June 25, 1957 W. L. GEORGEN 2,797,289

INDUCTION HEATING DEVICE FOR TREATING CYLINDER BORES

Filed Feb. 21, 1955 2 Sheets-Sheet 1

FIG. 1

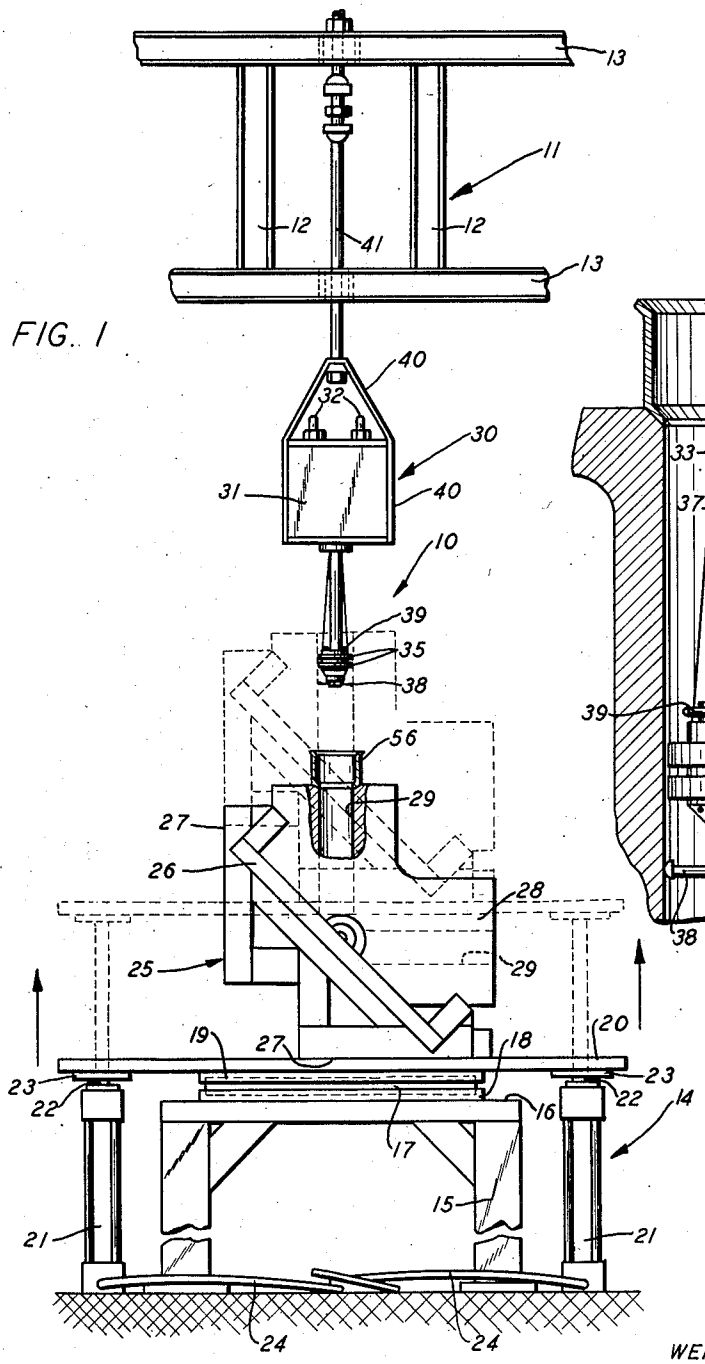
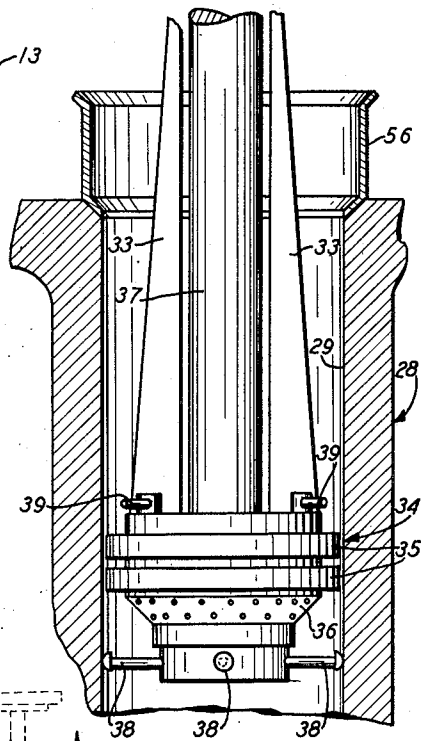


FIG. 4



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FIG. 2

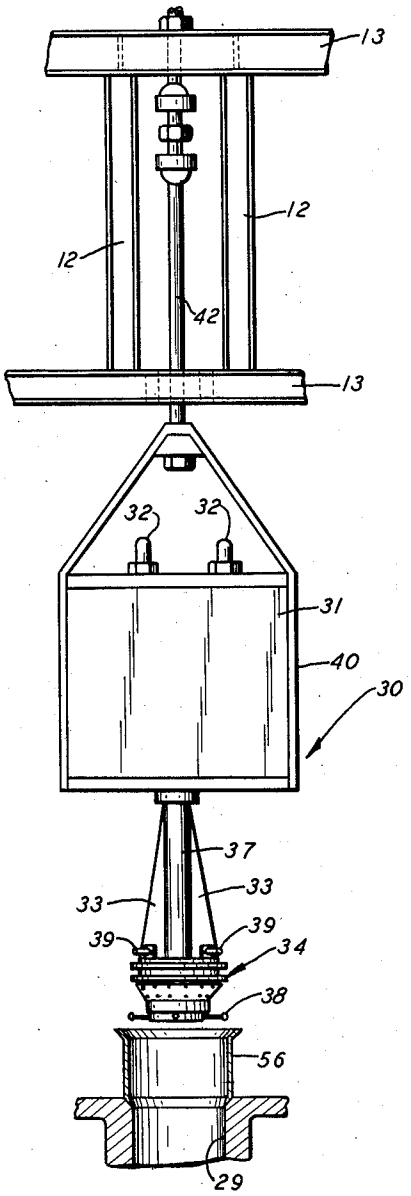


FIG. 3

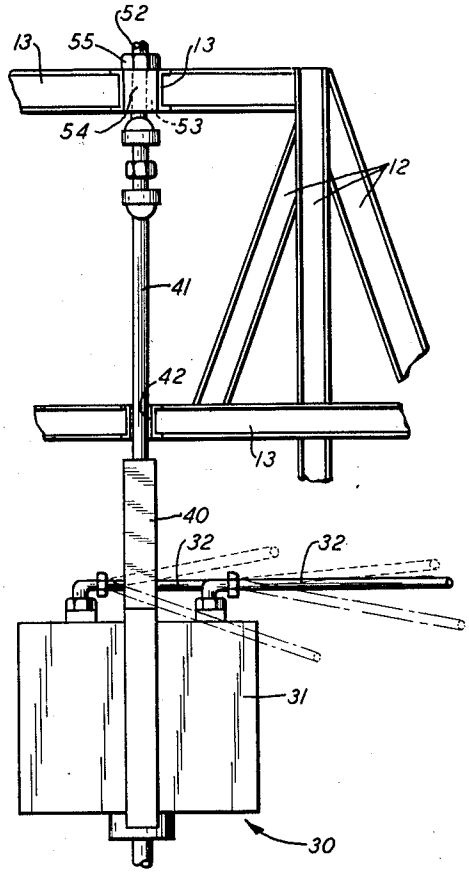
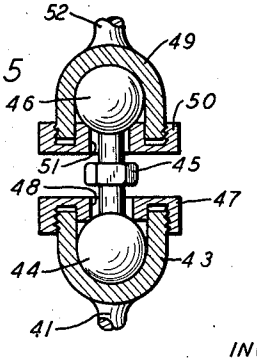


FIG. 5



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INDUCTION HEATING DEVICE FOR TREATING CYLINDER BORES

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Application February 21, 1955, Serial No. 489,407

9 Claims. (Cl. 219—10.57)

This invention relates to an apparatus for induction heating and more particularly to an induction heating device adapted for heating the inner wall of a cylinder bore.

In the field of cylinder bore hardening, various induction heating devices have been developed for treating the inner wall of the cylinder bores. These devices generally include a coil incorporated with a quench block for heating the bore and subsequently quenching the wall to provide a hardened inner surface. Induction devices of the type heretofore developed have generally been satisfactory where the bore is provided in a cylindrical member having a fairly consistent wall thickness. Such devices however are unsatisfactory generally for treating cylindrical bores where the said bores are part of a cylinder block of a type generally utilized in internal combustion engines. In view of inconsistencies in the thickness of wall occasioned by standard foundry practices it has been found extremely difficult to satisfactorily harden, to a sufficient thickness, the cylindrical inner surface defined by the cylinder bore. Extreme accuracy in the spacing of the inductor with respect to the inner surface to be hardened is extremely important, and devices developed heretofore have been unsatisfactory in this respect. It is therefore a prime object of this invention to provide an improved apparatus for induction heating of cylinder bores formed in the blocks of internal combustion engines.

A further object is to provide an improved induction heating device having provisions whereby the induction coil may be suitably and consistently spaced from the inner cylindrical wall of a bore during the heating operation.

A still further object of the invention is to provide an improved construction for suspending a high frequency transformer and an induction coil relative to a working position with respect to a bore of a cylinder block.

Still another object is to provide an improved induction heating device, including a transformer and an induction coil, the transformer being floatingly or adjustably mounted so that it may be self aligning or adjusting with respect to a cylinder bore in response to guide elements associated with the induction coil.

These and other objects will become more readily apparent from a reading of the specification when examined in connection with the accompanying sheets of drawings.

In the drawings:

Figure 1 is a side elevational view of an induction heating apparatus or device disclosing work supporting means and induction heating means with supporting structure therefor;

Figure 2 is an enlarged front elevational view of a portion of the apparatus shown in Figure 1;

Figure 3 is a side view in elevation showing a high frequency transformer suspended from a supporting structure;

Figure 4 is an enlarged sectional view through a cylinder block of an internal combustion engine showing

in elevation an induction heating coil in operative relation with respect to a cylinder bore; and

Figure 5 is a detail of an enlarged sectional view of an adjustable connecting means for supporting an induction heating device.

Referring to the drawings, an apparatus for induction heating is generally designated by the reference character 10. The induction heating apparatus 10 includes an upper support generally designated by the reference character 11. The upper support 11 consists of a plurality of generally upright or vertical channels 12 suitably connected to a plurality of horizontal channels 13 to form a rigid structure. A lower support is generally designated at 14. The lower support 14 includes a conveyor 15 having a generally flat horizontal table 16. A plurality of rollers (only one of which is shown) 17 are mounted on the horizontal table 16. The rollers 17 can be of any conventional type generally used in conveyor structures. A retainer 18 suitably connects each roller 17 to the table 16. A track or frame 19 is movably carried by the rollers 17 and the said track is connected to the underneath side of a platform 20. Thus the platform 20 by virtue of the track 19 may suitably move on the rollers 17 in a horizontal direction relative to the conveyor 15.

Means for raising the platform 20 is provided in the form of laterally spaced fluid cylinders 21. The cylinders 21 include piston rods 22 which have at their upper ends pads 23 adapted to engage and move the platform 20 free of the conveyor 15 as indicated in Figure 1. A number of such fluid cylinders 21 may be provided. Fluid conduits 24 are connected to the cylinders 21 providing fluid under pressure thereto.

As shown in Figure 1, the platform 20 supports a work holding fixture 25 providing a cradle 26 having base portions 27 disposed in right angle relation. The cradle 26 is adapted to support a V-type internal combustion engine block 28 having a plurality of cylinders or cylinder bores 29 positioned in V relation. Thus as shown in Figure 1 the fixtures 25 may rest upon either of the bases 27 depending which cylinders are to be treated.

An induction heating device is generally indicated at 30. The heating device 30 includes a high frequency transformer 31 having power input leads 32. The type of transformer utilized in this invention is of a conventional type used in conventional induction heating applications. A pair of copper conductors 33 are rigidly connected to the transformer 31. The copper conductors in turn are connected to an inductor unit generally designated at 34. The inductor unit comprises an induction coil 35. The induction coil 35 may be of a hollow construction which is conventional in the art for cooling such coils. In addition the unit 34 includes a quench block 36 which is connected to a conduit 37 through which a quenching liquid may be forced and discharged from the quench block 36.

As best shown in Figure 4 the inductor unit is disposed within a cylinder bore 29, and in order to keep the induction coil 35 suitably spaced from the interior wall, spacer members 38 are connected to a collar 38' which in turn is suitably connected to the quench block 36. The spacer members 38 extend radially outwardly from the collar 38' in circumferentially spaced relation. Likewise at the top of the inductor unit 34 a plurality of additional spacer members 39 are also connected, these spacer members also being circumferentially spaced and extending radially outwardly for sliding engagement with respect to the bore 29.

A sling 40 is suitably connected to the high frequency transformer 31. The sling 40 is in turn supported by means of a rod 41 extending through an opening 42 provided by the horizontal channels 13. The rod 41 fur-

ther extends upwardly and as best shown in Figure 5 is connected to a socket 43 in adjustable engagement with a ball 44. The ball 44 in turn is connected to a connecting member 45 which is connected to a ball 46. A cap 47 is threaded on the socket 43 to form a suitable ball and socket connection. The cap 47 is provided with a suitable opening 48 through which the connecting member 45 extends. A socket 49 is in adjustable engagement with respect to the ball 46 and a cap 50 is suitably threaded to the socket 49 to provide a ball and socket connection. An opening 51 similar to the opening 48 provides for limited adjustability of the sockets 43 and 49 relative to the balls 44 and 46. The socket 49 is connected to a bolt extension 52 which extends upwardly through a bore 53 provided in a block 54. The block 54 is suitably connected to the upper horizontal channels 13 as best shown in Figure 3. A nut 55 is threaded to the bolt extension 52 to suitably support the ball and socket connections. As best shown in Figures 2 and 4, a guide cup or funnel 56 is placed over the upper end of the cylinder 29, this guide cup serving to guide the induction coil 35 relative to the bore 29.

It is of course realized that the invention is not limited to a construction wherein the work support or table moves upwardly relative to the induction coil. For example, it is contemplated that the upper structure or support 11 might be movably positioned so that the transformer and induction coil can be moved relative to the work which is to be treated. In the construction shown however the cylinders 21 are effective to move the platform 20 upwardly whereupon the inductor unit 34 enters into the passage or cylinder 29 until it is at its lowermost position. At this point the power is turned on and heating takes place as the cylinder 29 is moved downwardly upon descent of the platform 30. Quenching also takes place at this time and suitable hardening is thus effected of the cylinder wall. It is noted that the guide members 38 and 39 engage the cylinder wall in relative sliding relation to maintain the inductor coil suitably spaced from the wall of the said cylinder. The transformer is adjustably mounted by virtue of the ball and socket connection so that the whole structure may be self-adjusting in response to the guiding action afforded by the guide elements 38 and 39. Each cylinder is thus progressively hardened. The platform 20 during its lowermost position may be indexed on the rollers 17 so that successive cylinders may be placed in vertical alignment with respect to the induction coil 35. Despite variances in the walls of the cylinders the coil is maintained in proper relation relative to the wall of the cylinder and the transformer is self-aligning in view of the adjustable suspension afforded by the ball and socket connection.

Thus it is believed that the objects of the invention have been fully achieved and that a new and improved induction heating apparatus for particularly heating cylinder bores has been described. It must be understood that changes and modifications may be made without departing from the spirit of the invention as disclosed nor the scope thereof as defined by the appended claims.

What is claimed is:

1. An apparatus for induction heating cylinder bores comprising an upper support, a work support below said upper support, said work support being adapted to position an object having an open end bore, heating means suspended from said upper support comprising a high frequency transformer, an induction heating coil rigidly connected to said transformer, said coil being adapted to enter a bore and heat the wall thereof, radially extending spacer members connected to said coil in vertically spaced relation, said spacer members being adapted to slidingly engage the wall of the bore to center said coil within the bore, adjustable means connecting said transformer to said upper support, said means comprising a hanger arm connected to said transformer, a ball and socket connection connected to said arm and to said upper support whereby said transformer may be laterally adjusted in response to centering of said induction coil within a bore, means limiting said lateral movement of said transformer, and means moving said support to move the object and the bore relative to the induction coil within said bore.

2. An apparatus for induction heating cylinder bores comprising an upper support, a work support below said upper support, said work support being adapted to position an object having an open end bore, heating means suspended from said upper support comprising a high frequency transformer, an induction heating coil rigidly connected to said transformer, said coil being adapted to enter a bore and heat the wall thereof, radially extending spacer members connected to said coil in vertically spaced relation, said spacer members being adapted to slidingly engage the wall of the bore to center said coil within the hose, adjustable means connecting said transformers to said upper support, said means comprising a hanger arm connected to said transformer, a ball and socket connector connected to said arm and to said upper support whereby said transformer may be laterally adjusted in response to centering of said induction coil within a bore, and means moving said work support to move the object and the bore relative to the induction coil within said bore.

3. An apparatus for induction heating cylinder bores comprising an upper support, a work support below said upper support, said work support being adapted to position an object having an open end bore, heating means suspended from said upper support comprising a high frequency transformer, an induction heating coil rigidly connected to said transformer, said coil being adapted to enter a bore and heat the wall thereof, radially extending spacer members connected to said coil in vertically spaced relation, said spacer members being adapted to slidingly engage the wall of the bore to center said coil within the bore, adjustable means connecting said transformer to said upper support, said means comprising a hanger arm connected to said transformer, a ball and socket connector connected to said arm and to said upper support whereby said transformer may be laterally adjusted in response to centering of said induction coil within a bore, and means providing for relative movement between the object and said induction coil.

4. An apparatus for induction heating cylinder bores comprising an upper support, a work support below said upper support, said work support being adapted to position an object having an open end bore, heating means suspended from said upper support comprising a high frequency transformer, an induction heating coil rigidly connected to said transformer, said coil being adapted to enter a bore and heat the wall thereof, radially extending spacer members connected to said coil, said spacer members being adapted to slidingly engage the wall of the bore to center said coil within the bore, adjustable means connecting said transformer to said upper support, said means comprising a hanger arm connected to said transformer, a ball and socket connector connected to said arm and to said upper support whereby said transformer may be laterally adjusted in response to centering of said induction coil within a bore, means limiting said lateral movement of said transformer, and means moving said work support to move the object and the bore relative to the induction coil within said bore.

5. An apparatus for induction heating cylinder bores comprising a support, a work holder adapted to position an object having an open end bore in proximity to said support, an induction heating unit including a transformer, an induction heating coil connected to said transformer, a guide element connected to said heating coil, said guide element being adapted to engage said bore to center said coil within a cylinder bore, and flexible means connecting said transformer to said support whereby said transformer is laterally moved relative to the

axis of the bore of the object in response to centering movement of said coil in response to operation of said guide element.

6. An apparatus for induction heating cylinder bores comprising a support, a work holder adapted to position an object having an open end bore in proximity to said support, an induction heating unit including a transformer, an induction heating coil rigidly connected to said transformers, a guide element connected to said heating coil, said guide element being adapted to engage a bore to center said coil within said cylinder bore; flexible means connecting said transformer to said support whereby said transformer is laterally moved relative to the axis of the line of the object in response to centering movement of said coil and in response to operation of said guide element, and means adapted to provide for relative movement between said coil and said cylinder bore whereby said bore is progressively heated.

7. An apparatus for induction heating cylinder bores comprising a support, a work holder adapted to position an object having an open end bore with an inner wall in proximity to said support, an induction heating unit including a transformer, an induction heating coil rigidly connected to said transformer, a guide element connected to said heating coil, said guide element being adapted to engage the inner wall of the bore to center said coil within said cylinder bore, and means movably connecting said transformer to said support whereby said transformer is laterally adjusted relative to the line of the object

in response to centering movement of said coil and in response to operation of said guide element, and means adapted to provide for relative movement between said coil and said cylinder bore whereby said bore is progressively heated.

8. An apparatus for induction heating cylinder bores comprising a transformer support, work holding means positioned adjacent said support, said work holding means being adapted to hold a work piece having an open end bore, heating means comprising a transformer, an inductor connected to said transformer, said inductor being adapted to progressively heat a cylinder bore, and means movably connecting said transformer to said support, said transformer being laterally adjustable in response to lateral movement of the inductor within a bore whereby said inductor is centered relative to said bore during relative movement between said inductor and the bore.

9. An apparatus in accordance with claim 8, the movable means including ball and socket joint connection connected to said transformer and said support.

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