Aug. 20, 1963 C. G. BARKLEY ETAL 3,101,165

METHOD AND APPARATUS FOR HEAT-TREATING

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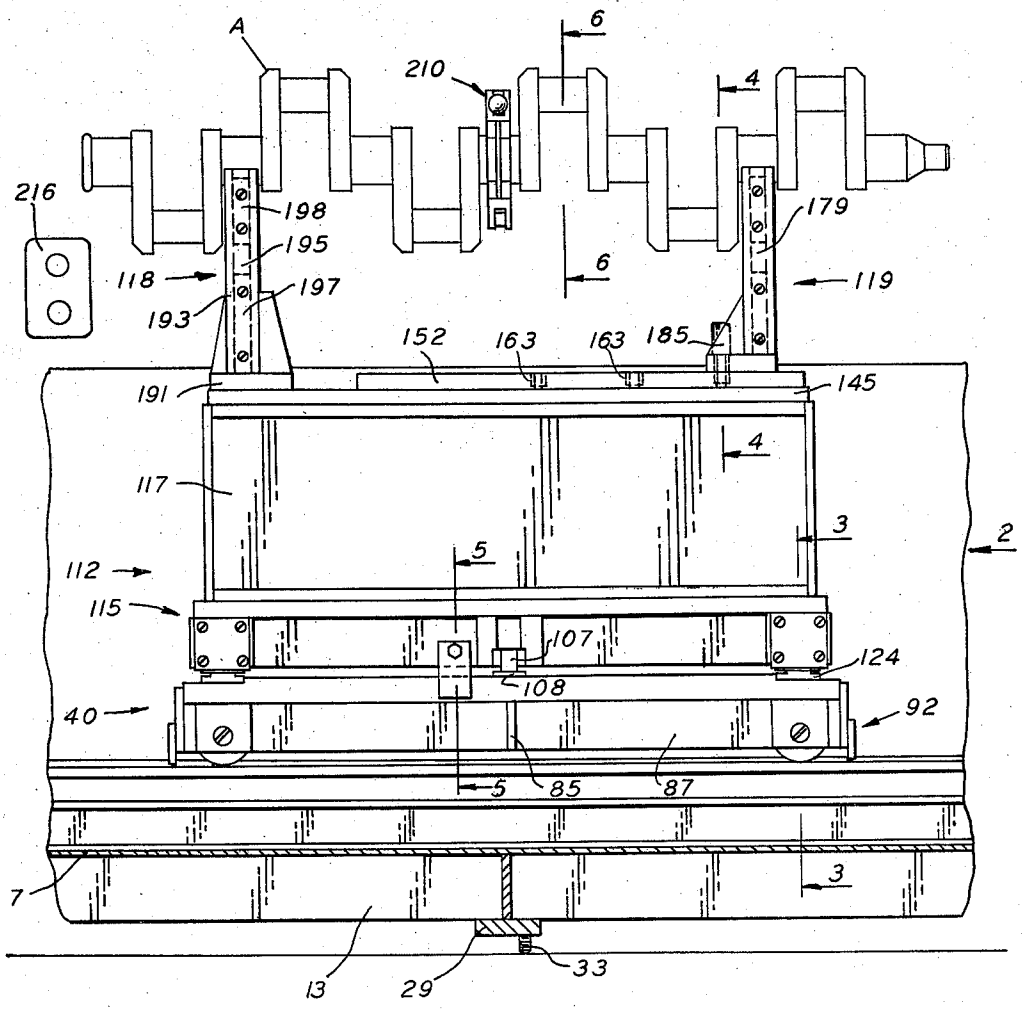


FIG. 1

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METHOD AND APPARATUS FOR HEAT-TREATING

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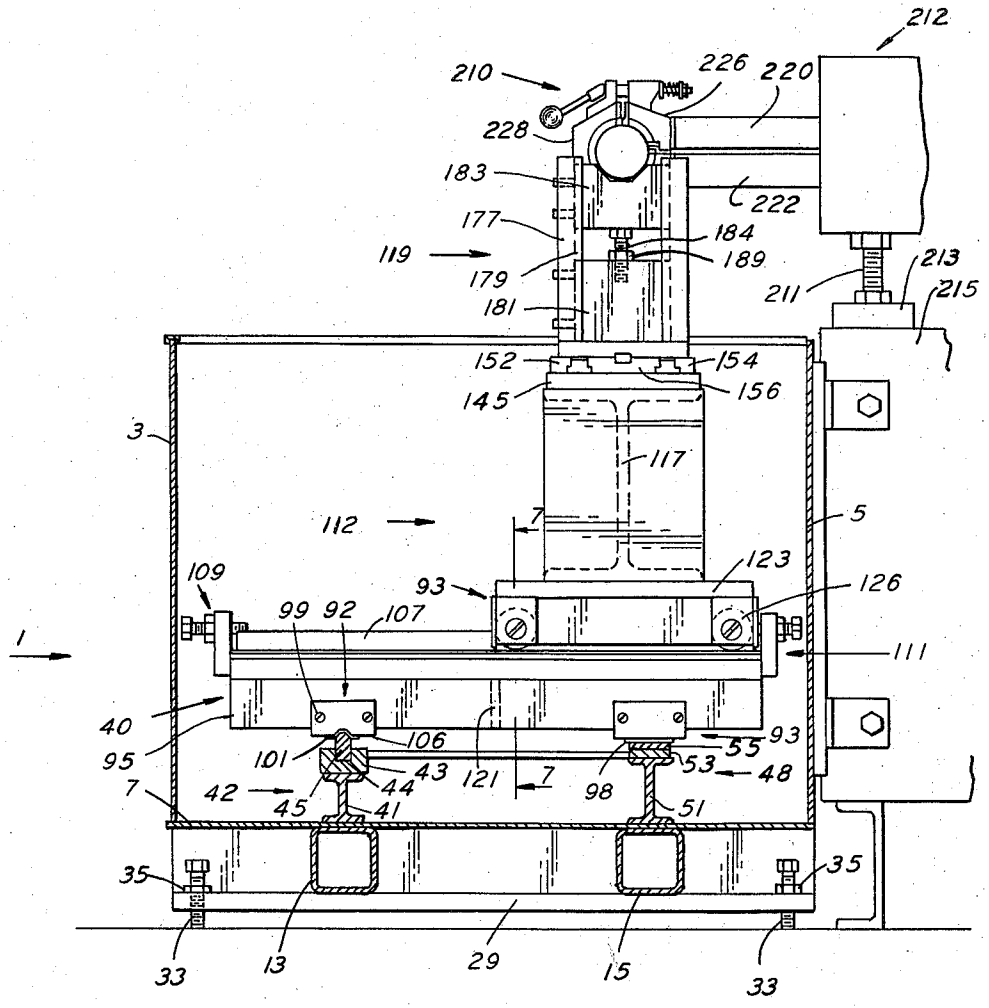


FIG. 2

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METHOD AND APPARATUS FOR HEAT-TREATING

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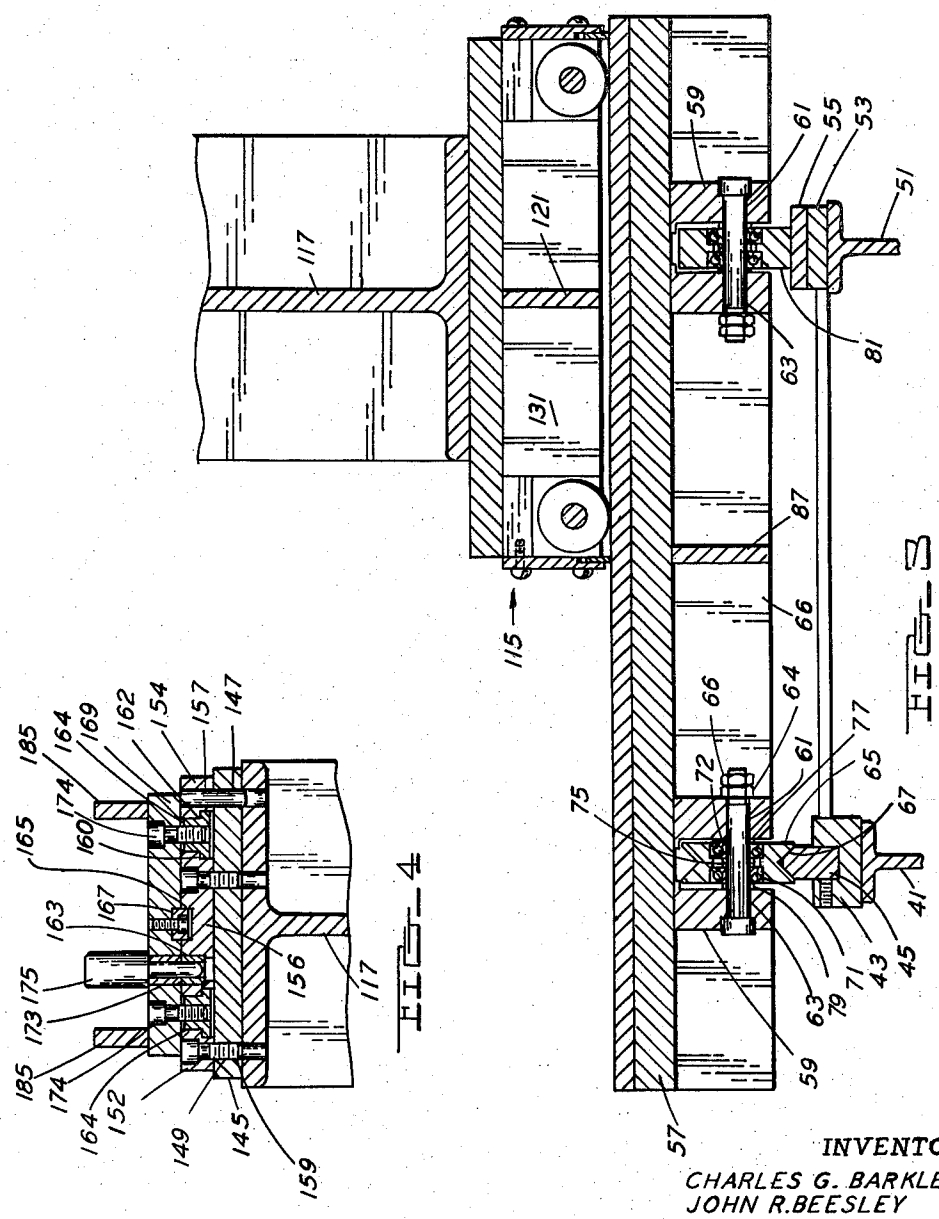


FIG. 3

FIG. 4

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METHOD AND APPARATUS FOR HEAT-TREATING

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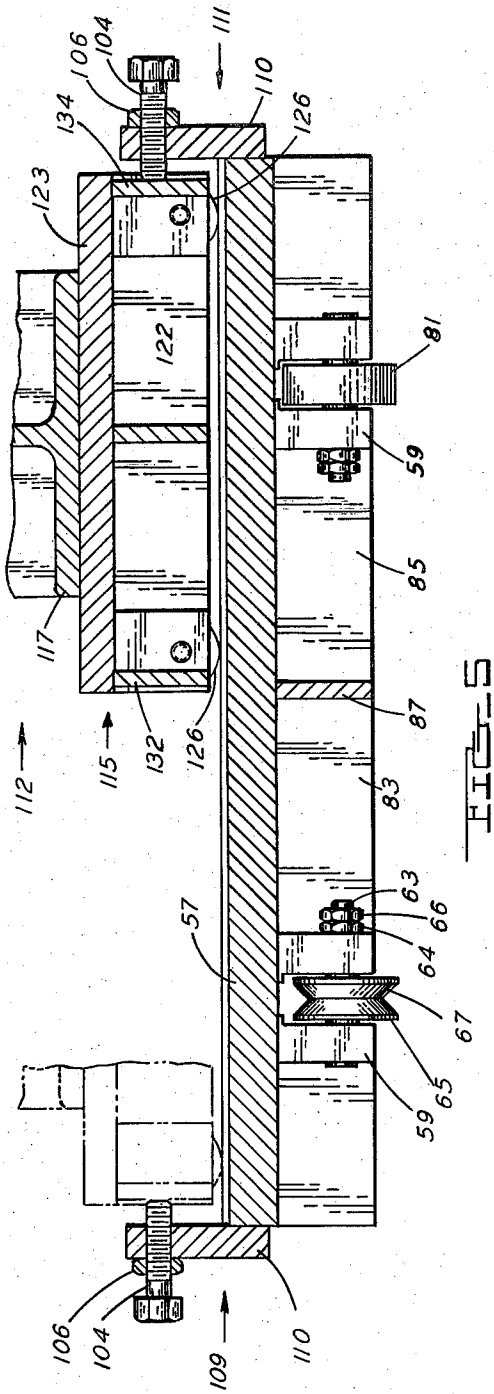


FIG. 5

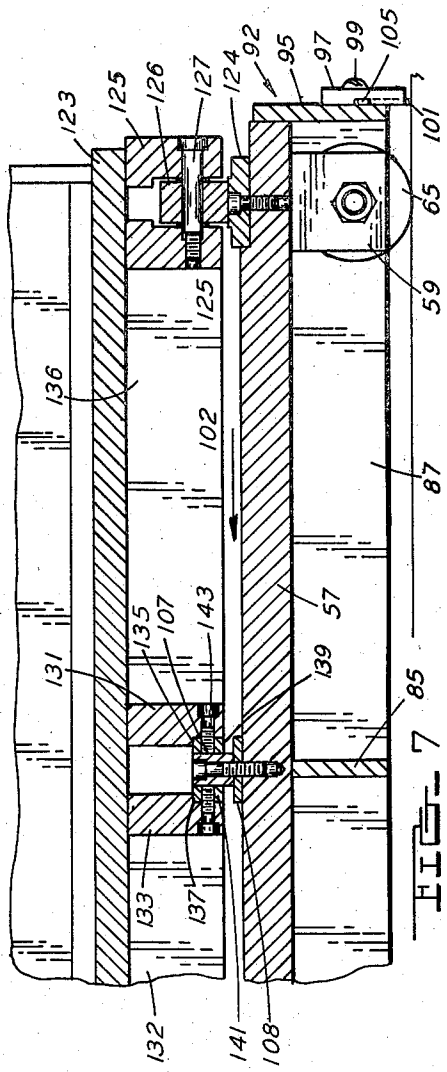


FIG. 7

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METHOD AND APPARATUS FOR HEAT-TREATING

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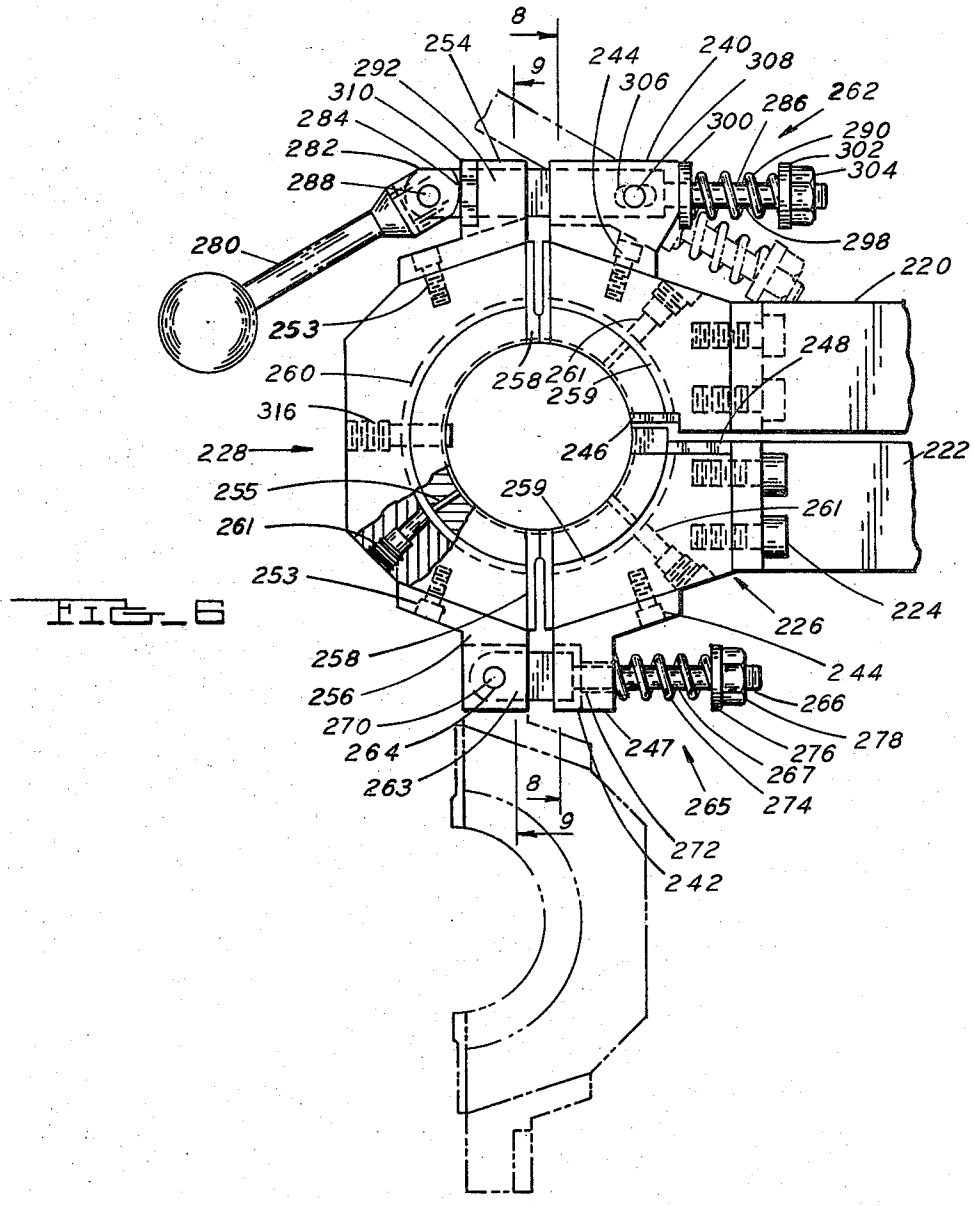


FIG. 6

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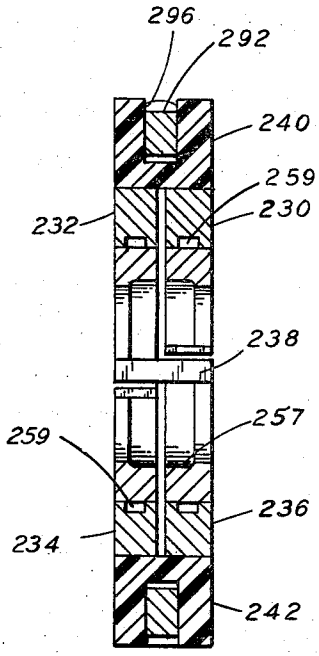


FIG. 8

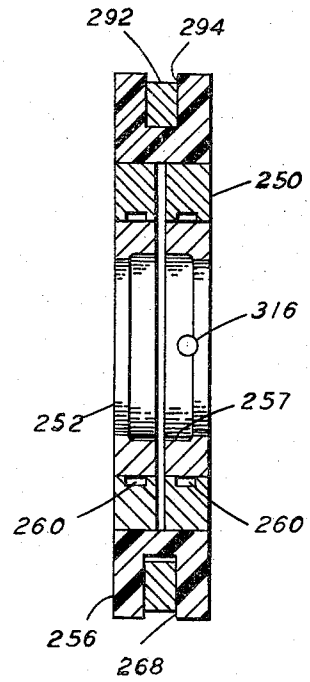


FIG. 9

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United States Patent Office 3,101,165 Patented Aug. 20, 1963

3,101,165
METHOD AND APPARATUS FOR HEAT-TREATING

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Filed May 13, 1960, Ser. No. 28,913
4 Claims. (Cl. 266—4)

This invention relates to the heat treatment of metals and more particularly to the heat treatment of elongate metallic articles.

In the manufacture of certain elongate steel articles such as crankshafts, it is frequently necessary to increase the hardness of selected areas, such as the axially aligned main bearings and the radially offset connecting rod bearings, for the purpose of providing a durable and wear resistant surface. To accomplish this, the selected area of the article is subjected to a heat treating operation in which heat is applied to the area for a prescribed length of time; the heat is shut off; and a quenching solution is applied to the selected area to rapidly cool it and effect the necessary hardening.

In performing such a heat treating operation it is becoming increasingly important that the time consumed in heat treating be reduced and that the quality be increased. This invention discloses a method and apparatus which improves the speed and quality of such heat treating. It utilizes a pair of carriages which are movable in relation to each other and also with respect to an improved heat treating means. One of the carriages supports the article to be treated and moves it into position for heat treating. In this invention the means for heat treating includes means for heating the selected area and integral means for applying a quenching solution to the selected area and is further constructed to permit pivotal separation of certain components thereof for positioning of the selected area within the confines of the heat treating means.

It is, therefore, an object of this invention to provide an accurate and rapid means for positioning an elongate metallic article in relation to a heat treating means. It is a further object of this invention to provide a heat treating means that uniformly circumvents the selected area of the article during the heat treating operation and that is separable to permit rapid withdrawal of the article upon the completion of the operation. In addition it is a goal of this invention to provide an arrangement wherein the article is supported on a first carriage for movement toward and away from a heat treating means and wherein said article and carriage are indexed longitudinally to position another selected area through movement of a second carriage supporting said first carriage. It is a further object of this invention to provide a method of heat treating elongate metallic articles whereby the article is supported for movement into position with respect to a heat treating means which is relatively immobile. It is also an object of this invention to provide a means for pivotally separating a heat treating head to receive an article to be treated and to provide a means for biasing the contacts of a pivotal member into firm engagement with the contacts of a fixed member.

Other objects and advantages of this invention may be seen from the following description wherein a preferred embodiment of this invention as utilized to heat treat selected areas of a crankshaft is clearly shown and from the following drawings wherein FIGURE 1 shows a front elevation partially cut away; FIGURE 2 shows a side elevation of this invention taken in the direction indicated by the arrow 2 of FIGURE 1; FIGURE 3 is a sectional view taken along line 3—3 of FIGURE 1; FIGURE 4 is a partial section taken along line 4—4 of FIGURE 1;

FIGURE 5 is a section taken along line 5—5 of FIGURE 1; FIGURE 6 is a view, partially cut away, taken along line 6—6 of FIGURE 1 with the crankshaft A removed; FIGURE 7 is a section along line 7—7 of FIGURE 2; FIGURE 8 is a section taken along line 8—8 of FIGURE 6; and FIGURE 9 is a view taken from line 9—9 of FIGURE 6.

In the drawings, 1 designates a rectangularly shaped tank which holds the quenching solution utilized in the heat treating operation. It is comprised of a front sheet 3, a rear sheet 5, end sheets (not shown) extending vertically upwardly from a bottom sheet 7, appropriately joined to each other as by welding. For the purpose of strengthening the tank, reinforcing members 13 and 15 are joined to the underside of the bottom sheet 7 and extend parallel with the longest dimension of the tank 1 which direction is hereinafter called a transverse direction. The member 13 is located toward the front of the tank 1 and the member 15 is spaced from member 13 toward the rear of the tank.

A support pad (not shown) is located across the members 13 and 15 at each end of the tank and a similar pad 29 is centrally located with respect to the ends of the tank 1 and also extends across the reinforcing members 13 and 15. It has two tapped holes to receive bolts 33 for the purpose of centrally supporting the tank particularly in instances where the floor on which the tank is located is not level throughout the length of the tank. Locknuts 35 hold the bolts in a selected position.

A lower carriage movable in a transverse direction is generally designated by 40. For the purpose of supporting and guiding this lower carriage a front rail supporting arrangement 42 is utilized that comprises a beam 41, a rail holding block 43 having a recess 44 therein affixed to the upper surface of the beam 41, and a carriage guiding rail 45 having a triangularly shaped upper section mounted in the recess 44 of the rail holding block 43. A rear rail supporting arrangement 48 is comprised of a beam 51 joined to the upper surface of the bottom plate 7 and disposed above the member 15, a rail supporting block 53 joined to the upper surface of the beam 51, and a carriage tracking rail 55 mounted on the upper surface of the block 53.

As may best be seen in FIGURES 3 and 5, the lower carriage 40 includes a platform 57 that has a pair of downwardly extending wheel supporting lugs 59 near each of its corners. A wheel axle 63 extends through a hole 61 in each of the lugs 59 and is held in place by a nut 64 and a locking nut 66. For the purpose of properly guiding the carriage 40 in its transverse movement, the wheels 65 located at the forward side of the platform 57 have a V-shaped peripheral groove 67 therein which mates with the upwardly extending triangularly shaped section of the rail 45. Rear wheels 81 have a flat cylindrical peripheral surface that contacts the upper surface of the carriage tracking rail 55; however, these wheels primarily serve to support the carriage and do not serve the dual function of supporting and guiding as do the front wheels 65. Each of the wheels 65 and 81 is rotatably supported by the axle 63 through intermediate bearing means, such as ball bearings 71 and 73 separated from each other by a spacer 75 and from the lugs 59 by spacers 77 and 79. In order to provide additional structural strength a transverse reinforcing member 87 having gussets 83 and 85 extending therefrom is utilized.

As an aid in maintaining accuracy and keeping the rails 45 free of metallic particles that might be washed from a crankshaft during a quenching operation, a scraping arrangement 92 is located at each end of the platform 57 adjacent the wheels 65. It is comprised of a hanger 95 extending downwardly from the platform 57 above the rail 45, a cover plate 97 joined to the hanger 95 by screws

99, a scraper 101 having a V-shaped notch therein adapted to engage the triangularly shaped portion of the rail 45 and disposed between the plate 97 and the hanger 95, and a spring 105 placed between the hanger 95 and the plate 97 and above the scraper 101 to bias the scraper downwardly against the triangular shaped section of the rail 45. A similar scraping arrangement 93 having a flat scraper is also provided to clean rail 55.

A guiding arrangement 102 for an upper carriage 112 includes a track 107 affixed to a pad 108 on the upper surface of the platform 57 and extending perpendicular to the transverse center line of the platform. In order to properly limit the travel of the upper carriage 112 toward the front and the rear of the tank 1, it is necessary to provide adjustable stops 109 and 111 respectively which include stop plates 110 joined to the platform 57 and screws 104 threadably engaging the plates 110 and held in a selected position by locknuts 106.

The upper carriage 112 includes a base 115, an intermediate beam 117, a fixed supporting cradle 118 and a movable supporting cradle 119. The base 115 has a pair of central members 121 and 122 joined to the underside of a top plate 123, a pair of wheel supporting lugs 125 located at each corner of the top plate 123 and extending downwardly therefrom, wheels 126 mounted between the downwardly extending lugs on axles 127 which serve as wheel bearings, transversely extending stop members 132 and 134 at the front and rear respectively, and a transversely extending reinforcing member 136 extending from retaining block 131 to the lug 125. The wheels 126 move on flat rails 124 and are kept free of metallic particles by scraping arrangements 93.

To prevent transverse movement of the upper carriage when it is moved toward the front and rear of the tank 1 on the wheels 126, the guiding arrangement 102 includes retaining blocks 131 and 133 joined to the underside of the plate 123. These blocks have notches 135 and 137 cut in the lower portion thereof to receive wear plates 139 and 141 held in place by screws 143. When the upper carriage 112 is positioned above the lower carriage 40, these wear plates engage the track 107 mounted on the upper surface of the platform 57.

As best shown in FIGURE 4, pad 145 that has reamed holes 147 and tapped holes 149 therein is affixed to the top surface of the beam 117. These holes are situated to properly locate and retain outer guide segments 152 and 154 and an intermediate segment 156 when locating dowels 157 are inserted into holes 147 and retaining screws 159 are engaged with the threaded holes 149.

In order to accurately adjust the cradle 119, the intermediate segment 156 is provided with a guideway 165 formed in its upper surface to receive a guide 167 joined to the bottom of the cradle 119. In addition the lower edges of the segment 156 are cut away as at 160 to cooperate with adjacent cut away portions designated 162 of the outer segments 152 and 154 to form a groove for T-nuts 164 slidably mounted therein.

The adjustable cradle 119 includes a base 169 having a pin receiving bushing 173 therein adapted to receive a locating pin 175, vertical guides 177 having slots 179 to receive a lower support block 181 and an adjustable upper V-block 183, and reinforcing webs 185 connected with the guides to provide rigidity. The locating pin, acting through the bushing 173, engages bushings 163 in the segment 156, thus accurately locating the cradle.

Screws 174 extend through the base 169 and engage the T-nuts 164 to secure the cradle in a selected position when said screws are tightened. Transverse adjustment of the cradle to properly support crankshafts of varying lengths is effected by loosening the screws 174, lifting the pin 175 out of the bushing 173, and manually moving it. The guide 167 slides in the keyway 165 and the T-nuts are guided along the cut outs between the segments 156 and 152 and 154. When the desired position

is reached, the pin 175 is inserted in the selected bushing 163 and the screws 174 are tightened.

In order to adjust the upper block 183 a screw 184 is placed between block 183 and the lower block 181 with its threaded end engaging a tapped hole in the block 181 and its head engaging the lower side of block 183. Turning the screw into or out of the tapped hole lowers or raises the block 183. A locknut 189 locks the screw 184 in any desired position.

A fixed cradle 118 is mounted on the pad 145 and is transversely disposed from the cradle 119. It includes a base 191, vertical guides 193 having grooves 195 joined to the base, a lower block 197, an upper adjustable V-block 198 and an adjusting screw (not shown) between the blocks operable to adjust the vertical height in a fashion similar to the adjusting arrangement of the cradle 119.

The upper carriage 112 receives a crankshaft on the adjustable V-blocks 183 and 198 and, in heat treating position, locates the crankshaft in close proximity to a heating coil and quenching head 210 that is adapted to circumvent a connecting rod bearing or main bearing of the crankshaft. Through heat treating means, which will be hereinafter described, uniform heat is applied to the area selected for heat treating and at a proper time in the cycle, it is cut off and a quenching solution is sprayed on the area.

This heat treating means includes the heating coil and quenching head 210, a high frequency current supplying transformer and electrical control unit 212 and an operator control means 216. The details of the latter two elements will not be specifically described since they are well known in the art. It should suffice to state that the unit 212 be adapted to supply a high frequency current to the heating coil and quenching head 210 sufficient to heat the area to be heat treated. This unit 212 is shown on the drawings in block form and is adjustable in a vertical direction by screws 211 supporting the unit 212 on a platform 215. This affords a means for positioning the head 210 dependent upon whether a main bearing is being heat treated in which case it is located toward the top of its travel or whether a connecting rod bearing is being heat treated in which case it is located toward the bottom of its travel.

The electrical control portion of the unit 212 establishes the proper timing cycle and the application of electrical current and quenching solution when the operator engages the controls means 216.

Certain features of this invention will be found in the heating coil and quenching head 210 which is electrically connected to the transformer and control unit 212 and physically supported by bolts 224 holding it to the bus bars 220 and 222. This head is of the double turn induction ring type and includes a stationary half 226 and a movable half 228. As best seen in FIGURE 8, the stationary half has a quadrant 230 connected with the bus bar 220, an adjacent quadrant 232, a quadrant 234 below the quadrant 232 and joined to the bus bar 222, a quadrant 236 adjacent quadrant 234 and below quadrant 230, and a connector 238 electrically connecting quadrant 232 with quadrant 236. In order to physically join the adjacent quadrants and to maintain electrical individuality, insulating brackets 240 and 242 made of nylon or a similar substance are bolted to the quadrants 230 and 232, and 234 and 236, respectively, by screws 244.

As shown in FIGURE 9, the movable half 228 of the head is composed of two segments 250 and 252 which are physically joined by screws 253 extending through lugs 254 and 256 of materials similar to the brackets 240 and 242.

The segments and quadrants serve the two purposes of conducting electrical current and channeling the quenching solution. To properly distribute the application of heat, a recess 257 is provided in the internal peripheral

surface of the segments and quadrants, and to furnish an electrical path between the quadrants and segments, contacts 258 joined, as by brazing, to the open ends. This also serves to close quenching solution passages 260 in the segments and passages 259 in the quadrants. The passages 259 are closed at the end opposite the contacts 258 by closures 246, 248, and the connector 238. The quenching solution delivered to the passages 259 and 260 through inlets similar to inlet 261 located in each segment and quadrant is supplied from the tank 1 by pumping means (not shown). It is then taken from the passages 259 and 260 for application to a bearing portion of a crankshaft through a plurality of holes 255.

So that the movable half 228 may be pivoted to permit positioning of a crankshaft bearing between it and the stationary half 226 for heat treating and to insure a good electrical connection at the contacts 258, a pivot assembly, generally designated 265, and a latching arrangement 262 are utilized.

The pivot assembly includes a bolt 267 having an enlarged portion 263 with a hole 264 therein and having a threaded end 266. The enlarged end engages a slot 268 in the lug 256 and receives a pivot pin 270 about which the movable half 228 pivots, and the threaded end 266 extends through an opening 272 in the bracket 242. A spring 274 fits around the bolt 267 and at one end engages the bracket 242 and at the other end contacts a washer 276 held in place by a tension-adjusting nut 278 in threadable engagement with the threaded end 266.

The latching arrangement 262 is comprised of a locking handle 280 having a flat surface 282 and a cam surface 284, a latching member 286 pivotally supporting the locking handle by a pivot pin 288, and a spring 290. The latching member 286 has a flattened portion 292 that engages slots 294 and 296 in lug 254 and the bracket 240 and a cylindrical portion 298 that extends through a hole in the bracket 240 and receives the spring 290 at its outer end. Washers 300 and 302 engage opposite ends of the spring and bear against the bracket 240 and a retaining nut 304. For the purpose of permitting release of the movable half 228 and longitudinal biasing movement of the latching member 286, a longitudinally extending slot 306 is provided in the flattened portion 292 of the latching member which receives a hinge pin 308. A wear plate 310 is embedded in the locking handle side of the lug 254 to prevent excessive wear when the cam 284 is moved to tension the latching arrangement.

In performing a heat treating operation on an elongate metallic article, such as a crankshaft, an operator first moves the upper carriage 112 to what will be termed a "work loading" position. In this position (partially shown in broken lines on FIGURE 5), the upper carriage is disposed toward the front stop 109 away from the rear stop 111 and the heating coil and quenching head 210; and the movable half 228 of the head is open and ready to receive a bearing of a crankshaft. With the holding fixture so situated the operator selects a crankshaft which may then be lifted by an overhead crane hoist when the crankshaft is heavy or by manually picking it up when it is of relatively light weight. In the case of a crankshaft which has main bearing portions axially aligned and radially offset connecting rod bearings, the crankshaft is supported on selected main bearings. One bearing is placed on the adjustable block 198 of the fixed cradle 118, and a second main bearing is set on the adjustable block 183 of the adjustable cradle 119.

As may be best seen from FIGURE 2, the blocks 183 and 198 are vertically adjustable to afford a means of accurately locating the longitudinal center line of the main bearings of the crankshaft with respect to the center of the heating coil and quenching head 210. Such an adjusting means provides flexibility and permits rapid adaptation of the arrangement to crankshafts of different main bearing diameters. As an example, assume the fixture is adjusted to receive a crankshaft having a main

bearing diameter of two inches. If a crankshaft having a main bearing diameter of two and one eighth inches is placed on the cradles 118 and 119, the longitudinal center line of the crankshaft is elevated to a degree dependent upon the included angle of the V of the blocks 183 and 198. Thus, to properly position a larger crankshaft with respect to the center of the head, the locknut 189 is loosened, the adjusting screw 184 is turned downwardly into the tapped hole in the lower block 181 and when moved properly, the locking nut 189 is tightened. Such an adjustment is, of course, also made to the adjusting means of the fixed cradle 118. The screw 184 is turned in the opposite direction to accommodate crankshafts of smaller diameters.

After placing the crankshaft in the properly adjusted cradles, the operator moves the upper carriage from the "work loading" position to what will be termed a "heat treating" position. To effect this movement the operator grasps the crankshaft or any other convenient portion of the upper carriage 112 and exerts a force in the direction of the heating coil and quenching head 210. The carriage moves rearwardly on the wheels 126 moving along rails 124 and is guided by the wear plates 139 and 141 engaging the track 107 until the stop member 132 engages the adjustable stop 111 at the rear of the track 107. This stop limits the movement of the carriage toward the head 210 and is adjusted so that the longitudinal center line of the crankshaft will coincide with the center of the head. When this position is reached the movable half 228 of the head is pivoted about the pivot pin 270 to a closed position wherein the head circumvents the bearing to be treated. In closing, the movable half 228 pivots about pin 270 to a position where the contacts 258 closest to the pivot pin 270 engage each other. When this position is reached, the operator then swings the latching member 286 of the latching arrangement 262 into the slots 294 and 296 of the lug 254 and the bracket 240 and the flat surface 282 of the handle engages the wear plates 310 in the lug 254 of the movable half 228. Rotation of the locking handle 280 in a counter-clockwise direction, as shown in FIGURE 6, moves the cam surface 284 of the handle against the wear plate 310. This tends to pull the latching member to the left as viewed in FIGURE 6 against the force of spring 290; simultaneously, the spring 290 acts through the latching member and wear plate to move the contacts 258 of the movable half 228 into engagement with the contacts 258 of the stationary half 226. Such movement also moves the bolt 267 of the pivot assembly 265 to the left as viewed in FIGURE 6 against the tension of spring 274 holding the lower contacts 258 in firm engagement. Thus all contacts 258 are subjected to the force of springs 290 and 274 which establishes a good electrical contact.

With the movable half 228 closed, the operator then presses the electrical control means 216 to initiate the heat treating cycle. Electrical current is supplied to the head through bus bar 220 and carried through the head by quadrant 230, segment 252 and quadrant 236, connector 238, quadrant 232, segment 250, segment 234 and returned to the transformer and control unit 212 through bus bar 222. After the treated portion is sufficiently heated, the current is cut off by the transformer and control unit 212 and quenching solution is supplied through the inlets 261 to the grooves 259 and 260 and to the treated surface through a plurality of holes 255.

Upon completion of the quenching the operator opens the latching arrangement 262, pivots the movable half 228 to an open position as shown in broken lines in FIGURE 6, and pulls the upper carriage 112 longitudinally with respect to the head 210 toward a "work loading" position a sufficient distance to clear the crankshaft from the head. A force is then exerted on the lower carriage 40 in a transverse direction, thus moving it along the rails 45 and 55 on wheels 65 and 81 and positioning the next bearing to be heat treated in alignment with the head

210. The upper carriage 112 is then positioned for inward movement toward the head and a repetition of the above described cycle.

This cycle has been described with respect to the positioning and heat treating of a main bearing of a crankshaft; however, the procedure is similar with respect to a connecting rod bearing, except it is necessary to reposition the vertical height of either the head 210 or the cradles 112 and 119 since the connecting rod bearing is radially offset from the longitudinal center line of the main bearings. This may be done by raising the crankshaft on the blocks 183 and 198 or lowering the head 210 a distance equal to the offset. The latter adjustment may be effected by turning the adjusting screw 211 supporting the transformer and control unit 212. With the carriage 119 in a "work loading" position, the head in a lowered position and the crankshaft main bearings supported on the blocks 183 and 198, the crankshaft connecting rod bearing to be treated is rotated downwardly below and vertically aligned with the longitudinal center line of the main bearings. The carriage is then moved into "heat treating" position against the rear stop 111 wherein the center line of the connecting rod bearing aligns itself vertically with the center of the head 210 which is in its lowered position; the movable half 228 is closed; and the operator then exerts a force on the offset portion of the crankshaft toward the front of the tank bringing the bearing into locating contact with a ceramic locating stop 316 adjustably secured in the segment 250 of the movable half. Such a locating stop is necessitated because of the tendency of the connecting rod bearing to rotate about the main bearings. It is turned into the head a proper distance to locate the center line of the connecting rod bearing at the center of the head. To reduce the time consumed in changing from a set up adapted for treating main bearings to a set up for treating connecting rod bearings, two arrangements utilizing this invention may be provided wherein main bearings are treated on one and connecting rod bearings on the other.

While a particular embodiment of this invention has been shown, it will, of course, be understood that the invention is not to be limited thereto, since many modifications to the arrangements disclosed may be made without departing from the spirit and scope thereof. It is of course contemplated that the appending claims cover any such modifications as fall within the true spirit and scope of this invention.

We claim:

1. Apparatus for heat treating a crankshaft having a plurality of main bearings and at least one connecting rod bearing, comprising a base, heat treating means mounted at the rear of the base and including a heating and quenching head projecting forwardly over the base, said head including a fixed half and movable half pivotally mounted on said fixed half and adapted to concentrically receive a connecting rod bearing therebetween, means for supporting a crankshaft comprising a lower carriage mounted on said base for movement parallel to the front of the base, an upper carriage mounted on said lower carriage for movement forwardly and rearwardly of said base, supporting means mounted on said upper carriage for rotatably supporting main bearings of the crankshaft, said upper carriage being movable rearwardly of the base to move a connecting rod bearing toward said head, said lower carriage having stop means for limiting the rearward movement of said upper carriage substantially to a position where a vertical plane through the axis of the main bearings passes through the center of said halves, and an insulating stop pin mounted in one of said halves and the crankshaft being adapted to be rotated in said supporting means to engage the connecting rod bearing with said stop pin and thereby center the connecting rod bearing within said halves.

2. In an apparatus for heat treating the bearings of a crankshaft, a heating head comprising a pair of members having semicircular recesses to receive a crankshaft bearing therebetween, said members including conductors forming said recesses, said conductors having contacts at their ends with the contacts on each of said members adapted to engage the contacts on the other of said members, the conductors of one of said members being adapted to be connected to a source of electrical energy, said members being resiliently connected to each other at each of their ends to hold the contacts of the respective members in engagement under a predetermined pressure.

3. An apparatus according to claim 2, in which the resilient connection at each end of said members comprises a rod secured adjacent one of its ends to one of said members and slidably mounted in the other of said members, and a spring mounted on the other end of the rod and bearing against said other member.

4. An apparatus according to claim 3, in which the rod of one of said resilient connections is pivotally secured to said one member, and the rod of the other resilient connection is releasably secured to said one member, whereby said one member may be released from the other member at one end and swung away from said other member for insertion and removal of a crankshaft bearing.

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