

Feb. 18, 1941.

W. ERNST ET AL

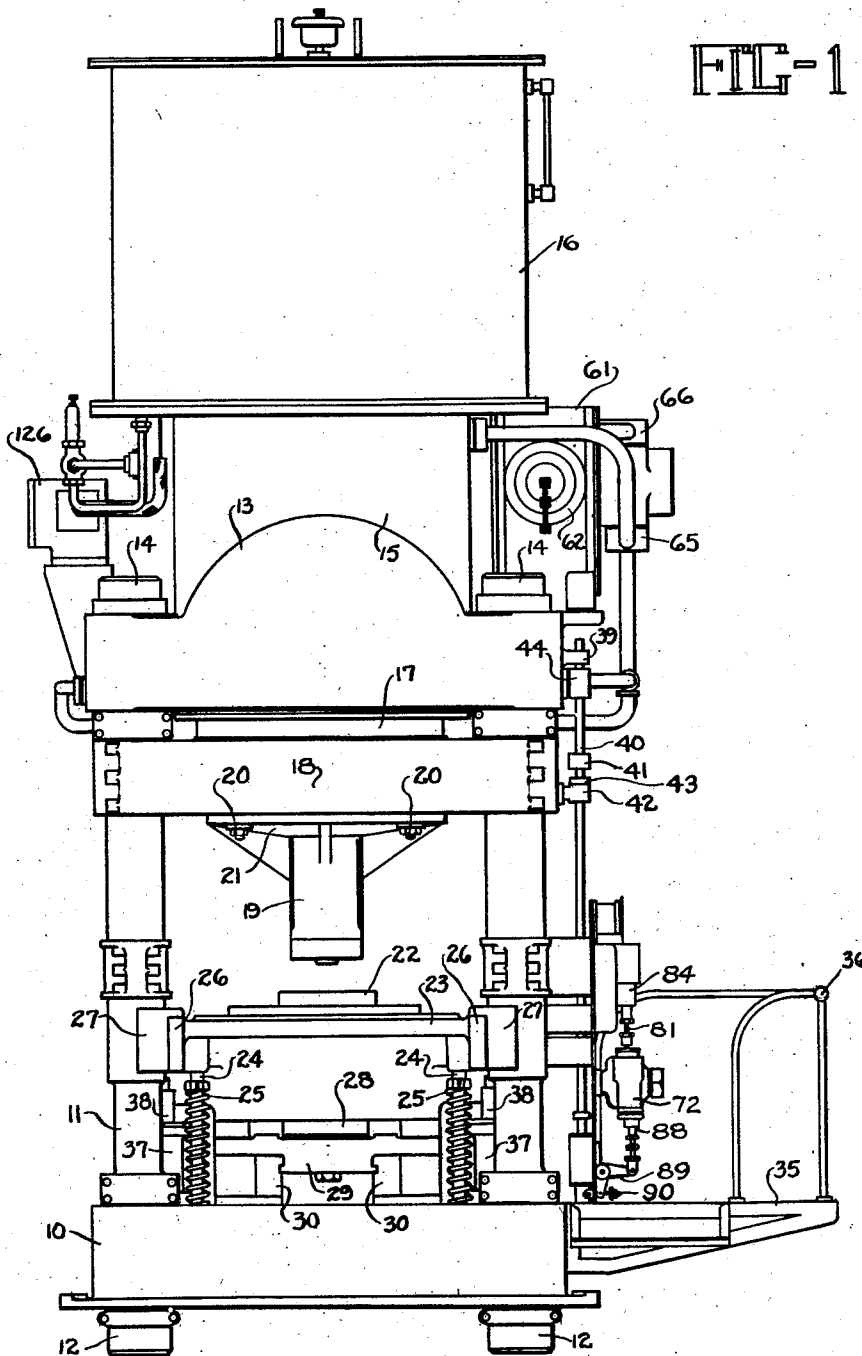
2,232,103

PRESS

Filed June 22, 1937

8 Sheets-Sheet 1

FIG-1



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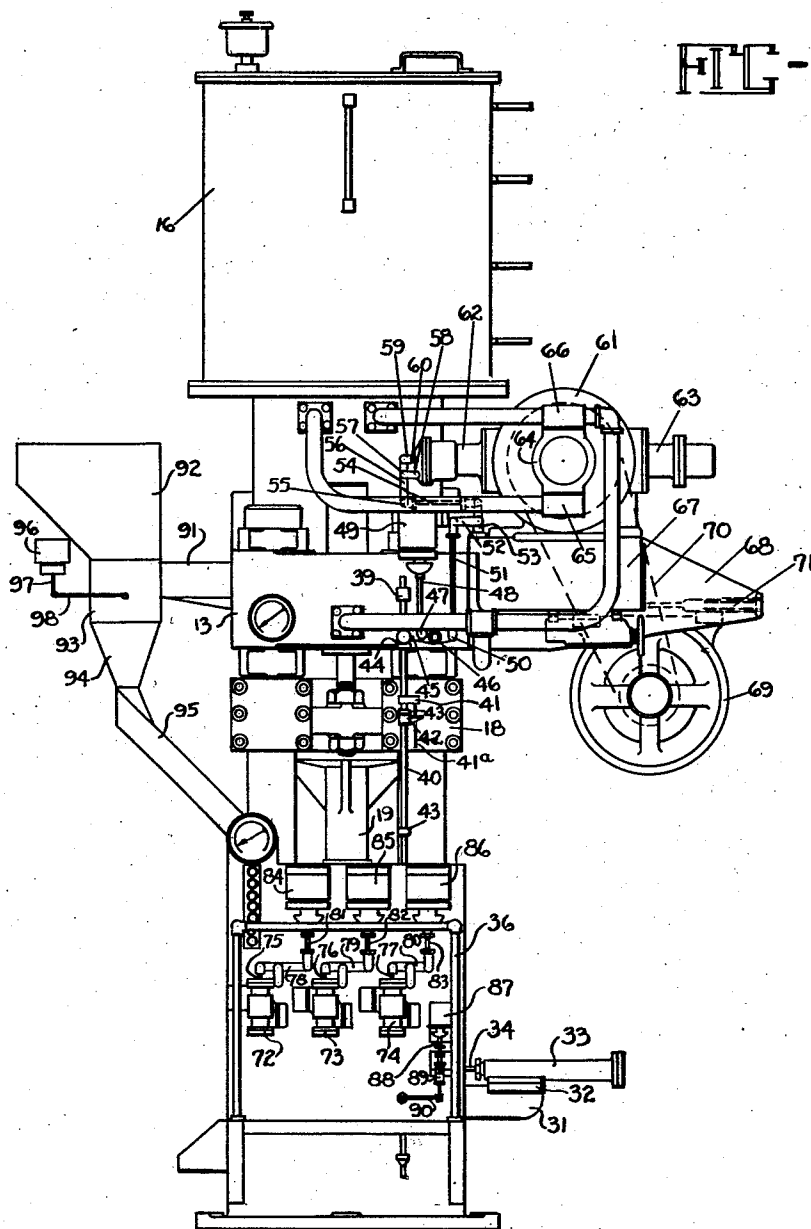
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PRESS

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8 Sheets-Sheet 2

FIG-2



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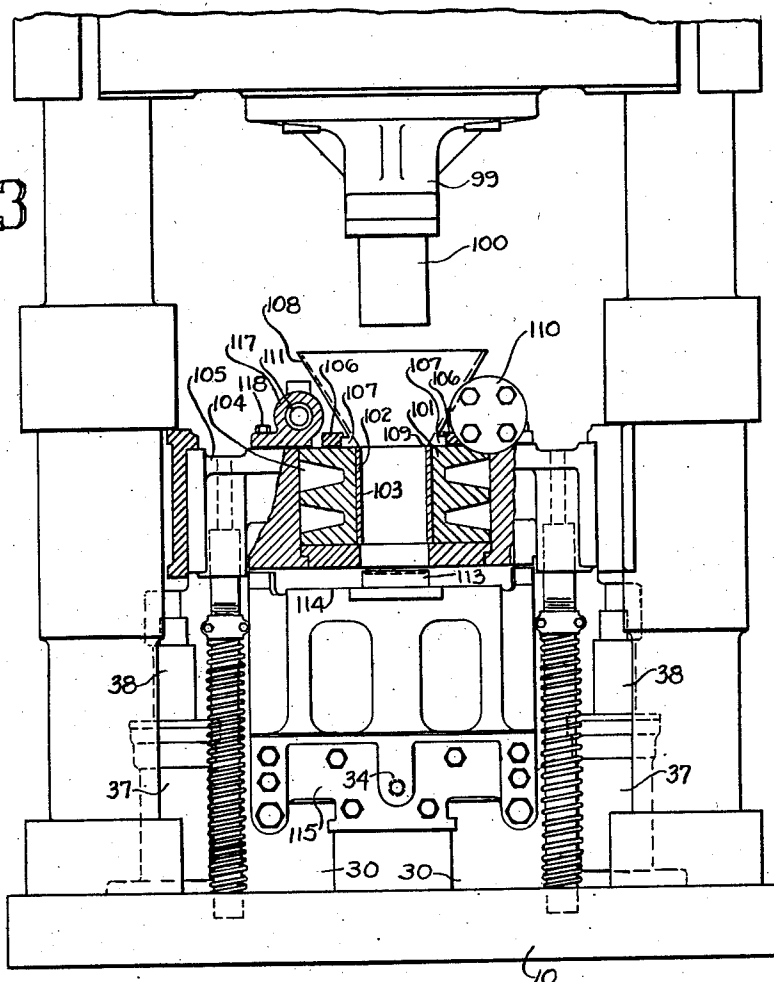
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PRESS

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8 Sheets-Sheet 3

FIG-3



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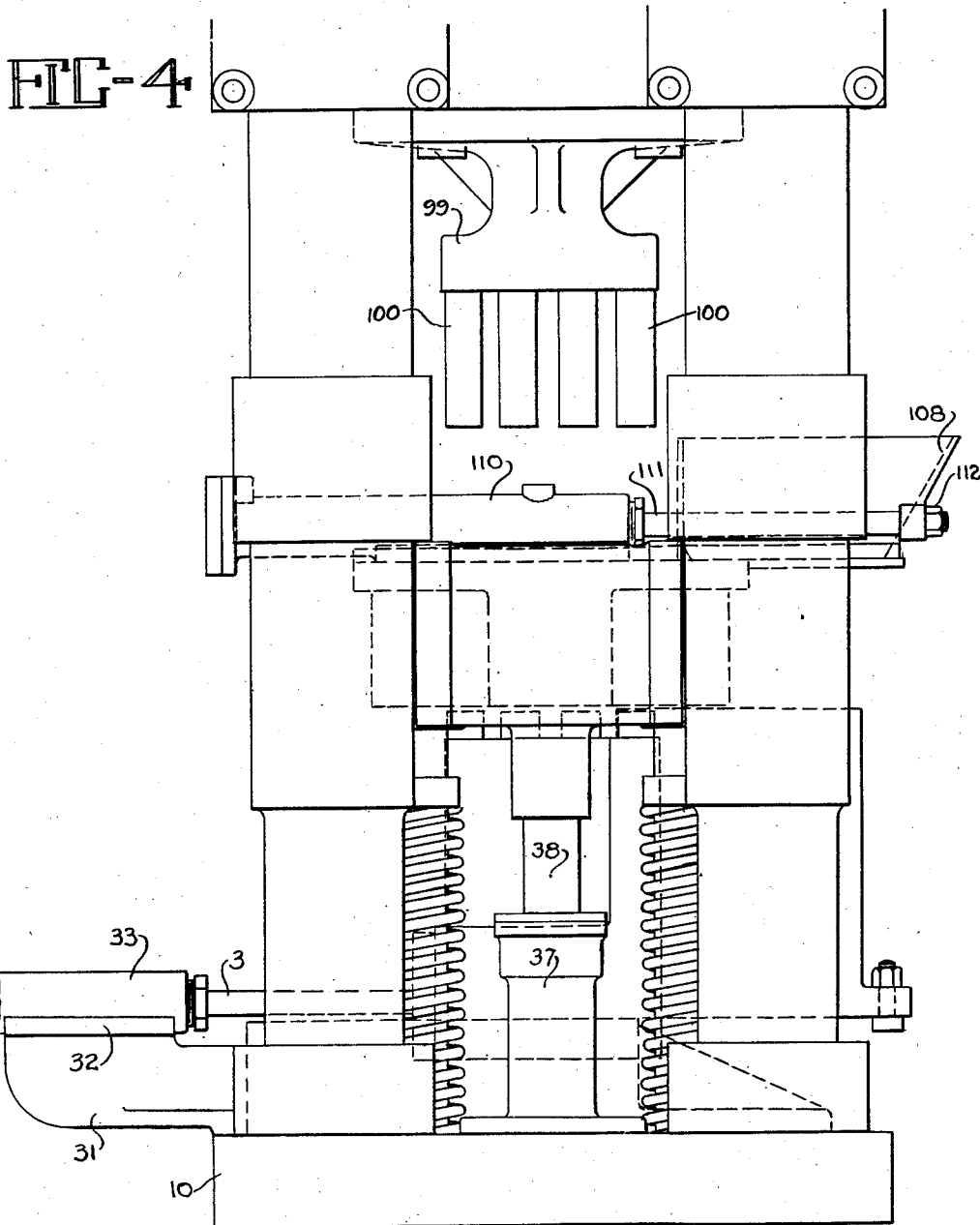
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PRESS

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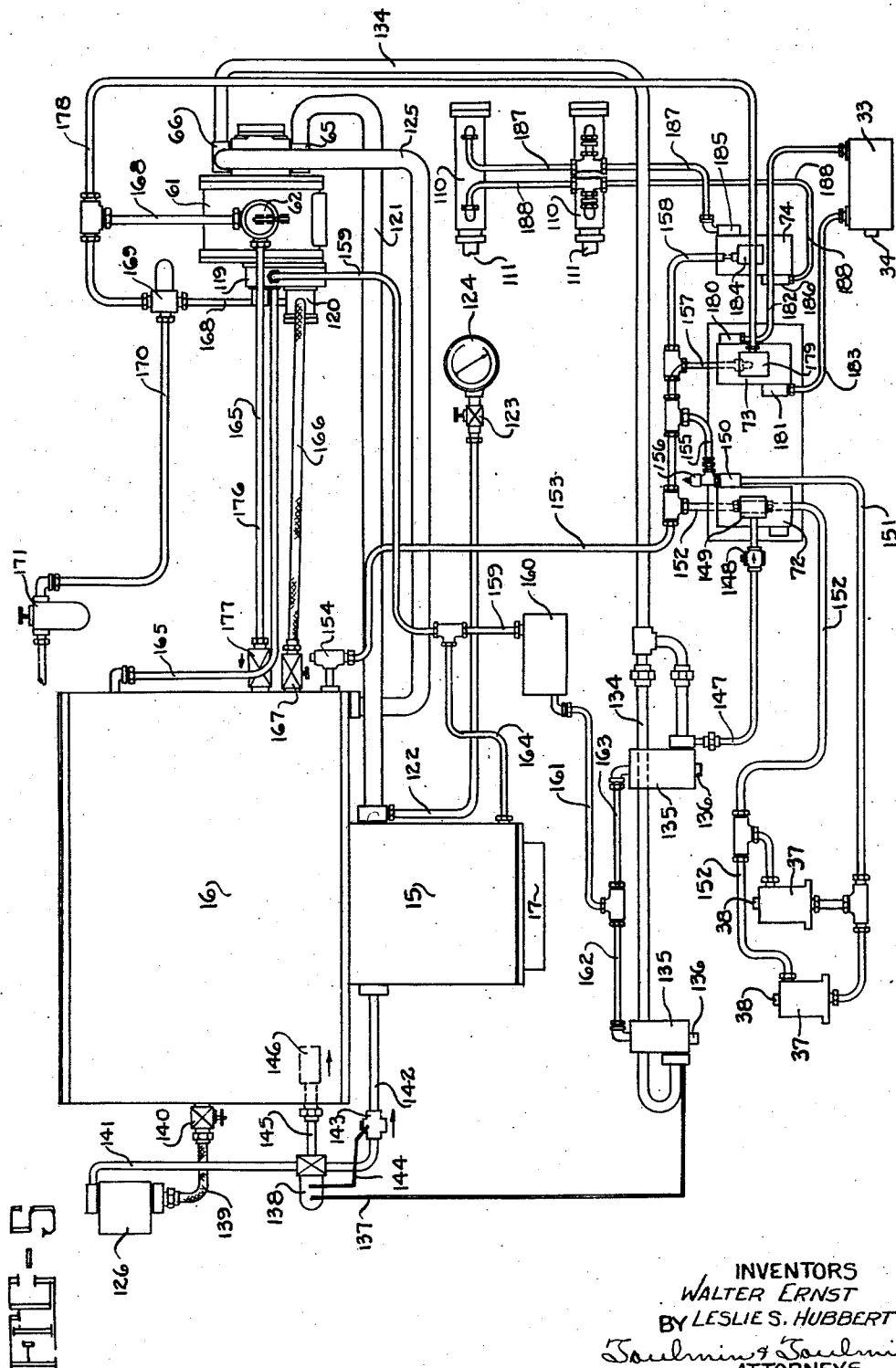
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PRESS

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8 Sheets-Sheet 5



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2,232,103

PRESS

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FIG-6

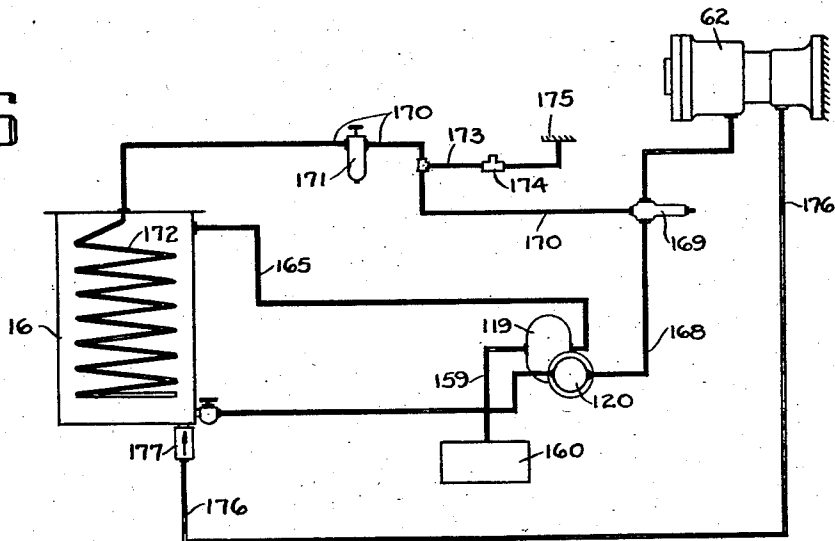
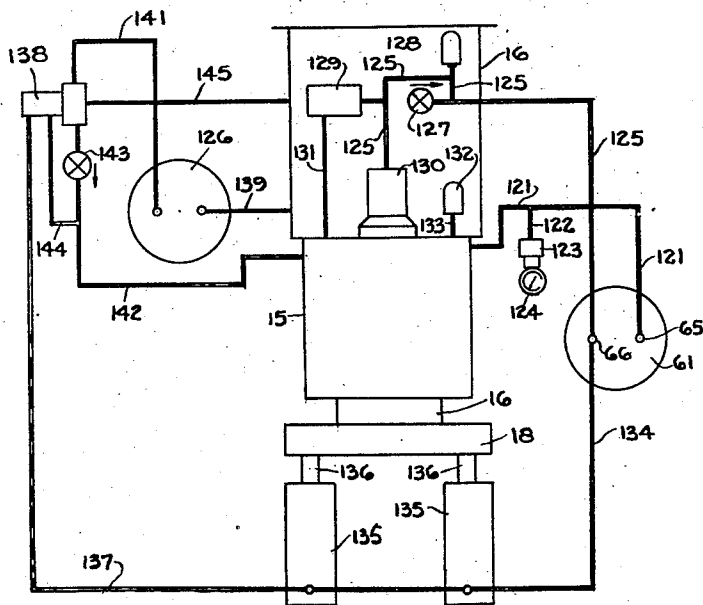


FIG-7



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2,232,103

PRESS

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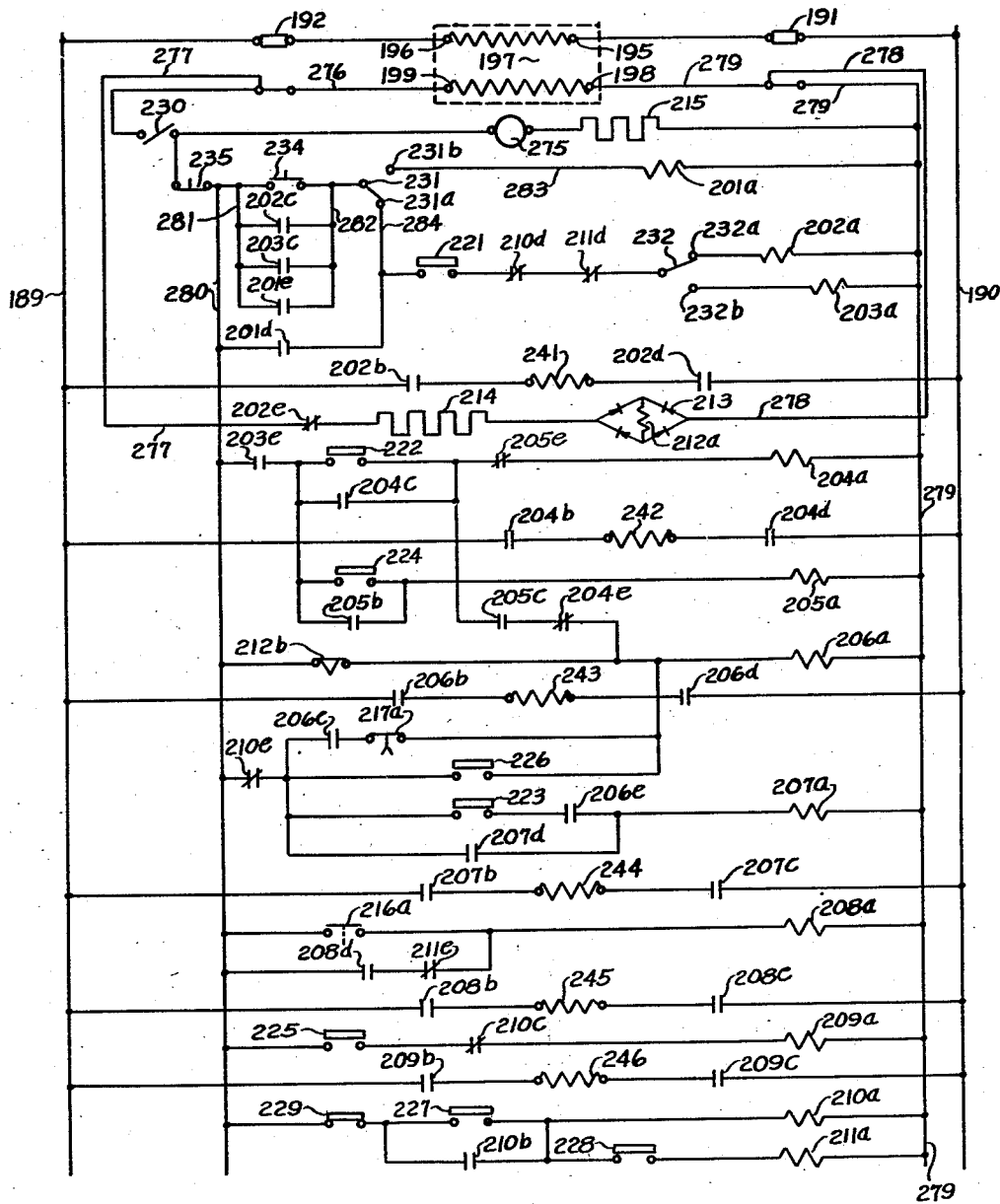


FIG-8

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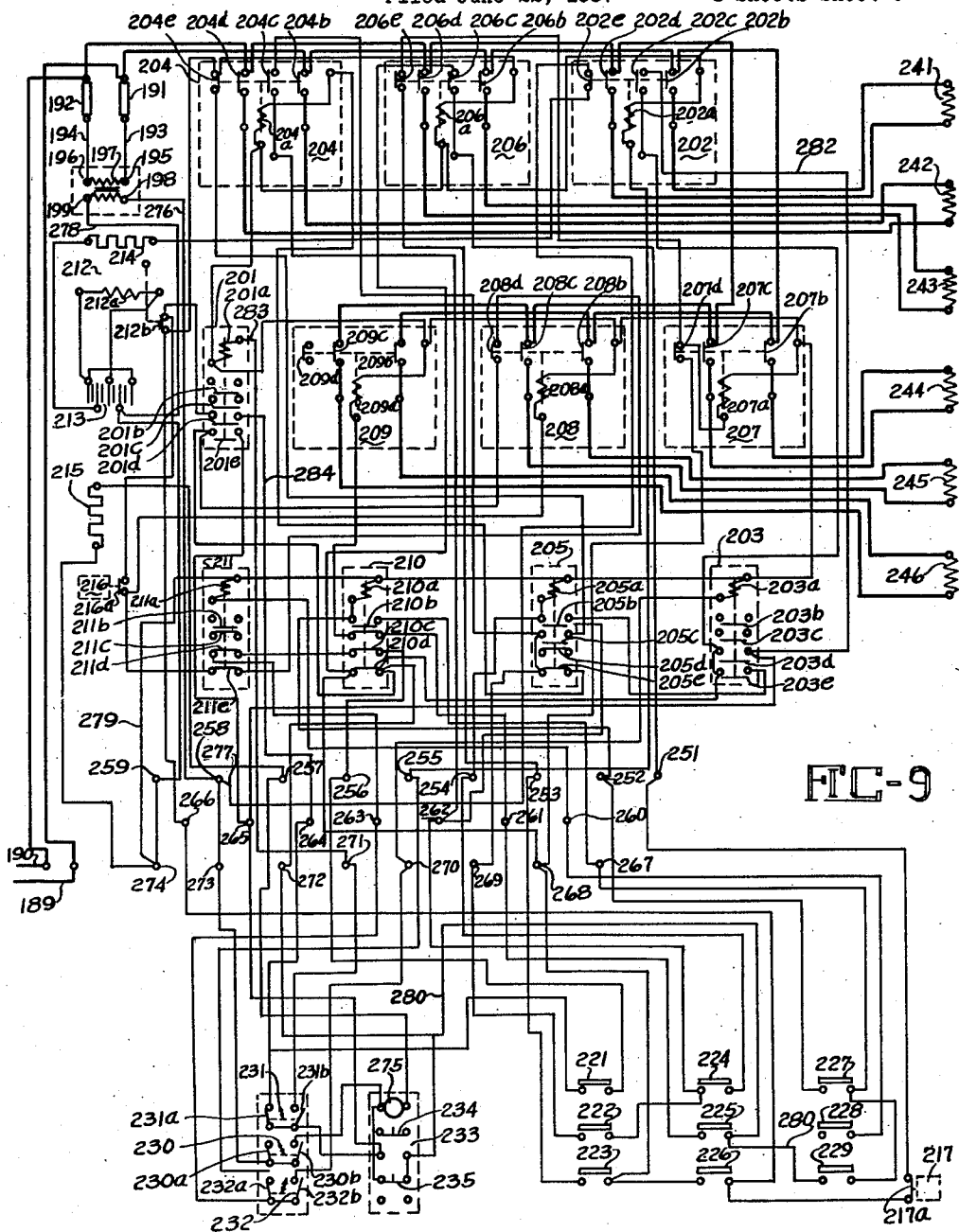
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PRESS

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8 Sheets-Sheet 8



FTC-9

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2,232,103

PRESS

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Application June 22, 1937, Serial No. 149,692

5 Claims. (Cl. 18—16)

This invention relates to hydraulic machinery, and in particular, to electrically controlled hydraulic molding presses.

One object of this invention is to provide a hydraulic molding press having a common electrical control system for selectively molding large or small pieces, the selection being made merely by throwing a switch.

Another object is to provide a hydraulic molding press circuit having an electrical control system, with means for molding articles semi-automatically by the automatic performance of a single cycle of operation, or completely automatically by the repeated performance of an indefinite succession of operating cycles.

Another object is to provide a hydraulic molding press having a separable mold with automatic means for moving the mold portions apart from each other, and for causing the press plunger to pass through one portion in order to eject the work-piece.

Another object is to provide a hydraulic molding press having a separable mold and die, together with means for raising the mold and moving the die to one side in order to cause a plunger to pass into the mold and eject the work-piece.

Another object is to provide an arrangement as described in the preceding paragraph, wherein automatic means is provided for causing the mold and die to come together again after the ejection of a work-piece.

Another object is to provide a hydraulic molding press arranged to perform alternate molding and ejection strokes, with means for automatically causing the plunger to execute a shortened return stroke between the molding and ejection strokes, thereby saving time and pressure fluid by performing a shorter ejection stroke than molding stroke.

Another object is to provide a hydraulic molding press circuit having means automatically responsive to the operation of a starting member, such as a switch, for filling the mold with material, preferably in a predetermined measured quantity, and having time delay means operative to start the molding plunger forward a predetermined time after the operation of said starting member.

Another object is to provide a hydraulic molding press circuit incorporating means responsive to pressure rising in the molding operation to start the plunger on its return stroke, as well as to shift the mold and move the die out from under the mold, preferably having the additional feature of holding the mold in its shifted position while operating the plunger on its ejection stroke, thereby pushing the molded piece out of the mold.

Another object is to provide a hydraulic molding press circuit having means for alternately performing a long molding stroke and a shortened

ejection stroke, together with means responsive to the ejection of a molded piece for causing the plunger to execute a full length return stroke.

Another object is to provide a hydraulic molding press circuit having means responsive to the execution of a return stroke of the press for returning the die and the mold to their closed positions, in readiness for the next molding operation.

Another object is to provide a hydraulic molding press circuit with a control circuit having separable mold portions, and an electrical circuit including means responsive to the arrival of one mold portion at a predetermined position for starting another mold portion upon a path bringing it into engagement with the first-mentioned mold portion.

Another object is to provide a hydraulic molding press having a platen and bed adaptable for making either large or small molded pieces merely by replacing the large mold with a small mold, or a plurality of small molds.

Another object is to provide a hydraulic molding press having means including a charging member, such as a movable box or hopper, for receiving the molding material and transporting it into and out of the charging position, together with means for causing the charging box to execute a forward and return stroke prior to the start of the forward stroke of the molding plunger.

Another object is to provide a hydraulic molding press with a hydraulic circuit for moving one part of the mold into molding and ejection positions, respectively, and for moving the die or other mold-closing portion into and out of its mold-closing position.

Another object is to provide a hydraulic molding press circuit, wherein the press is provided with push-back cylinders and served by low pressure and high pressure pumps, the low pressure pump being provided with a pilot-operated unloading valve to unload the discharge of the low pressure pump in response either to the attainment of a predetermined pressure in the main cylinder or to pressure being applied to the push-back cylinders.

In the drawings:

Figure 1 is a front elevation of a hydraulic press embodying the features of the present invention, employing a single large mold and molding plunger and with material-feeding mechanism omitted for clearness of showing.

Figure 2 is a right-hand side elevation of the press shown in Figure 1.

Figure 3 is a front elevation, partly in section, of a portion of the press shown in Figure 1, but modified slightly to accommodate a multiple molding arrangement together with multiple molding plungers for simultaneously molding a plurality of smaller pieces than in Figure 1.

Figure 4 is a side elevation of the portion of the press shown in Figure 3.

Figure 5 is a diagrammatic view of the hydraulic circuit employed in the press of Figures 1 and 2 when arranged to mold multiple small pieces, as shown in Figures 3 and 4.

Figure 6 is a diagrammatic view of a portion of the hydraulic circuit of Figure 5 pertaining to the pilot and slippage system.

Figure 7 is a diagrammatic view of another portion of the circuit shown in Figure 5, showing the high and low pressure press-operating circuit.

Figure 8 is a simplified diagram of the electrical control circuit for controlling the various motions of the press elements, and for controlling the distribution of the fluid in the hydraulic circuit in Figure 5.

Figure 9 is a wiring diagram showing the various electrical elements in their proper relative positions, but with the same connections as shown in the simplified diagram of Figure 8.

General construction

In general, the hydraulic press and circuit of this invention consists of a vertical molding press having a main molding plunger and a movable mold with a movable die closing the lower part of the mold. The mold is movable vertically and the die horizontally so that the main plunger may pass into the mold and eject the molded piece therefrom after the completion of a molding stroke. Electrical control elements and circuits are provided for timing the motions of the main plunger, the mold-raising plungers and the die-shifting plunger so that each will accomplish its motion at the proper relative time. An electrical circuit is provided whereby a single large work-piece or a plurality of small work-pieces may be molded merely by throwing a switch and by replacing the one set of molds and plungers by another. The apparatus for molding a plurality of small work-pieces is additionally provided with a charger operated by hydraulic plungers and likewise timed by means of an electrical control circuit to move into engagement with the mold charged with molding material, and return to its starting position before the molding plunger accomplishes its molding stroke.

The electrical circuit is also arranged so that the press may be caused to operate either in a semi-automatic or completely automatic manner. The press operates in a semi-automatic manner when it accomplishes a complete cycle of operations, namely, molding and ejection strokes, and then returns to its starting position where it halts. The press operates in a completely automatic manner when it does not halt at the end of this complete cycle of operations, but continues to perform an indefinite number of such cycles until halted by the operator. Means is also provided for causing the press to accomplish alternate molding and ejection strokes, wherein the ejection stroke is shorter than the molding stroke.

Press arranged for molding single large blocks

Referring to the drawings in detail, Figures 1 and 2 show the press of this invention as arranged for the molding of single large blocks, blocks of salt being chosen for illustrative purposes. This press consists of a base 10 having secured thereto the vertical strain rods 11, as by the nuts 12. The strain rods 11 at their upper ends are provided with a top member 13, held in place by the nuts 14, and containing the main cylinder 15 surmounted by the surge tank 16.

The main cylinder 15 is provided with a main plunger 17 with a platen 18 secured thereto, and having a molding plunger 19 depending therefrom and held in position by the bolts 20, engaging the laterally flanged portion 21.

Arranged opposite the molding plunger 19 is a mold 22 mounted upon a mold holder 23, which is vertically movable and supported upon the rods 24 and coil springs 25. The mold holder 23 is provided with projecting portions 26 adapted to engage guide portions 27 mounted upon the strain rods 11 and serving to guide the mold holder 23 in its vertical motion. Mounted beneath the mold 22 and mold holder 23 and arranged to close the lower end of the aperture in the mold 22, is a die 28 mounted upon a slide 29, which is slidably mounted upon a bifurcated support 30 with an extended portion 31 forming a bracket. The latter supports the base portion 32 of the hydraulic cylinder 33 having the plunger 34 which moves the die slide 29 into and out of position beneath the mold 22. Also secured to the bed 10 is a platform 35 for the operator, and having hand rails 36 rising therefrom. The mold holder 23 is provided with hydraulic cylinders 37 having plungers 38 emerging therefrom and engaging the mold holder 23 to raise and lower it.

Mounted on the side of the press in brackets 39 is a vertically movable and rotatable control rod 40 (Figure 2), having adjustable spaced stops 43 thereon engageable by a platen arm 42 having a projection or shelf thereon. The control rod 40 also is provided with an arm 41 carrying a vertically adjustable threaded stop rod 41a, the end of which is arranged to be engaged by the shelf of the platen arm 42 when the control rod 40 is rotated by the solenoid 47, thereby constituting a mechanical short stop for temporarily halting the main plunger 17 at an intermediate position upon its return stroke immediately after a working stroke as hereinafter explained. The upper end of the control rod 40 carries a stop 44 engaged by the end of a lever 45 (Fig. 2), pivoted to the top member 13, as at 46. Pivotaly attached, as at 47, to the lever 45, is the armature 48 of a solenoid 49. The opposite end of the lever 45 has secured thereto, as at 50, a link 51 pivotaly connected to a bellcrank 52 mounted upon the bracket 53, and having a rod 54 connected, as at 55, to the rocking lever 56 supported, as at 57, by the member 58 and having pivotaly secured thereto, as at 59, the control rod 60 of the main hydraulic pump 61. The control rod 60 passes into the servomotor control valve 62 of the pump 61. This valve 62 serves to control the admission of fluid to the servomotor 63, which shifts the shift ring or flow-control element of the main pump 61 in a manner determined by the position of the valve 62. The main pump 61 is of a reversible variable delivery type, the details of which form no part of the present invention. A pump with a servomotor control system, suitable for this purpose, is found in the Ernst Patent No. 2,038,272, issued April 21, 1936.

The main pump 61 is provided with a portion 64 having forward and return connections 65 and 66. The pump 61 is mounted upon an extension bracket 67 having an overhanging portion 68 from which the motor 69 is suspended. The motor 69 drives the pump 61 by means of an endless member 70, such as a sprocket chain or belt. The motor 69 is movably mounted and adjustable by means of the screw shaft 71 to tighten or loosen the sprocket chain or belt 70. Mounted upon the side of the press are three

valves 72, 73 and 74 (Figure 2) having valve rods 75, 76 and 77 operated by rocking levers 78, 79 and 80, connected to the armatures 81, 82 and 83 of solenoids 84, 85 and 86. A solenoid 87 (Figure 2) with an armature 88 shifts a bellcrank 89, which swings an arm 90 to rotate the rod 40 and interpose the stop rod 41a as a mechanical stop in the path of the press mechanism in order to shorten the stroke of the main plunger 17 upon the return stroke between the molding and ejection strokes.

Mounted upon the support 91 upon the top member 13 of the press is the molding material hopper 92, having a weighing chamber 93 below which is a funnel-shaped portion 94, terminating in a diagonal chute 95. A solenoid 96 is secured to the hopper 92, and its armature 97 is connected to the crank arm 98 leading to the interior of the weighing chamber 93, where it operates a material-releasing device. Thus, when the solenoid 96 is energized the material, such as salt, which has been weighed out in the weighing chamber 93, is released so as to fall by gravity through the funnel-shaped portion 94 into the inclined chute 95.

Press arranged for molding multiple small blocks

The press shown in Figures 3 and 4 is the same as the press shown in Figures 1 and 2, but the arrangements for holding the molds and dies are somewhat different. The molding plunger head 99 carries a plurality of molding plungers 100, beneath which is arranged a mold 101 (Figure 3) having a plurality of apertures 102 lined with sleeves 103. The mold 101 is arranged with a recess 104 within the mold holder 105. The latter in its floating supports and lifting plungers is the same as shown in Figure 1. Mounted upon the mold 101 are guides 106 serving to receive corresponding ridges 107 upon the charger 108. The latter is provided with apertures 109 matching the various apertures 102 of the mold 101, and is moved toward and from its charging position by means of hydraulic cylinders 110, operating plungers 111 connected to the charger 108. The plungers 111 are threaded at their outer ends and secured by the nuts 112 to the charger 108 (Figure 4).

Arranged beneath the apertures 102 of the mold 101 are corresponding dies 113 (Figure 3), mounted upon a die carrier 114 which is, in turn, supported upon a member 115 mounted for reciprocation upon the arms of the bifurcated support 30. Secured to the member 115 is the plunger 34 of the cylinder 33, the latter being supported, as before, upon the base portion 32 of the bracket 31 resting upon the bed 10. The plungers 111 pass through the portions 117, bolted as at 118, to the member 105.

Hydraulic circuit

The press arrangement of this invention includes a hydraulic circuit and an electrical circuit for controlling the actions of the hydraulic circuit. The hydraulic and electrical circuits will be described separately, but their operations will be described simultaneously.

The pump assembly, consisting of the main pump 61 and slippage and pilot pumps 119 and 120, is claimed in the copending application of Ernst, Ser. No. 41,281, filed September 19, 1935.

As shown in Figure 5, the hydraulic circuit includes the previously mentioned main cylinder 15 with its main molding plunger 17 surmounted

by the surge tank 16. Also previously mentioned are the mold-raising cylinders 37 with their plungers 38, as controlled by the valve 72 responsive to the action of the solenoid 84. Likewise previously mentioned are the die-shifting cylinder 33, with its plunger 34, controlled by the valve 73 responsive to the action of the solenoid 85; and also the charger-shifting cylinders 110 with their plungers 111, controlled by the valve 74 responsive to the action of the solenoid 86.

The hydraulic circuit shown in Figure 5 may be said to contain four different hydraulic circuits as regulated by four different pumps. The first circuit is the main or high pressure circuit for operating the main plunger 17, supplied with pressure from the main pump 61. The second circuit is a slippage circuit for removing operating fluid which escapes past the various plungers, this being operated by the slippage pump 119. The third circuit is a pilot circuit for supplying fluid pressure to operate the charger-shifting plungers 111 and the mold-shifting plunger 34, as well as the servomotor 63 and control valve 62 of the main pump 61. Fluid for this pilot circuit is supplied by the pilot pump 120. The fourth and final circuit is a low pressure circuit which operates in cooperation with the high pressure circuit supplied by the main pump 61, this low pressure circuit being supplied with fluid from the low pressure pump 126. The major portions of the pilot and slippage circuits are shown in simplified form in Figure 6, whereas the main portions of the high pressure and low pressure operating circuits are shown in Figure 7.

The main pump 61 in the high pressure circuit has associated therewith a slippage pump 119 and a pilot pump 120, all driven from the same mechanism. The pumps 61, 119 and 120 are independent of one another, but are merely associated with one another for mechanical convenience. The forward pressure connection 65 of the main pump 61 is connected by the conduit 121 to the main cylinder 15, from which a branch conduit 122 having a shut-off valve 123, leads to a pressure gauge 124 for indicating the pressure within the main cylinder 15. Similarly, the return pressure connection 66 is connected by the conduit 125 to the surge 16 by way of certain hydraulic devices shown more in detail in Figure 7.

These hydraulic devices, shown within the surge tank 16 in Figure 7, consist of a main cylinder release and by-pass hydraulic system, together with a surge valve, as set forth in detail in the Ernst patent, No. 1,956,758, issued May 1, 1934. This system is set forth in detail in the above-mentioned patent and forms no part of the present invention. It consists (Figure 7) of a check valve 127 connected to and opening toward the conduit 125; a by-pass valve 128 likewise connected to the line or conduit 125; a pressure release valve 129 similarly connected to the conduit 125, and a surge valve 130 which terminates the connection of the conduit 125. The pressure release valve 129 is connected, by the line 131, to the main cylinder 15. A safety valve 132 is mounted upon a conduit 133 connected to the main cylinder 15 for relieving abnormal pressures within the main cylinder 15. The operation of this pressure release and by-pass system for the main cylinder 15 is set forth in detail in the above-mentioned patent. The surge valve 130 serves for facilitating the down-

ward descent of the main plunger 16 by admitting fluid freely to the main cylinder 15 from the surge tank 16, in the manner set forth in detail in the above identified patent, and also in the Ernst patent, No. 1,892,568, issued December 27, 1932. The surge valve 130 is forcibly opened on the return stroke of the press by fluid reaching it through the return line 125.

Also connected to the return connection 66 is a conduit 134 leading to the push-back cylinders 135, having the push-back plungers 136 therein. These plungers 136 are connected to the platen 18 (Figure 7) for the purpose of returning the platen 18 and the main plunger 16 to their starting position after a pressing stroke has been made. Beyond the push-back cylinders 135 the line 137 leads to the operating cylinder of a double pilot-operated unloading valve 138, which controls the action of the low pressure circuit which cooperates with the high pressure circuit, and which is supplied with fluid by the low pressure pump 126. The suction line 139 thereof is connected directly to the surge tank 16 by way of the valve 140. The pressure line 141 therefrom is connected to the unloading valve 138, beyond which the line 142 containing the check valve 143, runs to the main cylinder 15. A line 144 likewise runs from the check valve 143 to the operating cylinder of the pilot-operated unloading valve 138. From the latter the discharge line 145 runs directly to the surge tank 16, and on its end carries the check valve 146.

Connected to the return line 134 at one of the push-back cylinders 135 is a branch line 147 (Figure 5), having therein the check valve 148. The line 147 is connected to the intake 149 of the valve 72, the outlet 150 of which is connected by the line 151 to the mold-raising cylinders 37. The opposite ends of these cylinders 37 are connected to the branch discharge line 152, running to the discharge line 153. The latter is connected, through the check valve 154, to the surge tank 16 so as to discharge into the latter, and is likewise connected by the branch line 155 to the safety valve 156, mounted upon the outlet 150 of the valve 72. The discharge line 153 is likewise connected, through the branches 157 and 158, to the valves 73 and 74 and serves to convey fluid therefrom back to the surge tank 16.

The slippage circuit consists of the slippage pump 119, previously mentioned, and having the line 159 running therefrom to the slippage tank 160, from the opposite side of which the line 161 proceeds by the branches 162 and 163 to the opposite ends of the push-back cylinder 135 from their connection with the line 134. In this manner any fluid leaking past the plungers 136 is removed to the slippage tank 160. Similarly, any fluid escaping past the main plunger 17 is removed through the branch line 164 connected to the line 159. From the opposite side of the slippage pump 119 the discharge line 165 returns to the surge tank 16 for discharging the excess fluid resulting from this slippage.

The pilot circuit (Figures 5 and 6) is supplied with fluid from the pilot pump 120, which draws in fluid from the surge tank 16 by way of the suction line 166 having the valve 167 therein. The pilot pump 120 discharges into the line 168 containing the relief valve 169. The discharge line 170 leads from the latter, through a fluid filter 171, to the cooling coils 172 within the surge tank 16. Leading from the line 170 is an

optional branch line 173 having an optional choke 174 (Figure 6), and running to the pintle cap 175 of the pump 61.

Beyond the relief valve 169 the line 168 continues to the servomotor valve cylinder 62, from which the line 176 returns to the surge tank 16 by way of the check valve 177. In this manner the pilot pump 120 supplies pressure fluid for controlling the actuation of the servomotor which moves the shift ring of the main pump 61 to vary the discharge thereof by varying the eccentricity between its primary rotor and its secondary rotor as is understood by those skilled in the variable delivery pump art. Beyond the relief valve 169 the branch line 178 runs from the line 168 to the intake 179 of the valve 73, from the outlets 180 and 181, of which the lines 182 and 183 run, respectively, to the opposite ends of the die-shifting cylinder 33 and its plunger 34 (Figure 5). The line 178 also leads into the intake 184 of the valve 74, the outlets 185 and 186 of which lead through the conduits 187 and 188 to opposite ends of the charger-shifting cylinders 110 and their plungers 111.

The four hydraulic circuits thus described are controlled by an electrical system through the actuation of solenoids 49, 84, 85 and 86, the solenoid 49 controlling the shifting of the valve rod 60 which controls the servomotor 63 of the main pump 61.

Electrical circuit and elements

The electrical circuit which controls the hydraulic circuit, in the manner previously described, is shown in simplified form in Figure 8 and in a rather more elaborate form in Figure 9. The simplified diagram of Figure 8 shows the relative connections of the various switches operated by the different relays. The more elaborate circuit of Figure 9, however, shows the relative positions of the switches operated by the different relays, without the possibility of showing simplified connections between them. For tracing the circuits, therefore, it is convenient to utilize Figure 8, whereas for locating the different interlocks or switch blades operated by the different relays, it is advisable to consult Figure 9.

The electrical circuit consists mainly of a plurality of relays, limit switches and solenoids, together with a transformer for supplying control current at a reduced voltage, a time delay relay, a rectifier, certain resistances and various manually-operated switches, mostly of the push-button type. These elements will be first listed for convenience, together with the functions they perform, after which the operation will be set forth in more detail.

The electrical control circuit (Figures 8 and 9) receives power from the power lines 189 and 190, which run through the control fuses 191 and 192 to the lines 193 and 194, leading to the terminals 195 and 196 of the primary winding of the transformer 197. The latter has terminals 198 and 199 leading from its secondary winding to various parts of the control circuit, as hereinafter described in detail. Also included in the control circuit are eleven control relays in the form of magnetically-operated switches, having switch blades either normally closed or normally opened, and operated magnetically by coils. These control relays are generally designated 201 to 211, inclusive. These control relays are supplied with operating coils 201a to 211a and with switch blades 201b to 211b, 201c to 211c

211c, 201d to 211d and 201e to 211e. Also connected in the circuit is a time relay 212 having a coil 212a and a switch blade 212b. This is connected to a rectifier 213 and a resistance 214.

Below the rectifier 213 is a resistance 215, a pressure switch 216, having a switch blade 216a. A second pressure switch 217, having a switch blade 217a, is found in the lower right-hand corner of Figure 9.

The control relays 201 to 211, inclusive, are in part controlled by the closing and opening of a plurality of limit switches 221 to 229, inclusive, and the circuits to these are under the control of various manually-operated switches of the push-button type. Among these are the off-on switch 230, the hand automatic switch 231 and the block size selector switch 232. Each of these has switch blades or switch positions, respectively designated a and b, and each is normally open or normally closed, according to the positions of the switch blades as shown in Figures 8 and 9. A reversing switch 233 is also provided, and includes a forward switch member 234 and a reverse switch member 235.

The actions of the various control relays 201 to 211 energize or deenergize the coil windings 241 to 246, respectively, corresponding to the solenoids 96, 86, 49, 87, 84 and 85. The wires from the various control relays 201 to 211 are brought out to a plurality of terminals 251 to 274, inclusive. An incandescent light bulb 275 indicates the operating condition of the circuit.

The electrical circuit is roughly divided into two sub-circuits. The power sub-circuit supplies relatively high voltage electricity to the solenoid windings 241 to 246, these being energized from the power lines 189 and 190, through the various relay switch blades shown in Figure 8. The control sub-circuit receives current from the secondary terminals 198 and 199 of the transformer 197, the control current thus being of a lower voltage. From the transformer secondary terminal 199 a line 276 runs to the off-on switch 230, and a branch line 277 runs to the rectifier 213 by way of the relay switch blade 202e and the resistor 214, the energization being completed by the line 278 returning as a branch line of the line 279 leading from the transformer secondary terminal 198. The line 279 energizes one side of all of the relay coils 201a to 211a. The normally closed reverse switch 235 is directly connected to the off-on switch 230, and beyond it the line 280 runs downward substantially parallel with the line 279, and energizing the opposite side of the circuit.

Beyond the junction of the line 280 at the reverse switch 235 is connected the normally open forward switch 234, this being bridged by the lines 281 and 282, interconnected by the relay switch blades 202c, 203c and 201e. Beyond the forward switch 234 is connected the hand automatic switch 231, having an automatic position 231b and a hand position 231a. Connected to the automatic position 231b is the line 283, leading to the relay coil 201a. Similarly, from the hand position 231a the line 284 leads back to the line 280 by way of the relay switch blade 201d. Connected to the line 284 is the limit switch 221, which is in turn connected through the normally closed relay switch blades 210d and 211d to the block size selector switch 232. The latter has large block and small block selecting positions 232a or 232b from the line 279 (Figure 8).

Summarizing the functions of the various relays, the relay 201 controls the completely auto-

matic or full automatic operation only, and maintains a continuous bridging through the relay switch blade 201e, around the forward push-button switch 234. The control relay 202 controls the energization of the solenoid winding 241 of the solenoid 96. The relay 203 controls the energization of the circuit containing the relay coils 204a and 205a for molding small blocks or small work-pieces. The relay 204 controls the energization of the winding 242 of the solenoid 86 for operating the charger mechanism. The relay 205, when energized, deenergizes the relay coil 204a and the solenoid winding 242 of the solenoid 86, and also the relay coil 206a under certain conditions. The relay 206 controls the energization of the solenoid winding 243 of the solenoid 49 for starting the main plunger on its forward stroke. The relay 207 controls the energization of the solenoid winding 244 of the solenoid 87 for interposing a mechanical short stop on the return stroke between the molding and ejection strokes of the main plunger. The relay 208 controls the energization of the solenoid winding 245 of the solenoid 84 for urging the mold in an upward direction. The relay 209 controls the energization of the solenoid winding 246 of the solenoid 85 for forcing the die out from under the mold. The relays 210 and 211, both with normally closed switch blades, operate in conjunction with various limit switches to control the sequence of operations of certain other relays, as set forth in more detail below.

The six solenoids have the following functions. The solenoid 96 with winding 241 operates the crankarm 98 for releasing the molding material from the weighing chamber 93 to the conical chutes 94 and 95 (Figure 2). The solenoid 86 with winding 242 shifts the valve 74 for operating the cylinder 110 and plungers 111 for moving the charger. The solenoid 49 with winding 243 shifts the control of the variable delivery pump 61 through the links and levers, previously described, thereby starting the main plunger 17 on its forward stroke. The solenoid 87 with its winding 244 interposes a mechanical short stop in the path of the main plunger to prevent its making a full return stroke between its molding and ejection strokes. The solenoid 84 with winding 245 shifts the valve 72 for supplying fluid to the plungers 38, urging the mold in the upward direction. The solenoid 85 with winding 246 shifts the valve 73 for supplying fluid to the cylinder 33 and plunger 34 for moving the die inward and outward relative to the mold.

The various limit switches have the following functions, all being normally open excepting limit switch 229, which is normally closed. The limit switch 221 is closed when the main plunger 17 is in its retracted position, and opens as soon as it starts its forward stroke. The limit switch 222 is closed with the charger 108 out. The limit switch 223 is closed momentarily when the main plunger 17 starts on its forward stroke, and thereby energizes the relay coil 207d. The limit switch 224 is closed with the charger 108 in. The limit switch 225 is closed when the mold 101 is in its raised position. The limit switch 226 closes when the die 113 reaches its outer position, and thereby reenergizes the relay coil 206a to start the main plunger 17 on another forward stroke. The limit switch 227 closes when the molded piece or block is ejected from the mold 101, and thereby energizes the relay coil 210a. The limit switch 228 closes when the die 113 returns to its normal or inner position, beneath the mold 101. The

normally closed limit switch 229 opens when the mold 101 starts on its upward travel.

The pressure switches have the following functions. The pressure switch 216 is normally opened but closes at a predetermined low pressure in the main cylinder 15, at the end of a forward stroke of the main plunger 17. The pressure switch 217 is also normally open, but closes at a predetermined higher pressure at the end of the same forward stroke. The time relay 212 has a normally closed switch blade 212b which opens when the time relay coil 212a is energized, and closes again a predetermined time thereafter.

The manual switches have the following functions. The off-on switch 230 serves to place the entire electrical circuit in and out of operation as a whole. The hand automatic switch 231 controls the circuit, determining whether the circuit is set for semi-automatic (hand) operation or completely automatic operation. Semi-automatic or hand operation occurs when the press executes a complete working cycle, molding and ejecting one work-piece and returning to its retracted position. The complete or full automatic operation occurs when the press executes an indefinite number of complete working strokes and turns out an indefinite number of molded work-pieces until the entire press is halted by the operator.

The block size selector switch 232 controls whether large or small blocks or work-pieces are to be molded by determining which of the relay coils 202a or 203a is to be energized. The forward switch 234 serves to energize the press control circuit for a forward stroke of the main plunger 17, and is normally open. The reverse switch 235 is normally closed, and serves, when operated, to cause the main plunger 17 to halt instantly and return to its retracted position, thereby serving as an emergency or safety switch.

Operation

In the operation of the press the motor 69 for operating the pumps 61, 119, 120 and 126 is started, thereby causing these pumps to begin operation. It will first be assumed that the hand automatic switch 231 is set for hand or semi-automatic operation, and that the block size selector switch 232 is set for making large blocks. The off-on switch is, of course, closed in its "on" position, and the forward push-button switch 234 is depressed, thereby closing its contacts. When the forward switch 234 is closed the operating cycle will be started by energizing the relay coil 202a from the line 276 from the transformer secondary terminal 199, by way of the off-on switch 230, the normally closed reverse switch 235, the forward switch 234, the hand automatic switch 231, now set in its position 231a, the line 284 (Figure 8), the normally open limit switch 221 (which is closed in the retracted position of the main plunger 17), the normally closed relay switch blades 210d and 211d and the size selector switch blade 232, now set in its "large-size" position 232a. The normally closed switch blade 210d indicates that the die occupies its inner position, and the normally closed switch blade 211d indicates that the mold is in its lowered position.

When the relay coil 202a is energized, its normally open switch blade 202c bridges the circuit around the forward push-button switch 234 so that the relay coil 202 remains energized, even after the forward push-button switch 234 is released. The energization of the relay coil 202a

closes its normally open switch blades 202b and 202d, thereby applying power current to the winding 241 of the solenoid 96. The operation of this solenoid moves the crank arm 98 and permits the molding material, such as salt, to flow into the mold 22. At the same time the energization of the relay coil 202a opens the normally closed switch blade 202e and deenergizes the time relay coil 212a by breaking the circuit between the lines 277 and 278.

The deenergization of the time relay 212 opens its normally closed switch blade 212b. After the lapse of a definite time interval, such as eight seconds, the time relay switch blade 212b again closes, thereby energizing the relay coil 206a. This lapse of time permits the filling of the mold in adequate time. The energization of the relay coil 206a closes its normally open switch blades 206b and 206d, thereby energizing the solenoid winding 243 of the solenoid 49 by closing the circuit between the lines 189 and 190. This action shifts the pump control mechanism through the previously described linkage, and causes the pump 61 to discharge pressure fluid into the line 121 leading to the main cylinder 15.

Meanwhile, the low pressure pump 126 has also been discharging pressure fluid through the line 141, the pilot-operated unloading valve 138, the check valve 143 and the line 142 into the main cylinder 15. The main plunger 17 starts downward, thereby opening the surge valve 130 and drawing in additional fluid from the surge tank 16 (Figure 7). The pressure fluid for shifting the pump control mechanism in response to the action of the solenoid 49 has meanwhile been supplied from the pilot pump 120, through the line 168 and the relief valve 169. The slippage pump 119 has meanwhile been operating to withdraw slippage fluid from the various cylinders.

As soon as the main plunger 17 starts downward the limit switch 221 opens and deenergizes the relay coil 202a, thereby closing the normally closed switch blade 202e and energizing the time relay coil 212a. The normally closed time relay switch blade 212b then opens, but this does not deenergize the relay coil 206a because this coil is now held in an energized condition through a holding circuit, by way of the normally closed switch blade 210e, the now closed normally open switch blade 206c and the normally closed switch blade 217a of the pressure switch 217. As the main plunger 17 moves downward the normally open switch 223 closes and energizes the relay coil 207a through the normally open but now closed switch blade 206e. The coil 207a remains energized by a holding circuit bridging the limit switch 223 and the switch blade 206e by way of the normally open but now closed switch blade 207d. The energization of the relay coil 207a closes its normally open switch blades 207b, and energizes the solenoid winding 244 of the solenoid 87 which operates a mechanical short stop to limit the travel on the return stroke of the main plunger 17 to a shortened stroke prior to its ejection stroke.

Meanwhile, the main plunger 17 continues on its downward or forward stroke until it reaches the end of its molding stroke and compresses the molded material within the mold. At this point pressure is built up within the main cylinder 15, and eventually operates the low pressure switch 216, closing its normally open switch blade 216a. This action energizes the relay coil 208a, the energization being held through a holding circuit

by way of the normally open but now closed switch blade 208d and the normally closed switch blade 211e. The energization of the relay coil 208a closes its normally open switch blades 208b and 208c, thereby energizing the winding 245 of the solenoid 84. This shifts the valve 72, thereby admitting pressure fluid from the line 147 to the line 151 (Figure 5) for urging the mold-raising plungers 38 in an upward direction. The mold 22, however, does not travel upward immediately, due to the high pressure which is being exerted in the opposite direction by the main plunger 17 and molding plunger 19.

As the molding operation continues, the pressure accumulates within the main cylinder 15 to the point where it exceeds the high pressure setting of the high pressure switch 217, thereby opening the normally closed switch blade 217a. This action deenergizes the solenoid winding 243 and solenoid 49, thus shifting the control rod of the variable delivery pump 61 into its reverse position and causing pressure fluid to pass through the line 134 into the push-back cylinders 135, actuating the push-back plungers 136 to raise the platen 18 and the main plunger 17 to their retracted positions.

In the meantime, the low pressure pump 126 has been unloaded and its discharge directed through the line 145 and check valve 146, into the surge tank 16. This action occurs when the pressure within the main cylinder 15 passes through the line 144 to the operating cylinder of the unloading valve 138, and operates the valve to accomplish this action. When the push-back cylinders 135 are operated, pressure fluid also proceeds along the line 137 to the unloading valve 138, and continues to operate this valve to discharge the fluid of the low pressure pump 126 into the surge tank 16 by way of the line 145. As pressure has already been applied to the mold-raising cylinders 37, the mold 101 will also travel upward in the same direction as the main plunger 17. The latter is stopped when the platen arm 42 engages the end of the rod 41a of the mechanical short stop interposed by the operation of the solenoid 87 and lifts the press control rod 40 to shift the pump control rod 60 to its neutral position so as to place the pump 61 in a zero delivery condition, and thereby halt the main plunger 17 at an intermediate position upon its return stroke. At this instant the normally open limit switch 225 is closed when the mold reaches its raised position.

The closing of limit switch blade 225 energizes the relay coil 209a through the normally closed switch blade 210c. The consequent closing of the normally open switch blades 209b and 209c energizes the winding 246 of the solenoid 85, thereby shifting the valve 73 to cause pressure fluid to be applied through the line 183 to the die-shifting cylinder 33, thereby causing the plunger 34 to withdraw the die from under the mold. When the die has reached its outer limit of travel, the normally open limit switch 226 is closed, thereby again closing the circuit and again energizing the relay coil 206a and solenoid 49 to reverse the delivery of the pump 61, as described above. This action again starts the main plunger 17 on a downward stroke, this time an ejection stroke. As pressure is still being applied to the mold 101, thereby holding it in its raised position, the molding plunger 19 passes into the mold and forces the molded piece, such as a salt block, out of the mold. When the piece has been ejected from the mold it operates the

limit switch 227, the closing of which energizes the relay coil 210a through the normally closed limit switch 229. The relay coil 210a remains energized after the opening of the limit switch 227 by way of a holding circuit including the normally open but now closed relay switch blade 210b.

When the relay coil 210a is thus energized, it opens the normally closed switch blade 210e in series with the relay coil 206a, deenergizing the winding 243 of the solenoid 49 and reversing the delivery of the pump 61, thereby starting the main plunger 17 on another upward stroke, in the manner previously described. This same operation deenergizes the relay coil 207a, which consequently deenergizes the solenoid winding 244 of the solenoid 87 and removes the mechanical short stop by rotating the press control rod 40, thereby permitting the main plunger 17 to return to its starting point without being halted at an intermediate point. The energization of the relay coil 210a also opens the circuit to the relay coil 209a by opening the normally closed switch blade 210c, thereby opening the normally closed switch blades 209b and 209c. This action deenergizes the solenoid winding 246 of the solenoid 85 and causes the deenergized solenoid 85 to permit the valve 73 to shift to a position causing the plunger 34 to return the die to its normal position beneath the mold.

When the die has reached its normal or inner position, the normally open limit switch 228 closes, thereby energizing the relay coil 211a by way of the now closed switch blade 210b and the normally closed limit switch 229. The energization of the relay coil 211a opens the normally closed switch blade 211e in the circuit of the relay coil 208a, thereby opening the normally open switch blades 208b and 208c. This action deenergizes the winding 245 of the solenoid 84 and permits the shifting of the valve 72 into a position permitting the mold-raising plungers 38 to move downward, lowering the mold 22 into engagement with the die 28. When the mold reaches its lowered position, it opens the normally closed limit switch 229, thereby deenergizing the relay coils 210a and 211a, which again closes the normally closed switch blades 210d and 211d in series with the relay coil 202a. This action sets the control circuit in a condition for immediate starting when the operator again closes the forward switch 234 after the main plunger 17 has returned to its retracted position and has closed the limit switch 221.

To operate the press for making small blocks or small molded pieces, the single molding plunger 19 and mold 22 are removed and replaced by the multiple molding plungers 100 and multiple mold 101, together with the charger 103 and its operating plunger 111 and cylinder 110. The press arrangement shown in Figures 1 and 2 is thereby changed to the arrangement shown in Figures 3 and 4. The block size selector switch 232 is shifted from the "large block" position to the "small block" position opening upon 232a and closing upon 232b. The other selector switches 230 and 231 remain in the same positions, namely, in the "on" and "hand" positions, respectively. The operator now depresses the forward push-button switch 234, thereby energizing the coil 203a of the relay 203 through the contacts of the now closed limit switch 221 and the normally closed switch blades 210d and 211d of the relays 210 and 211, respectively. The closed positions of these switch blades indicate that the die is

in and that the mold is down, respectively. The energization of the relay coil 203a closes its normally open switch blade 203c, thereby creating a holding circuit around the forward push-button 234 so that the circuit remains energized after the push-button 234 is released.

With the charger 108 in its "out" position (Figure 4), the normally open limit switch 222 is closed. As soon as the relay 203 has been energized and its normally open switch blade 203c consequently closed in series with the limit switch 222, the relay coil 204a is energized therefrom by way of the normally closed switch blade 205e. This action closes the normally open switch blades 204b and 204d, thereby energizing the solenoid winding 242 of the solenoid 86. The latter, thus energized, shifts the valve 74, thereby supplying pressure fluid to the cylinders 110 to cause the plungers 111 to move the charger 108 inward. The energization of the relay 204 likewise closes its normally open switch blade 204c, thereby setting up a temporary holding circuit for the relay coil 204a around the limit switch 222, causing the coil 204a to remain energized after the opening of this limit switch 222.

When the charger 108 has traveled its full stroke inward, it engages the normally open limit switch 224, closing it and thereby energizing the relay coil 205a. The energization closes the normally open switch blade 205b, thereby setting up a holding circuit around the limit switch 224 so that the relay coil 205a remains energized after the opening of the limit switch 224. As soon as the relay coil 205a is energized it opens its normally closed switch blade 205e, connected in series with the relay coil 204a, thereby causing the normally open switch blades 204b and 204d to open and deenergize the solenoid winding 242 of the solenoid 86. This action permits the valve 74 to shift, causing the flow of fluid to the cylinders 110 to be reversed and thereby causing the plungers 111 to reverse the charger 108 and move it back to its starting position.

When the charger 108 returns to its starting position it again engages and closes the normally open limit switch 222, but the relay coil 204a now remains deenergized since the now energized relay coil 205a holds open its normally closed switch blade 205e in series therewith. The closing of the limit switch 222, however, energizes the relay coil 206a through the normally open but now closed switch blade 205c, and through the normally closed switch blade 204e. The closing of relay 206 closes its normally open switch blades 206b and 206d, thereby energizing the solenoid winding 243 of the solenoid 49. This action shifts the pump control of the main pump 61 to its forward position, thereby supplying pressure fluid through the line 121 to the main cylinder 15, and causing the main plunger 17 to start on its downward or molding stroke.

As soon as the main plunger 17 starts downward, it releases the limit switch 221 and permits its normally open contacts to open, thereby deenergizing the relay coil 203a. This deenergization now opens the normally open switch blade 203c in series with the relay coil 205a, thereby deenergizing the latter. The opening of the normally open switch blade 203c also deenergizes the relay coil 204a in series therewith, thereby opening the normally open switch blades 204b and 204d and deenergizing the solenoid winding 242 of the solenoid 86. This action deenergizes the charger-operating circuit controlled by the solenoid 86 and the valve 74 controlled thereby.

From this point of the operating cycle the balance of the cycle proceeds in the same manner and according to the same energizations and deenergizations as previously described in connection with the making of large blocks.

For completely automatic or full automatic operation, whereby the press continues to operate an indefinite number of cycles to produce an indefinite number of molded blocks without requiring the attention of the operator, the hand automatic selector switch 231 is set to its automatic position, thereby opening it upon 231a and closing it upon 231b. The other selector switches are set in the manner previously described, depending upon whether large blocks or small blocks are to be made.

When the forward push-button switch 234 is now depressed by the operator, the cycle of operations is started in the manner previously described in connection with the semi-automatic or hand operation. In addition to the energizations and deenergizations described in that connection, the operation of the forward push-button 234 now also energizes the relay coil 201a. This action closes the normally open switch blade 201d, thereby setting up a holding circuit around the forward push-button 234 and hand automatic selector switch 231. This circuit remains in its holding position until the press is completely halted by the operator by shifting the off-on selector switch 230 or by depressing the reverse switch 235. The cycle of operations and the consequent energizations and deenergizations repeat themselves in the manner previously described in connection with the hand or semi-automatic operation, except that the continuously closed switch blade 201d continuously maintains the holding or bridging circuit around the forward push-button 234 instead of maintaining it merely temporarily, as is the case with the holding circuits operated by the closing of the normally open switch blades 202c and 203c between the bridging lines 281 and 282. The normally open switch blades 202c and 203c in hand operation are opened at the end of each operating cycle by the deenergization of their relay coils 202a or 203a by reason of the subsequent energizations of the relay coils 210a and 211a and the consequent opening of their normally closed switch blades 210d and 211d in series with the relay coils 202a or 203a, according to the setting of the block size selector switch 232.

As a consequence, at the end of the operating cycle when the positions of the switch blade of the relay 206 indicate that the die is in its inward position, and the normally closed switch blades of relay 207 indicate that the mold is in its downward position, and the normally open limit switch 221 is closed, indicating that the main plunger 17 is in its upper position, the next work operating cycle will repeat itself automatically. This occurs through the normally open switch blades 201d and 201e, which remain closed continuously after the forward push-button 234 is once operated. The remainder of the operating circuit occurs as previously described under hand operation, with the exception of the fact that the press continues to perform an indefinite number of complete cycles, thereby producing an indefinite number of molded pieces until the operator shuts off the press entirely by opening the off-on switch 230 or the reverse switch 235.

It will be understood that we desire to comprehend within our invention such modifications

as come within the scope of the claims and the invention.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent, is:

1. In an electrical control system for a molding press having hydraulic ram means and a hollow mold with a movable closure, said ram means having connected thereto a pump with a fluid flow-controller movable into forward and return positions for selectively controlling delivery of fluid to respectively advance and retract said ram means, and movable into a neutral position to halt said ram means when said ram means reaches a predetermined position on its return stroke, the combination of a movable short stop engageable by said ram means and operatively connected to said pump flow-controller, electrically operative means for moving said short stop into operative position for actuation by said ram means to shift said flow-controller to its neutral position and halt said ram means at an intermediate point on its return stroke, and means including an electrical control circuit for controlling the shifting of said flow-controller to its forward and return positions, said control circuit including electrically operative means responsive to the completion of a forward molding stroke of said ram means for shifting said flow-controller to its return position to retract said ram means, electrically operative means for concomitantly moving said mold closure to its mold-opening position, electrically operative means responsive to the opening of said mold by said closure for shifting said flow-controller to its forward position to advance said ram means upon its forward ejection stroke, and electrically operative means responsive to the completion of said ejection stroke for shifting said flow-controller to its return position to retract said ram means.

2. In an electrical control system for a molding press having hydraulic ram means and a hollow mold with a movable closure, said ram means having connected thereto a pump with a fluid flow-controller movable into forward and return positions for selectively controlling delivery of fluid to respectively advance and retract said ram means, and movable into a neutral position to halt said ram means when said ram means reaches a predetermined position on its return stroke, the combination of a movable short stop engageable by said ram means and operatively connected to said pump flow-controller, electrically operative means for moving said short stop into operative position for actuation by said ram means to shift said flow-controller to its neutral position and halt said ram means at an intermediate point on its return stroke, and means including an electrical control circuit for controlling the shifting of said flow-controller to its forward and return positions, said control circuit including electrically operative means responsive to the completion of a forward molding stroke of said ram means for shifting said flow-controller to its return position to retract said ram means, electrically operative means for concomitantly moving said mold closure to its mold-opening position, electrically operative means responsive to the opening of said mold by said closure for shifting said flow-controller to its forward position to advance said ram means upon its forward ejection stroke, and electrically operative means responsive to the completion of said ejection stroke for shifting said flow-controller to its return position to retract said ram means,

said electrically operative short-stop-moving means being responsive to the travel of said ram means upon its forward stroke for placing said short stop in its operative position.

3. In an electrical control system for a molding press having hydraulic ram means and a hollow mold with a movable closure, said ram means having connected thereto a pump with a fluid flow-controller movable into forward and return positions for selectively controlling delivery of fluid to respectively advance and retract said ram means, and movable into a neutral position to halt said ram means when said ram means reaches a predetermined position on its return stroke, the combination of a movable short stop engageable by said ram means and operatively connected to said pump flow-controller, electrically operative means for moving said short stop into operative position for actuation by said ram means to shift said flow-controller to its neutral position and halt said ram means at an intermediate point on its return stroke, and means including an electrical control circuit for controlling the shifting of said flow-controller to its forward and return positions, said control circuit including electrically operative means responsive to the completion of a forward molding stroke of said ram means for shifting said flow-controller to its return position to retract said ram means, electrically operative means for concomitantly moving said mold closure to its mold-opening position, electrically operative means responsive to the opening of said mold by said closure for shifting said flow-controller to its forward position to advance said ram means upon its forward ejection stroke, electrically operative means responsive to the completion of said ejection stroke for shifting said flow-controller to its return position to retract said ram means, said electrically operative short-stop-moving means being responsive to the travel of said ram means upon its forward stroke for placing said short stop in its operative position, and electrically operative means responsive to the travel of said ram means to a predetermined position on its return stroke for shifting said flow-controller to its forward position whereby to automatically repeat an indeterminate number of operating cycles of said press system.

4. In an electrical control system for a molding press having hydraulic ram means and a hollow mold with a movable closure, said ram means having connected thereto a pump with a fluid flow-controller movable into forward and return positions for selectively controlling delivery of fluid to respectively advance and retract said ram means, and movable into a neutral position to halt said ram means when said ram means reaches a predetermined position on its return stroke, the combination of a movable short stop engageable by said ram means and operatively connected to said pump flow-controller, electrically operative means for moving said short stop into operative position for actuation of said ram means to shift said flow-controller to its neutral position and halt said ram means at an intermediate point on its return stroke, and means including an electrical control circuit for controlling the shifting of said flow-controller to its forward and return positions, said control circuit including electrically operative means responsive to the completion of a forward molding stroke of said ram means for shifting said flow-controller to its return position to retract

said ram means, electrically operative means for concomitantly moving said mold closure to its mold-opening position, electrically operative means responsive to the opening of said mold by said closure for shifting said flow-controller to its forward position to advance said ram means upon its forward ejection stroke, electrically operative means responsive to the completion of said ejection stroke for shifting said flow-controller to its return position to retract said ram means, and electrically operative means responsive to the travel of said ram means to a predetermined position on its return stroke for shifting said flow-controller to its forward position whereby to automatically repeat an indeterminate number of operating cycles of said press system.

5. In an electrical control system for a molding press having hydraulic ram means and a hollow mold with a movable closure, said ram means having connected thereto a pump with a fluid flow-controller movable into forward and return positions for selectively controlling delivery of fluid to respectively advance and retract said ram means, and movable into a neutral position to halt said ram means when said ram means reaches a predetermined position on its return stroke, the combination of a movable short stop engagable by said ram means and operatively connected to said pumpflow-controller, electrically operative means for moving said short stop into operative position for engagement by said ram means to shift said flow-con-

troller to its neutral position and halt said ram means at an intermediate point on its return stroke, and means including an electrical control circuit for controlling the shifting of said flow-controller to its forward and return positions, said control circuit including electrically operative means responsive to the completion of a forward molding stroke of said ram means for shifting said flow-controller to its return position to retract said ram means, electrically operative means for concomitantly moving said mold closure to its mold-opening position, electrically operative means responsive to the opening of said mold by said closure for shifting said flow-controller to its forward position to advance said ram means upon its forward ejection stroke, electrically operative means responsive to the completion of said ejection stroke for shifting said flow-controller to its return position to retract said ram means, said electrically operative short-stop-moving means being responsive to the travel of said ram means upon its forward stroke for placing said short stop in its operative position, and electrically operative means responsive to the travel of said ram means to a predetermined position on its return stroke for shifting said flow-controller to its forward position whereby to automatically repeat an indeterminate number of operating cycles of said press system.

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