Oct. 29, 1940. M. ROLLMAN ET AL 2,220,002

HEAT TREATING

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FIG. 1

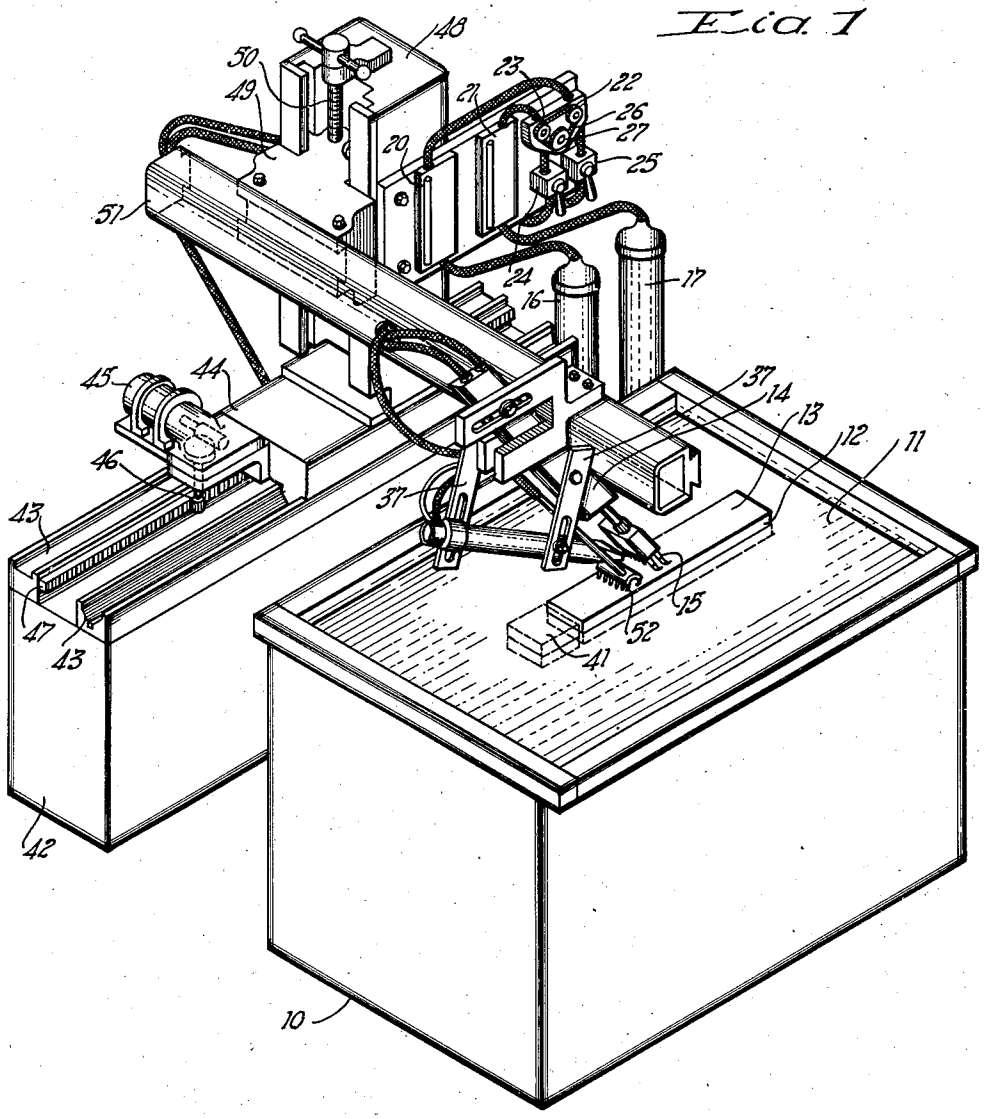

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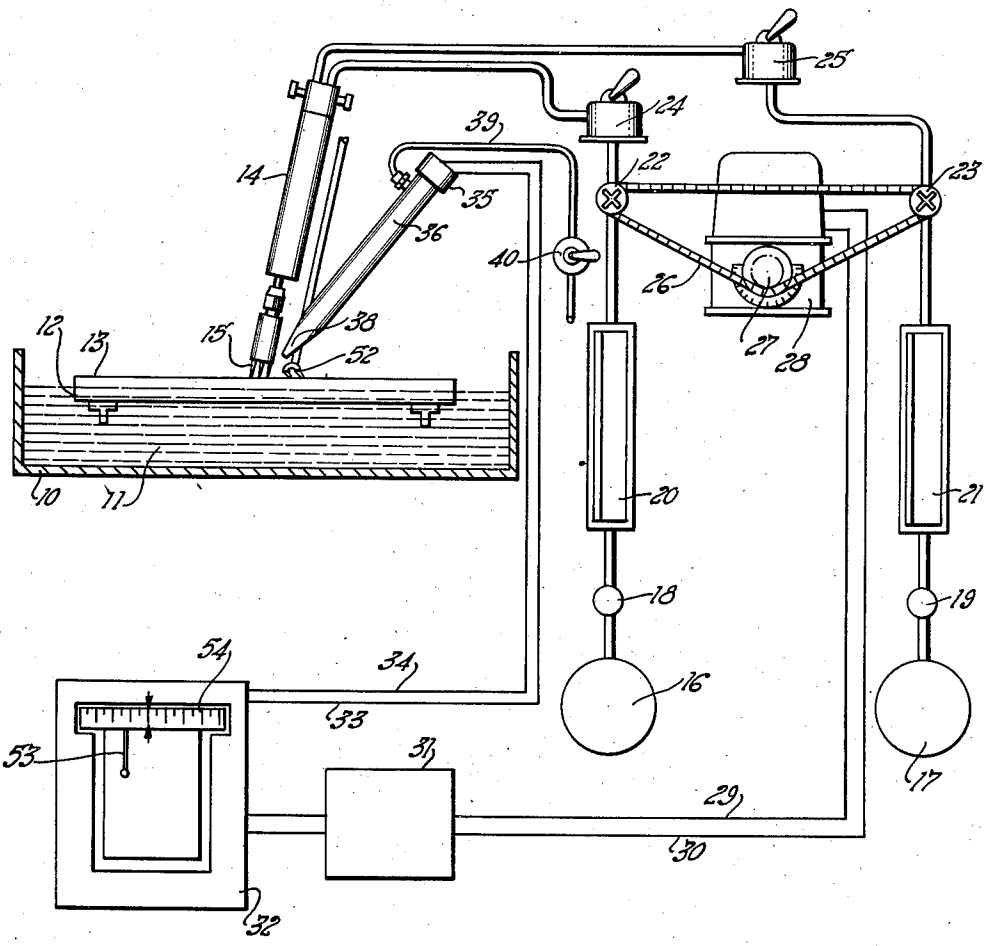
Fig. 2



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UNITED STATES PATENT OFFICE

2,220,002

HEAT TREATING

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Application May 17, 1939, Serial No. 274,208

5 Claims. (Cl. 266—4)

This invention relates to improvements in methods and apparatus for heat treating, particularly of the surface of metal or other workpieces to produce a suitably hardened or softened layer according to the particular requirements of the finished article. It is particularly adapted for use in what is commercially known as flame hardening, which consists essentially in locally heating the surface of the material to be hardened to a temperature above the critical range, holding it at this temperature for a sufficient time to dissolve the carbides into solution, followed by a cooling at a rate sufficiently fast to obtain the desired hardened characteristic desired for use, for example, as ways on machine tools or other structures where repeated relative movements of heavy parts are to be effected.

The principal object of the present invention is to provide an improved method of heat treating and an apparatus for carrying out of same which will produce a condition of uniformity in the finished product not hitherto attainable and facilitate constant duplicating of treated surfaces of good uniformity from unit area to unit area and as to successive work pieces.

A further object of the invention is the provision of a method and apparatus of heat treating which will reduce to a minimum the fatigue of the operator and dependence upon the particular skill of the individual operator for attainment of satisfactory results.

Another object of the invention is the provision of an improved method and an apparatus for employment in heat treating which will enable the operator accurately to determine the instant condition of the surface being treated and the necessary compensation for irregularities in the mechanical condition or chemical components of the said surface.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification, considered in conjunction with the accompanying drawings forming a part thereof and it is to be understood that any modifications may be made in the exact structural details there shown and described, within the scope of the appended claims, without departing from or exceeding the spirit of the invention.

The present invention is particularly applicable for utilization in connection with the progressive method of hardening or softening of metal and basically consists in effecting a relative traversing movement of the work surface to be treated and an oxy-acetylene or similar torch, preferably disposed in a fixed plane as respects said surface, in some cases followed by a corresponding relative traverse of a quenching member adapted to force a jet or multiplicity of jets of a suitable quench or coolant, such as water, onto the surface of the work in a manner to cool the heated surface progressively as it is traversed by the torch.

In the carrying out of the present method, an area is cleared of interfering gases, or solid particles, intermediate the torch and the quench member and the condition of the surface prior to the quench is viewed to determine from the existing light wave emanations the reaction at any particular moment of the torch upon the work surface.

This determination may be either a visual one, enabling the operator manually to adjust the flow relationship of the gases to the torch or may be through the medium of an optical responsive device coupled automatically to vary the gas ratios or to gas volumes to compensate for any variance in conditions as the need is indicated.

For convenience in a more complete understanding of the utilization of the present process, an apparatus utilizable for carrying out the same has been illustrated in the accompanying drawings in which:

Figure 1 is a perspective view illustrating the performance of the present invention, and

Figure 2 is a semi-diagrammatic view of one employment of the essential mechanical devices.

In these drawings there has been illustrated a tank 10 filled with a suitable liquid such as water at 11 in which the body 12 of the article on which the flame hardened surface 13 is to be produced is submerged. Such supporting of the work localizes the heating reaction to the surface to be treated, and prevents a general heating which might twist or warp the work, while cooperating with the quench to attain proper speed of cooling of the treated surface. Disposed above the surface 13 is a torch 14 having a multiplicity of nozzles 15 for directing the flame jets against the surface 13, this being preferably disposed at an angle to the surface so that the reflection of the jets will be in a slightly forward direction, as is particularly illustrated in connection with Figure 1.

Due to this angular relation of the torch flame to the work, the reflected heat, in place of being redirected against the torch tips, acts in a forward direction, tending to preheat the surface and at the same time prolonging the life of the torch tips.

The torch is fed as by tanks 16 and 17 respectively with the oxygen and acetylene gases employed for this purpose, which pass through the initial pressure regulators 18 and 19 into the respective flow meters 20 and 21 from which the respective gases are shown as passing through the rotatively adjustable needle valves 22 and 23 and the subsequent control valves 24 and 25 to the body 14 of the torch.

In order that simultaneous adjustment of the valves 22 and 23 may be readily effected, they are preferably coupled as shown by a sprocket chain 26 passing over sprocket 27 which may be either manually actuated or controlled by a reversible motor, such as 28.

This motor has been indicated as coupled by the leads 29 and 30 with a suitable reversing relay unit 31 operated by Thyratron tube control from a Micromax 32. This Micromax is electrically coupled by leads 33—34 with a thermopile unit 35 disposed at the upper end of a viewing tube 36. This tube is suitably supported as by adjustable bracket members 37 to dispose the lower slot type nozzle 38 thereof intermediate the torch nozzle tips and the quench nozzle 52. To facilitate accurate optical scanning and determination of the condition of the surface at this point, a connection 39 controlled by a valve 40 extends to a suitable source of compressed air or the like which will create a jet through the nozzle, blowing aside at this point the envelope of burning gases as well as any potential spray from the quench tube so that a direct reaction will be had through the tube unaffected by secondary flames, fumes, condensation or dirt, while at the same time this air jet will provide necessary cooling for the tube itself irrespective of its projection into the general flame area.

It is to be understood that a thermopile unit of this character is particularly desirable in that it is insensitive to the ultra-violet end of the spectrum and, is therefore practically unaffected by the intense flame cones.

In conventional flame hardening the depth of case cannot be closely predicted, especially where less than $\frac{1}{16}$" case is desired. This is true because the factors of speed, gas pressure and torch height determine the rate of heat input to the work surface. While temperature control may be obtained in several ways, such as by varying either the torch speed, the gas pressures, ratio, volume or torch height, accuracy of result in commercial production makes it practically imperative that only one of these variables be employed.

Gas control makes for most efficient operation in that it reduces the difficulties due to inertia of moving parts, minimizes the number of necessary controls, gives a wider range of heat capacity and does not affect the quenching speed. Additionally, with gas control a multiplicity of torches may be simultaneously employed, according to the particular work being operated upon, and through the method of optical determination of the work surface temperature condition, the nature of the resultant product as an entirety may be accurately controlled.

It is to be noted that by the employment of the pressure regulators 18 and 19 and flow meters 20 and 21 the proportions of the gases making up the combustible mixture, such as the oxygen and acetylene, can be accurately controlled and is preferably in a ratio of about 1.2 to 1.0. The accurate control of this proportion is necessary for the reason that a portion only of the oxygen needed for combustion is supplied through the torch, the remainder being supplied by the surrounding atmosphere, inasmuch as the acetylene requires for complete combustion an oxygen ratio of the nature of 2.5.

This ratio having been properly established, the corresponding joint actuation of the valves 22 and 23 serve to control the quantity of this correct mixture supplied according to the heat demands of the work at any particular instant.

In performance of the process, use may be made of an initial test piece as indicated at 41, the proper starting conditions set on the controls and the torch lighted and held in stationary position until the optical device indicates that the metal is substantially to the proper temperature when a relative traversing is effected between the torch and work piece so that the entire desired surface will be progressively subjected to the heating and quenching action.

This traversing may be performed in any desired manner but in the structure shown in Figure 1 it is indicated as accomplished by provision of a bed 42 adjacent the tank 10 having ways 43 supporting the traveling carriage 44 driven as by motor 45 to suitable reduction gearing terminating in pinion 46 meshing with rack 47 on the bed. The carriage 44 has rising therefrom a column portion 48 supporting the slide 49, vertically adjustable as by screw 50. Transversely adjustable on this slide is the arm 51 which serves as the support for the torch 14, the optical viewing device 36 and the quench nozzle 52.

From the mechanism thus shown, it will be noted that the desired torch or torches carried by the arm 51 may be laterally adjusted, suitably to position same with respect to the work—that the structure as an entirety may be vertically adjusted by operation of the screw 50 and the entire unit traversed with respect to the work by movement of slide 44. It will, of course, be understood that any or all of the movement in question may, if preferred, be imparted to the work in place of to the torch and associate parts—the mechanism shown being particularly desirable for carrying out the present process in connection with large or heavy work pieces.

Due to the method of operation here described it will be appreciated that, the work or test piece having been brought to the proper temperature, the traversing operation may be a uniform continuous movement and all normal condition variants taken care of solely through control of the mixture supplied to the torch for effecting the heating operation.

It will further be understood that the Micromax unit 32 may be equipped with a recording device, as diagrammatically indicated at 53 in connection with its dial 54 by which a record may be maintained as to the existing working conditions and torch variations found necessary in performance of hardening operation on the individual work piece.

Particular attention is invited to the fact that in the practice of this invention, the submergence of the work protects it as an entirety from a heating action which might otherwise cause twisting or warping and localizes the torch reaction; and that the angular relation of the directed torch flame with respect to the relative traverse of the parts causes an advanced reflection of the heat away from the torch, prolonging the life while preheating the surface being treated. Also, that the optical device determines the

positive or negative temperature or other increasing or decreasing reactions effected by the torch on the work, while the controls inversely vary the flame to correct or compensate for such momentary changes to insure uniformity in the treated product.

We claim:

1. A flame hardening apparatus of the character described comprising a bed and a juxtapositioned tank unit, said bed having guideways formed thereon, a carriage mounted on the guideways, means for effecting translation of the carriage with respect to the bed, a column rising from the carriage, a vertically movable slide carried by the column, means for effecting adjustment of the slide on the column, a transversely adjustable arm mounted on the slide and extending in overlying relation to the tank unit, a torch unit depending from the arm in the direction of the tank for application of heat to a work piece in the tank, a quench nozzle depending from the arm in spaced relation to the torch unit, a hollow viewing tube depending from the arm having a portion projecting into the space intermediate the torch and quenching units, a thermopile within the tube, a source of fuel supply for the torch, power actuable means for controlling the supply of fuel to the torch, and connections between the thermopile and said power means for effecting actuation thereof to compensatingly vary the fuel supply to the torch in accordance with the reactions of the heating of the work on the thermopile.

2. A flame hardening apparatus of the character described comprising a bed and a juxtapositioned tank unit, said bed having guideways formed thereon, a carriage mounted on the guideways, means for effecting translation of the carriage with respect to the bed, a column rising from the carriage, a vertically movable slide carried by the column, means for effecting adjustment of the slide on the column, a transversely adjustable arm mounted on the slide and extending in overlying relation to the tank unit, a torch unit depending from the arm in the direction of the tank for application of heat to a work piece in the tank, a quench nozzle depending from the arm in spaced relation to the torch unit, a hollow viewing tube depending from the arm having a portion projecting into the space intermediate the torch and quenching units, a thermopile within the tube, a source of fuel supply for the torch, power actuable means for controlling the supply of fuel to the torch, connections between the thermopile and said power means for effecting actuation thereof to compensatingly vary the fuel supply to the torch in accordance with the reactions of the heating of the work on the thermopile, and means for creating a clearing blast at the work intermediate the torch and quench by way of the viewing tube to insure direct reaction of the work piece temperature on the thermopile while preventing deleterious heating of the tube.

3. A flame hardening apparatus of the character described including means for supporting a work piece in semi-submerged condition and means for supporting and translating a hardening and controlled unit in opposition to the work piece, said unit including an angularly disposed torch head for directing a heating flame against the work, a quench nozzle, and an optical viewing tube having a terminal portion projecting into proximity with the work intermediate said nozzles, and means for maintaining a constant heating action of the flame nozzle on the work irrespective of variations in the work including independent supply sources for the gases to be fed to the torch, conduits individual to said gases extending from said sources to the torch, means for individually determining and controlling the proportional flows through the conduits to the torch, additional means for determining the volume of flow individual to each of said conduits, a reversible motor, a drive pinion on the motor, individual sprockets carried by the flow control means of the respective conduits, a sprocket chain jointly connecting the pinion and sprockets, a thermopile in the viewing tube, and operative connections between the thermopile and the motor for variably determining the operation thereof in accordance with temperature changes in the work piece at a point immediately adjacent the torch whereby the quantity of gases of predetermined proportions supplied to the torch are automatically changed to effect a reaction compensating for the thermopile determined temperature variations of the work piece.

4. A flame hardening apparatus of the character described, including a bed unit having longitudinally extending ways formed thereon, a carriage member having guide portions slidably engaging the ways, means for effecting movement of the carriage along said ways, a column rising from the carriage, a slide mounted on the column for vertical adjustment relative thereto, a flame hardening torch supporting member carried by the slide whereby adjustment of the slide will determine the position of the torch with respect to a work piece, and means for controlling the action of the torch on a work piece including a first bracket carried by the arm, a viewing tube adjustably mounted on said bracket and projectable into position adjacent the torch, an additional bracket member carried by the column, separate sources of commingleable gases for supply to the torch, and interconnected means on the respective brackets for determining the flow of gases to the torch including a pair of flow meters on the column bracket individual to the respective sources of gas supply, conduits extending from said flow meters to the torch, valves individual to the respective conduits having exposed actuating sprockets, a reversible motor, a drive pinion on the motor, a sprocket chain jointly interengaged with the pinion and the sprockets whereby actuation of the motor correspondingly actuates the sprockets and associate valves for control of the flow through the respective conduits, a thermopile unit carried by the bracket on the arm in association with the viewing tube, and electrical connections between said unit and the motor for determining the actuation thereof to compensate for variations in work temperature as registered through the tube by the unit.

5. A flame hardening apparatus of the character described, including a bed unit having longitudinally extending ways formed thereon, a carriage member having guide portions slidably engaging the ways, means for effecting movement of the carriage along said ways, a column rising from the carriage, a slide mounted on the column for vertical adjustment relative thereto, a flame hardening torch supporting member carried by the slide whereby adjustment of the slide will determine the position of the torch with respect to a work piece, and means for controlling the action of the torch on a work piece including a first bracket carried by the arm, a viewing tube adjustably mounted on said bracket and projectable into position adjacent the torch, an

additional bracket member carried by the column, separate sources of commingleable gases for supply to the torch, and interconnected means on the respective brackets for determining the flow of gases to the torch including a pair of flow meters on the column bracket individual to the respective sources of gas supply, conduits extending from said flow meters to the torch, valves individual to the respective conduits having exposed actuating sprockets, a reversible motor, a drive pinion on the motor, a sprocket chain jointly interengaged with the pinion and the sprockets whereby actuation of the motor correspondingly actuates the sprockets and associate valves for control of the flow through the respective conduits, a thermopile unit carried by the bracket on the arm in association with the viewing tube, electrical connections between said unit and the motor for determining the actuation thereof to compensate for variations in work temperature as registered through the tube by the unit, and means for directing a controlled blast through the tube on to the surface of the work to prevent secondary reactions of flame or the like on the thermopile.

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