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HEAT-TREATMENT FOR METAL ARTICLES

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This invention relates to a method for eliminating porosity in a metal article such as a bronze or bronze-like casting by heat treatment. The invention relates particularly to a method for eliminating porosity by heat treatment at critical temperatures for critical periods of time.

This application is a continuation-in-part of patent application Serial No. 608,800, filed August 3, 1945, now abandoned, by Frank B. Austin, for "Method for eliminating porosity in bronze castings."

In casting bronze valves for use in high-pressure hydraulic systems it is found that many castings are not in satisfactory condition when given a high-pressure hydraulic test because of leakage of fluid at localized areas of the castings. Such leakage is caused by porosity of the casting and the pores appear to result from interdendritic unsoundness that originates when the casting initially cools. The porosity can occur uniformly throughout the casting but frequently is confined to a localized portion of the casting. Attempts have been made to overcome such porosity by heat treating the casting at a high temperature such as 1400° F. for extended periods of time of the order of several hours. However, such attempts have failed and one reason is that cracking and distortion of the castings upon cooling from the heat treatment renders them useless; failure for this reason has been encountered particularly with castings that have been finish-machined and threaded before heat treatment because all such castings suffer fatal cracking and distortion of the machined surfaces and threads upon cooling after treatment at high temperature for several hours.

The present invention provides a method for heat treating a metal article such as a bronze or bronze-like casting which method unexpectedly eliminates porosity in a highly efficient manner and in the complete absence of cracking and distortion of the article including an article such as a bronze casting that has been finish-machined and threaded before the treatment. The method includes treatment of the article at critical temperatures and for critical periods of time and preferably heating is for a few minutes to a temperature of about 460° F. to 850° F.

It is of the essence of the invention that the porous article be heated for a few minutes to a temperature of about 460° F. to 850° F. and preferably about 600° F. In one form of the invention preferably the entire casting is initially heated for a few minutes to a temperature of about 200° F. to 300° F. and the localized porous portion is

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then heated for a few minutes to a temperature of about 460° F. to 850° F. followed by cooling of the casting preferably in air. In another form of the invention the entire article is heated to about 250° F. This is followed by heating to about 580° F. and cooling to room temperature. Final heating is to about 600° F. to 610° F. followed by cooling. Heating can be effected by use of an acetylene-torch flame having a temperature of about 3000° F. or heating can be effected by other means including a furnace such as an oil furnace.

An object of this invention is to provide a method for eliminating porosity in metal articles such as bronze and bronze-like castings.

Another object is to provide a method for eliminating porosity in such articles by heat treatment at critical temperatures for critical periods of time.

Another object is to provide a method for eliminating porosity in such articles without any distortion or injury to the metal and without appreciably reducing its strength and elongation and particularly with respect to articles that are finish-machined and threaded.

Another object is to provide a method for eliminating porosity in such articles which can be used to treat articles individually in any desired location without expensive and complicated equipment or simultaneously to treat a number of castings in apparatus intended therefor.

Another object is to provide a method for eliminating porosity in such articles by heating for a few minutes to a temperature of about 460° F. to 850° F.

Another object is to provide a method for eliminating porosity in such articles by heating the entire article for a few minutes to a temperature of about 200° F. to 300° F. and then heating the porous portion of the article for a few minutes to a temperature of about 460° F. to 850° F. followed by cooling of the casting preferably in air.

Another object is to provide a method for eliminating porosity in such articles by heating the entire casting to about 250° F. followed by heating to about 580° F. and cooling to room temperature with a final heating to about 600° F. to 610° F. and cooling to room temperature.

Further objects and advantages of this invention will be apparent from the following description and claims.

In carrying out one form of the invention the porous metal article, such as a bronze or bronze-like casting, is heated for a few minutes and pref-

erably for three or four minutes to a treating temperature of about 460° F. to 850° F. and preferably to a treating temperature of about 600° F. The article is then cooled to room temperature; if desired, the article can be maintained at the treating temperature for a few minutes before cooling although it is not necessary in all treatment.

Example I

A porous bronze valve body was heated in an oil furnace controlled to a maximum temperature of 600° F. The valve body after a few minutes of heating attained a temperature of 600° F. following which it was cooled to room temperature. Hydraulic tests after treatment indicated that porosity was completely eliminated. As a further test, a flanged surface was machined off for a depth of $\frac{1}{16}$ inch and tested hydraulically; no porosity was indicated.

A second form of the invention is particularly effective in treating a metal article, such as a bronze or bronze-like casting, in which the porosity occurs only in a localized portion of the article. In this form of the invention the entire article is initially heated for a few minutes and preferably for three or four minutes to a temperature of about 200° F. to 300° F.; if desired this temperature can be maintained for a few minutes although it is not necessary in all treatments. The localized porous portion of the article is next heated for a few minutes and preferably for one or two minutes to a temperature of about 460° F. to 850° F.; if desired this temperature can be maintained for a few minutes although it is not necessary in all treatment. The article is then cooled in air.

Example II

A bronze valve body having a localized porous portion was heated for a few minutes to a temperature of about 200° F. by exposing the entire surface of the casting to an acetylene-torch flame having a temperature of about 3000° F. The flame was then concentrated on the localized porous portion which was heated further for a few minutes to a temperature of about 600° F. following which the casting was cooled to room temperature. Hydraulic tests after treatment indicated that porosity was completely eliminated. There was no distortion and cracking of the body including machined surfaces and threads were not warped.

In another form of the invention the entire metal article, such as a bronze or bronze-like casting, is heated for a few minutes and preferably three or four minutes to about 250° F.; if desired this temperature can be maintained for a few minutes although it is not necessary in all treatments. This is followed by heating for a few minutes to a temperature of about 580° F.; if desired this temperature can be maintained for a few minutes although it is not necessary in all treatments. The article is next cooled to room temperature. Final heating is effected for a few minutes to a temperature of about 600° F. to 610° F.; if desired this temperature can be maintained for a few minutes although it is not necessary in all treatments. The article is then cooled to room temperature.

Example III

A porous bronze valve body casting was treated in the following manner. The whole casting was heated for a few minutes to about 250° F. Further heating for a few minutes was carried out to bring the body to a temperature of about 580° F. following which it was cooled to room temperature. Reheating was carried out to a temperature of about 600° F. to 610° F, followed by cooling to room temperature. Hydraulic tests after treatment indicated that porosity was completely eliminated. There was no distortion and cracking of the body including machined surfaces and threads were not warped.

The essence of the heat treatment of this invention resides in heating of the article to be treated to critical temperatures for critical periods of time. In accordance with the invention heating can be effected in any conventional manner. A preferred form of heating is accomplished by use of the soft flame from an acetylene torch with the flame played over the surface of the article to be heated. The flame can be played over the entire surface of the article to heat the entire article or the flame can be directed to a localized portion of the article to raise the temperature of the localized portion above the temperature of the remainder of the article. Use of the flame from an acetylene torch has the further advantage that the rate at which the article is heated can be controlled by regulating the proximity of the flame to the casting, the flame being close to the casting for rapid heating and being withdrawn somewhat from the casting for slow heating. A satisfactory flame temperature is found to be about 3000° F. In place of an acetylene-torch flame, it is found satisfactory to use an oil furnace for heating.

Temperature of the article or any localized portion thereof can be determined in any conventional manner. Estimate of the approximate temperature can be made by observation of the surface color of a particular article because in a particular kind of article the surface color varies with the temperature. More accurate determination of the article temperature can be had by use of an optical surface-control pyrometer. Another method found satisfactory for determining article temperature consists in drilling holes from the article surface into the interior and inserting in each hole a laboratory thermometer.

Use of a heating temperature for the porous portion of the article of about 460° F. to 850° F. and preferably about 600° F. is critical in order to effect such change in the interdendritic structure as to eliminate porosity; use of a lower temperature is inoperative to eliminate porosity and use of a higher temperature is not satisfactory because of cracking and distortion of the casting. In the form of the invention in which the entire casting is heated before the localized porous portion is given final heating, a temperature of about 200° F. to 300° F. is desirable in order that uniform expansion of the entire article occur and in order that the interdendritic structure of the entire article be properly conditioned before localized heating of the porous area is effected. Initial heating of the entire article to about 200° F. to 300° F. eliminates any possibility of distortion and cracking in the article when final heating to about 460° F. to 850° F. of the localized porous portion is effected.

Use of a heating period of a few minutes to bring the casting to the desired temperature is critical because use of a shorter period results in too rapid a temperature increase with resulting cracking and distortion and a longer period causes undesirable changes in the article. In the form of invention in which the entire article is initially heated to about 200° F. to 300° F., a heat-

ing period of about three to four minutes is critical and provides a highly satisfactory rate of heat increase; final heating to about 460° F. to 850° F. takes place in a critical period of about one to two minutes.

Porous metal articles such as bronze and bronze-like castings are completely free from porosity after heat treatment in accordance with this invention. Regardless of whether porosity in the untreated article extended throughout the article or existed in a localized portion, heat treatment in accordance with the invention is effective to eliminate the porosity. Because of the critical time and temperature factors in the treatment there is no distortion, cracking and warpage of the article; in particular threads and machined surfaces of the untreated article are not affected by the treatment.

The tensile strength and elongation characteristics under tensile stress are not affected by the treatment as indicated by numerous tests run upon treated sample bars and untreated control bars. An analysis of bronze and bronze-like test specimens before and after treatment indicate that no chemical change takes place in the article as the result of the treatment.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. A method for treating articles such as bronze and bronze-like castings to eliminate porosity comprising the steps of heating the article, continuing the heating for a period of several minutes until the article reaches a temperature of about 460° F. to 850° F., and cooling the article.

2. A method for treating articles such as bronze and bronze-like castings to eliminate porosity comprising the steps of heating the article, continuing the heating for a period of several minutes until the article reaches a temperature of about 600° F., and cooling the article.

3. A method for treating articles such as bronze and bronze-like castings to eliminate porosity comprising the steps of applying to the surface of the article a flame, maintaining application of the flame for a period of several minutes until the article reaches a temperature of about 600° F., and cooling the article.

4. A method for treating articles such as bronze and bronze-like castings to eliminate porosity comprising the steps of heating substantially the entire surface of the article, continuing the heating until substantially the entire body of the article reaches a temperature of about 200° F. to 300° F., then heating further the porous portion of the article, continuing the heating of the porous portion until the porous portion reaches a temperature of about 460° F. to 850° F., and cooling the article.

5. A method for treating articles such as bronze and bronze-like castings to eliminate porosity comprising the steps of applying to the surface of the article a flame having a temperature of about 3000° F., maintaining application of the flame for a period of about 3 to 4 minutes until substantially the entire body of the article reaches a temperature of about 200° F. to 300° F., then concentrating the flame on the porous portion of the article, maintaining the concentration of the flame for a period of about 1 to 2 minutes until the porous portion reaches a temperature of about 460° F. to 850° F., and cooling the article.

6. A method for treating articles such as bronze and bronze-like castings to eliminate porosity comprising the steps of applying to substantially the entire surface of the article a flame having a temperature of about 3000° F., maintaining application of the flame for a period of about 3 to 4 minutes until substantially the entire body of the article reaches a temperature of about 200° F. to 300° F., then concentrating the flame on the porous portion of the article, maintaining the concentration of the flame for a period of about 1 to 2 minutes until the porous portion reaches a temperature of about 600° F., and cooling the article in air.

7. A method for treating articles such as bronze and bronze-like castings to eliminate porosity comprising the steps of heating the entire article to a temperature of about 250° F., heating the article further to a temperature of about 580° F., cooling the article to room temperature, reheating to a temperature of about 600° F. to 610° F., and cooling the article to room temperature.

8. A method for treating articles formed of bronze and bronze-like material to eliminate porosity comprising the steps of heating the article, continuing the heating for a period of several minutes until the article reaches a temperature of about 460° F. to 850° F., and cooling the article.

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No references cited.