Sept. 27, 1949. R. M. ROOKE 2,482,937

FLAME HARDENING OF INTERNAL CYLINDRICAL SURFACES

Filed Aug. 21, 1946 2 Sheets-Sheet 1

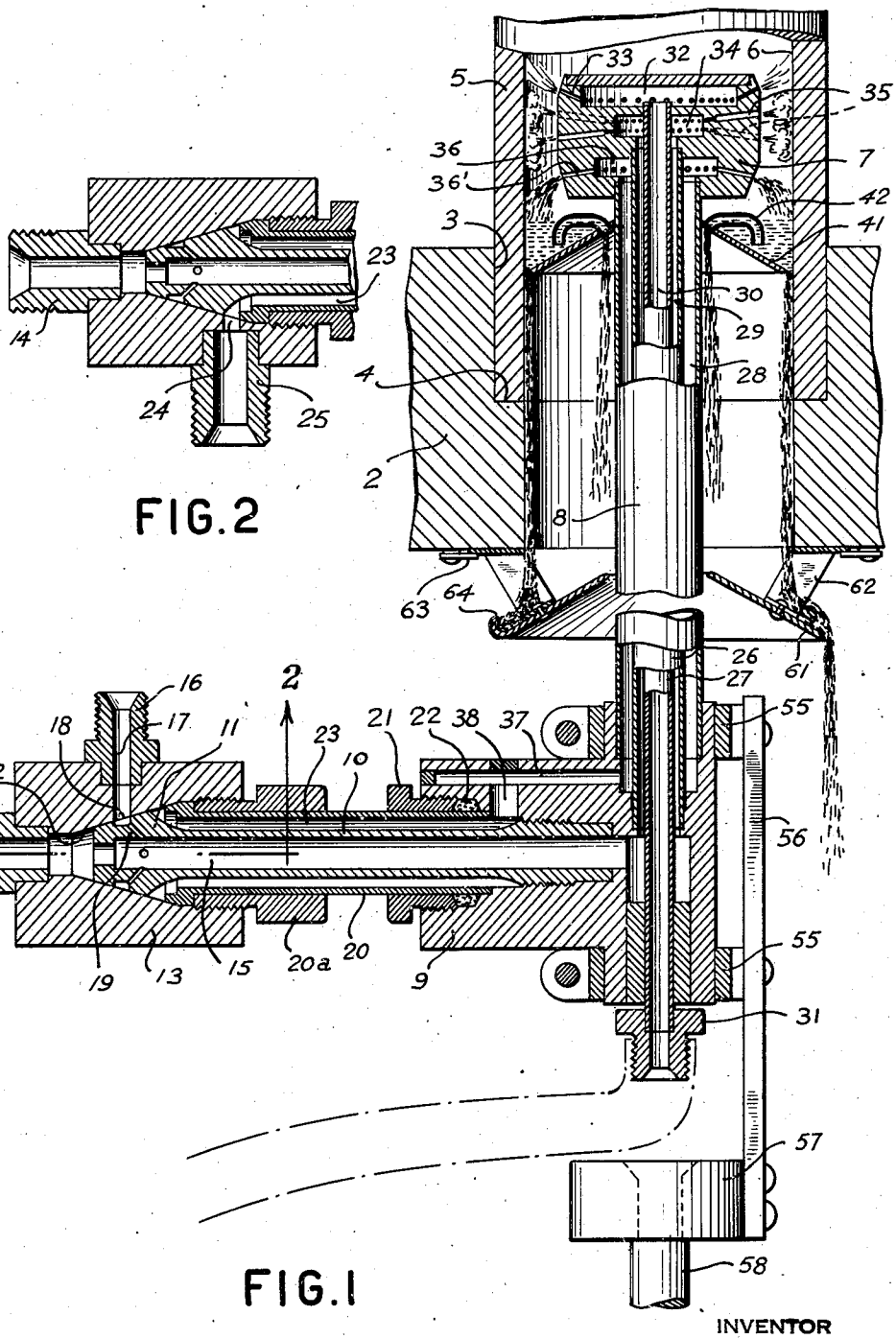


FIG. 2

FIG. 1

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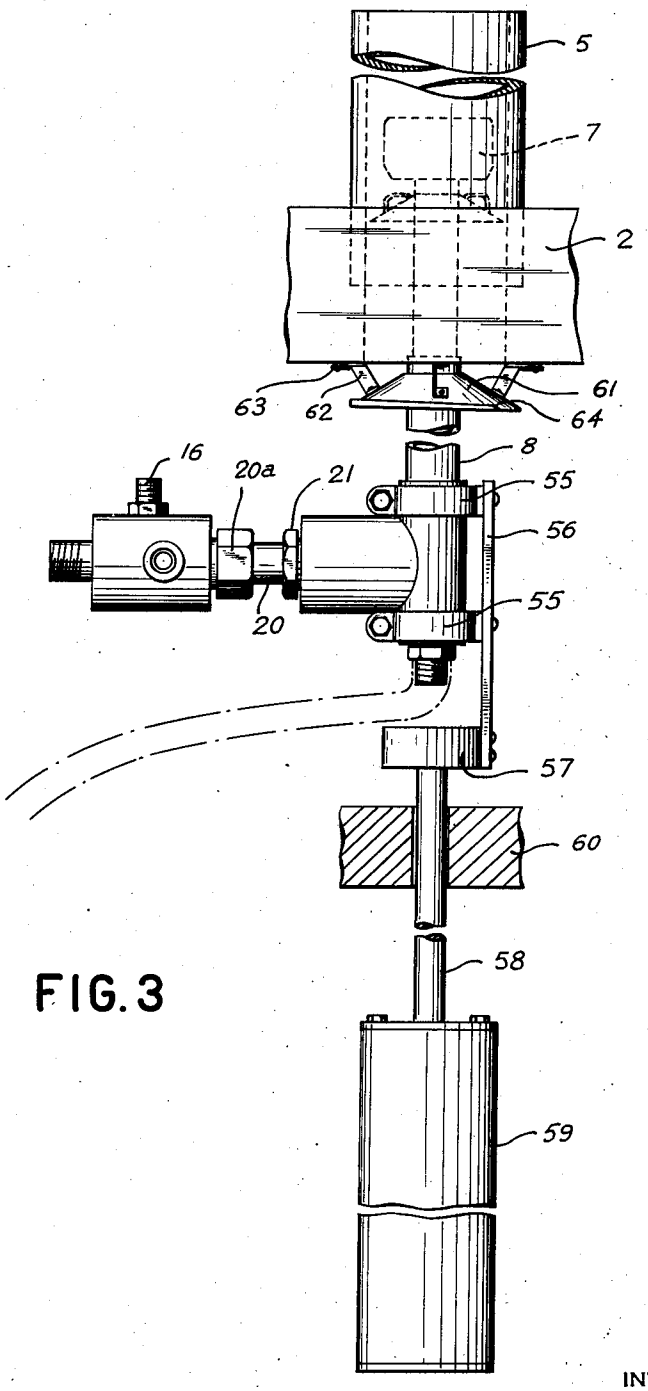


FIG. 3

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FLAME HARDENING OF INTERNAL CYLINDRICAL SURFACES

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6 Claims. (Cl. 148—21.56)

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This invention relates to the hardening of cylindrical surfaces of cast iron, steel and the like, and particularly to an improved method of and apparatus for effecting such hardening.

It has been suggested heretofore that internal cylindrical surfaces of iron, steel and the like can be hardened by subjecting the surface to heating by a circumferential row of radially disposed flames and thereafter quenching the heated surface. With the workpiece in vertical position, the quenching water drains away as rapidly as it is applied. Consequently heat in the underlying metal is conducted to the hardened surface and tends to anneal and thus eliminate the hardening effect for which the procedure is designed.

It is the object of the present invention to provide a method of and apparatus for hardening internal cylindrical surfaces by heating and quenching, including improvements which facilitate the operation and ensure successful production of hardening of uniform depth over the surface treated.

Another object of the invention is the maintenance of a pool of quenching liquid in contact with the surface metal so that heat in the underlying metal is removed and annealing of the hardened surface is prevented.

Other objects and advantages of the invention will be apparent as it is better understood by reference to the following specification and the accompanying drawing, in which

Fig. 1 is a sectional view showing a suitable heating device for the practice of the invention disposed in a cylindrical body, such as a pump liner, in operative position to permit application of the method for hardening the surface;

Fig. 2 is a fragmentary sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is an elevation of a driving mechanism adapted to permit manipulation of the device to secure the desired result.

In accordance with the invention, a cylindrical surface is subjected to heating around a relatively narrow circumferential substantially horizontal portion, to a temperature above the critical range for the metal treated, and immediately thereafter the heated portion is quenched. The procedure is carried out progressively as the heating flames, arranged in a circumferential band, are moved upwardly at a substantially uniform rate from the bottom to the top of the cylindrical surface, with the quench following progressively behind the band of flames.

The heating is effected by flames produced by any combustible and oxidizing gas supplied there-

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to in a mixture of proper proportions. Oxyacetylene flames are well adapted for the purpose of the invention, but other gases may be used so long as the flames are capable of heating the metal rapidly to the desired temperature.

In order to hold a substantial pool of quenching liquid in contact with the cylindrical surface long enough to remove heat from the metal behind the quenched surface, a baffle is provided beneath the flames. The quenching liquid such as water which is delivered from the quenching jets is in sufficient volume to accumulate above the baffle. The latter is arranged to permit overflow of any excess of liquid.

In the practice of the method, it is desirable also to maintain the surface of the metal above the heating zone at a relatively low temperature and to prevent the uneven preheating that is caused by conduction of heat through the metal ahead of the flames and by contact of the surface metal with combustion gases rising from the flames. This result, as well as control of combustion of the envelope gases, is effected by supplying a blast of cold gas such as air through a plurality of circumferentially disposed orifices above the heating zone. The cold gas impinges on the surface metal, removes heat conducted through the metal, and dilutes and reduces the temperature of the combustion gases. Thus uneven heating of the surface at different regions along its length is prevented, and it is possible to advance the heating flames at a uniform rate instead of progressively increasing the speed of the heating device as is otherwise necessary in order to prevent overheating of the upper portions of the surface treated.

To facilitate the operation, it is also desirable to support the workpiece in such a way as to ensure effectiveness of the liquid seal before starting the initial heating at the lower end of the surface to be treated. For that purpose, the workpiece is mounted upon a fixture having an opening conforming in diameter substantially to the diameter of the cylindrical opening in the workpiece. The heating device which is moved upwardly from the lower end of the fixture establishes the water seal therein before the flames engage and heat the lowermost portion of the surface to be treated.

Referring to Fig. 1 of the drawing, 2 indicates a fixture having a bore 3 and a ledge 4 which is adapted to support the workpiece 5 consisting of a cylindrical body having a bore or cylindrical surface 6 which is adapted to be hardened by the practice of the invention as described herein. A

torch head 7 is supported on a tubular member 8 for vertical movement in the bore 6.

The lower end of the tubular member 8 is secured to a block 9 which is threadedly connected to a tubular member 10 having a conical end 11 which fits snugly in a conical seat 12 of a block 13. A threaded nipple 14 is connected to the block 13 and a hose (not shown) may be secured to the nipple and connected with a source of oxygen which flows through the passage 15 in the tubular member 10. A threaded nipple 16, also secured to the block 13, is adapted to be connected by a hose (not shown) to a source of acetylene which flows through a passage 17 to a groove 18 and thence through inlets 19 into the mixing chamber 15 where it mixes with the oxygen and provides the fuel to maintain the heating jets. A tubular member 20 surrounds the member 10. One end of the member 20 sets on a ledge in the block 9 and the other end is conical and seats against the conical seat 12 of the block 13. The member 20 is secured to the block 13 by a nut 20a which holds the conical end firmly against the seat 12. A nut 21 surrounds the member 20 and threads into the block 9, packing 22 being disposed behind the nut 21 to prevent the leakage of gas from the annular passage 23 formed between the member 10 and the outer member 20. This passage 23 communicates through a passage 24 in the block 13 (Fig. 2) with a nipple 25 which is adapted to be connected through a hose (not shown) with a source of quenching medium such as water.

Within the tubular member 8 are two concentric tubes 26 and 27 forming passages 28, 29 and 30. The lower end of the tube 27 terminates in a threaded nipple 31 which is adapted to be connected through a hose (shown dotted) with a source of air or other cooling gas under pressure. The latter is conducted through the tube 27 to a chamber 32 at the top of the torch head 7, and a plurality of orifices 33 distribute the cooling gas circumferentially about the torch head in a plurality of jets which impinge upon the cylindrical surface 6.

Directly beneath the chamber 32 is a chamber 34 which communicates with the passage 29 between the tubes 26 and 27. This passage in turn communicates with the mixing chamber 15 and thus the mixture of combustible and oxidizing gas is delivered to the chamber 34 and distributed through a set of staggered orifices 35 disposed circumferentially about the torch head 7. When ignited, the gaseous mixture forms a plurality of flame jets which impinge upon the cylindrical surface 6 to effect the desired heating thereof.

Below the chamber 34 is a third chamber 36 communicating with the passage 28 formed between the tubular member 8 and the concentric tube 26, and this passage 28 communicates, through a passage 37 and a passage 38, with the passage 23 in the tubular member 20. This affords a supply of quenching medium, such as water, to the chamber 36. The water is distributed through a plurality of circumferentially disposed orifices 36' in the torch head 7 so that the quenching medium impinges upon the surface 6 below the flame jets.

A baffle 41 is supported beneath the torch head 7. Having a diameter only very slightly less than that of the bore 6, it is adapted to hold a substantial volume of the quenching water trapped against the side of the bore just below the quenching jets. This pool of water is agitated by the water running down from the quenching jets and serves as an effective and substantially uniform cooling medium for preventing the reheating of the surface metal by heat conducted back to the surface from the underlying metal. This water maintains an effective seal against the upward passage of air as the result of draft created by the heated combustion gases. In order that the proper volume of liquid may be maintained, the baffle 41 is provided with a number of tantalus tubes 42 through which the surplus water is drained whenever the level rises to a predetermined maximum. As will be apparent, the water seal becomes effective within the bore of the fixture 2 before the heating flames impinge upon the surface 6. Thereafter the quenching effect is uniform throughout the length of the workpiece and no air can rise through the space defined by the surface 6.

To effect the vertical movement of the torch head 7, the block 9 may be mounted in any suitable clamping device such as clamps 55 which are rigidly attached to a support 56 fixed to a base 57. This base 57 is supported by a piston rod 58 of a hydraulic motor 59 (Fig. 3). A fixed guide 60 maintains the torch head centered in the workpiece. However, any other device capable of moving the torch vertically may be employed. Thus, with the torch head 7 disposed below the lower edge of the surface 6, the combustible gas may be ignited to produce the flame jets. The quenching water may be turned on, and when the baffle 41 is in the fixture 2, the water provides the seal. Thereafter the torch head may be raised at a uniform speed into and through the cylindrical workpiece to be hardened. As the torch head 7 rises, each increment of the surface 6 is subjected successively to the cooling effect of the cooling gas, is then heated rapidly to the critical temperature, and quickly thereafter is cooled by the cooling medium to reduce the temperature and effect the desired hardening of the surface. The mass of water trapped above the baffle 41 ensures uniform quenching results.

The surface 6 above the level of the heating flames is continuously maintained at low temperature as the result of the large volume of cooling medium which continuously impinges on and flows upwardly over the surface. The desired hardening effect of uniform character is thus effected.

A deflecting shield 61 is removably attached to the fixture 2 by supporting links 62 and rotatable dogs 63. The quench water falls on this deflecting shield 61 and is directed by a lip 64 to run off at the desired point.

Various changes may be made in the details of the operation and in the apparatus employed without departing from the invention or sacrificing the advantages thereof.

I claim:

1. The method of hardening internal cylindrical surfaces of metal bodies which comprises directing a plurality of radially disposed heating flames against a substantially horizontal circumferential portion of the surface, moving the flames vertically and upwardly along the surface, quenching the heated surface immediately after the heating flames have been removed therefrom and maintaining a pool of quenching liquid in contact with the internal cylindrical surface and below the heating flames.

2. The method of hardening internal cylindrical surfaces of metal bodies which comprises directing a plurality of radially disposed heating

flames against a substantially horizontal circumferential portion of the surface, moving the flames vertically and upwardly along the surface, cooling the surface above the heating flames to a relatively low temperature, quenching the heated surface immediately after the heating flames have been removed therefrom and maintaining a pool of quenching liquid in contact with the internal cylindrical surface and below the heating flames.

3. The method of hardening internal cylindrical surfaces of metal bodies as set forth in claim 1 in which the pool of quenching liquid is maintained at a substantially uniform predetermined depth.

4. An apparatus for hardening internal cylindrical surfaces of metal bodies while they are supported in a vertical position comprising a torch support, a torch head carried by said support having a plurality of circumferential rows of orifices, means for supplying a mixture of combustible and oxidizing gases to one of said rows of orifices, means for supplying a quenching liquid to a row of said orifices which is below the row of orifices to which the combustible and oxidizing gases is supplied when the torch is in operative position within the cylindrical surface, an annular flange extending from the torch support beneath the torch head when the latter is in operative position within the cylindrical surface, the outer diameter of the flange being only slightly less than the internal diameter of the cylindrical surface so that the peripheral edge of the flange lies closely adjacent the cylindrical surface when therein and cooperates with said surface to maintain a pool of quenching liquid below the torch head and in

contact with the internal cylindrical surface, and overflow means for the quenching liquid forming the pool above said flange positioned above the level of the lower portion of the flange to maintain quenching liquid in the pool at a substantially uniform predetermined level.

5. An apparatus for hardening internal cylindrical surfaces of metal bodies as defined in claim 4 in which the overflow means includes tantalus tubes.

6. An apparatus for hardening internal cylindrical surfaces of metal bodies as defined in claim 4 which includes means for supplying a blast of cold gas to a row of the orifices which is above the row of orifices to which the combustible and oxidizing gases is supplied when the torch is in operative position within the cylindrical surface.

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