March 24, 1959 R. M. NORMAN ET AL 2,878,648

MOLDING MACHINE RAM AND VALVE CONSTRUCTION

Filed Aug. 26, 1957 2 Sheets-Sheet 1

Fig. 1

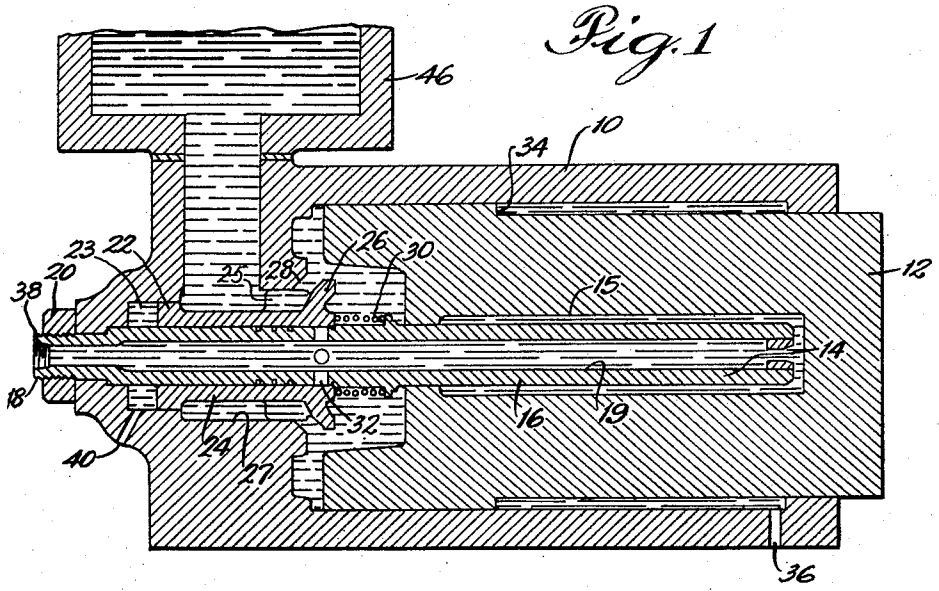
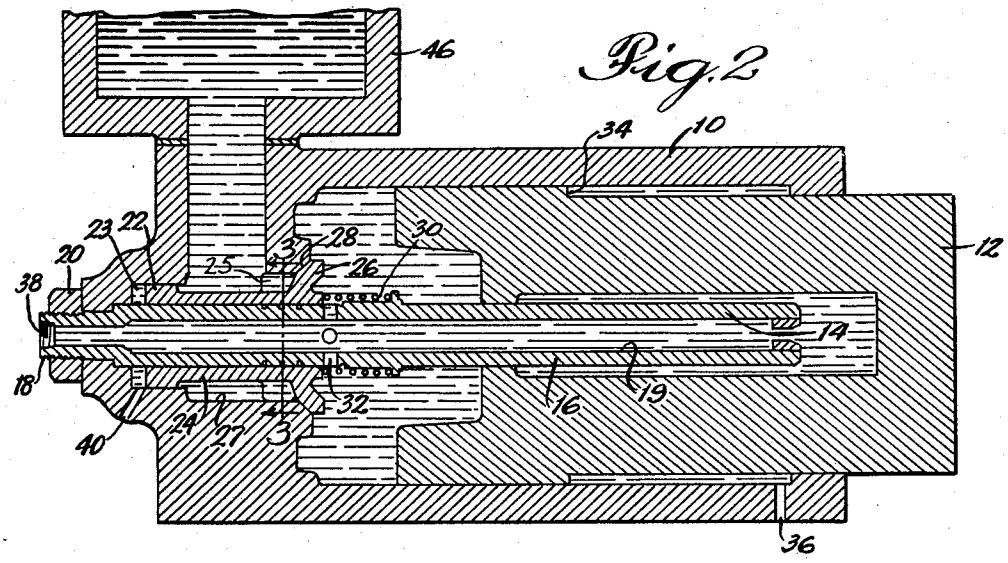


Fig. 2



INVENTORS:
Richard M. Norman
and Russell V. Powell,

BY Bair, Freeman & Molinare
ATTORNEYS.

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Fig. 4

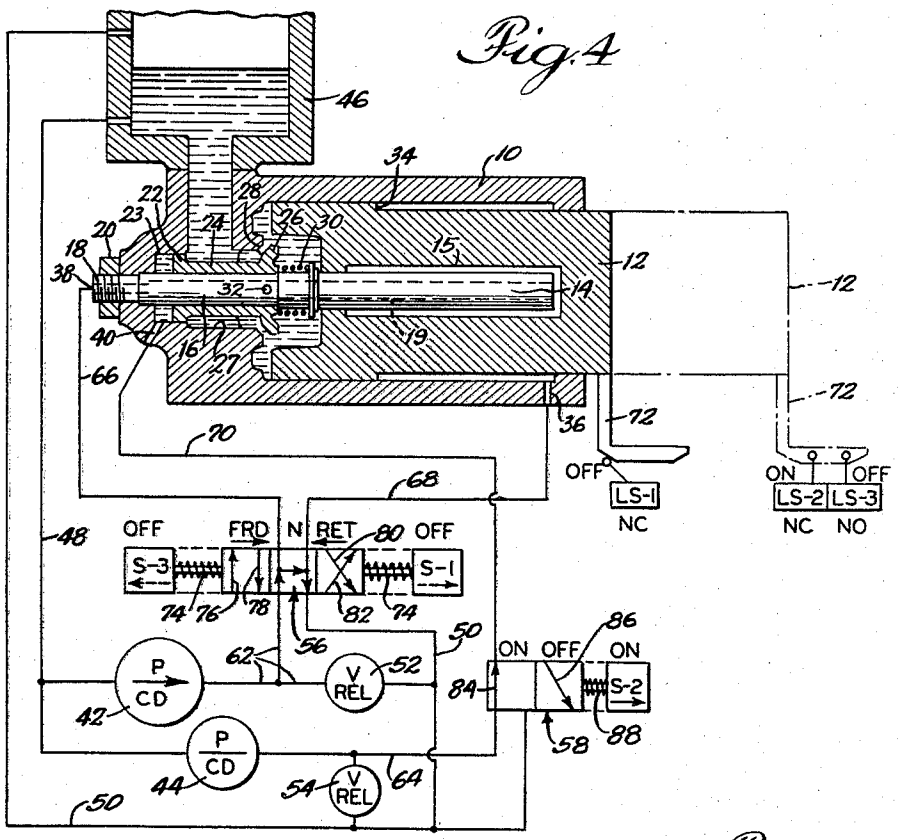


Fig. 3

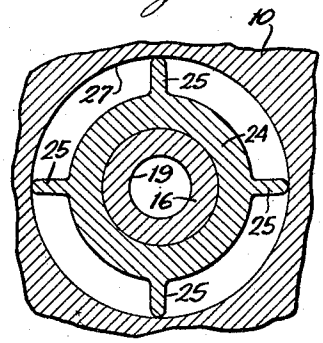
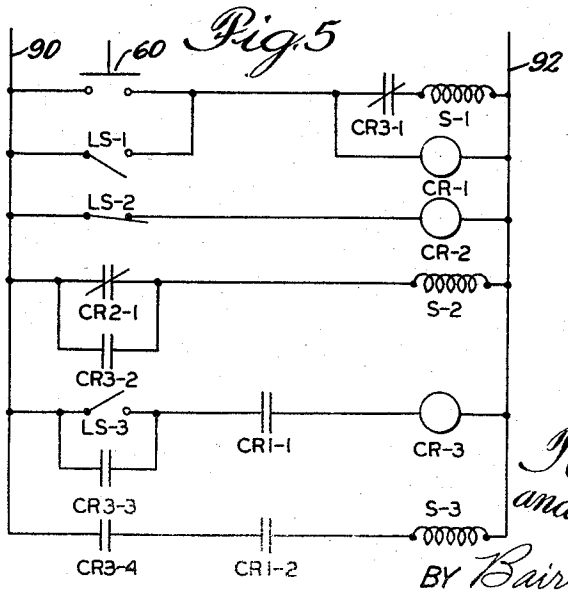


Fig. 5



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

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MOLDING MACHINE RAM AND VALVE CONSTRUCTION

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

Application August 26, 1957, Serial No. 680,124

6 Claims. (Cl. 60—97)

This invention relates to a molding machine such as one for molding articles from plastic materials. Our invention is directed to a working ram and valve construction of the molding machine and especially the hydraulic control thereof whereby the ram is initially advanced at high speed and then slows down as it approaches the work.

One object of the invention is to provide a comparatively simple prefill or "surge valve" arrangement wherein a "wrap-around" prefill valve is so constructed as to perform a shift-over or change-over function from fast advance to slow advance of the working ram, in addition to its usual function of serving as a prefill valve to permit filling of the volume behind a main ram while the ram is under fast advance by operation of a speed booster ram.

Another object is to provide a combined prefill and change-over valve, thus eliminating the necessity for two pilot control hydraulic circuits, one for a prefill valve and the other for a change-over valve as heretofore necessary, our invention on the other hand requiring but a single pilot hydraulic circuit for the combined prefill and change-over valve.

A further object is to provide a molding machine in which a main hydraulic circuit controls the flow of oil with respect to a main ram and a speed booster ram, and a pilot hydraulic circuit controls the combined prefill and change-over valve in such a manner as to direct the main hydraulic circuit as desired to either the booster ram alone or to both the main and booster rams.

Still a further object is to provide an electric control circuit for the main and pilot hydraulic circuits which includes limit switches under control of the main ram in various positions thereof so as to perform an operating cycle involving fast advance, slow advance and fast return, and which three operations constitute a complete operating cycle that may be initiated by a cycle start button.

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 sectional view through a molding machine embodying our present invention and showing the main ram thereof in the retracted position at the start of a cycle and our combined prefill and change-over valve in a position for rapid advance of the main ram of the molding machine;

Fig. 2 is a similar sectional view showing the ram partially advanced and our combined prefill and change-over valve in another position (for slow main ram advance);

Fig. 3 is a sectional view on the line 3—3 of Fig. 2 showing details of our valve;

Fig. 4 is a diagrammatic view of our molding machine

showing the main and pilot hydraulic circuits, the control valves therein and three limit switches controlled by the main ram; and

Fig. 5 is an electrical diagram showing the electric control circuit for the hydraulic circuits and including the three limit switches of Fig. 4.

On the accompanying drawings we have used the reference numeral 10 to indicate a hydraulic cylinder and 12 a main ram reciprocable therein. A speed booster ram 14 enters a booster ram cavity 15 of the main ram 12 and is provided with a stem 16 having a threaded portion 18. A booster ram lock nut 20 is screwed thereon for retaining the booster ram 14 in fixed relation to the cylinder 10.

At 26 we illustrate a combined prefill and change-over valve disc adapted to be normally seated against a seat 28 by a valve closing spring 30. The valve disc 26 has a tubular stem 24 which terminates in a valve actuating piston 22. The tubular stem 24 and the disc 26 it will be noted surround the booster ram 14 to constitute what is generally termed a "wrap-around" valve. The piston 22 is reciprocable in a cavity 23 of the hydraulic cylinder 10 which is ported at 40 for the flow of pilot oil to and from the cavity behind the piston 22 as will hereinafter appear. The tubular stem 24 is provided with guide fins 25 as shown in Fig. 3 slidable in an enlargement 27 of the cavity 23.

The booster ram stem 16 is provided with several slow advance ports 32 that are normally uncovered by the tubular stem 24 as shown in Fig. 2 under the action of the spring 30. When oil under pressure is introduced through the port 40 the stem 24 covers the ports 32 as shown in Figs. 1 and 4. Within the hydraulic cylinder 10 there is an annular pull back area 34 and a pull back port 36 communicates therewith. The booster ram 14 at its left-hand end is provided with a ram port 38. The ports 36 and 38 are adapted for connection to a main system hydraulic circuit which will now be described.

Referring to Fig. 4 a main system hydraulic pump 42 is provided which may be of the constant delivery type receiving oil from a reservoir 46 through an oil supply line 48. An out flow line 62 extends from the pump 42 to a main circuit directional control valve 56 and to a relief valve 52. The relief valve 52 limits the pressure in the line 62 and permits the excess oil to flow through a return line 50 back to the reservoir 46.

A pilot system hydraulic pump 44 is provided, also of the constant delivery type but of less capacity than the pump 42, and an out flow line 64 extends therefrom to a pilot circuit directional control valve 58. A relief valve 54 limits the pressure in the line 64 and is connected on its outlet side to the oil return line 50.

The main circuit directional control valve 56 is connected by hydraulic lines 66 and 68 to the ram port 38 and the pull back port 36 respectively. The pilot circuit directional control valve 58 is connected by a hydraulic line 70 to the port 40. The valve 56 is shown in the neutral ("N") position in Fig. 4 under the action of a pair of centering springs 74 and has forward and return positions indicated "FRD" and "RET" respectively. It may be shifted to the forward position by energization of a solenoid S-3 and to the return position by energization of a solenoid S-1, both of which are indicated "Off."

The neutral section of the valve 56 is provided with suitable passageways as shown which relieve all pressure in the hydraulic lines 66 and 68 and which bypass the oil constantly pumped by the pump 42 from the out flow line 62 to the return line 50. The forward section of the valve 56 has passageways 76 and 78 for permitting flow from 62 to 66 and from 68 to 50 respectively. The return

section of the valve 56 has passageways 80 and 82 permitting connection between 66 and 50, and between 62 and 68 respectively.

The valve 58 has "On" and "Off" sections in which are passageways 84 and 86 respectively permitting in the "On" position flow from 64 to 70 and in the "Off" position return flow from 70 to 50. The valve 58 is normally in the "Off" position under the action of a spring 88 and is moved to the "On" position by a solenoid S–2 which is shown in Fig. 4 in the "On" or energized position.

A limit switch actuator 72 extends from the main ram 12 and is adapted to actuate three limit switches LS–1, LS–2 and LS–3 which are normally closed, normally closed and normally open respectively as indicated "NC" and "NO" adjacent the limit switches. The limit switch LS–1 has been moved to the "Off" position by the actuator 72 whereas the limit switches LS–2 and LS–3 are "On" and "Off" respectively as also indicated.

Referring to Fig. 5, an electric circuit is shown which is supplied with electricity from current supply wires 90 and 92. The circuit illustrated includes the three limit switches just referred to and the three solenoids S–1, S–2 and S–3 shown in Fig. 4. It further includes control relays CR–1, CR–2 and CR–3 (the circles so designated being the relay coils). The control relay CR–1 controls two sets of normally open contacts CR1–1 and CR1–2. The control relay CR–2 when energized closes normally open contacts CR2–1 which in Fig. 5 are shown closed because CR–2 is energized by reason of LS–2 being closed which is the normal position of this limit switch. The control relay CR–3 controls four sets of contacts, as follows:

CR3–1 which are normally closed,
CR3–2 which are normally open,
CR3–3 which are normally open, and
CR3–4 which are normally open.

Limit switch LS–1 is normally closed but is shown open in Fig. 5 to correspond to the position of the parts in Fig. 4 so that the circuit as illustrated in Fig. 5 is ready for operation when desired. To start the operation a cycle start switch 60 is provided. This is a push button type of switch and is normally open as illustrated.

Practical operation

To start the operating cycle, the cycle start button 60 is depressed for energizing S–1 and CR–1. The energization of S–1 moves the control valve 56 to the forward position so that oil from the pump 42 flows through 62, 76 and 66 to the ram port 38 and then through a bore 19 of the ram into the booster ram cavity 15. This drives the main ram 12 forward rapidly because of the small area of the booster ram 14. Gravity flow of oil from the reservoir 46 through the open valve 26—28 makes up the volume of oil required in the cylinder 10 back of the main ram 12 for free advance of the ram 12. The oil displaced by the pull back area 34 flows from the port 36 through 68, 78 and 50 to the reservoir 46.

During the rapid advance of the ram 12, the pump 44 is supplying pilot oil through 64, 84, 70 and 40 to the cavity 23, thus acting on the valve actuating piston 22 to keep the valve 26—28 open.

The energization of CR–1 closes switches CR1–1 and CR1–2 to condition the circuits for CR–3 and S–3 for a subsequent operation.

When the actuator 72 reaches the limit switch LS–2 it turns it off for de-energizing the control relay CR–2. The opening of its contacts CR2–1 de-energizes the solenoid S–2 thereby shifting the valve 58 from the "On" position to the "Off" position and permitting out flow of oil from the cavity 23 under the action of the spring 30 through 40, 70, 86 and 50 to the reservoir 46. The valve 26—28 thereupon closes as in Fig. 2 and this opens the change-over portion of the valve by reason of the tubular stem 24 uncovering the slow advance ports 32. Thereupon the oil being supplied through the hydraulic line 66 flows to both the booster ram cavity 15 and the cylinder 10 behind the main ram 12 for acting on both their areas to effect slow advance at a reduced speed in inverse ratio to their areas. This prevents harmful impact between working parts such as injection molds when they close and permits full area tonnage for clamping the mold parts closed. Advance continues until resistance is met and the pressure builds up to whatever is required for the work.

When the actuator 72 reaches the switch LS–3 it is closed to energize CR–3 which results in de-energization of the solenoid S–1 by opening of the switch CR3–1. At the same time CR3–2 and CR3–4 are closed to energize S–2 and S–3. When the hydraulic circuit is in this condition the valve 56, in its return position because of S–3 being energized, directs the oil from 62 through 82 to 68 and 36 thus acting on the pull back area 34 of the ram 12 and the valve 26—28 is open because of S–2 being energized so that the oil displaced from behind the ram 12 flows past valve disc 26 and through valve seat 28 back to the reservoir 46 while the oils displaced from the booster ram cavity 15 flows through 14, 19, 38, 66, 80 and 50 back to the reservoir 46. The ram 12 is retracted rapidly because the pull back area 34 is relatively small. CR3–3 is at this time closed to shunt LS–3 and thus keep CR–3 energized after LS–3 reopens and until LS–1 opens to de-energize CR–1. This opens CR1–1 to de-energize CR–3 so it is ready for the next cycle.

When LS–1 is contacted the solenoid S–3 is de-energized by CR–1 opening CR1–2 so that the valve 56 returns to neutral and bypasses oil from 62 to 50 and this reduces the pressure in the main hydraulic system to substantially zero. This is the "rest" condition and thereafter another cycle may be started by depressing the cycle start button 60.

While we have shown a molding machine of the open circuit type using constant displacement pumps and a 4-way valve, our invention applies equally well to closed circuits employing variable reversible pumps such as shown in our co-pending application, Serial No. 569,474, filed March 5, 1956, now Patent No. 2,804,752, dated September 3, 1957.

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. In a molding machine, a cylinder, a main ram reciprocable therein with the volume in said cylinder behind said main ram constituting a main ram cavity, a booster ram stationary relative to said cylinder and provided with ports, said main ram having a booster ram cavity therein and said booster ram entering said last cavity, a combined prefill and change-over valve comprising a sleeve surrounding said booster ram and having an enlarged closure element in said main ram cavity, a seat in the inner end of said cylinder for said closure element, said valve having an actuating piston also surrounding said booster ram, said cylinder having a reduced bore beyond said inner end thereof serving as a cylinder for said actuating piston, spring means normally seating said closure element on said seat, said valve when in unseated position by introduction of fluid under pressure to said reduced bore, establishing communication between a fluid reservoir and said main ram cavity through said seat and past said enlarged closure element, and at the same time cutting off communication between said cavities by said sleeve covering said parts, and when in seated position blocking communication between said fluid reservoir and said main ram cavity and at the same time establishing communication between both of said

cavities by said sleeve uncovering said ports whereby fluid under pressure supplied to said booster ram cavity also flows to said main ram cavity for slow advance of said main ram.

2. In a molding machine, a cylinder, a main ram reciprocable therein with the volume in said cylinder behind said main ram constituting a main ram cavity, a booster arm stationary relative to said cylinder, said main ram having a booster ram cavity therein and said booster ram entering said cavity, a combined prefill and change-over valve surrounding said booster ram and having a closure element, a seat in said cylinder for said closure element, said valve having an actuating piston, said valve when in one position establishing communication between a fluid reservoir and said main ram cavity and cutting off communication between said cavities, and when in another position cutting off communication between said fluid reservoir and said main ram cavity and establishing communication between both of said cavities whereby fluid under pressure supplied to said booster ram cavity also flows to said main ram cavity for slow advance of said main ram, said cylinder having a pull back cavity, a main pump, a first valve for forward and return control of the output of said main pump to and from said booster ram cavity and said pull back cavity, a pilot pump, a second valve for on-off control of the output from said pilot pump to said actuating piston of said combined prefill and change-over valve, an electric circuit for actuating said first and second valves and having a cycle start switch and three limit switches, said first limit switch being actuated by said main ram adjacent the end of its return stroke to actuate said first valve to neutral position and thereby stop said main ram at the end of the operating cycle, said cycle start switch when actuated initiating an operating cycle by actuating said first valve to its forward position, said second limit switch being actuated by said main ram before the end of its forward stroke and said third limit switch being actuated adjacent the end thereof, said second limit switch effecting movement of said combined prefill and change-over valve from prefill position to change-over position and said second valve to off position, and said third limit switch actuating said first valve to its return position and said second valve to on position for the return stroke of said main ram.

3. In a molding machine, a cylinder, a main ram reciprocable therein with the volume in said cylinder behind said main ram constituting a main ram cavity, a booster ram stationary relative to said cylinder, said main ram having a booster ram cavity therein and said booster ram entering said cavity, a combined prefill and change-over valve surrounding said booster ram and having a closure element, a seat in said cylinder for said closure element, said valve having an actuating piston, said valve when in one position establishing communication between a fluid reservoir and said main ram cavity and cutting off communication between said cavities, and when in another position cutting off communication between said fluid reservoir and said main ram cavity and establishing communication between both of said cavities whereby fluid under pressure supplied to said booster ram cavity also flows to said main ram cavity for slow advance of said main ram, said cylinder having a pull back cavity, a main pump, a first valve for forward and return control of the output of said main pump to and from said booster ram cavity and said pull back cavity, a pilot pump, a second valve for on-off control of the output from said pilot pump to said actuating piston, an electric circuit for actuating said first and second valves and having a cycle start switch and three limit switches, said first limit switch being actuated by said main ram adjacent the end of its return stroke to actuate said first valve to neutral position and thereby stop said main ram at the end of the operating cycle, said cycle start switch when actuated initiating an operating cycle by actuating said first valve to its forward position, said second limit switch being actuated by said main ram before the end of its forward stroke and effecting movement of said combined prefill and change-over valve from prefill position to change-over position and said second valve to off position, and said third limit switch being actuated by said main ram at the end of its forward stroke and actuating said first valve to its return position and said second valve to on position for the return stroke of said main ram.

4. In a molding machine, a cylinder, a main ram reciprocable therein with the volume in said cylinder behind said main ram constituting a main ram cavity, a booster ram, a combined prefill and change-over valve having a closure element, a seat in said cylinder for said closure element, means normally seating said closure element on said seat, said valve when in unseated position establishing communication between a fluid reservoir and said main ram cavity, and when in seated position blocking communication between said fluid reservoir and said main ram cavity and establishing communication between said booster ram and said main ram cavity whereby fluid under pressure supplied to said booster ram also flows to said main ram cavity for slow advance of said main ram, said cylinder having a pull back area, a main pump, a first valve for forward and return control of the output of said main pump to and from said booster ram and said pull back area, a pilot pump, a second valve for on-off control of the output from said pilot pump to said actuating piston of said combined prefill and change-over valve, an electric circuit for actuating said first and second valves and having a cycle start switch, and means actuated by the position of said main ram to sequentially shift said valves to first supply oil from said main pump to said booster ram and from said pilot pump to said combined prefill and change-over valve for moving it to said another position, then supply oil to said main ram and said booster ram together while permitting said combined prefill and change-over valve to assume said seated position, and then supply oil to said pull back area to therby return said main ram to its initial position while said prefill valve is again in said another position.

5. In a molding machine, a main ram, a booster ram, a combined prefill and change-over valve having an actuating piston, said valve when in one position establishing communication between a fluid reservoir and said main ram and when in another position establishing communication between said rams, a main pump, a first valve for forward and return control of the output of said main pump to and from said rams, a pilot pump, a second valve for on-off control of the output from said pilot pump to said actuating piston, an electric circuit for actuating said first and second valves and having a cycle start switch and three limit switches, said first limit switch being actuated by said main ram adjacent the end of its return stroke to actuate said first valve to neutral position and thereby stop said main ram at the end of the operating cycle, said cycle start switch when actuated initiating an operating cycle by actuating said first valve to its forward position, said second limit switch being actuated by said main ram before the end of its forward stroke and said third limit switch being actuated at the end thereof, said second limit switch effecting movement of said combined prefill and change-over valve from said one position to said another position and said second valve to off position, and said third limit switch actuating said first valve to its return position, said second valve to its on position for the return stroke of said main ram and said combined prefill and change-over valve to said one position.

6. In a molding machine, a main ram, a booster ram, a combined prefill and change-over valve, actuating means therefor, said valve when in one position establishing communication between a fluid reservoir and said

main ram and cutting off communication between said rams, and when in another establishing communication between said rams for slow advance of said main ram, a main pump, a pilot pump, a first valve for forward and return control of the output of said main pump to and from said rams, a second valve for on-off control of the output from said pilot pump to said actuating means, control means operable as a result of movement of said main ram and operable in different positions thereof for operating said first and second valves, cycle start means for moving said first valve from neutral to forward position, said main ram before the end of its forward stroke effecting through said control means movement of said second valve to off position and thereby said combined prefill and change-over valve from said one position to said another position, said main ram at the end of its forward stroke effecting through said control means shift of said first valve from forward to return positions and said second valve to on position and thereby said combined prefill and change-over valve from said another position to said one position for the return stroke of said main ram, and said main ram at the end of its return stroke effecting through said control means return movement of said first valve to neutral position to thereby stop said main ram at the end of an operating cycle thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

2,152,837	Cannon	Apr. 4, 1939
2,152,870	Cannon	Apr. 4, 1939
2,190,755	Dinzl	Feb. 20, 1940
2,343,177	Flowers	Feb. 29, 1944

Notice of Adverse Decision in Interference

In Interference No. 90,623 involving Patent No. 2,878,648, R. M. Norman and R. W. Powell, Molding machine ram and valve construction, final judgment adverse to the patentees was rendered Apr. 24, 1962, as to claims 4 and 6.

[*Official Gazette September 18, 1962.*]