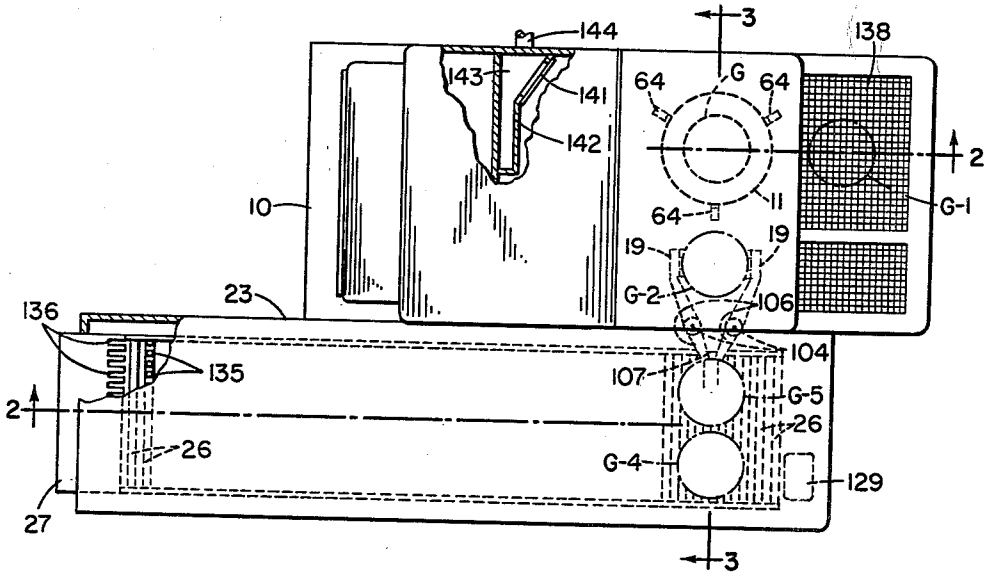
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QUENCHING MACHINE

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FIG. 1



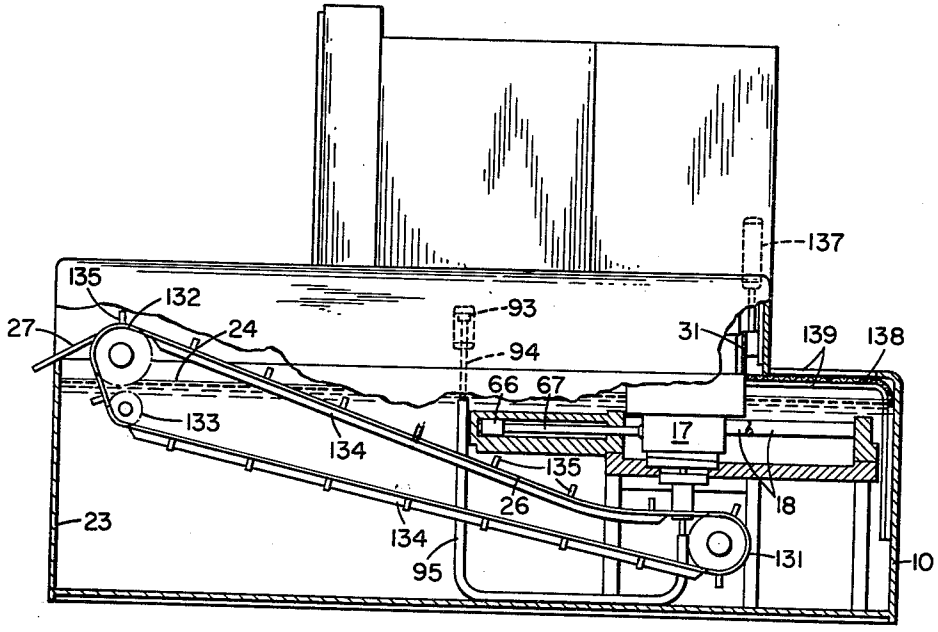


FIG. 2

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FIG. 4

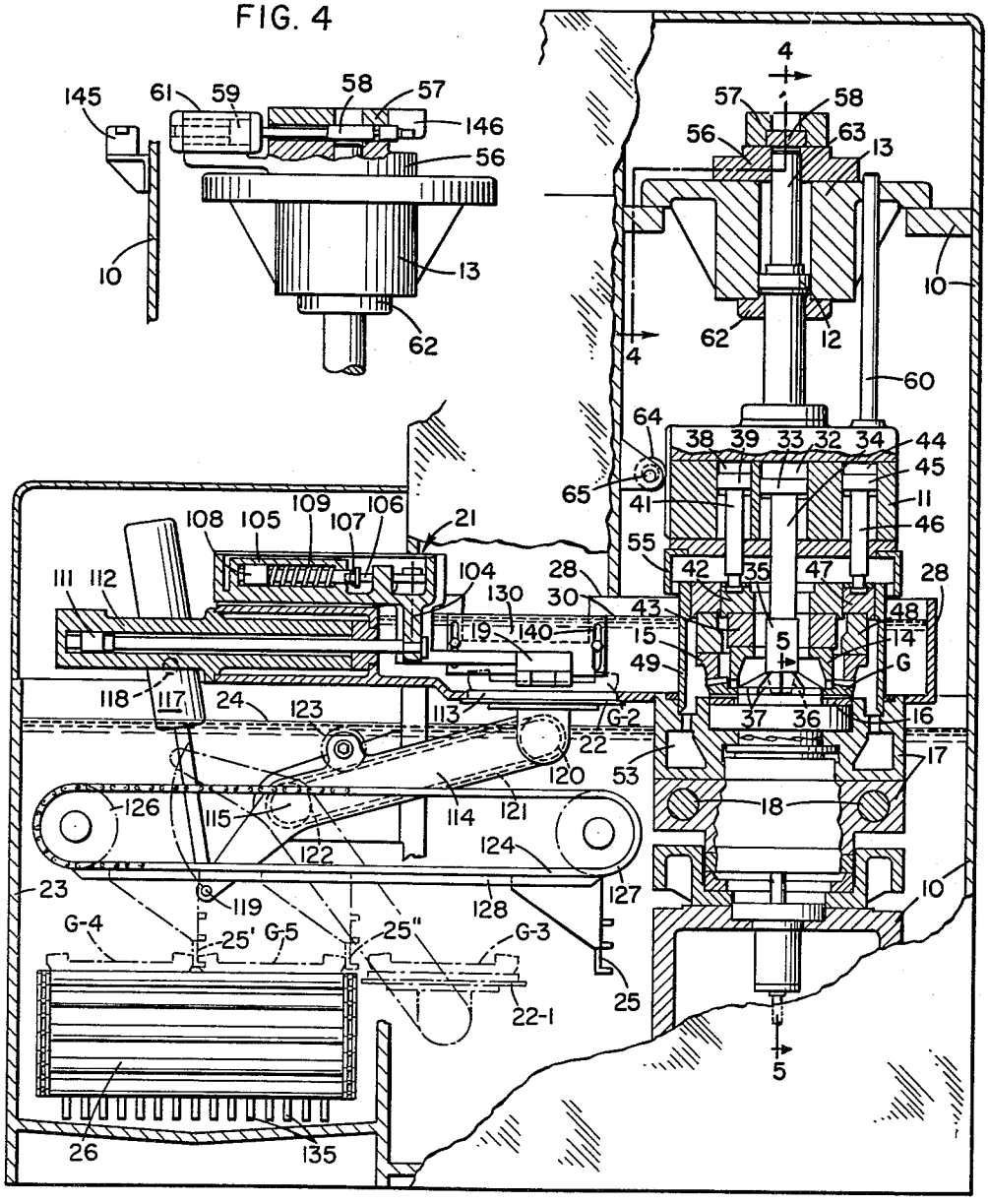


FIG. 3

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FIG. 5

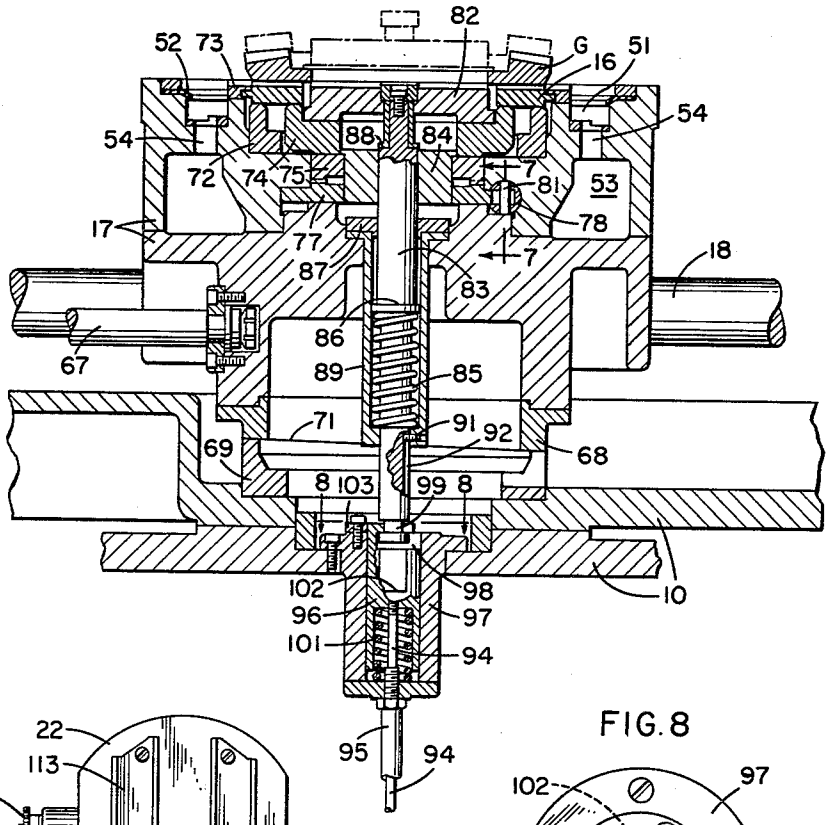
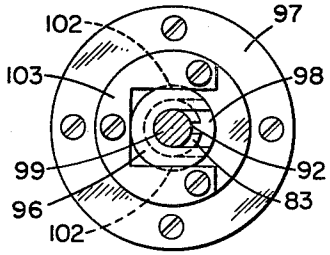


FIG. 8



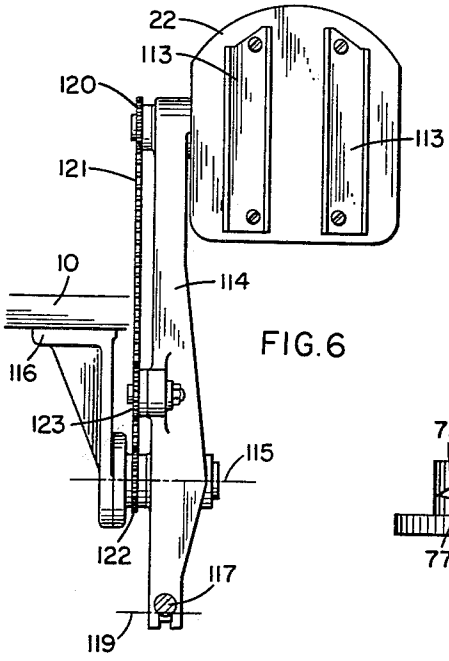


FIG. 6

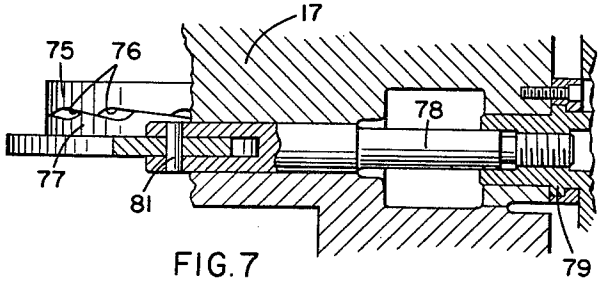


FIG. 7

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3,170,975

QUENCHING MACHINE

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Filed June 30, 1960, Ser. No. 40,012
3 Claims. (Cl. 266—6)

The present invention relates to a quenching machine for gears, and like workpieces.

An object of the invention is a machine of simple and inexpensive construction, capable of carrying out the quenching method of co-pending application Serial No. 710,882, filed January 24, 1958, by R. V. Adair and O. F. Bauer, now Patent No. 3,007,823.

Another important object is a machine, in which workpieces may be initially quenched while held clamped between upper and lower dies and then discharged into a tank of liquid coolant, wherein the dies remain above the level of liquid in the tank and yet the workpieces are kept immersed from the time of their initial quenching until their removal from the tank, to thereby inhibit oxidation of the workpieces and decrease the likelihood of fire in cases where the coolant is combustible, and to prevent reheating and softening of the surface portions of the workpieces by internal heat.

The foregoing and other objects and advantages will appear from the following description of the preferred embodiment of the invention shown in the accompanying drawings, wherein:

FIG. 1 is a plan view of the machine and FIG. 2 a side view thereof partly in section in planes 2—2 of FIG. 1;

FIG. 3 is a vertical sectional view in plane 3—3 of FIG. 1;

FIGS. 4 and 4 are detail vertical views respectively in planes 4—4 and 5—5 of FIG. 3;

FIG. 6 is a detail horizontal view; and

FIGS. 7 and 8 are detail sectional views respectively in planes 7—7 and 8—8 of FIG. 5.

The press frame 10 supports a ram 11, FIGS. 1 and 3, for vertical movement by means of a hydraulically actuated piston 12 in a cylinder 13 secured to the frame. The ram carries inner and outer die rings 14 and 15 for engagement with the upper surface of a workpiece being quenched, in this case a ring gear G, which rests upon bars 16 of a lower die assembly shown in detail in FIG. 5. The support 17 of this lower die assembly is movable horizontally on rods 18 to carry the gear from a loading position G–1, FIG. 1, at the front of the press, to its working position G in vertical alignment with the upper dies 14, 15.

After initial quenching of the gear, by circulating liquid coolant over it while it is held clamped between the dies, the circulation is stopped, the dies are opened by raising of the ram 11 by piston 12, and the workpiece is grasped by jaws 19 of an unloader 21 and moved horizontally into position G–2 on a transfer plate 22 which lowers it to position G–3 in a tank 23. The tank constitutes a part of the frame 10 and contains coolant liquid to the level designated 24, well below the die bars 16. A pusher 25 then moves to positions 25′ or 25″ to move the gear to position G–4 or G–5 onto an intermittently advancing endless conveyer 26 which carries it out of the tank onto a discharge chute 27. The pusher 25 and transfer plate 22 then return to their positions shown in full lines in FIG. 3. Inasmuch as the conveyer 26 can accommodate a relatively large number of gears simultaneously, the gears remain in the tank a number of times as long as their initial quench between the dies.

The coolant liquid which is circulated over the gears while confined by the dies is discharged into a container 28 and, at the time the dies are opened, the liquid in this container reaches a level 30 high enough to maintain the gears submerged. The transfer plate 22 constitutes a closure for an opening in the bottom of the container, and as it lowers the liquid in the container flows into the tank, surrounding the gear as it descends into the liquid in the tank at level 24. As soon as the container has emptied, a door 31, FIG. 2, which constitutes the front wall of the container 28, opens; the support 17 moves forwardly to receive a fresh heated gear at position G–1; and the cycle described above is repeated.

The ram 11 has a central cylinder 32 aligned axially with cylinder 13. A piston 33 in the cylinder acts downwardly through a rod 34, adaptor 35, and tapered expander 36, to expand a set of segments 37 in the bore of the gear G, for centering and maintaining roundness of the latter. Arranged in a circle around cylinder 32 are a plurality of vertical cylinders 38 containing pistons 39 connected to die ring 14 by piston rods 41, ring 42 and adaptor 43; and arranged in a circle around cylinders 32 are a plurality of vertical cylinders 44 having pistons 45 which similarly are connected to die ring 15 by piston rods 46, ring 47 and adaptor 48. Slidable on the ring 47 and secured to the ram 11 is a guard sleeve 49 which in the lower position of the ram fits into an annular recess 51, FIG. 5, in the upper surface of lower die support 17, and is sealed by a flexible rubber ring 52. For handling gears of different designs, the die rings 14, 15, expanders 36, 37, and if necessary, adaptors 35, 43, 48, of different heights are employed, so that the ram and the guard 49 are in all cases in the same relationship to the lower die support 17.

The liquid circulated around the gear in the dies is drawn from tank 23 by a suitable pump, not shown, and forced through passage 53 and openings 54 in the lower die support, into the interior of guard 49, thence over and under the gear through the tooth spaces and fluid passages provided in the radial bars 16, thence upwardly through the central openings of parts 14, 43 and 42, and finally is discharged downwardly into container 28 through an annular opening between guard 49 and its skirt 55. During such quenching the upper die rings 14, 15 and expander 36 are pressed downwardly by hydraulic pressure acting on pistons 33, 39 and 45 to hold the gear against distortion. Periodically this pressure may be released and reapplied, according to the method of the aforementioned patent application Serial No. 710,882.

The upward reaction of the die pressure is transmitted to the frame 10 by metal-to-metal contact in such manner that the periodic release does not result in motion of ram 11. For this purpose there is secured to upper head 56 of cylinder 13 a keeper 57, FIG. 4, for a horizontally slidable bolt 58 actuated hydraulically by a piston 59 in a cylinder 61 secured to the head of cylinder 13. In the position shown in FIGS. 3 and 4, wherein the piston 12 is resting on bottom head 62 of the cylinder 13, there is a slight vertical clearance between the piston rod 63 and the bolt 58 to allow the latter to be slid easily into and out of place. When the bolt is in place, hydraulic pressure is applied against the bottom of piston 12 to press the rod against the bolt and thus take up this clearance. Such pressure is maintained throughout the periodic release and re-application of pressure to pistons 33, 39 and 45 but is reversed prior to withdrawal of the bolt by piston 59, preceding raising of the ram by piston 12 to open the dies.

The ram 11 while being raised and lowered is guided by rollers 64, FIGS. 1 and 3, mounted on the frame 10. The one of these rollers which appears in FIG. 3 is mounted on an adjustably rotatable eccentric pin 65 to enable the roller to be adjusted radially of the piston and

ram assembly 12, 11, to eliminate looseness between this assembly and the frame. The ram is held against rotation by a rod 60 which is secured thereto and is slidable in a flange of cylinder 13.

The lower die support 17 is moved on rods 18 between loading and working positions by a hydraulically actuated piston 66, which, in the working position, FIG. 2, abuts the left end of its cylinder chamber. The piston rod 67 is connected to the support in a manner which permits adjustment by means of shims, to exactly align the lower die assembly with the upper die rings 14, 15 in the working position when the piston 66 abuts the left end of its cylinder (in FIG. 2). When in this position the bottom plate 68 of the lower die support 17 bears directly on a plate 69 on the frame 10, so that the pressure exerted by the upper dies is not borne by the rods 18. The contacting load-bearing plane faces 71 of plates 68, 69 are inclined to the horizontal at a small angle which in this particular machine is about one degree but in any case should be no greater than the static angle of friction of the plate material.

The radial bars 16 of the lower die assembly are supported at their outer ends on a ring 72, and are circumferentially confined by another ring 73. Both of these rings seat directly on support 17. The inner ends of the bars are supported on a ring 74 which is adjustable vertically on the support, and for this purpose seats on an annular member 75 which is non-rotatable but axially (vertically) movable in the support. Member 75 has on its bottom face a plurality of cam faces 76, FIG. 7, which seat on mating cam faces on the upper surface of an annular member 77 which is rotatable but axially immovable in the support 17. Member 77 is turned through a small angle, to raise or lower the ring 74, by means of a screw 78 threaded to a calibrated nut 79 that is manually adjustable (rotatable) in the support. The screw is slidable in the support and is pivoted to annular member 77 by pin 81. This adjustment by means of nut 79 and screw 78 enables the bottom surface of the gear G clamped on bars 16 to be flat or slightly dished either concavely or convexly.

For centering the gear on the lower die assembly before quenching and for subsequently elevating it slightly to enable it to be gripped by unloader jaws 19, a vertically movable center 82 is provided. The center is adapted to enter the bore of the gear and has a flange adapted to engage the bottom surface of the gear. The center is adapted for limited sliding motion on a rod 83 that is guided for vertical motion by a sleeve 84 seated on and within annular member 75. The rod is constantly urged upwardly by a spring 85 which, when free to do so, lifts the rod until its shoulder 86 abuts a retainer 87 that is secured to support 17. A shoulder 88 on the rod engages the center 82, lifting it and gear G to their positions shown in broken lines in FIG. 5. It is in this elevated position of the center 82 that the gear is loaded onto it at position G–1, FIG. 1, and that the gear at G is gripped by the unloader jaws 19. Spring 85 is mounted on the support by means of a flanged tube 89 held by retainer 87. To prevent rotation of the rod 83 a key 91 on the tube engages in a keyway 92 in the rod 83.

Prior to closing of the dies, and again after the unloader jaws 19 are closed on the gear, the rod 83 and the center 82 are lowered to their position shown in full lines in FIG. 5 by action of a hydraulically actuated piston 93, FIG. 2. This piston is connected, by a flexible rod 94 guided by a sheath 95, to a rod 96 that is slidable in cylinder 97 on the frame in alignment with rod 83. A T-slot 98 in the rod 96 is adapted to engage the lower end of rod 83 which, for this purpose, has a reduced neck 99. The arrangement is such that when this neck and the T-slot are at the same level the rods 83, 96 may be connected and disconnected by horizontal movement of rod 83 together with support 17 into and out of the latter's working position. The rod 83 is always held in its elevated position by spring 85 when such connection and disconnection occur, and similarly the rod 96 at these times is held by a spring 101 in an elevated position wherein its shoulders 102, FIGS. 5 and 8, abut the bottom of a C-shaped plate 103 that is secured to cylinder 97. Only while the rods 96, 83 are connected does the piston 93 act to lower them and the center 82 to the position in which they appear in full lines in FIG. 5.

The unloader jaws 19, which grip the gear when it is raised on the center 82 subsequent to its quenching between dies 14, 15, 16, are pivoted on axes 104, FIGS. 1 and 3, to a slide 105. Rigid with the jaws are arms 106 which are urged toward one another about axes 104 by springs (not shown) to open the jaws, and are moved apart, to close the jaws, by a tapered member 107 which is actuated by a piston 108 in a cylinder formed in the slide. In the position of the piston and member 107 shown in FIG. 3, wherein the piston is held to the left by a spring 109, the jaws are closed. Upon movement of piston to the right by hydraulic pressure, the jaws are opened. The slide 105 is moved horizontally on the frame by a piston 111 in a cylinder 112, to carry the jaws 19 between a retracted position above transfer plate 22 and a forward position wherein they are engageable with a gear on center 82.

As shown in FIGS. 3 and 6 the transfer plate 22 has spaced rails 113, on which a gear may rest, and it is pivotally carried by a lever 114 which is fulcrumed on axis 115 to a bracket 116 carried by the frame. The lever is actuated by a hydraulic cylinder-piston device 117 whose cylinder is pivoted to the frame at 118 and whose piston rod is pivoted to the lever at 119. In order to maintain the transfer plate horizontal throughout its travel, a sprocket 120 secured to it carries a chain 121 which extends around a stationary sprocket 122 located on axis 115 and supported by bracket 116. An idler sprocket 123 is adjustable on the lever 114 to take up slack in the chain.

The pusher 25, which moves gears from the transfer plate 22, in position 22–1, FIG. 3, to the endless conveyer 26, is carried by an endless chain 124 running over sprockets 126 and 127 and additionally supported by rail 128. Sprocket 126 is driven back and forth by a reversible electric motor 129, FIG. 1, through suitable reduction gearing, not shown. The conveyer is supported by drums 131 and 132 and tensioning roller 133, FIG. 2, and, additionally, by rails 134. It has lugs 135 at spaced intervals therealong to prevent retrograde motion of the gears as they are carried on the upwardly sloping span of the conveyer between drum 131 and drum 132. The discharge chute 27 is slotted, as shown at 136 in FIG. 1, to pass the lugs. The conveyer is driven intermittently by a motor, not shown, connected to drum 132. Following each second reciprocation of pusher 25, this drive advances the conveyer by a distance equal to the spacing of successive sets of lugs.

Preceding and following each reciprocation of the lower die support 17 from working position to loading position and return, the door 31, FIG. 2, is opened by a hydraulically actuated piston 137 that is reciprocable vertically in a cylinder carried by the frame. To cover the opening into the tank in front of lower die support 17 when the latter is in working position, a wire mesh curtain 138 and a guide channel 139 therefor are provided, the curtain being secured to the lower die support 17 for movement therewith.

The liquid level 30 in container 28 is controlled by a gate 130 which is vertically adjustable, as permitted by elongated slots 140 for fasteners which secure it to one side wall of the container. The level 24 of tank 23 is controlled by a gate 141 which is similarly adjustable vertically on a wall 142 between the tank and a chamber 143 which opens into a pipe 144 leading to a main coolant reservoir and cooling system. In a usual installation cool oil will constantly be supplied from this system to

the tank 23 by suitable means, not shown, while heated oil returns through pipe 144.

An electrical coordinating system, not shown, is provided to operate the several motors, including the motor for the coolant circulating pump, and also to control solenoid-operated valves in the hydraulic lines leading to and from the several cylinders. The system includes a number of switches, exemplified by the switches 145 and 146 shown in FIG. 4 which respectively are actuated upon placement and retraction of bolt 58. These and the various other switches effect operation of the several components of the machine in the following sequence: (*a*) operation of piston 66 to move the lower die support 17 to working position, (*b*) operation of piston 93 to lower center 82, (*c*) operation of pistons 12 and 137 to lower ram 11 and door 31, (*d*) operation of piston 59 to emplace bolt 58, (*e*) application of upward pressure to piston 12, (*f*) application of pressure to pistons 33, 39, 45 to clamp gear G between the dies, (*g*) operation of the coolant circulating pump for a selected period of time during which, preferably, there is a release and re-application of pressure to pistons 33, 39, 45 one or more times, (*h*) discontinuance of operation of coolant circulating pump, (*i*) discontinuance of upward pressure on piston 12 and withdrawal of the bolt by piston 59, (*j*) re-application of upward pressure on piston 12 to elevate ram 11, (*k*) operation of piston 111 to advance the unloader, (*l*) operation of piston 108 to cause jaws 19 to grip gear G, (*m*) operation of piston 93, to lower center 82, (*n*) operation of piston 111 to retract unloader, (*o*) operation of piston 108 to release gear onto transfer plate 22, (*p*) operation of device 117 to lower transfer plate and drain container 28, (*q*) forward and return operation of motor for pusher 25, (*r*) operation (once for two reciprocations of the pusher) of the motor for conveyer 26, (*s*) return motion of device 117, (*t*) the operation at a time immediately following emptying of container 28, step (*p*), of piston 137 to open door 31 and operation of piston 93 to elevate center 82, and operation of piston 66 to advance support 17 to loading position. The details of the coordinating system are within the province of those skilled in the electrical control art, and therefore not being a part of the present invention are not illustrated.

Having now described our invention, and its operation, what we claim is:

1. A quenching machine for gears and like workpieces, having a chamber for initial quenching, upper and lower dies arranged to hold a workpiece in said chamber during such initial quenching, means for circulating coolant liquid around a workpiece held by the dies for effecting such initial quenching and providing liquid to said chamber to a level above a workpiece therein, a tank for the further cooling of workpieces and adapted to contain coolant liquid to a level lower than the bottom of said chamber, the bottom wall of said chamber having a discharge orifice to said tank, a closure for said orifice and actuating means therefor, and transfer means for moving a workpiece beneath the level of liquid in the container from the dies to a position above said closure, said orifice and closure being so arranged that upon opening of the latter by said actuating means the workpiece and the body of liquid in which it is immersed in the container may together pass through the orifice to the tank.

2. A machine according to claim 1 in which said closure is downwardly opening and constitutes a support for said workpiece during its descent from the container into the tank.

3. A machine according to claim 2 in which there are support means for said closure which maintain it horizontal during its downward motion, whereby it may support said workpiece stationarily thereon during descent into the tank, and there is another work transfer means for removing the workpiece from the closure beneath the level of liquid in the tank.

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