HEAT TREATMENT OF PREFORMED FINISH-MACHINED ARTICLES

2 Claims. (Cl. 148—13)

The present invention relates generally to heat treatment and more particularly to a means and method for heat treating articles while preventing oxidation and distortion.

Many metals and alloys which require heat treatment during the manufacture of various articles or parts are subject to distortion and oxidation during the heat treatment process. As a result, parts which have been performed or machined prior to heat treatment require finishing by additional machining or shaping and careful removal of oxides after treatment. Any machining of the finished parts introduces stresses into the surface portions of the material of the finished piece, especially noticeable when temperature of surface portions is unevenly affected by such machining. Certain materials, particularly some of the newer stainless steel based alloys, are extremely hard after heat treatment and conventional cutting tools are virtually useless for finishing operations, even diamond grinders being ineffective in some cases. Thus finishing operations may be impractical in many cases and the parts must be completely finished before heat treatment.

When metals are exposed to atmosphere during heating, oxidation is virtually unavoidable and this is undesirable in high strength alloys, since even minor surface oxidation can set up stress risers which extend into the material. Oxidation can be avoided by treating the parts in an inert atmosphere, which requires a controllable atmosphere oven or autoclave, or special retorts. Further, the changes of temperature during heat treatment cause distortions of many parts which are difficult to control when the materials are hardened. Hot parts can be held in quenching dies to prevent distortion while cooling, but this involves transferring the parts from an oven, or other source of heat, to the dies and is effective only during a part of the process.

The ideal situation is achieved when we enclose a part in a sealed container in which an inert atmosphere can be maintained, the entire heat treatment process being carried out while the part is so enclosed. Since the heat treatment of some alloys involves temperatures of 2,000 degrees F. and more, the container must be of heat resistant material. Also, in order to prevent distortion, the part must be rigidly held, as by shaped dies, while still in the sealed container.

The primary object of this invention, therefore, is to provide means for heat treating an article including enclosing the article in a sealed container containing an inert atmosphere to prevent oxidation and holding the article between shaped clamping members, the envelope being flexible to fit closely around the article under pressure of the clamping members so that distortion is prevented. Another object of this invention is to provide a heat treating means in which the envelope is constructed from heat resistant material, such as very thin sheet metal and has provision for purging the atmosphere therein after the article is enclosed and sealed.

Another object of this invention is to provide a heat treating means in which the article is held in the dies until the heat treatment is completed, the dies having means for heating and cooling if necessary for the cycle of operations.

Still another object of this invention is to provide a heat treating means in which the shaped clamping means can be used to perform a final, minor forging or coining operation before the article becomes hardened by heat treatment and while the article is in an inert atmosphere in its envelope.

A further object of this invention is to provide heat treating means capable of handling many different types of articles of various materials.

Finally, it is an object to provide a heat treating means and method of the aforementioned character which is simple and convenient in operation and may be carried out without the need for large ovens, autoclaves or the like.

With these and other objects definitely in view, this invention consists in the novel construction, combination and arrangement of elements and portions, as will be hereinafter fully described in the specification, particularly pointed out in the claims and illustrated in the drawings which forms a material part of this disclosure, and in which:

FIGURE 1 is a perspective view of a prepared envelope;
FIGURE 2 is a longitudinal sectional view of the closed envelope containing an article to be heat treated;
FIGURE 3 is a sectional view similar to FIGURE 2, showing the envelope and article clamped in shaped dies;
FIGURE 4 is a sectional view, taken diametrically, of a ring type article sealed in an envelope and held in dies; and
FIGURE 5 is an enlarged fragmentary sectional view, similar to a portion of FIGURE 2, showing the article coated with a lubricant.

Similar characters of reference indicate similar or identical elements and portions throughout the specification and throughout the views of the drawings.

The envelope 10, illustrated in FIGURE 1 is made from a pair of thin metal sheets 12 secured together around the major portion of their peripheries by seam welding 14, leaving an open end 16. The sheets 12 are of material capable of withstanding high temperatures and sufficiently flexible to be deformed to fit closely around a shaped part. Stainless steel sheet having a thickness of two to five thousandths of an inch, or thereabout, has been found to be satisfactory although other materials can be used.

The part to be treated is illustrated as a turbine blade, indicated at 18, by way of an example, this type of blade being used in a jet engine and usually being made from a stainless steel alloy which is heat treated to provide the necessary hardness. The final portion of the envelope 10 is welded shut, as at 20, to enclose the part 18 and a suitable purging connection 22, such as a nipple or the like, is attached to the envelope at a convenient position clear of the part. The atmosphere is withdrawn from the envelope 10 through the connection 22 and a vacuum can be maintained or the envelope filled with an inert gas, as desired.

The part, sealed in its envelope, is then heated to the required temperature by any suitable means, such as an oven, flame heating, resistance heating or induction heating, after which the heated assembly is placed between shaped dies 24 and 26 and operation clamped tightly as in FIGURE 3. The material from which the sheets 12 are made is sufficiently flexible to be deformed by the dies 24 and 26 and conform to the shape of the part 18, the dies being made with allowance for the small thickness of said sheets. With the part thus held, distortion is impossible and the part can be quenched or slowly cooled while in the dies.

Since heat treatment processes, including low temperature steps, vary considerably the exact sequence of operations may be changed to suit. For instance, the part in
its envelope may be clamped in the dies before heating and holding them together, although this necessitates making the dies from material resistant to very high temperatures in the case of certain alloys. If it is practical to carry out the heating while the part is clamped in the dies, this may be performed in a conventional oven or by heating elements embedded in the dies, suitably arranged, as is known. When the part is heated before insertion into the dies, the dies are preferably heated to a reasonable degree to prevent sudden cooling of the part. Often the heat is only maintained for a few minutes, depending on the specific heat treatment cycle of the part involved, although certain heat applications may extend to an hour or more.

Many different types of parts can be handled, a further example being illustrated in Figure 4, in which a ring member 30 is enclosed in an envelope 32 having an inner sheet 34 and an outer sheet 36 of flexible, heat resistant material. As previously described, the envelope 32 is provided with a purging connection, indicated at 38, to evacuate the envelope and avoid oxidation. The enclosed ring member 30 is held between an inner die 40 and an outer die 42, which may be constructed in any convenient manner for assembly and removal. To facilitate quenching, the dies 40 and 42 may be provided with suitably spaced ducts 44 through which a cooling medium may be passed, the use of cooled dies being well known.

A further utilization of the process is illustrated in Figure 5, in which the part 18 is enclosed in an envelope 16, as previously described, but the part is coated with a lubricant 46, a dry or heat resistant lubricant being necessary. When the shaped dies 24 and 26 are applied, as in Figure 3, the pressure may be used to perform final minor shaping of the part 18 by a forging or colling action while the part is in an inert atmosphere and before the part is hardened. The lubricant 46 allows slight shifting of the part to accommodate the forging action and the operation may be advantageous with certain parts. This additional function further ensures accurate, distortion free clamping of the part and combines a final shaping step with the clamping stage of the heat treatment process. It will be evident that the means for holding a part and the cycle of operations may be subject to considerable variation. The significant features in each instance, however, include the enclosure of each part in a sealed envelope containing an inert, or non-oxidizing atmosphere and maintaining the sealing during the heat treatment cycle, the part being held in shaped dies or similar members at any period during the heat treatment when distortion is likely to occur. The envelope may be constructed from as many pieces as necessary, to enclose a part in such a manner that the envelope can be deformed to fit closely around the part and allow the dies to hold the shape properly. In the case of simple shapes, several parts may be enclosed in a single envelope which, if desired, can be made oversize and used several times, since only one end need be cut open to remove the parts and an excess of material would permit rescaling.

The operation of this invention will be clearly comprehended from a consideration of the foregoing description of the mechanical details thereof, taken in connection with the drawing and the above recited objects. It will be obvious that all said objects are amply achieved by this invention.

I claim:

1. A method of heat treating a pre-formed finish machined article susceptible to oxidation and distortion during the heat treating, comprising: sealing the article in an envelope of thin, substantially flexible material resistant to the heat to be applied; purging the oxide-forming atmosphere from the envelope; heating the article to the required heat treatment temperature; clamping the envelope and the article contained therein in clamping means shaped to conform exactly to the desired final shape of the heat treated article, for at least the portion of the heat treatment process during which distortion may occur, the envelope being deformed by the clamping means and fitting closely around the article; removing the envelope and article from the clamping means; and removing the article from the envelope, whereby the resultant heat treated article has the desired final shape of the finished, heat treated article and the necessity for further machining is obviated.

2. A method of heat treating a pre-formed finish machined article susceptible to oxidation and distortion during the heat treating, comprising: coating the article with a heat resistant lubricant; sealing the article in an envelope of thin, substantially flexible material resistant to the heat to be applied; purging the oxide-forming atmosphere from the envelope; clamping the article in clamping means conforming exactly to the desired final shape of the finished heat treated article, whereby any minor forging of the part to make the same conform to said final shape will be accomplished; performing the desired heat treatment process on the article thus clamped and retaining the envelope and article in the clamping means for at least that portion of the heat treatment process during which distortion may occur; removing the envelope and article from the clamping means; and removing the article from the envelope, whereby the resultant heat treated article has the desired final shape of the finished, heat treated article and the necessity for further machining is obviated.

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