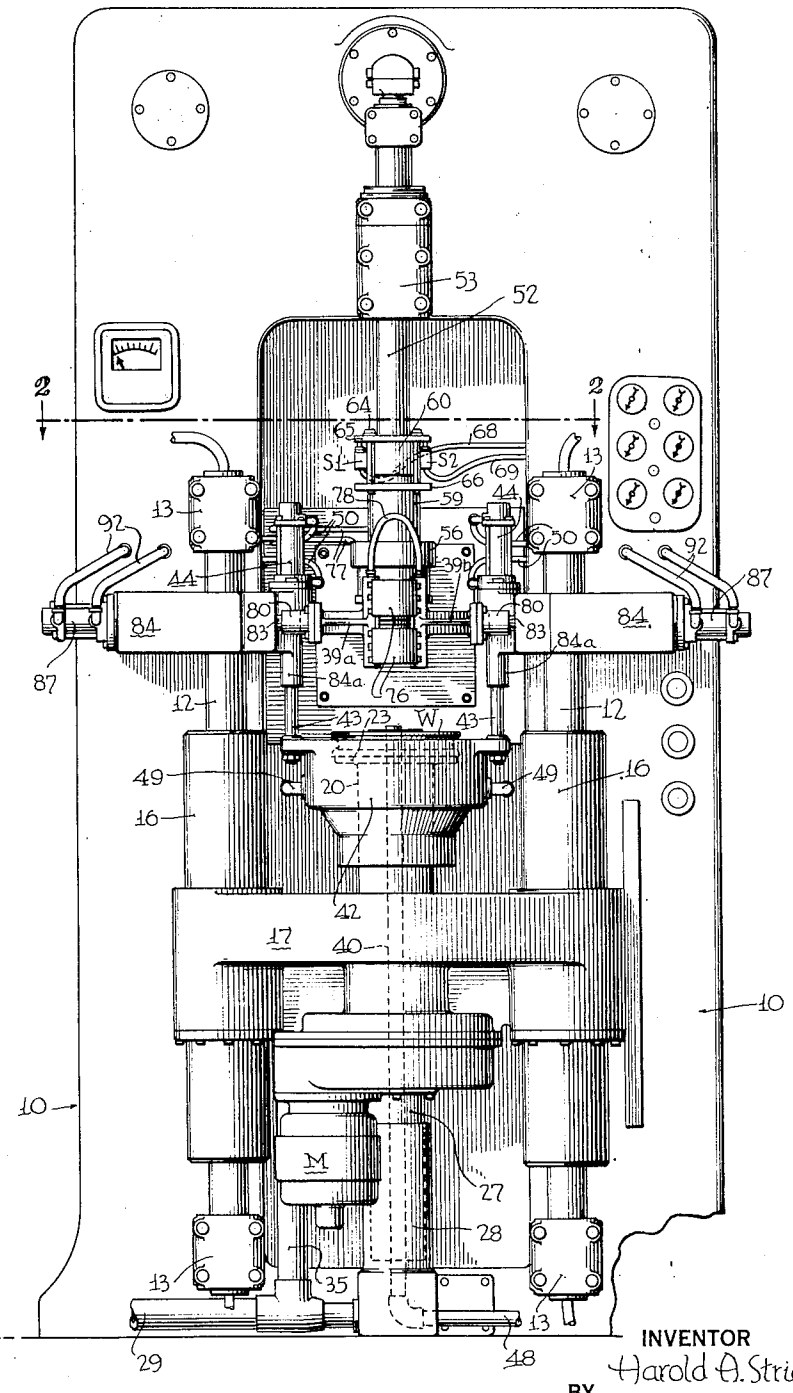
Aug. 8, 1950 H. A. STRICKLAND, JR 2,517,607

INDUCTION HEAT TREATING APPARATUS

Filed March 22, 1947 3 Sheets-Sheet 1

Fig. 1.



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INDUCTION HEAT TREATING APPARATUS

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Fig. 4.

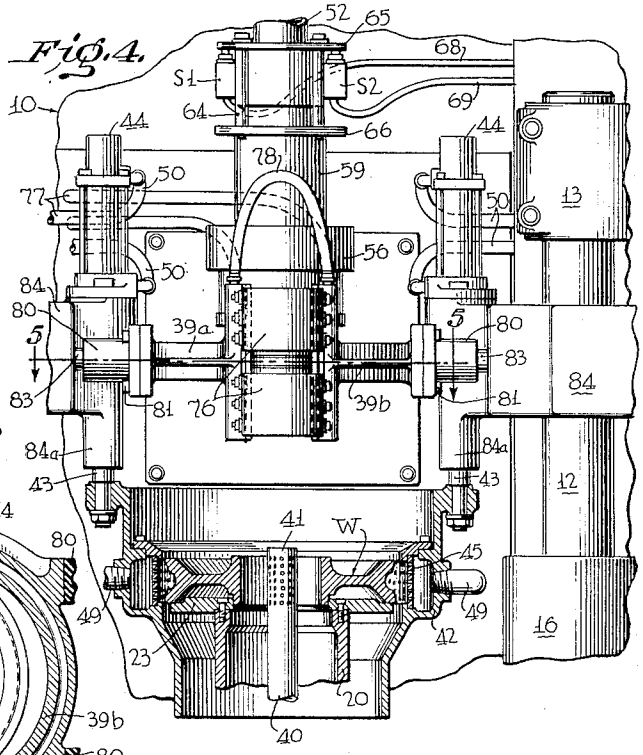
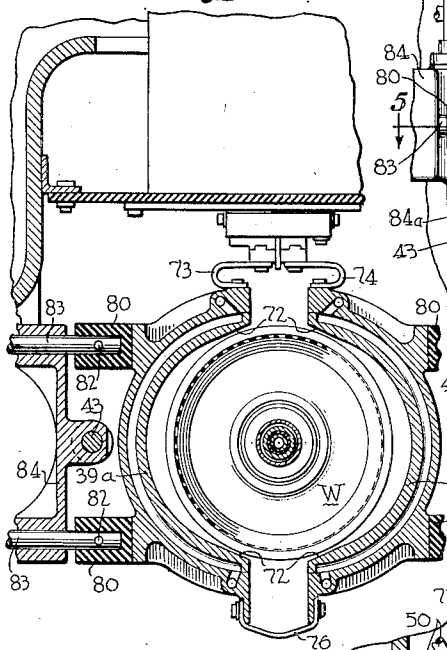


Fig. 5.



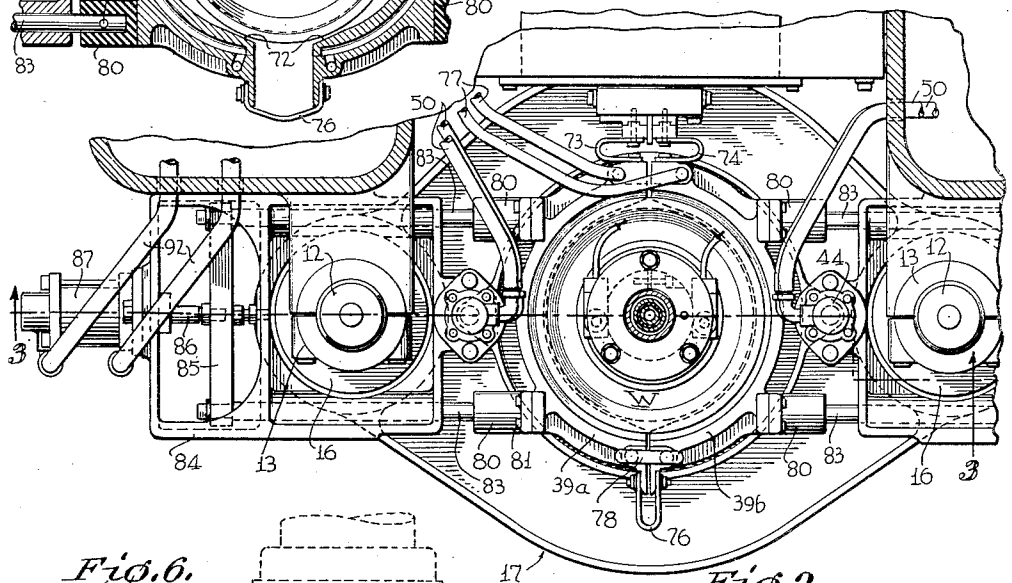
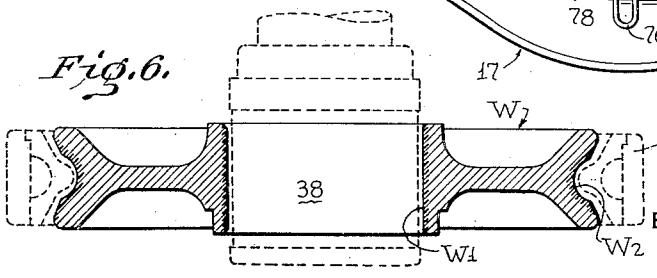


Fig. 2.

Fig. 6.



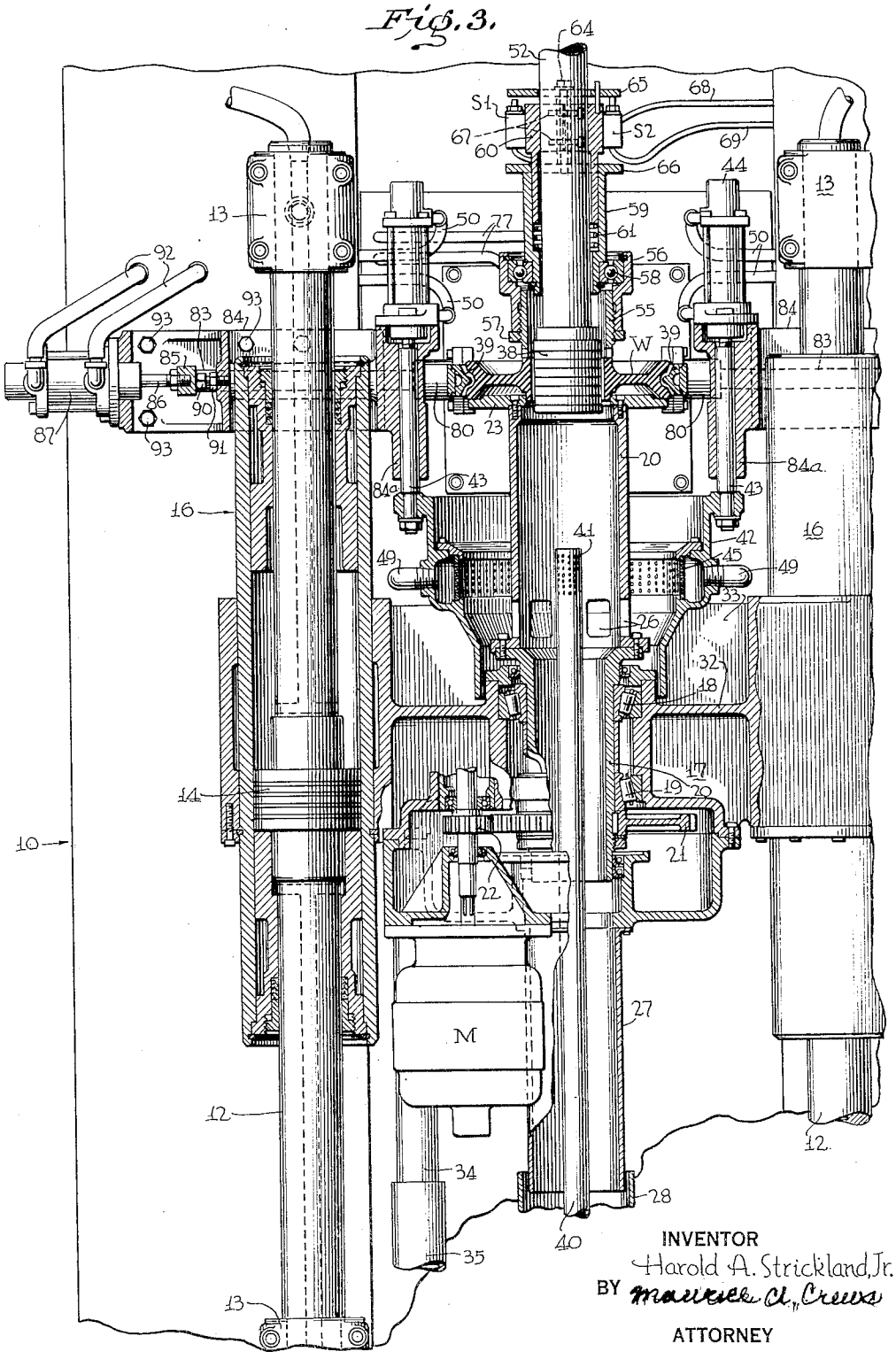
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Filed March 22, 1947 3 Sheets-Sheet 3

Fig. 3.



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Patented Aug. 8, 1950

2,517,607

UNITED STATES PATENT OFFICE

2,517,607

INDUCTION HEAT-TREATING APPARATUS

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Application March 22, 1947, Serial No. 736,439

3 Claims. (Cl. 266—4)

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This invention relates to heat treating apparatus, particularly to apparatus for heating and quenching two circumferential surfaces of a workpiece and more particularly to apparatus for heat treating a short workpiece having an external groove, and has for an object the provision of improvements in this art.

One of the particular objects of the invention is to provide means for accurately placing the workpiece relative to the heating means and for furnishing an indication whether the workpiece is of proper length.

Another object is to provide improved means for heating the external groove of a workpiece.

Another object of the invention is the provision of a new and improved inductor comprised of segments each adapted to be moved into and out of mating engagement with a recess on the surface of a workpiece, the ends of the segments being cut away so as to facilitate movement of the workpiece in a direction transverse to the plane of the segment.

Another object is to provide improved means for enabling, introducing and removing a workpiece into and from an induction-heating coil.

The above objects and certain novel features will be apparent from the following description of an exemplary embodiment, reference being made to the accompanying drawings thereof, wherein:

Figure 1 is a front elevation of the apparatus;

Figure 2 is an enlarged horizontal section taken on the line 2—2 of Fig. 1;

Figure 3 is a vertical section taken on the line 3—3 of Fig. 2 but with the workpiece in heating position;

Figure 4 is a partial section similar to Fig. 3 but showing the workpiece in quenching position;

Figure 5 is a horizontal section taken on the line 5—5 of Fig. 4; and

Figure 6 is an axial section through the hardened workpiece, showing in dotted lines the relation thereto of the heating means.

The apparatus in general comprises a support for holding a relatively short workpiece such as a sheave which is to be hardened on the interior of the hub and within the external groove, means for moving the workpiece support into heating and quenching position, means for moving the external heating means laterally into and out of heating position, means for moving the external quenching means axially to clear the workpiece position for the introduction and removal of a workpiece, and means for accurately gauging the thickness and position of the workpiece in heating position to prevent the application of heating current until the proper arrangement is attained.

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The apparatus illustrated in the drawings includes a fixed frame 10 to which a plurality (two here) of spaced parallel guide rods 12 are secured at their ends by clamps 13, the rods 12 being spaced outwardly from the vertical portion of the frame 10 and each being provided intermediate its ends with a piston 14. Suitable ports and passages in the rods provide for the flow of motive fluid to and from the cylinders. Operatively associated with each piston 14, which is mounted thus in a fixed position, is a cylinder 16, and these cylinders are rigidly connected by a cross piece 17. The connected cylinder assembly may be referred to as a carriage.

Upon the carriage on bearings 18 and 19 there is rotatably mounted a tubular workpiece support 20. The support is rotated through gears 21 and 22 by a motor M mounted on the carriage. At its upper end the support 20 carries a workpiece holder plate 23 having an interior opening adapted to receive and accurately position the flanged hub of the workpiece W and a reduced outer edge adapted to receive the outer edge of the workpiece.

The intermediate portion of the tubular workpiece support 20 is provided with a plurality of holes 26 for the passage of quenching fluid to the interior, and a depending tubular extension 27 telescoped within an upstanding fixed drain tube 28 emptying into a pipe 29 (Fig. 1). The transverse web 32 and upstanding sidewalls 33 of the carriage constitute a collecting basin for quench fluid, and a depending pipe 34 therefrom cooperates with a telescoping pipe 35 and the drain pipe 29 to remove fluid from this basin. As shown in Fig. 6, the workpiece is hardened at W1 on its inner circumference, as by a heating head 38 shown in dotted lines, and at W2 on its outer grooved circumference, as by a heating head 39 also shown here in dotted lines. The heating means will be discussed in detail hereinafter. It will be understood from the fact that the workpiece is hardened by induction heating and quenching, that it is composed of a metal which is of such a nature that it is subject to being heated by induction heating means (usually high frequency) and to being quenched by a fluid such as air, water, oil or other known medium, the workpiece being of the same chemical composition throughout before and after hardening as distinguished from a metal whose

chemical character is changed by the hardening process.

The means for quenching are shown in operative relationship to the workpiece in Fig. 4, a fixed quench tube 40 being secured within the tubular support 20 and drain pipe 28, with its perforated end or head 41 properly located to quench the interior hub surface W1 when the workpiece is in its lowermost position, and a quench head 42 being supported on depending rods 43 which are movable (with pistons, not shown) within fixed cylinders 44, the quench head having its perforated inner portion 45 properly located to quench the exterior sheave groove W2 when the workpiece is in its lowermost position and the quench head is in its uppermost position.

Quench fluid is supplied to the quench tube 40 by a pipe 48, and to the quench head 42 by pipes 49 connected to flexible hose, not shown. Motive fluid is supplied to and removed from the cylinders 44 by pipes 50. When the quench head is moved down to its lowermost position the upper end of the workpiece support and the plate 23 are exposed above the quench head to permit easy insertion and removal of a workpiece.

The hub heating head 38 is supported in fixed position upon a tubular rod 52 supported at 53 on the frame 10 and supplied with electric current, coil cooling fluid, appropriate insulation, and the like in known manner.

Means are provided for accurately locating and gauging the workpiece in heating position and these means are coordinated with means for clamping the workpiece for rotation. As shown in Fig. 3, a tubular workpiece clamp 55 engages the upper end of the hub of the workpiece when it is in its uppermost position. The clamp member 55 is carried adjustably by a rotatable head member 56, a locknut 57 being provided for holding the parts securely in adjusted position.

The head member 56 is, through bearings 58, rotatably mounted on a sleeve 59 which is vertically slidable on a fixed tubular support 60. A coil spring 61 urges the sleeve 59 downwardly. Secured to the sleeve 59 in spaced relation, as by stud bolts 64, is an annular plate 65 adapted to operate switches S1 and S2 which are mounted on the fixed support 60. The sleeve 59 may be provided with an outstanding flange 66 to furnish convenient anchorage for the bolts 64. The bolts have nuts or heads at their upper ends to prevent the sleeve 59 from moving too far downwardly by the action of the spring 61 and gravity.

A convenient way to mount the fixed support 60 is to make it as a split part and clamp it to the fixed induction head supporting rod or mandrel 52, as by bolts 67.

Cable 68, 69 connect the switches S1, S2 into a power control circuit of any suitable type. The switches may be either of the make or break type but it is not thought to be necessary to illustrate either the switch or circuit details, these being matters regularly supplied according to requirements.

When the workpiece is of the proper thickness at the hub and is pushed up accurately into heating position, as shown in Fig. 3, one of the switches, as S1, will be cleared from the operating plate 65 while the other will not be cleared. In this situation the circuit is cleared for operation; but if neither switch is cleared or if both are cleared the machine will not operate to heat the workpiece. The switches are of the micro type so that the movements involved are very small.

The induction heating head 38 for heating the bore W1 of the workpiece has already been described and the external heating head 39 has been referred to. As shown in Fig. 5, the head 39 is made in two semicircular parts 39*a* and 39*b* which can be moved radially toward and from each other to embrace the workpiece for heating or to clear it so it can be moved axially into and out of heating position. The parts 39*a*, 39*b* are cut away adjacent their meeting edges, as at 72, to clear the outer edge of the workpiece.

The induction heating head 39 is made as a single turn coil which is supplied with current by conductors 73 and 74 which are adequately flexible in keeping with their length to accommodate the movements of the parts of the head toward and from each other. At the other side, the front, the parts 39*a*, 39*b* are connected by a flexible jumper conductor 76. The conductors 73, 74 and 76, to have suitable flexibility, may be formed of laminated soft copper strips.

Cooling fluid is supplied to and removed from the heating head 39 by flexible conduits 77 and is transferred between the divided head parts by a short flexible jumper conduit 78.

Means are provided for moving the heating head parts 39*a*, 39*b* toward and from each other. As best shown in Fig. 5, the parts 39*a*, 39*b* are mounted on insulating blocks 80, which blocks, as shown in Figs. 2 and 4, are secured to the parts by bolts 81.

The blocks 80 have secured thereto, as by pins 82, operating rods 83 which operate in guide passages in brackets 84 and the rods 83 are connected in pairs beyond the brackets by crossbars 85. Piston rods 86, operated by pistons within cylinders 87, are secured to the crossbars 85 intermediate their length. The inward position of the crossbars 85 and of the heating head parts 39*a*, 39*b* carried thereby is defined and limited by stop screws 90 provided with locknuts 91. Motive fluid is supplied to and exhausted from the cylinders 87 by conduits 92.

As shown in Fig. 3, the brackets 84 are secured to the base frame 10 by bolts 93 and provide openings between the rods 83 for accommodating the large carriage cylinders 16. The brackets also provide suitable portions 84*a* at their inner ends which form guides for the quench head operating rods 43 and mounting means for the cylinders 44.

In operation, a workpiece W is introduced when the quench head 42 and the carrier plate 23 are in their lowermost positions. As shown in Fig. 1, the workpiece position is accessible from the front between the rods 43 and above the quench head 42 carried thereby at this time.

The carriage, comprised of the cylinders 16 and the cross member 17, is then moved upwardly as shown in Fig. 3, the heating head parts 39*a*, 39*b* being in their separated position at this time, until the switch S1 is cleared but without clearing switch S2. The ends of the cylinders 16 at this time abut the ends of the pistons 14 to limit upward movement. The switches S1, S2 register the completion of this upward movement and determine whether the workpiece is too thick or too thin. If conditions are not right the machine does not heat the workpiece.

With the workpiece in correct heating position, the exterior heating head elements 39*a*, 39*b* are forced inward by their rods 83 and connected motive means until the crossbars 85 engage the heads of the limit gauge bolts 90. The contoured

inner surfaces of the heating head parts 39*a*, 39*b* then fit accurately within the groove W2 of the workpiece, as shown in Figs. 3 and 6. The internal heating head 38 being fixed in position is also suitably disposed with relation to the internal surface W1 of the workpiece.

If sufficient power is available both heating heads 38 and 39 may be operated simultaneously but when desired they may be operated in succession, preferably the inner first and the outer following.

After the workpiece has been heated it is moved down to the quenching position shown in Fig. 4, the heating head parts 39*a*, 39*b* first being moved apart to clear the grooved outer edge of the workpiece as it moves down. The quench head 42 is moved up into quenching position and when the parts are all in proper position fluid is supplied to the inner quench head 41 and to the outer quench head 42 simultaneously, to quench both the inside surfaces W1 and W2.

After quenching, the quench head 42 is moved back down to the Fig. 1 position to permit the hardened workpiece to be removed and a new workpiece to be introduced.

While the invention has been described as applied to treating an externally grooved workpiece it will be understood that it is applicable to any workpiece which has any portion extending outwardly beyond the surface to be treated so as to make useful the radially movable heating head parts; and in certain aspects the invention is applicable, of course, to workpieces having uniform and readily accessible outer surfaces.

While one embodiment of the invention has been described in detail, it is to be understood that there may be various embodiments within the limits of the prior art and the scope of the subjoined claims.

What is claimed is:

1. Apparatus for heat treating an article, comprising in combination, an axially movable workpiece support, electric induction heating means for heating the workpiece externally at one point along its axis of travel, said heating means including divided parts mounted to move radially toward and from the axis of the workpiece and having elements adapted to be positioned radially within a radially projecting element of the workpiece, said divided heating head parts being radially cut away adjacent their meeting edges to provide clearance when in their radially retracted position for the radially projecting part of the workpiece during relative axial movements.

2. Apparatus for heat treating an article, comprising in combination, a workpiece support, an induction heating head adapted to induce heating currents in a radial recessed portion of the workpiece, said workpiece support and heating head having axial movement relative to each other, said heating head being divided and the parts thereof having radial movement relative to the axis of the workpiece and heating head, and said heating head parts being cut away radially near their meeting edges to provide clearance for radially extending portions of the workpiece during the relative axial movements.

3. Apparatus for heat treating an article, comprising in combination, an axially movable workpiece carriage, an axially movable quench head adapted to surroundingly embrace the workpiece, laterally spaced axially movable power means for moving said workpiece carriage, fixed brackets surrounding said power means, a heating head having radially movable parts, operating rods for said heating head parts and reciprocable generally laterally to said workpiece axis, said rods being mounted in said brackets and spaced on opposite sides of said power means, and operating rods for said quench head mounted for movement on said brackets.

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