tensile strength attained by the allow is less than in the case of quenching the allow either in water or allowing it to cool in glycerine. Also the period required for the alloy to attain its maximum hardness is considerably longer than in the case of the other two cooling media heretofore mentioned.

Graph D illustrates the behavior of the alloy when it is allowed to cool in an oil which is heated to substantially a temperature slightly below the eutectic fusing temperature of the alloy resulting from the combination of lead and antimony. In practice. this step in the treatment of the alloy, has been accomplished by heating the alloy in the oil to a temperature slightly below the eutectic fusing temperature of the alloy and allowing the thus immersed alloy and the oil to assume substantially room temperature. The rate of cooling is thus considerably slower than in the case of the quenching of the alloy in water or cooling it in other cooling media heretofore mentioned, and produces a resulting alloy having a considerably lower tensile strength and requiring a considerably longer period of time for it to attain its maximum tensile strength.

After the alloys are cooled to substantially room temperature in a cooling media selected to produce in the resulting alloy the desired mechanical and other characteristic properties, it is allowed to age. Aging may take place at any temperature below the temperature of appreciable crystal growth of the components of the alloy, believed for lead antimony alloys of the type susceptible to improvements to be about 100° C. In practice a good temperature is found to be around room temperature.

The term "slow cooling" as used in the foregoing description and the appended claims refers to the step in the process of treating age hardenable alloys in which the alloy becomes supersaturated being carried out at a rate such that the alloy assumes a more stable state subsequent to its heat treatment at a rate different from that resulting when the same alloy is quenched in water at substantially room temperature, the result being to produce an alloy having different characteristic properties.

What is claimed is:

1. A process for controlling the characteristics of hardenable alloys, which consists in heating a solid alloy for a period of time at a high temperature and causing the alloy to attain a supersaturated condition at a controlled rate.

2. A process for controlling the characteristics of hardenable alloys, which consists in heating a solid alloy at a high temperature until a substantially homogeneous solid solution is formed, cooling the alloy at a controlled rate to produce a supersaturated solid solution, and allowing the alloy to assume a substantially stable condition.

3. A method of controlling the rate of hardening of age hardenable alloys, which consists in reducing an alloy to a substantially homogeneous solid solution, cooling the alloy at a controlled rate, and aging.

4. A process for controlling the characteristics of hardenable lead alloys which consists in heating a solid alloy for a period of time at a high temperature, and causing the alloy to assume a supersaturated condition in media having different cooling properties.

5. A process of making an improved lead alloy, which consists in adding alloying matter to lead, heating the solid alloy at a high temperature and reducing the resulting alloy to a supersaturated solid solution, by cooling the alloy in a cooling medium having heat absorption properties different from water.

6. A process of making an improved lead-antimony alloy, which consists in adding alloying matter to lead, forming the resulting alloy into solid solution, and reducing the said alloy to a supersaturated solution by slowly cooling the alloy at a rate dependent on the mechanical properties desired.

7. A process for making an improved lead-antimony alloy, which consists in heating a solid alloy to a temperature high enough to allow the antimony present to enter solid

solution, cooling the alloy slowly until it assumes a supersaturated condition and aging.

8. A process for making an improved lead-antimony alloy, which consists in heating a solid alloy at a temperature of 240° C. for a period of time, and cooling the alloy slowly at a rate determined by the degree of hardness desired.

In witness whereof I hereunto subscribe my name this 20th day of January, A. D. 1926.

REGINALD SCOTT DEAN.