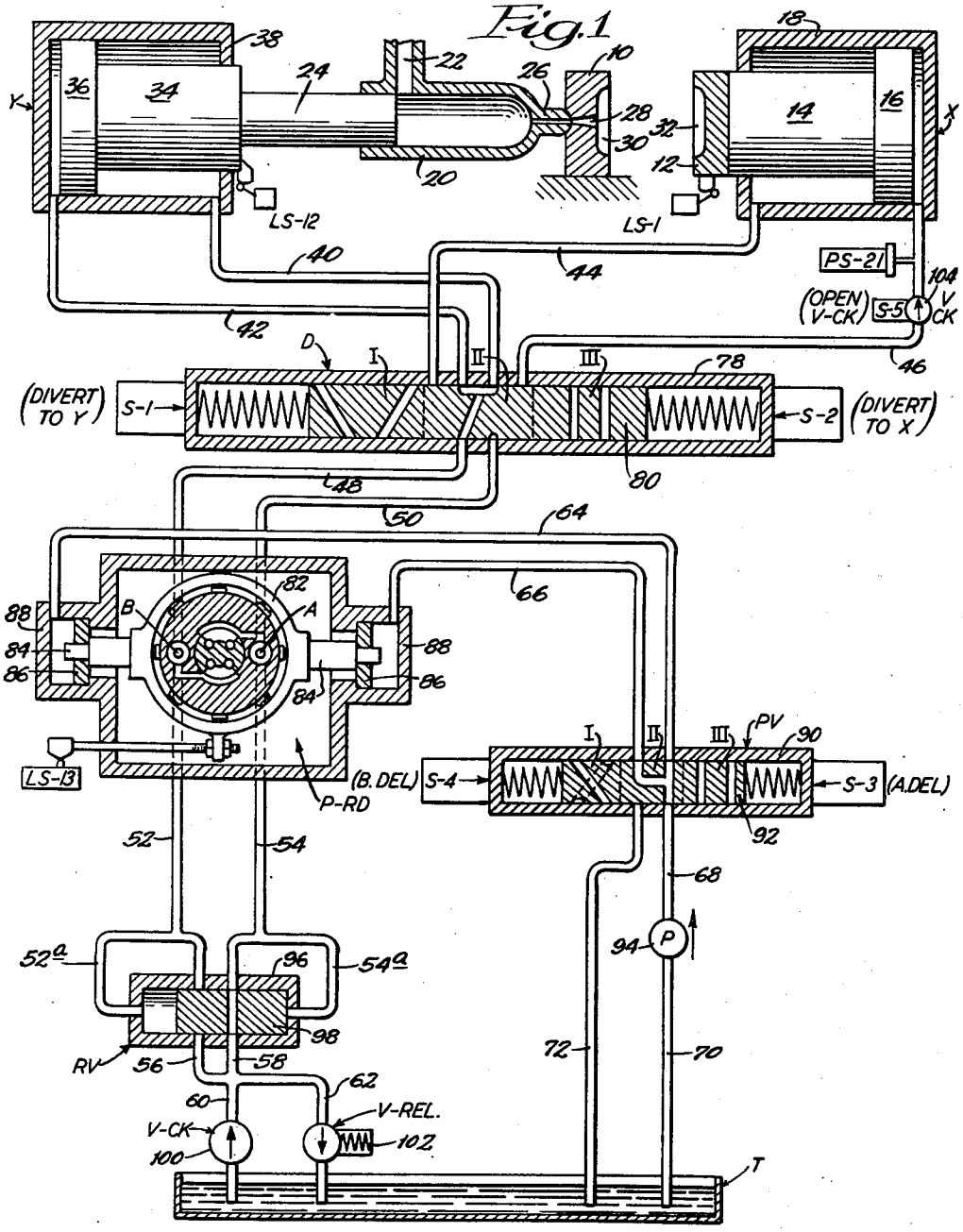
Sept. 3, 1957 R. M. NORMAN ET AL 2,804,752

MOLDING MACHINE

Filed March 5, 1956 3 Sheets-Sheet 1

Fig. 1



INVENTORS:
Richard M. Norman and
BY Russell W. Powell,
Bair, Freeman & Molinare

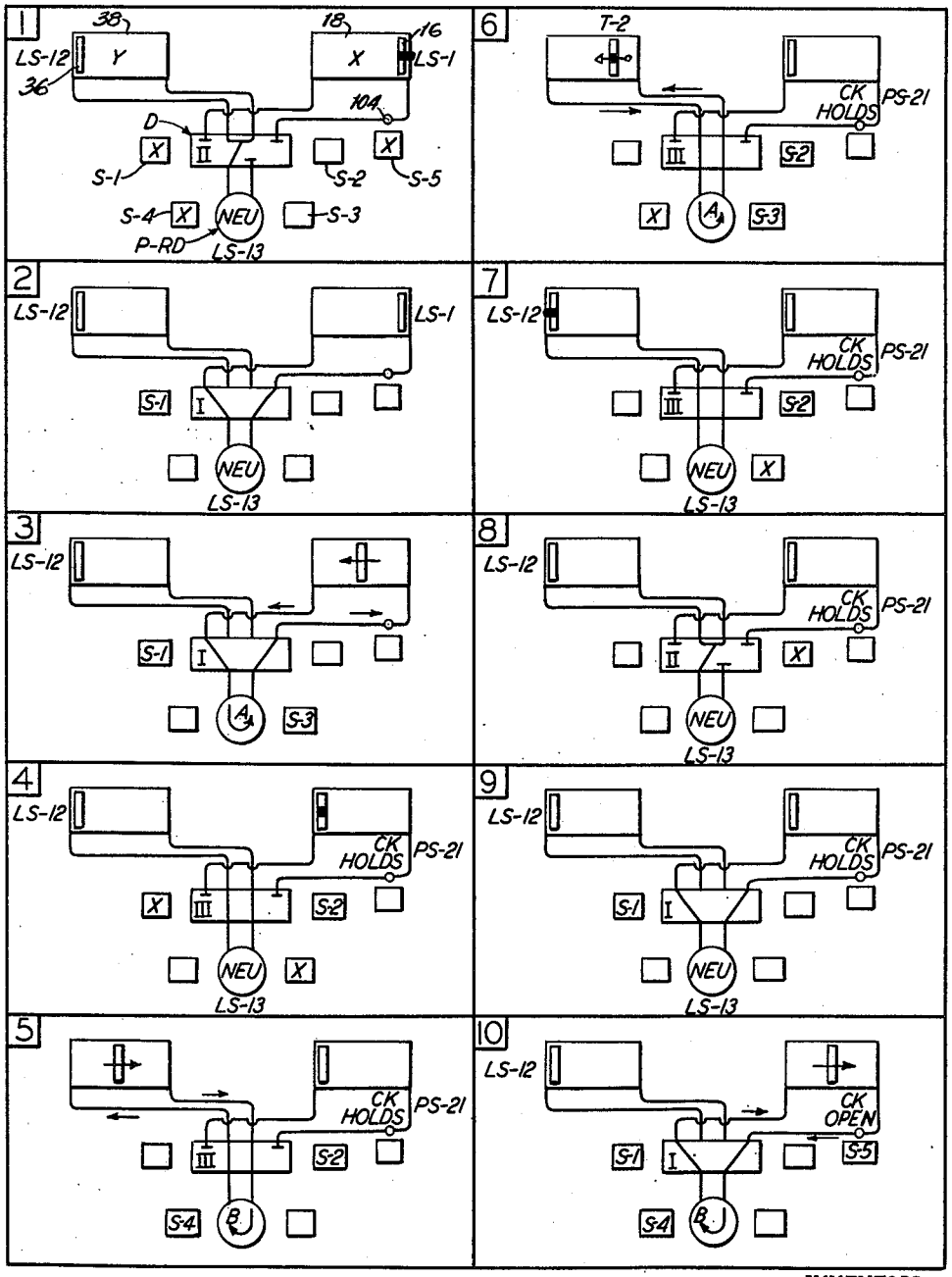
ATTORNEYS.

Sept. 3, 1957 R. M. NORMAN ET AL 2,804,752

MOLDING MACHINE

Filed March 5, 1956 3 Sheets-Sheet 2

Fig. 2



INVENTORS:
Richard M. Norman and
BY Russell W. Powell,
Bair, Freeman & Molinare

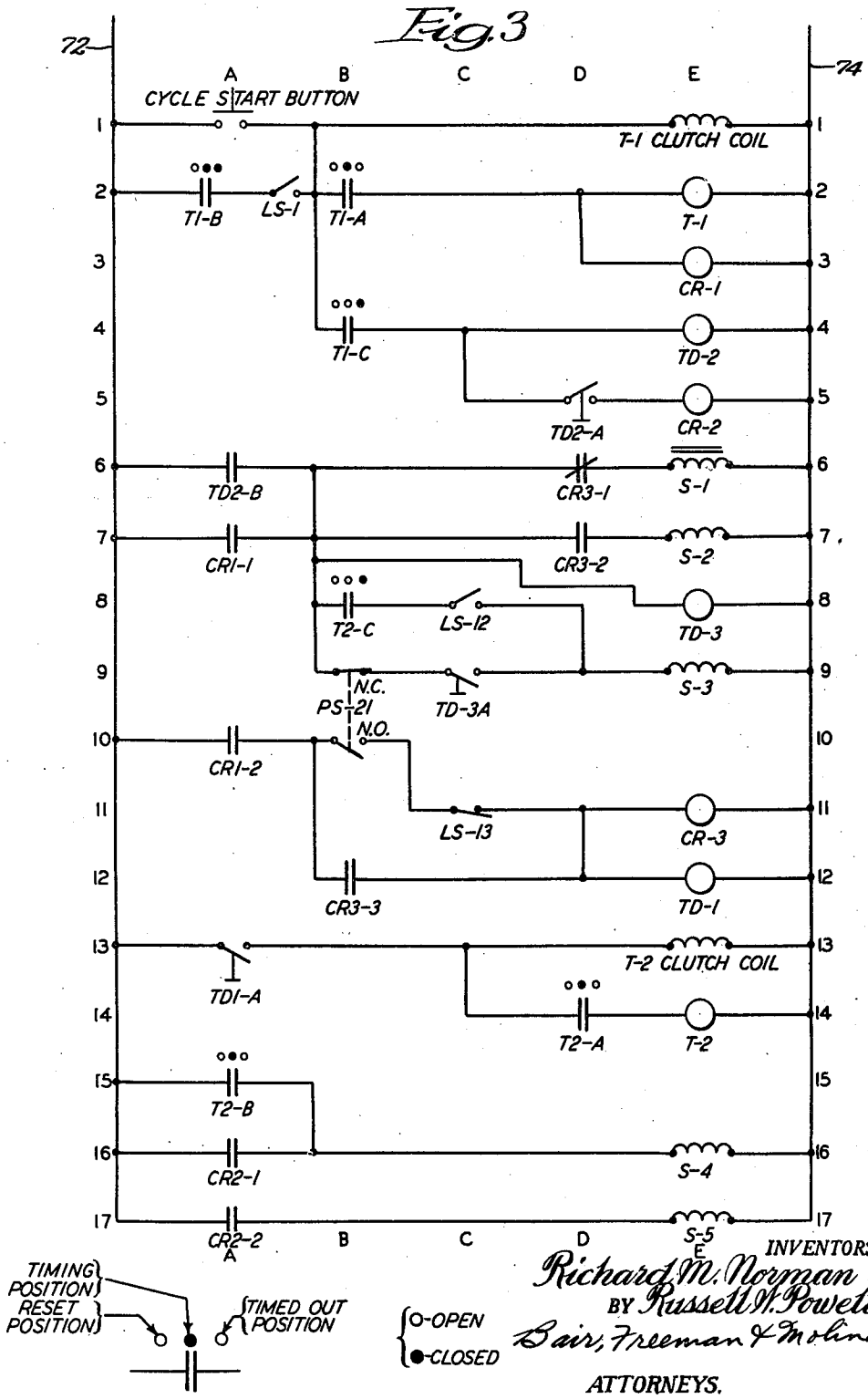
ATTORNEYS.

Sept. 3, 1957 R. M. NORMAN ET AL 2,804,752

MOLDING MACHINE

Filed March 5, 1956 3 Sheets-Sheet 3

Fig. 3



INVENTORS:
Richard M. Norman and
BY Russell W. Powell,
Bair, Freeman & Molinare
ATTORNEYS.

United States Patent Office 2,804,752 Patented Sept. 3, 1957

2,804,752

MOLDING MACHINE

Richard M. Norman and Russell W. Powell, Richmond, Ind., assignors to National Automatic Tool Co., Inc., Richmond, Ind., a corporation of Indiana

Application March 5, 1956, Serial No. 569,474

10 Claims. (Cl. 60—97)

This invention relates to a molding machine and more particularly to a hydraulic circuit therefor.

One object of the invention is to provide a comparatively simple hydraulic circuit which makes possible the use of a single, reversible delivery pump for actuating both a mold closing hydraulic motor and a plastic material injection hydraulic motor of the molding machine at different times, a hydraulic diverter being included in the circuit between the pump and the two motors and the hydraulic circuit, together with an electric controlling circuit therefor, being designed so as to shift the diverter only when the pump is in the neutral position to thereby prevent excessive hydraulic shock which may cause pipe breakage and valve malfunctioning in addition to other harmful effects.

Another object is to provide a diverter which may be shifted from a central position to one port delivery position controlling the flow of hydraulic fluid to and from the mold closing hydraulic motor or another port delivery position controlling flow of the hydraulic fluid to and from the injection hydraulic motor, the pump for supplying the hydraulic fluid having a neutral position in which there is no fluid flow and an electric circuit responding to the neutral position to insure movement from such position to pumping position only after the diverter has been shifted to said one position or said another position thereof.

Still another object is to provide a timing circuit for our molding machine which, upon response to manual depression of a cycle start button, will initiate the operation of a timer and its clutch coil to establish circuits for first shifting the diverter to position for forward motion of the mold closing hydraulic motor and then shift the pump from neutral position to delivery in one direction for movement of the mold closing ram forwardly followed by movement of the injection ram forwardly after the mold is closed for filling the mold with the molding material, after which the injection ram is retracted while the diverter is in the same position and then the pump goes to neutral at the end of the retraction followed by shifting of the diverter again for return of the mold closing ram and reversion of the hydraulic and electric circuits to the initial position for a subsequent operation when the cycle start button is again depressed.

A further object is to provide interlocking circuits between solenoids for operating the diverter and shifting the pump through its neutral position to one or the other of its port delivery positions, one of which is reversed relative to the other, and for controlling a check valve that holds the hydraulic pressure in the mold closing hydraulic motor when the diverted is shifted to position for operation of the injection hydraulic motor both forward and return before the mold closing hydraulic motor is retracted for opening the mold.

Still a further object is to provide a pressure switch responsive to the build-up of pressure in the mold closing motor when the mold is closed, and circuits controlled

thereby for then operating the injection hydraulic motor with reversion to operation of the mold closing hydraulic motor for opening the mold, and the energization of a solenoid to open the check valve at that time to permit the proper hydraulic circuit for the opening action.

With these and other objects in view, our invention consists in the construction, arrangement and combination of the various parts of our molding machine, whereby the objects above contemplated are attained, as hereinafter more fully set forth, pointed out in our claims and illustrated in detail on the accompanying drawings, wherein:

Fig. 1 is a semi-diagrammatic view of a molding machine embodying our present invention and shows particularly the hydraulic circuit, control switches and solenoids energized thereby for actuating hydraulic elements of the machine.

Fig. 2 is a diagram in 10 sections showing successive positions of the main parts of the molding machine and its control apparatus during a complete cycle of operation; and

Fig. 3 is a diagram of a typical electrical circuit for our molding machine and its control apparatus.

On the accompanying drawings, referring first to Fig. 1, the molding machine and its hydraulic apparatus includes in general a pair of hydraulic motors indicated at X and Y, a diverter D and a pump P–RD of the reversible delivery type. A pump valve PV controls the direction of flow as between the ports A and B of the pump P–RD and a reversing valve RV and associated apparatus insure proper makeup and discharge of surplus hydraulic fluid during the operation of the pump P–RD.

Referring now to the parts in greater detail, a stationary mold half **10** is shown for molding plastic material or the like and a cooperating movable mold half **12** is shown as supported by a ram of the hydraulic motor X. The motor X further includes a piston **16** in a cylinder **18**.

The hydraulic motor Y is for operating a feed plunger **24** in a feed cylinder **20** to which plastic material is introduced through a chute **22**. The material is melted in the usual way and discharged through a nozzle **26** and sprue opening **28** into the mold cavity **30—32** of the mold halves **10** and **12** when they are in closed position. The feed plunger **24** is carried by a ram **34** of the motor Y and this motor further includes a piston **36** in a cylinder **38**.

Limit switches LS–1 and LS–12 are provided in conjunction with the motors X and Y respectively and these switches are normally closed, being held open by the rams **14** and **34** when they are in the retracted positions shown in Fig. 1.

The diverter D is similar to a slide valve and controls hydraulic circuits in a manner similar to a slide valve but in accordance with our invention is never shifted while hydraulic fluid under pressure is flowing through it and for this reason we prefer to term it a "diverter" rather than a "valve." In general, it consists of a cylinder **78** with a diverter plunger **80** slidable therein and normally centered as shown in Fig. 1. It will be noted that the diverter plunger **80** is divided into three sections. Dotted lines indicate the divisions, and the sections are indicated as I, II and III. The centered position above referred to is II. Solenoids S–1 and S–2 are indicated for sliding the diverter plunger **80** toward the right to position I or toward the left to position III respectively. This may be done directly or through intermediate hydraulic instrumentalities as usual in the molding machine art.

Throughout Fig. 1 even reference numerals **40** to **72** inclusive refer to hydraulic conduits which will be referred

to hereinafter. Since their connections to the various elements of the apparatus are obvious, they will not be described in detail.

PS–21 is a pressure switch connected for response to pressure in the conduit 46 and is normally in one position, operating to the other position when high pressure is present in the conduit 46 as a result of the ram 14 closing the mold 10—12 and attaining a predetermined mold holding pressure at which the switch PS–21 is set. Also in the conduit 46 is a check valve 104 normally permitting flow in one direction and preventing it in the other as indicated by the arrow thereon, but capable of being opened for flow in said other direction by energization of a solenoid S–5 thereof.

The pump P–RD may be of any suitable reversible delivery type and is illustrated as having a cage 82 normally in centered position under the action of hydraulic plungers 84 and pistons 86 in cylinders 88. The cylinders 88 are connected by the pipes 64 and 66 with the pump valve PV as shown which, similar to the diverter D, has a cylinder 90 and a pump valve plunger 92 slideable therein. The plunger 92 is likewise divided into three sections, I, II and III, and solenoids S–3 (for delivery from port A of the pump P–RD) and S–4 (for delivery from port B of the pump P–RD) are provided for sliding it to the III and I positions respectively, the valve being normally centered at II. The valve PV has a pilot pressure supply pipe 68 and a return pipe 72. A pilot pressure pump 94 receives hydraulic fluid through a conduit 70 from a reservoir or tank T and supplies it to the conduit 68.

A limit switch LS–13 is associated with the pump P–RD and is normally open, being closed by positioning of the cage 82 at the central of neutral position as illustrated in Fig. 1.

The reversing valve RV has a hydraulic cylinder 96 with a reversing valve plunger 98 slidable therein. Conduit connections 52 and 54 from the pump ports B and A respectively are arranged opposite conduits 56 and 58 leading by means of conduits 60 and 62 to a check valve 100 and a relief valve 102. The valve 100 has a connection to the reservoir T for receiving hydraulic fluid whereas the valve 102 has a connection thereto for discharging hydraulic fluid as indicated by arrows on these valves. The conduits 52*a* and 54*a* connected with the conduits 52 and 54 and with the ends of the hydraulic cylinder 96 shift the reversing valve plunger 98 to the position shown when delivery from the pump P–RD is from the port B, and to the opposite position (toward the left) when delivery is from port A.

Referring next to Fig. 2, there are ten sections numbered 1 to 10 showing the positions of various parts of the molding machine and its control apparatus during a complete cycle of operation. Section (hereinafter referred to as "sec.") 1 contains the reference numerals and reference characters of the significant parts illustrated throughout Fig. 2 but these numerals have been omitted from secs. 2 to 10 for clarity. Only that section I, II or III of the diverter D in operation at the time is illustrated in secs. 1 to 10.

Returning to Sec. 1 of Fig. 2, the plunger of the diverter D is in position II and the pump is in neutral (NEU) position, these being the positions for the start of a cycle. Solenoids S–1, S–4 and S–5 have been de-energized to return the parts from the position of sec. 10 to that of sec. 1 as indicated by "*x*" in the box for each. Also, limit switch LS–1 has been opened and limit switch LS–13 has been closed due to the return of the piston 16 in hydraulic motor X from the sec. 10 position to the sec. 1 position, and due to the pump P–RD having returned to neutral by de-energization of the solenoid S–4 respectively.

Throughout secs. 2 to 10, the positions of the pistons 16 and 36 at all times are indicated together with the direction of motion thereof in secs. 3, 5, 6 and 10 by means of arrows. Hydraulic fluid flow is also indicated by arrows and whether from port A or port B of the pump P–RD. Piston 16 is stopped in sec. 4, piston 36 is stopped and reversed in sec. 6 due to expiration of a timing period and is stopped in sec. 7 where it operates limit switch LS–12.

The position I of the diverter D in sec. 2 of Fig. 2 compared to sec. 1 (position II) remains through sec. 3, changes to III in sec. 4 (which remains through secs. 5, 6 and 7), changes to II in sec. 8, and changes to I in sec. 9 where it remains through sec. 10. Each solenoid box in secs. 2 to 10 is indicated by reference character when the solenoid is energized, and also when it remains energized such as S–1 energized in sec. 2, remains energized in sec. 3. The diverter D maintaining its position in succeeding sections is similarly indicated and likewise the pump flow or "NEU" position as the case may be while "*x*" indicates when a solenoid is de-energized in a given section such as S–3 de-energized in sec. 4. The pressure switch PS–21 is operated in sec. 4 and remains operated in secs. 5 to 9 inclusive. The limit switch LS–13 is closed in sec. 1, is again closed in sec. 4, and again in sec. 7 whereupon it remains closed in secs. 2, 8 and 9. The limit switch LS–1 is opened in sec. 1 and remains open in sec. 2.

Referring to Fig. 3, some of the already described elements are shown in the electrical circuit and the remaining ones will now be described. Fig. 3 is a typical timing operation circuit for the molding machine and its control apparatus as shown in Figs. 1 and 2. Current supply wires 72 and 74 are provided and the various timer motors, relays, contacts, etc. are connected in circuits across these wires and arranged at positions which may be identified by horizontal columns 1 to 17 and vertical columns A to E. The identification will be referred to in parentheses such as the "cycle start button" (so labeled) at (1A).

While the hydraulic motors X and Y may be used for various purposes, we have illustrated them in Fig. 1 in connection with a molding machine for plastic material but it is not our purpose to have our claims limited to a molding machine.

In Fig. 3, a timing motor T–1 (2E) operates a relay through a clutch, closed by operation of a T–1 clutch coil (1E) and thereby closes three sets of contacts of the relay indicated at T1–B (2A), T1–A (2B) and T1–C (4B). As indicated by three small circles above each set of contacts and the code at the lower left corner of Fig. 3, the T1–B contact is open in the reset position, closed in the timing position and closed in the timed out position, whereas the contact T1–A is open in the reset position, closed in the timing position and open in the timed out position, and the contact T1–C is open in the reset position, open in the timing position and closed in the timed out position. The limit switch LS–1 (opened when X retracted) is interposed in the circuit between the contact T1–B and the three elements T–1 clutch coil, T1–A and T1–C. The timer motor T–1 and its T–1 clutch coil together may be considered an "X-closed timer" as they time the closing of the mold half 12 against the mold half 10 by movement of the piston 16 as indicated in Fig. 2, sec. 3.

An X-closed relay, CR–1 (3E) shunts the timer motor T–1, and when energized closes contacts CR1–1 (7A) and CR1–2 (10A).

The timer contact T1–C controls energization of a time delay relay TD–2 (4E) which closes normally open contacts TD2–A (5D) after a time delay and instantaneously closes normally open contact TD2–B (6A). The contact TD2–A when closed energizes an X-open relay CR–2 (5E) which closes normally open contacts CR2–1 (16A) and CR2–2 (17A).

Closure of the contact TD2–B energizes solenoid S–1 which positions the diverter D at I (Fig. 2, sec. 2) for diverting hydraulic fluid flow from port A of the pump P–RD to the motor X (Fig. 2, sec. 3). The energization is accomplished through normally closed relay contact CR3–1 (6D).

Solenoid S–2 (7E) when energized will shift the diverter D to position III (Fig. 2, sec. 4) and is energized by closure of relay contact CR3–2 (7D) after closure of CR1–1. The contacts CR3–1 and CR3–2 are opened and closed respectively by energization of a divert-to-Y relay CR–3 (11E) which also closes normally open contact CR3–3 (12B).

Solenoid S–3 (9E) for pump delivery at port A is energized by closure of the contact CR1–1 through normally closed contact N. C. (9B) of the pressure switch PS–21, which switch also includes normally open contact N. O. (10B).

The contact N. C. of PS–21 is shunted by timer contact T2–C (8B) and the limit switch LS–12 (8C), and is in series with contact TD–3A (9C) of a time delay relay TD–3 (8E).

The normally open contact N. O. of PS–21 is in circuit with the limit switch LS–13 (11C) and the relay CR–3, the relay contact CR3–3 shunts N. O. and LS–13 for controlling CR–3 and a time delay relay TD–1 (12E). This relay closes contact TD1–A (13A) after a time delay which contact controls the T–2 clutch coil (13E) and a timer motor T–2 (14E) which coil and motor are for Y-forward timing. The contact T2–C, and contacts T2–A (14D) and T2–B (15A) are all closed by energization of T–2 and the T–2 clutch coil.

The solenoid S–4 (16E) for pump delivery at port B is energized by closure of the contact T2–B which is shunted by the contact CR2–1. Finally, the solenoid S–5 (17E) for opening the check valve 104 is energized by closure of the contact CR2–2.

Having described our molding machine and its control apparatus together with the hydraulic and electrical circuits therefor, we will now describe a cycle of operation. The pumps P–RD and 94 are running and the various switches and contacts are in the positions illustrated in Fig. 3 at the beginning of the cycle, the parts of the molding machine and its control apparatus being in the idle position illustrated in Fig. 1 and in Fig. 2 (sec. 1).

When the cycle start button is depressed, the T–1 clutch coil is energized for placing all three T1 contacts in the timing position. T1–B and T1–A are closed in this position for energizing the timer motor T–1 and the X-closed relay CR–1. Energization of CR–1 closes CR1–1 to establish a circuit from (7) on the wire 72 through CR3–1, which is closed because CR–3 is de-energized and hence CR3–1 contacts which are normally closed remain closed, and the divert-to-X solenoid S–1 is energized as in Fig. 2, sec. 2. This shifts the diverter from position II to sec. 1 to position I in sec. 2. It will be noted that the pump P–RD is still in neutral position so that shift is accomplished at a time when there is substantially no pressure in the hydraulic circuit.

In this connection, it is to be pointed out that the pump P–RD, being of the reversible delivery type can be shifted from full delivery from port B for instance to full delivery from port A, and during the shift passes through a neutral position. The pump pressure is maintained almost until the neutral position is reached, then abruptly diminishes to substantially zero and quickly rises again with substantially equal high pressure at all positions of shift except in neutral zone. Thus, by arranging the control circuits, both electric and hydraulic, so that shift of the diverter occurs only while the pump is at neutral, one of the major problems of high pressure hydraulic control (where pressures are on the order of 2,000 p. s. i. to 10,000 p. s. i. and fluid delivery at 50 G. P. M. utilizing 50 or more horsepower) is readily solved. Valves that control high pressures while the pressures are in effect must be very nicely balanced and even so the passage of ports past each other results in excessive hydraulic shock which may cause pipe breakage and valve malfunctioning in addition to other harmful effects. On the other hand, by providing a diverter as we do which operates to connect various passages in a desired manner only at the time there is substantially no pressure in the hydraulic system, the shortcomings mentioned are overcome. The parts are now in the position for operation of the pump.

At the time S–1 is energized, TD–3 shunting S–1 is also energized, and S–3 (Fig. 2, sec. 3) is energized through the N. C. contact of PS–21 when TD3–A closes at the end of the time delay set on TD–3. The circuit then continues as before. Referring to Fig. 1, the energization of S–3 must first move the pump valve plunger 92 to its lefthand position for operation of section III thereof and oil must be supplied by the pilot pump 94 through the connection 64 to the lefthand cylinder 88 of the pump to act on the plunger 84 thereof while at the same time hydraulic fluid is discharged from the right-hand cylinder 88 ahead of the piston 86 through 66 and 72 back to the reservoir T. This operation usually gives the necessary delay to permit shifting of the diverter D to the III position before the pump can be shifted out of neutral position. The time delay relay TD–3, however, provides positive assurance that the pump P–RD will not start delivering until after the diverter D has been moved to the correct operating position.

Hydraulic fluid is now being pumped and the piston 16 of the hydraulic motor X is advancing as indicated by the arrow to close the mold half 12 against the mold half 10. Since more hydraulic fluid is required behind the piston 16 than is displaced from in front thereof, the check valve 100 will permit flow from the reservoir T to the pump port A to supplement that being received from the port B. The "cycle start button" must be held depressed until the limit switch LS–1 is released by operation of the motor Y away from its initial position, thereby permitting the switch to close to interlock the circuit.

Mold closing has been completed in Fig. 2, sec. 4 and the pressure behind piston 16 will be built up to whatever value the switch PS–21 is set which will open the normally closed (N. C.) contact and close the normally open (N. O.) contact thereof. The pressure in the conduit 46 and behind the piston 16 is now held by the check valve 104 indicated "Ck. Holds" and the diverter D may now be shifted again when the pump goes to neutral. Opening of the N. C. contact of PS–21 de-energizes the solenoid S–3 (indicated *x* in Fig. 2, Sec. 4) and the pump returns to neutral which operates the limit switch LS–13 as indicated for de-energizing the solenoid S–1 and energizing the solenoid S–2 as explained below. Through the contacts of CR1–2, PS–21 (N. O.) and LS–13 which are now all closed, relay CR–3 and time delay relay TD–1 are energized. The CR3–3 contact interlocks both these relays around PS–21 (N. O.) and LS–13. When relay CR–3 is energized, solenoid S–1 (divert to X) is de-energized and solenoid S–2 (divert to Y) is energized through the action of contacts CR3–1 and CR3–2. The diverter then shifts to position III preparatory for the Y-forward phase of the operation. Since LS–13 must be closed to effect the diverter shift, we insure such shift only when the pump is in the neutral position.

When the time set on TD–1 has expired, contact TD1–A closes, energizing timer T–2 (Y-forward). The T–2 clutch coil places the T2 contacts in the timing position and the timing motor T–2 starts running. The T2–B contact energizes solenoid S–4 (pump delivery at port B, Fig. 2, sec. 5). The pump starts delivering oil to the motor Y and its piston 36 moves forwardly as shown.

When the time set on T–2 has elapsed, the timer shifts to the timed out position. The T2–B contact opens de-energizing solenoid S–4, and the T2–C contact closes energizing solenoid S–3. This shifts the pump through neutral (while the diverter remains in position III) to the A port delivery position and the forward motion of the Y ram stops (Fig. 2, sec. 6), the total travel thereof having been determined by the timing of the timer motor T–2.

When the piston 36 retracts to the position of Fig. 2, sec. 7, the limit switch LS–12 is opened, the solenoid S–3 being thereby de-energized and the pump P–RD going to neutral.

When the time set on the timer T–1 has elapsed, the contacts of T–1 all go to the timed out position. Through the action of T1–A the timer motor T–1 stops and relay CR–1 is de-energized. When CR1–2 opens, relays CR–3 and TD–1 are de-energized. Therefore, CR3–1 closes and CR3–2 opens, de-energizing solenoid S–2 to shift the diverter from position III to position II as in Fig. 2, sec. 8 while the pump is in neutral. CR1–1 also opens at this time to be ready for the next cycle.

Through the action of T1–C time delay relay TD–2 is energized. The TD2–B contact closes, energizing solenoid S–1 (Fig. 2, sec. 9) causing again a divert-to-X hydraulic circuit arrangement by the diverter shifting from II to I preparatory to opening the mold. When the delay set on TD–2 is up, the TD2–A contact closes, energizing the X-open relay CR–2.

Contacts CR2–1 and CR2–2 close, energizing solenoids S–4 (pump delivery at port B) and S–5 (check valve 104 opens). The parts are then in the position of Fig. 2, sec. 10. Hydraulic fluid then flows as indicated by the arrows to return the piston 16 to the initial position of Fig. 1 and the flow of hydraulic fluid to the pullback side of the hydraulic motor X with the check valve 104 open causes retraction of the piston 16. Since less hydraulic fluid is required behind the piston 16 on its retraction stroke than is displaced from in front of it, the surplus returns through 58, 62 and the relief valve 102 to the reservoir T.

As the piston completes its retraction stroke, limit switch LS–1 is opened as in Fig. 2, sec. 1. This de-energizes the T–1 clutch coil, relay TD–2 and relay CR–2. The timer T–1 goes to the reset position and all energized solenoids (S–1, S–4 and S–5) are de-energized, the machine cycle having been completed. The completion of the cycle results in the pump going to neutral because of de-energization of S–4, the diverter shifting from I to II due to de-energization of the solenoid S–1 and the check valve 104 reverting to its normal function by de-energization of S–5. The cycle may then be repeated by again depressing the "cycle start button."

Some changes may be made in the construction and arrangement of the parts of our molding machine without departing from the real spirit and purpose of our invention, and it is our intention to cover by our claims any modified forms of structure or use of mechanical equivalents which may reasonably be included within their scope.

We claim as our invention:

1. A machine of the character disclosed comprising a pair of hydraulic motors, a diverter, a pump having a pair of ports for delivery in opposite flow directions, said pump being reversible to select the direction of flow, hydraulic connections from said ports to said diverter and from said diverter to each of said motors, said diverter in one position thereof diverting hydraulic fluid to and from one of said motors and in another position thereof diverting hydraulic fluid to and from the other of said hydraulic motors, and means for shifting said diverter between said one position and said another position only when said pump is in an intermediate position between delivery from one of said ports and delivery from the other of said ports.

2. In a molding machine having a mold closing hydraulic motor and an injection hydraulic motor, a diverter, a reversible delivery pump having a pair of opposed ports, hydraulic connections from said ports to said diverter and from said diverter to each of said motors, said diverter in one position thereof diverting hydraulic fluid to and from said mold closing hydraulic motor and in another position thereof diverting hydraulic fluid to and from said injection hydraulic motor, and means for shifting said diverter from said one position to said another position or vice versa only when said pump is in a neutral position.

3. In a molding machine having a mold closing hydraulic motor and an injection hydraulic motor, a diverter, a reversible delivery pump having a pair of ports for intake to one and delivery from the other, hydraulic connections from said ports to said diverter and from said diverter to each of said motors, said diverter in a first position diverting hydraulic fluid to and from said mold closing hydraulic motor and in a second position diverting hydraulic fluid to and from said injection hydraulic motor, and means for shifting said diverter from said first position to said second position or vice versa only when said pump is in an intermediate position between delivery from one of said ports and delivery from the other of said ports.

4. A molding machine having a mold closing hydraulic motor and an injection hydraulic motor, a diverter, a pump having a pair of opposite ports, said pump being reversible for selective delivery from said ports, hydraulic connections from said ports to said diverter and from said diverter to each of said motors, said diverter in one position thereof controlling flow of hydraulic fluid between said pump and said mold closing hydraulic motor and in another position thereof controlling flow of hydraulic fluid between said pump and said injection hydraulic motor, and means for shifting said diverter from said one of its positions to the other only when said pump is in an intermediate position between delivery from one of said ports and delivery from the other of said ports.

5. A machine of the character disclosed comprising a pair of hydraulic motors, a diverter, a pump having a pair of opposed ports, said pump being reversible for selective delivery from said ports, hydraulic connections from said ports to said diverter and from said diverter to each of said motors, said diverter in one position controlling flow of hydraulic fluid to and from one of said motors and in another position controlling flow of hydraulic fluid to and from the other of said hydraulic motors, and means for shifting said diverter from said one position to said another position and from said another position to said one position only when said pump is in a neutral position between delivery from one of said ports and delivery from the other thereof.

6. In a machine having a pair of motors, a diverter, a reversible delivery pump having a pair of opposed ports, hydraulic connections from said ports to said diverter and from said diverter to each of said motors, said diverter in one position thereof diverting hydraulic fluid to and from one of said hydraulic motors and in another position thereof diverting hydraulic fluid to and from the other of said hydraulic motors, means for shifting said diverter from said one position to said another position or vice versa only when said pump is in neutral position, said means comprising electrically operable shifting means for said diverter, electrically operable shifting means for said pump, and control circuits therefor including a cycle start button, timers, time delay relays and control relays for sequentially energizing said electrically operable shifting means for said diverter and then said electrically operable shifting means for said pump to move one of said hydraulic motors in one direction, shifting said pump to neutral, reversing said diverter and shifting said pump again to delivery position to move the other of said hydraulic motors in one direction, reversing the pump delivery to retract said other of said hydraulic motors, shifting said pump to neutral, reversing said diverter and shifting said pump again to delivery position to retract said one of said hydraulic motors, and completing the cycle by shifting said pump to neutral.

7. In a machine having a pair of motors, a diverter, a reversible delivery pump having a pair of opposed ports, hydraulic connections from said ports to said diverter and from said diverter to each of said motors, said diverter in one position thereof diverting hydraulic fluid to and from one of said hydraulic motors and in another position thereof diverting hydraulic fluid to and from the other of said hydraulic motors, means for shifting said diverter from said one position to said another position or vice versa only when said pump is in neutral position, said means comprising shifting means for said diverter, shifting means for said pump, and cycle control means for sequentially shifting said diverter and then said pump to move one of said hydraulic motors in one direction, shifting said pump to neutral, reversing said diverter and shifting said pump again to delivery position to move the other of said hydraulic motors in one direction, reversing the pump delivery to retract said other of said hydraulic motors shifting said pump to neutral, reversing said diverter and shifting said pump again to delivery position to retract said one of said hydraulic motors, and completing the cycle by shifting said pump to neutral.

8. In a molding machine having a mold closing hydraulic motor and an injection hydraulic motor, a diverter, a pump having a pair of opposed ports, said pump being reversible for selective delivery from said ports, hydraulic connections from said ports to said diverter and from said diverter to each of said motors, said diverter in one position thereof controlling flow of hydraulic fluid to and from said mold closing hydraulic motor and in another position thereof controlling flow of hydraulic fluid to and from said injection hydraulic motor, means for shifting said diverter from said one position to said another position only when said pump is in an intermediate position between delivery from one of said ports and delivery from the other of said ports, said means comprising electrically operable shifting means for said diverter, electrically operable shifting means for said pump, and control circuits therefor for sequentially energizing said electrically operable shifting means for said diverter and then said electrically operable shifting means for said pump to move said mold closing hydraulic motor in mold closing direction, shifting said pump to intermediate position, reversing said diverter and shifting said pump again to delivery position to move said injection hydraulic motor in the injecting direction, reversing the pump delivery to retract said injection hydraulic motor and shifting said pump to intermediate position, reversing said diverter and shifting said pump again to delivery position to retract said mold closing hydraulic motor.

9. In a molding machine having a mold closing hydraulic motor and an injection hydraulic motor, a diverter, a pump having a pair of opposed ports, said pump being reversible for selective delivery from said ports, hydraulic connections from said ports to said diverter and from said diverter to each of said motors, said diverter in one position thereof controlling flow of hydraulic fluid to and from said mold closing hydraulic motor and in another position thereof controlling flow of hydraulic fluid to and from said injection hydraulic motor, means for shifting said diverter from said one position to said another position only when said pump is in an intermediate position between delivery from one of said ports and delivery from

the other of said ports, said means comprising electrically operable shifting means for said diverter, electrically operable shifting means for said pump, and control circuits therefor for sequentially energizing said electrically operable shifting means for said diverter and then said electrically operable shifting means for said pump to move said mold closing hydraulic motor in mold closing direction, a check valve in the hydraulic connections between said diverter and said mold closing hydraulic motor to hold said mold closing motor against retraction while said injection hydraulic motor is being operated, shifting said pump to intermediate position, reversing said diverter and shifting said pump again to delivery position to move said injection hydraulic motor in the injecting direction, reversing the pump delivery to retract said injection hydraulic motor, shifting said pump to intermediate position, reversing said diverter and shifting said pump again to delivery position to retract said mold closing hydraulic motor, and electrically operated means for opening said check valve when such retraction is desired.

10. In a molding machine having a mold closing hydraulic motor and an injection hydraulic motor, a diverter, a pump having a pair of opposed ports, said pump being reversible for selective delivery from said ports, hydraulic connections from said ports to said diverter and from said diverter to each of said motors, said diverter in one position thereof controlling flow of hydraulic fluid to and from said mold closing hydraulic motor and in another position thereof controlling flow of hydraulic fluid to and from said injection hydraulic motor, means for shifting said diverter from said one position to said another position only when said pump is in an intermediate position between delivery from one of said ports and delivery from the other of said ports, said means comprising electrically operable shifting means for said diverter, electrically operable shifting means for said pump, and control circuits therefor for sequentially energizing said electrically operable shifting means for said diverter and then said electrically operable shifting means for said pump to move said mold closing hydraulic motor in mold closing direction, a check valve in the hydraulic connections between said diverter and said mold closing hydraulic motor to hold said mold closing motor against retraction while said injection hydraulic motor is being operated, shifting said pump to intermediate position, reversing said diverter and shifting said pump again to delivery position to move said injection hydraulic motor in the injecting direction, reversing the pump delivery to retract said injection hydraulic motor, shifting said pump to intermediate position, reversing said diverter and shifting said pump again to delivery position to retract said mold closing hydraulic motor, electrically operated means for opening said check valve when such retraction is desired, and a pressure switch between said check valve and said mold closing hydraulic motor to sense the mold holding pressure thereof and thereupon effect shifting of said pump to said first mentioned intermediate position followed by said first mentioned shifting of said diverter to delivery position for discontinuing operation of said mold closing hydraulic motor by said pump and effecting operation of said injection hydraulic motor thereby.

No references cited.