July 28, 1953 E. M. WHARFF, JR 2,647,199

INDUCTION HEATING EQUIPMENT

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Fig.1.

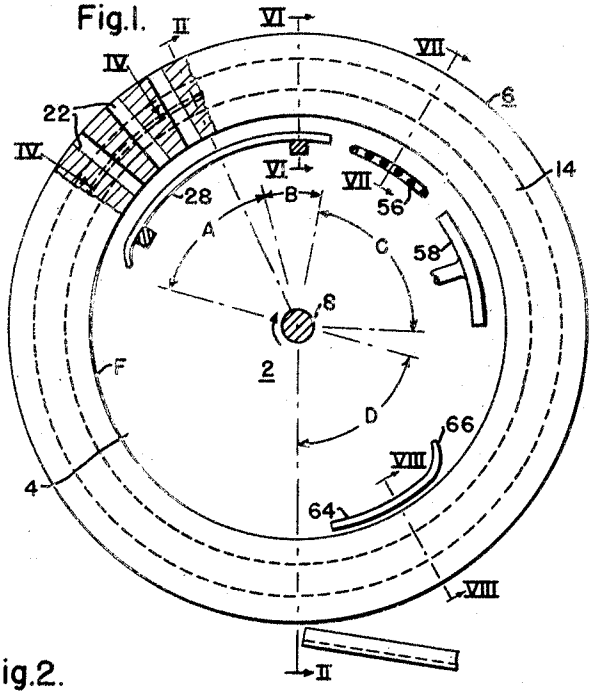


Fig.4.

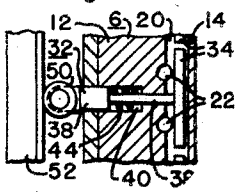


Fig.2.

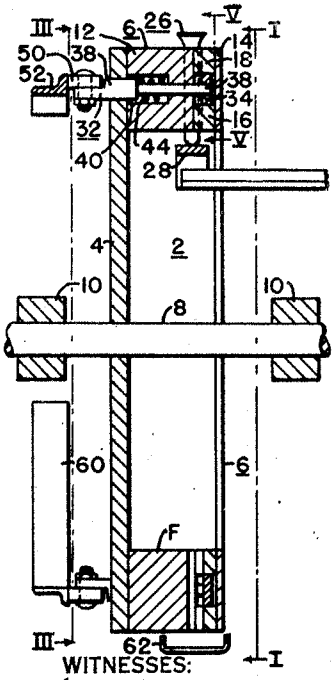
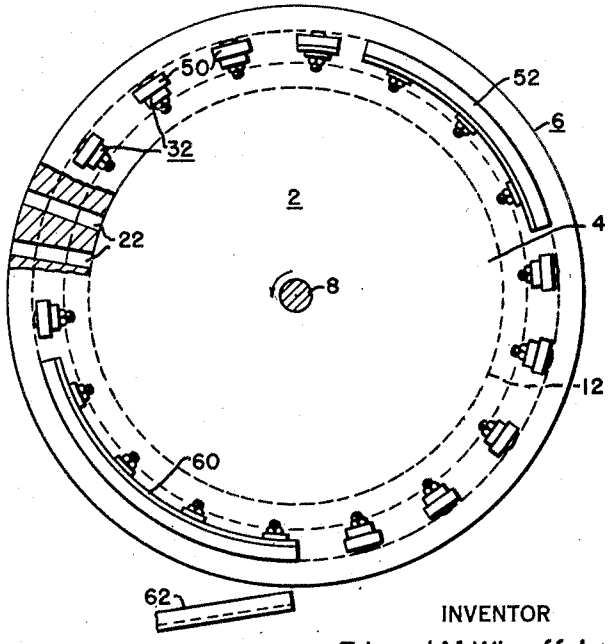


Fig.3.



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Fig.5.

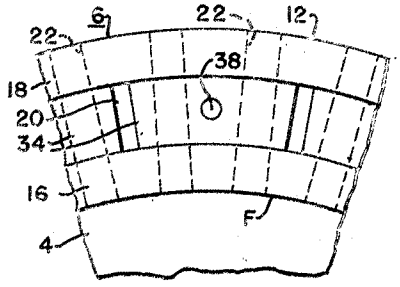


Fig.6.

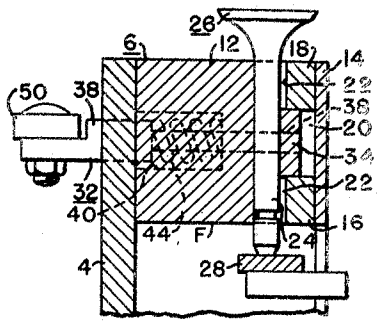


Fig.7.

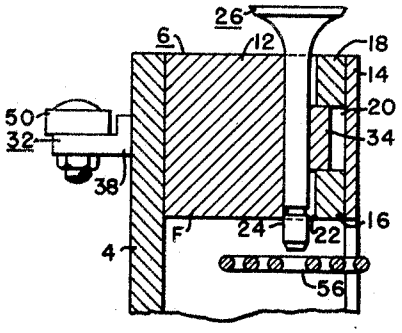


Fig.8.

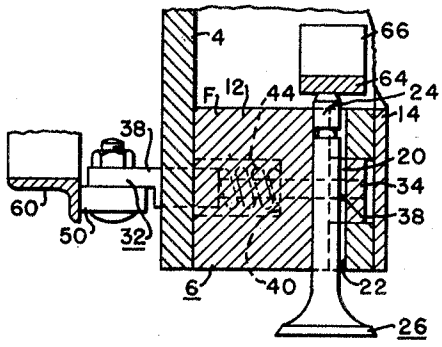
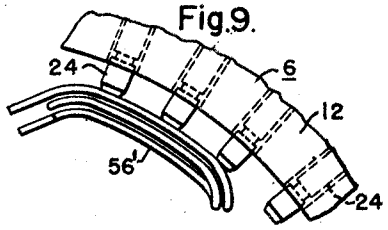


Fig.9.



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2,647,199

UNITED STATES PATENT OFFICE

2,647,199

INDUCTION HEATING EQUIPMENT

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Application May 12, 1949, Serial No. 92,901

7 Claims. (Cl. 219—47)

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My invention particularly relates to an induction heating machine in which valve stems and other rod-like objects can be inductively heat-treated on a mass-production basis, but in such a manner that each object is individually treated. However, my invention has broader aspects.

A purpose of my invention is to provide a means in which rod-like parts are successively and automatically moved through the heating field of an induction heating coil with each part having a predetermined relation to the coil as it moves through the field. An ancillary purpose of my invention is to harden, by heat-treatment, a predetermined portion of each such part.

My invention can perhaps be better understood in connection with a particular application thereof for the hardening of the ends of engine-valve stems that are to ride on timing cams. For such application my invention comprises a rotatable work-holding carrier that comprises an annular member which is perforated with a plurality of radially-extending, circumferentially-spaced holes. A valve is placed in each hole, with an end of the valve protruding inwardly beyond the annular member. As the work-holding carrier rotates, it successively moves the protruding valve-ends past a heat-treating station. The heat-treating station comprises an induction heating coil, and, if desired, the heating station may be provided with a quenching means. In accordance with the invention, a positioning means places the end of each valve-stem in a preselected position in the associated hole, and a clamping means frictionally holds it in such position. Consequently, the stem-ends of the successive valves will always bear a fixed predetermined relation to the induction heating coil at the heating station, and all the valves will receive substantially the same heat-treatment. After heat-treatment, the valves are released and fall from the work-carrier, preferably into a chute.

Objects, features and innovations of my invention, in addition to the foregoing, will be discernible from the following description of a preferred but specific embodiment of the invention. This description is to be taken in conjunction with the accompanying somewhat simplified drawings, the figures of which are on different scales. In the drawings:

Figure 1 is a front broadside view, partly in section, of an apparatus embodying my invention, looking at it through the line I—I of Fig. 2;

Fig. 2 is a central vertical sectional view of such embodiment, substantially along the line

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II—II of Fig. 1, showing a valve in place at the loading zone of the apparatus;

Fig. 3 is a rear broadside view, partly in section, of the embodiment substantially along the line III—III of Fig. 2;

Fig. 4 is a sectional view substantially on the line IV—IV of Fig. 1;

Fig. 5 is a sectional view on the line V—V of Fig.2;

Figs. 6 and 7 are sectional views, including valves, substantially on the lines VI—VI and VII—VII, respectively, of Fig. 1,

Fig. 8 is a sectional view substantially on the line VIII—VIII of Fig. 1; and

Fig. 9 is a modified form of induction heating coil for apparatus embodying my invention.

In accordance with the drawings, apparatus embodying a presently-preferred form of my invention comprises an endless work-holding carrier which is indicated in its entirety by the reference numeral 2. The carrier 2 is like a wheel and has a radially flat wall-portion 4 and an annular work-receiving wall-portion or member 6. The wheel-carrier 2 is carried by a shaft 8 journaled in bearings 10 for rotation about a horizontal axis in the direction shown by the arrows in Figs. 1 and 3. The work-receiving member 6 of the carrier 2 projects axially from an upright face or side of the wall-portion 4 of the carrier so as to provide a clear inner space in which stationary equipment can be located which will not interfere with rotation of the work-holding wheel-carrier 2.

The annular work-receiving wall-portion or member 6 of the carrier 2 comprises a pair of axially-spaced rings 12 and 14, the former preferably being much thicker than the latter. The rings 12 and 14 are axially spaced by a pair of narrow inner and outer rings or bands 16 and 18, respectively. The spacer bands 16 and 18 are radially separated so as to provide an annular space 20 within the work-receiving member 6.

Near the upright side of ring 12, toward the ring 14, the annular work-receiving member 6 is provided with a plurality of work-receiving seats or holes 22 which extend radially through the annular member 6 and are equally circumferentially spaced around it. Each seat or hole 22 merges with the annular space 20, and a part of the seat is in the member 12 and complementary parts in the bands 16 and 18. Each seat or hole 22 can receive a stem 24 of an automobile-engine valve 26. The work-receiving holes 22 are slightly oversize with respect to the diameters of the valve-stems; but the radial width

of the annular work-receiving member 6 is such that the tip-end of each valve-stem 24 projects inwardly beyond the inner face F of the annular work-receiving member 6.

As the wheel-carrier 2 rotates in a clockwise direction with respect to Fig. 1, each point of the annular work-receiving member 6 successively passes a loading region or station A, a clamping region B, a heat-treating region or station C, and an unloading or work-releasing region D.

The loading region A includes a valve-positioning region, so that valves can be individually placed in the work-receiving holes 22 and arranged in a proper preselected position therein. When a valve reaches the clamping region, it is automatically clamped and kept in such position for subsequent heat treatment of its valve-stem end in the heat-treating region C. The valves are automatically released from the carrier 2 in the unloading or work-releasing region or station D.

It should be noted that, at any instant, all the points in the left-hand half of the carrier 2, as seen in Fig. 1, are rising. The loading region A and at least the beginning of the clamping region B are in the upper quadrant of this rising half of the carrier. The clamping region B extends slightly beyond the end of the loading region A and embraces the topmost part of the path of rotation of the carrier. The heat-treating region C can be anywhere after the clamping region B and before the unloading region D. The unloading region D is preferably in the lower part of the lower quadrant of the half of the carrier 2 in which all points of the carrier are moving downwardly.

At the loading station A, the valves 26 to be heat-treated are put in their holes 22 in the carrier 2. Each valve passes freely into its associated hole which is deliberately oversize. Inserting movement of the valve is limited by a stationary curved positioning bar 28. The positioning bar 28 has a flat surface which stops further inward movement of a valve 26 being loaded into the carrier 2, when the stem-tip of the valve reaches the positioning bar. In case the valve is not fully inserted by an operator or workman, then its own weight will force its stem-tip against the positioning bar 28, when it reaches the upper part of the loading station A. Consequently, as each valve leaves the loading station A, its stem-tip will be a fixed predetermined distance from the center of the shaft 8.

In accordance with my invention, the valves 26 in the carrier 2, leaving the positioning-bar 28, are frictionally but slidably held in their respective seats or holes 22 by spring-pressed clamping means carried by the carrier 2. The clamping means comprises a plurality of clamp-means 32, there being a clamp-means 32 for each pair of holes 22 in the annular work-receiving member 6 of the work-holding carrier 2. Each clamp-means 32 comprises a clamp-bar 34 located in the annular space 20 in the annular member 6. The clamp-bar 34 is axially slidable to a limited extent in the annular space 20. Circumferentially, each clamp-bar 34 is of a length slightly more than the section of the annular member 6, which is occupied by a pair of consecutive valves 26. Consequently, the annular space 20 will have a plurality of such clamp-bars arranged therein, spaced slightly from each other. In the preferred embodiment, there are half as many clamp-bars 34 as there are valve-holes 22.

Each clamp-bar 34 is force-pressed against the stems 24 of the pair of valves 26 associated therewith. For so clamping the valve-stems 24 in their seats 22, each clamp-bar 34 is fixed to an end of a spring-pressed actuator-bar 38; the opposite end of the actuator bar being enlarged and projecting axially beyond the wall-portion 4 of the carrier 2. Each actuator-bar 38 is slidable in an axially-directed stepped hole 40. Each hole 40 passes partly through the rim or annular member 6 of the wheel-carrier 2, ending at the annular space 20 therein. Each hole 40 is preferably located centrally between the pair of valve-receiving holes associated with its actuator-bar 38. A spring 44 is located in each hole 40, around a narrow portion of the associated actuator-bar 38, and is compressed between the enlarged end of the bar and the facing wall-portion of the annular member 6 at the stepped portion of the hole 40. Consequently, the spring 44 of each actuator-bar 38 normally tends to press the associated clamp-bar 34 against two associated valve-stems, for frictionally clamping valve-stems 24 in place in their seats 22.

At the loading station A, it is desirable to compress the springs 44 of the clamp-means 32 thereat so that valves can be easily loaded into the associated holes 22 thereat. To this end, each actuator-bar 38 of each clamp-means 32 is provided with a small wheel 50 rotatably secured to the end thereof which projects beyond the wall-portion 4 of the carrier 2. This wheel 50 is adapted to ride on a release-bar 52 at the loading station A. The release-bar 52 is stationarily supported axially away from the protruding ends of the actuator-bars 38. The release-bar 52 is curved, being coaxial with the carrier 2 and having a radius equal to the distance from the axis of the shaft 8 to the centers of the holes 40 of the clamping means in the carrier.

The release-bar 52 is so arranged that wheels 50 of the actuator-bars 38 at the loading station must ride thereon, forcing the associated actuator-bars 38 to move their associated clamp-bars 34 in a direction away from the release-bar 52. Consequently, valves can freely pass through the work-receiving holes 22 at the loading station A, until their stem-ends rest on the positioning bar 28.

It is to be noted that the positioning bar 28 extends for a slightly greater extent than the release bar 52 in the direction of rotation of the carrier 2. The extra length of the positioning bar forms the clamping region B, and should extend beyond the release bar 52 for a distance at least half that between centers of consecutive holes 22.

As the wheels 50 of the actuator-bars 38 of the clamp-means 32 successively leave the release bar 52, while the associated valves 26 still engage the position bar 28, the associated springs 44 successively go into action to force the associated clamp-bars 34 against these valves. These valves are, consequently, frictionally clamped in their seats 22 while positioned by the part of the positioning bar 28 in the clamping region B. After leaving the clamping region B, the released clamp-means 32 will hold such valves in their seats or holes 22.

Upon leaving the clamping region B, the valve-stems are rotated by the carrier 2 into the field of an induction heating coil 56. To permit the carrier 2 to be rotated continuously or intermittently, the induction heating coil may be of the pancake type as shown in the drawings, or may

be a channel-type coil 56', such as, for example, that shown in Fig. 9 and in the Goodridge Reissue Patent 22,322, dated May 25, 1943. Should the carrier 2 be moved step by step, a helical induction heating coil can also be used which is radially reciprocable; being moved about a protruding stem-end while the carrier is stationary and being returned to a rest position out of the path of this stem before the carrier moves its next succeeding step.

A quench means 58 is provided in the heating region C for quenching heated valve stem ends so that they will have a hardened zone.

The carrier 2 carries the valves 26 which have been heat-treated in the region C to the unloading region or station D which is provided with a second release-bar 60 that is generally similar to the first release bar 52 which is in the loading region A, except for its location. As each clamp-means 32 reaches the release-bar 60, the wheel 50 of its actuator-bar 38 rides on the release-bar 60 and compresses the associated spring 44. This unclamps the associated valves 26 in the associated work-receiving holes 22, whereupon the valves sooner or later drop from the hole 22 into a chute 62. The weight of a valve is usually sufficient to cause it to drop while it is in the lower quadrant of rotation of the carrier 2 where the release region is located. However, a pusher bar 64 can be provided in the release region B, which is generally similar to the positioning bar 28. The pusher bar 64 has a ramp-portion 66 at its leading end. The valve stem ends ride on the pusher bar 64 and are forced loose in their holes 22.

While I have described my invention in its preferred form for a particular application, it is obvious that it has wider application and is subject to wide modification therefrom.

I claim as my invention:

1. Means for inductively heating an object, comprising, in combination, a carrier rotatable in a predetermined path, said carrier comprising a seat for loosely receiving the object to be heat treated, an induction heating coil at a first predetermined work-heating location alongside said path, a positioning means along a limited portion of said path, before said work-heating location, for positioning the object in its seat so that it has a predetermined fixed spaced relation to said heating coil when at said work-heating location, said carrier comprising clamping means normally tending to clamp the object in its seat of the carrier, said clamping means comprising an actuator bar operable to unclamp the object temporarily so that the object may be positioned by said positioning means, said actuator-bar being rendered inoperable before the object leaves the positioning means, and a release-bar arranged to operate said actuator-bar as the actuator-bar passes a second location alongside said path beyond said heating coil.

2. Means for successively inductively heating a plurality of work-objects, comprising, in combination, a carrier comprising an annular work-receiving member, support-means rotatably carrying said carrier, work-heating means at a first predetermined work-heating location alongside said annular member, said annular member comprising a plurality of work-receiving holes spaced around it, each of said holes being arranged to receive a piece of work, with a portion of the work-piece protruding outside of said annular member, said carrier comprising a plurality of clamp-means for clamping a work-piece in each of said holes, when it is at said work-heating location, releasers successively releasing said clamp-means through an extended distance of travel of the carrier, before and at a point after said work-heating location, and positioning means along said extended distance and partially beyond in a direction toward said work-heating location arranged to operate on work-pieces in said holes before they reach said work-heating location, for positioning said protruding portion of each work-piece in a predetermined position, whereby each work-piece reaches said work-heating location in a preset spatial relation with respect to said heating-means.

3. Means for successively inductively heating a plurality of work-objects, comprising, in combination, a carrier comprising an annular work-receiving member, support-means carrying said carrier for rotation about a horizontal axis, said annular member comprising a plurality of work-receiving holes spaced around it, each of said holes passing radially through it, and being arranged to receive a work-piece with a portion of the work-piece protruding from said annular member, said carrier comprising a plurality of clamp-means associated with said plurality of holes, each clamp-means comprising a biased clamp-bar to clamp a work-piece in its associated hole, and comprising an actuator-bar which passes through an axial opening in said annular work-receiving member and is operable for actuating a clamp-bar to unclamp an associated work-piece, positioning means radially positioning the protruding portions of each work-piece, said positioning means extending along the upper quadrant of the upward path of movement of said work-receiving member, a releaser-means for successively operating said actuator-bars, and an induction heating coil alongside said annular member along the path for said protruding work-portions, said releaser-means being operable along the lower part of rotation of said annular member, whereby work-pieces in said holes which are in such lower part of said annular member can drop out of the last said holes.

4. Means for successively inductively heating a plurality of work-objects, comprising, in combination, a carrier comprising an annular work-receiving member, support-means carrying said carrier for rotation about a horizontal axis, said annular member comprising a plurality of work-receiving holes spaced around it, each of said holes passing radially through it, and being arranged to receive a work-piece with a portion of the work-piece protruding from said annular member, said carrier comprising a plurality of clamp-means associated with said plurality of holes, each clamp-means comprising a clamp-bar biased to clamp a work-piece in its associated hole, and comprising an actuator-bar operable for actuating a clamp-bar against its bias to unclamp an associated work-piece, each of said actuator-bars having a bar-portion extending out from a side of said annular member, the last said side being an upright side, a first release bar of limited extent arranged along said upright side at the upper part of the path of rising points on said annular member, said release bar also being in the path of said bar-portions for actuating the actuator-bars thereof, a second release bar of limited extent arranged along said upright side at the lower part of the path for falling points on said annular member, and an induction heating means along a circular side of said annular member and in the space between said first and second release bars, said induction heating means being adapted to pro-

vide a magnetic field in the path of movement of said protruding portions of said work-pieces.

5. An invention including that of claim 4 but further characterized by including a positioning bar of limited extent along said circular side of said annular member having a portion in the space between said first release bar and said induction heating coil, said positioning bar being arranged in the path of movement of said protruding portions of said work-pieces.

6. Work-carrying means for successively exposing parts of work-pieces to a high frequency heating field, comprising, an annular member, means carrying said annular member for rotation in an upstanding plane, said annular member comprising a plurality of work-receiving holes passing radially therethrough, said holes being circumferentially spaced, a plurality of movable clamp-bars carried by said annular member, each clamp-bar spanning a plurality of said holes, a plurality of actuator-bars passing through axial holes in said annular member, each actuator-bar being associated with one of said clamp-bars, a plurality of springs acting on said plurality of actuator-bars, said actuator-bars having exposed tips, and a stationary bar arranged alongside said annular member adapted to engage said tips as they rotate past the stationary bar, for moving the engaged actuator bar or bars against the force of the associated spring or springs.

7. Work-carrying means for successively exposing parts of work-pieces to a high frequency heating field, comprising, an annular member, means carrying said annular member for rotation in an upstanding plane, said annular member comprising a plurality of work-receiving holes passing radially therethrough, said holes being circumferentially spaced, a plurality of movable clamp-bars carried by said annular member, each clamp-bar spanning a plurality of said holes, a plurality of actuator-bars passing through axial holes in said annular member, each actuator-bar being associated with one of said clamp-bars, a plurality of springs acting on said plurality of actuator-bars, said actuator-bars having exposed tips, and a stationary bar arranged alongside said annular member adapted to engage said tips as they rotate past the stationary bar, for moving the engaged actuator bar or bars against the force of the associated spring or springs, and a work-positioning bar inwardly spaced from said annular member in the plane of said holes.

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