April 3, 1951 H. E. SOMES, JR., ET AL 2,547,053

METHOD OF QUENCHING

Original Filed Aug. 11, 1943

FIG. 1.

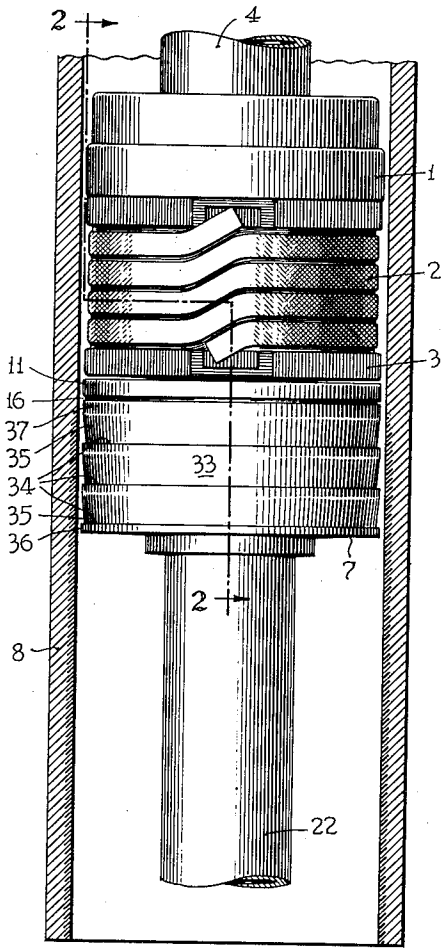
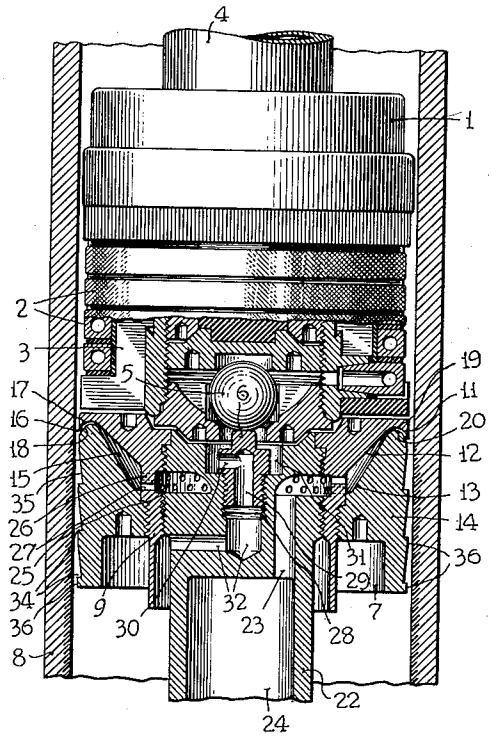


FIG. 2.



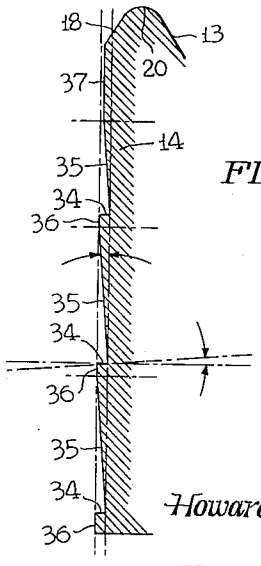


FIG. 3.

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Patented Apr. 3, 1951

2,547,053

UNITED STATES PATENT OFFICE

2,547,053

METHOD OF QUENCHING

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Original application August 11, 1943, Serial No. 498,184, now Patent No. 2,415,856, dated February 18, 1947. Divided and this application November 3, 1945, Serial No. 626,464

2 Claims. (Cl. 148—21.55)

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This invention, the application of which is a division of our copending application Serial No. 498,184, filed August 11, 1943, now Patent No. 2,415,856, issued February 18, 1947, relates to the heat treatment of hardenable metallic articles, particularly to the quenching of such articles after heating, and an object of this invention is to provide an improved method for quenching heated metallic articles in connection with the hardening thereof.

In one well-known machine for treating metallic articles by heating and quenching, an electromagnetic induction heating head is moved along a surface to raise the temperature thereof to the critical, and a quenching head is simultaneously moved along the surface immediately behind the heating head to direct a continuous sheet of quenching fluid against the surface along a line extending across the entire surface closely adjacent the heating head. Upon relative movement between the surface and the heating and quenching heads the entire surface is progressively heated and immediately quenched to produce the desired degree of hardness.

After impingement on the heated surface the fluid flows along it in contact therewith and in a direction away from the heating head. In the machine referred to, which is designed to harden the inner surfaces of tubes, the quench head is provided with a nozzle directing a continuous annular sheet of fluid on to the inner tubular surface, together with an annular skirt or wall positioned closely adjacent the surface being quenched and forming therewith a confining path which compels the fluid to flow along the surface and in contact therewith to complete the quenching operation. Usually, the heating and quenching operations are progressive and are carried out simultaneously by relative movement between the heads and the surface in close proximity to one another.

While the quenching effect of such an arrangement has produced satisfactorily hardened surfaces, for example 41–40 steel having a hardness of from 58 to 61 Rockwell C, the purpose of the present invention is to increase the efficiency and improve the hardening effect of the operation described.

It has been observed that, under conditions found in the machine referred to, the sheet of fluid flowing along the path between the heated surface and the quench head skirt tends to contract upon the skirt, and to draw away, to some extent at least, from the heated surface.

A further object, therefore, is to provide an

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improved method for quenching heated surfaces wherein the quenching fluid is maintained in good quenching contact with the surface being quenched throughout its entire path of flow, whereby to provide a quench of increased efficiency resulting in an increased hardening effect.

These and other objects which will be apparent from the following description are accomplished by the present invention, one embodiment of which is shown in the accompanying drawing in which:

Fig. 1 is a view in elevation of a quench head constructed in accordance with one embodiment of this invention, showing the same in conjunction with an associated electromagnetic induction heating head in operative position within a tube or cylinder, the inner surface of which is being progressively heated and quenched;

Fig. 2 is a sectional view through the apparatus shown in Fig. 1, and

Fig. 3 is an enlarged partial section showing in detail the construction of the quench head skirt shown in Figs. 1 and 2.

Although for the purposes of disclosure the present invention is described in connection with the quenching of internal surfaces, it will be apparent from the following description that various features, both of the method and apparatus are not limited thereto, but are of equal utility in the treatment of other surfaces.

As illustrated, the present invention is shown in connection with an electromagnetic induction heating head 1 having a heating coil 2 carried by a laminated core 3 which is suitably supported by a mandrel 4. The heating coil is hollow for the passage of coolant therethrough and connects at its lower end with a ball valve 5 which is open only when lifted from its seat by a hollow pin 6 projecting above the upper face of a quench head 7 when the latter is in operative position immediately adjacent the heating head, as shown in Figs. 1 and 2.

For the purposes of disclosure, the invention is described in connection with hardening the inner surface of a cylinder or sleeve 8, but it will be apparent that the present invention is not limited to the treatment of any specific article. The quench head 7 comprises an inner annular member 9 having a flange 11 formed at the upper end thereof and provided with a conical surface 12 which cooperates with a conical surface 13 forming the upper face of an outer annular nozzle member 14, to provide a tapered passage 15 for quenching fluid leading to the annular nozzle orifice 16 formed between the parallel walls 17

and 18 of the inner and outer nozzle members 9 and 14, respectively. The walls 17 and 18 are connected to the conical surfaces 12 and 13 by curved walls 19 and 20 tangent to the surfaces 12 and 13, respectively, and are formed so as to provide a downwardly opening orifice which will project an annular sheet of quenching fluid against the inner heated face of the tube 8 at an angle of between 25° to 45° to such face. As illustrated, the orifice walls are at an angle of about 32°.

The inner and outer nozzle members 9 and 14 are threaded together as shown in Fig. 2, and the inner member is, in turn, threaded to the upper end of a hollow mandrel 22 having quench passages 23 in the upper end thereof leading from the bore 24 to a circumferential quench chamber 25. The inner nozzle member 9 has an annular wall 26 which encloses the circumferential quench chamber 25 when the parts are secured together. The wall 26 is provided with a plurality of openings 27 through which quenching fluid flows into the tapered passage 15 leading to the nozzle 16. The upper end of the mandrel 22 has a bore 28 in which the hollow pin 6 is threaded having an axial passage 29 communicating at one end with the bore 28 and at the other end with a radial passage 30 communicating with a chamber 31 in the end of the mandrel. When the quench and heat heads are brought together in operative association as shown in Fig. 2, the pin 6 raises the ball valve 5 from its seat to permit the flow of coolant through the tubular heating coil 2 outwardly through the quench nozzle chamber 31, passage 29 in the pin 6, mandrel passages 32 to the space between the mandrel and the inner nozzle member 9 from which the coolant discharges.

The mechanism so far described forms no part of the present invention and is more fully set forth in our copending application Serial No. 336,129, filed May 20, 1940, now Patent No. 2,376,515.

The present invention relates to the control of quenching fluid after its discharge from the orifice 16 and during the time it is flowing along the heated surface of the tube 8, or other article, in the confining path formed between the article wall and the skirt 33 of the outer nozzle member 14. For this purpose, the skirt is provided with means for forcing the fluid into contact with the article surface by applying an impelling force to the fluid in the direction of the article surface during the flow of fluid along the confining path, so as to overcome any tendency which the fluid may have to follow the surface of the piston skirt and draw away from the article surface being quenched. For this purpose, the skirt is provided with annular shoulders 34 extending circumferentially around the quench head skirt and facing the nozzle 16, whereby the quenching fluid is repeatedly impelled toward the article surface as it flows downwardly between such surface and the quench head.

As illustrated, the quench orifice 15 directs the fluid downwardly against the heated surface at an angle of approximately 32°. Below the orifice the wall 35 of the quench head skirt is coned inwardly on an angle of approximately 4° to the vertical. The face of each shoulder 34 is formed at approximately a 4° angle to the horizontal, or at about right angles to the conical face 35. In the same way, the skirt face between succeeding shoulders 34 is coned inwardly at about the same 4° angle. Usually, the spacing between adjacent shoulders 34 is such that a land 36, or short face parallel to the axis of the head, and hence parallel to the heated surface, is formed just below each shoulder 34, but the dimension of this land does not appear to be critical and may vary somewhat on different quench heads. It will be found advantageous to have the outer diameter of the shoulders 34 slightly greater than the outer diameter of the quench head skirt adjacent the orifice 16, but this does not appear to be essential to the successful operation of this invention. As shown in the drawing, this results in a relatively longer land 37 being formed just beneath the nozzle 16. It is important that the dimensions be such that a sufficient space is provided between the quench head skirt and the heated surface to permit the free flow of quenching fluid through such space without any backing up above the orifice, such as would cause the fluid to come into contact with the heating head. As an example of satisfactory dimensions, the inner wall of a tube having a diameter of 6.500 inches has been successfully hardened by employing a quench head having a diameter at the orifice of approximately 6.375 inches and having shoulders of a diameter approximately 6.400 inches, each shoulder having a depth of approximately .039 inch.

In operation, assuming an inner surface layer of the tube 8 is to be hardened, the heating and quench heads are brought into operative association within the tube as illustrated. This opens the ball valve 5 permitting coolant to flow through the tubular heating coil 2. Upon relative movement between the heads and the article, the high-power, high frequency electric current passing through the coil 2 progressively induces electromagnetic heating currents in an inner surface layer of the tube of such magnitude that the layer to which the currents are confined is quickly raised to a hardening temperature. Substantially immediately upon reaching a hardening temperature, the heated material is quenched by quenching fluid impinged thereon through the annular orifice 16, a continuous circumferential sheet of quenching fluid being directed thereby upon the heated surface at such an angle, approximately 32°, as causes the fluid to flow downwardly in a direction away from the heating head without any backing up of the quenching fluid around the heating head. Should the quenching fluid tend to bounce off the heated surface, or for any reason tend to contract upon the skirt of the quench head rather than flow downwardly along the heated surface, the fluid will be repeatedly impelled outwardly against the heated surface by successively contacting the shoulders 34. Any fluid which tends to flow along the skirt surface flows into contact with the shoulders 34 and is directed outwardly by such shoulders into engagement with the heated surface. The circumferential corners of the shoulders 34 are preferably very sharp so that the fluid will not tend to cling thereto but will flow freely off the shoulder surfaces and against the cylinder wall.

As a result of this invention, a highly efficient quenching operation is obtained; for example, where rough machined surfaces have heretofore been difficult to successfully harden by heating and quenching, the present invention provides a quench which will readily harden such surfaces when heated to the critical temperature. It will be apparent that the invention can be variously modified and adapted within the scope of the appended claims.

What is claimed is:

1. The method of quenching a heated surface which comprises the steps of: flowing a thin stream of quenching fluid against the heated surface at an acute angle relative to the surface, flowing all the quench fluid along the surface for an appreciable distance, scraping off that part of the fluid remote from the surface and redirecting such part of the fluid again toward and against said surface.

2. The method of quenching a heated surface which comprises the steps of: flowing a continuous thin stream of quench fluid toward the heated surface and at an acute angle relative thereto, flowing all the fluid along the surface for an appreciable distance, scraping off that portion of the fluid remote from the surface at a plurality of points spaced along the length of the surface and redirecting such portions again toward and against the said surface.

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