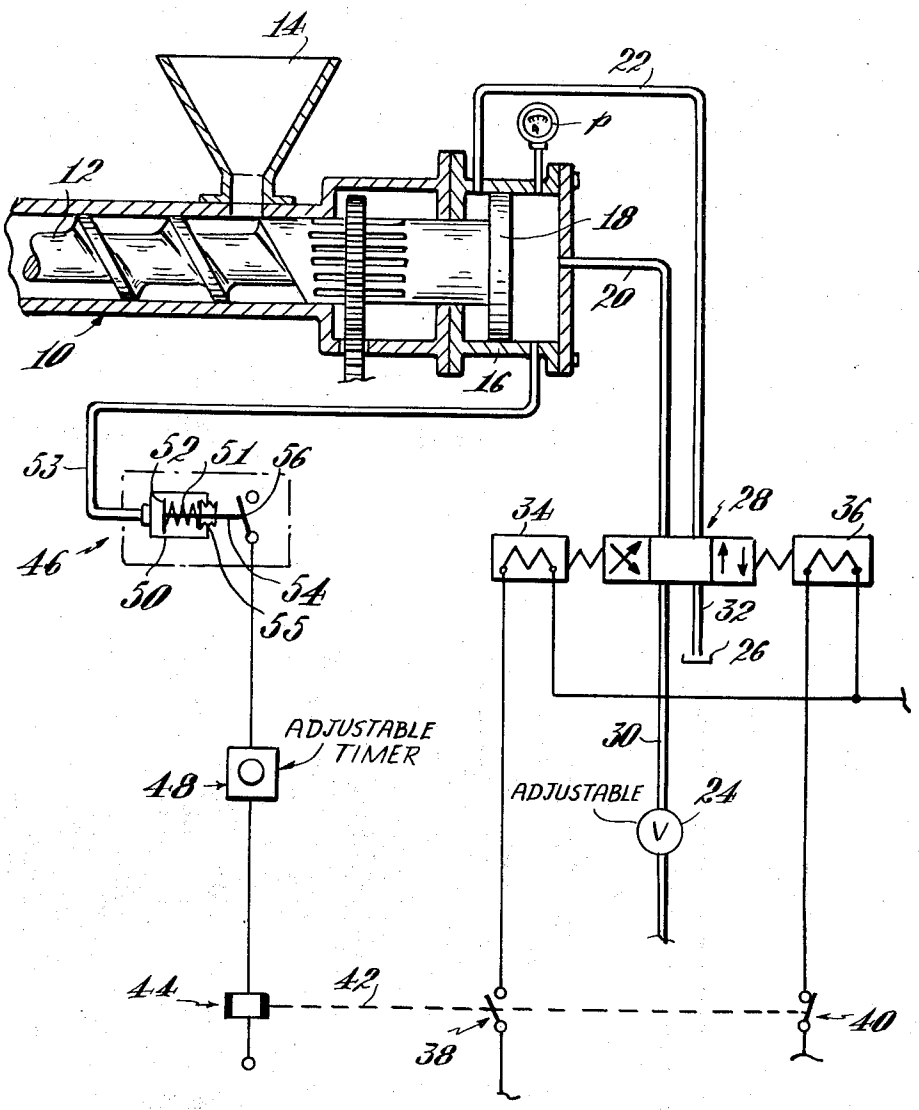
March 5, 1968 H. LUDWIG 3,371,386

INJECTION APPARATUS WITH PRESSURE REGULATION

Filed March 31, 1966



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United States Patent Office

3,371,386

Patented Mar. 5, 1968

3,371,386

INJECTION APPARATUS WITH PRESSURE REGULATION

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Filed Mar. 31, 1966, Ser. No. 539,047

9 Claims. (Cl. 18—30)

This invention relates to apparatus for preparing elastomers for molding purposes and especially to injection apparatus for injecting elastomer into molds.

The principal objects of the invention are to provide injection apparatus designed to enable automatically terminating injection at just the right time to insure optimum filling whether or not the molds are of the same or different size, without having to employ large mold castings and high pressure closing means which are costly, without having to employ volume regulation or time control which are inaccurate and wasteful of material, and without having to use a shut-off switch for each individual mold which requires modification of the mold assemblies and is expensive. Other objects are to provide a control for effecting shut-off at the right time which will not operate prematurely by reason of momentary surges or fluctuation in pressure in the hydraulic system of the injector and non-uniform flow characteristics of the elastomer or temporary obstructions in the injector or the mold. Further objects are to provide a control which is reliable, is employed in conjunction with the injector instead of the mold and hence only one such control is required for use in filling a plurality of molds, can be easily installed without redesign of the injection equipment and is comprised of relatively few and readily available component parts.

As herein illustrated, the injection apparatus in which the control is embodied comprises a barrel within which there is mounted a screw for both rotation and reciprocation to effect plasticization of an elastomer supplied to the barrel and ejection of the elastomer from the barrel after it has been sufficiently plasticized. The screw at its rear end projects into a motor cylinder and has on it a piston which fits within the motor cylinder and there are conductors at opposite ends of the motor cylinder by means of which pressure fluid is alternately supplied from a source of pressure to one side or the other of the piston and by means of which hydraulic fluid is vented from the opposite side. The control, as herein illustrated, comprises a slide valve operable, in one position, to connect the conductors, respectively, to the source of pressure and a sump to apply pressure to one side of the piston and vent the other side and in another position to reverse the connections, a pressure-responsive means connected to the motor cylinder at the rear side of the piston responsive to a pressure in excess of the predetermined amount to effect a shifting of the slide valve to supply pressure to the motor cylinder at the front side of the piston and to vent the rear side, and means for delaying the operation of the slide valve an appreciable interval following activation of the pressure-responsive means. The pressure-responsive means is in the form of a control cylinder containing a control piston normally held in an inoperative position by yieldable means engaged with one side thereof and movable to an operative position in opposition to the yieldable means by pressure supplied to the opposite side from the motor cylinder. Preferably there is means for adjusting the resistance of the yieldable means to provide for operation at a predetermined pressure. The control piston is operably connected to the slide valve to effect movement thereof by means comprising a circuit containing solenoids operable to shift the slide valve and a delay relay, operation of which is initiated by the control piston and which operates, in turn, to effect energization of one or the other of the solenoids connected to the slide valve.

The delay relay is adjustable to provide for delay of from 0 to 30 seconds.

The invention will now be described in greater detail with reference to the accompanying drawing wherein a fragmentary portion of an injection apparatus is shown in vertical section, with the hydraulic and electrical components of the control system shown diagrammatically.

Referring to the drawing, the injection apparatus comprises a barrel 10 within which there is mounted a screw 12 for rotation about its longitudinal axis and reciprocation along its longitudinal axis in accordance with conventional practice. The elastomer which is to be plasticized and injected by this apparatus is delivered to the barrel through a hopper 14 mounted on the barrel adjacent the rear end of the screw. The rear end of the screw extends into a motor cylinder 16 formed at the rear end of the barrel or secured thereto and the screw has on it a piston 18 which fits into the motor cylinder. The screw is rotated in conventional fashion by means not herein illustrated, for example, a gear on the screw shaft such as shown in Patent No. 3,133,316, dated May 19, 1964, and is reciprocated by supplying pressure fluid from a source 24 to the opposite ends of the cylinder 16 through conductor pipes 20 and 22 which also serve as vents for allowing the pressure fluid to escape from the cylinder back to a sump at 26. A slide valve 28, interposed in the conductor pipes 20 and 22, is shiftable alternately to connect the conductor pipe 20 with a pipe 30 from the fluid pressure source 24 or a pipe 32 to the sump 26. Similarly, the valve is operable alternately to connect the conductor pipe 22 by way of the pipe 30 with the source of pressure fluid 24 or by way of the pipe 32 with the sump 26. When the apparatus is not in operation the slide valve 28 occupies a neutral position. A pair of solenoids 34 and 36, connected at the opposite ends of the slide valve, provide for movement when energized to move the slide valve to the left, for example, to connect the conductor pipe 20 to the pipe 30 and the conductor pipe 22 to the pipe 32 in which position pressure fluid will be supplied through the conductor pipe 20 to the rear side of the piston 18 to force the screw forwardly in the barrel and at the same time to permit pressure fluid in front of the piston 18 to flow through the conductor pipe 22 and pipe 32 back to the sump 26. In the right-hand position of the slide valve the conductor pipe 22 becomes connected by the pipe 30 to the pressure source so that pressure fluid is delivered through the conductor pipe 22 to the front side of the piston 18, forcing it rearwardly in the motor cylinder 16. At this same time the conductor pipe 20 is connected to the pipe 32 to the sump 26 so that the pressure fluid behind the piston 18 is permitted to flow through the conductor pipe 20 to the sump. The solenoids 34 and 36 are alternately energized by a pair of relay switches 38 and 40 mechanically connected by a link 42 for movement in unison so that when one is open the other is closed. Movement of the link 42 is effected through a relay 44.

As indicated heretofore, it is desirable to control injection in such a way as to insure properly filling the mold or molds being serviced by the injection apparatus without too high injection pressure such, for example, as might cause damage to the mold assembly or to the injector itself and at the same time without premature cut-off due to temporary surges in the hydraulic system of the ejector, non-uniform flow characteristics of the elastomer or temporary obstructions in the injector or the mold into which the material is being injected. Accordingly, control of the pressure fluid through the slide valve 28 is effected herein by means of a pressure-responsive device 46 which is operable to effect operation of the relay 44 with an interposed time delay 48 which delays operation of the relay 44 for a sufficient length of time so that if the rise in pressure for whatever reason

is of short duration, the relay 44 will not be operated and the slide valve will remain in its normal position for delivering pressure to the rear side of the piston so as to effect continuous ejection of the plasticized material.

The pressure-responsive means 46 comprises a small control cylinder 50 containing a control piston 52 yieldably held against one end of the cylinder by a spring 51. A conductor pipe 53 connected at one end to the motor cylinder 16 at the rear side of the piston 18 and at its other end to the control cylinder 50 provides for applying the injection pressure to the control piston 52 in a direction to displace the piston against the spring 51. The resistance of the spring to yield may be adjusted by means of an adjustable collar 55 threaded into the end wall of the control cylinder. The control piston 52 has a rod 54 extending therefrom, the distal end of which is connected to a switch 56. In the absence of an excess pressure, the switch is held open by the spring. Closing of the switch 56 due to a rise in pressure in excess of a predetermined amount at the rear side of the piston 18 will move the control piston 52 toward the right to complete a circuit to the time delay device 48. Any conventional time delay device may be employed which can be adjusted to provide delays of from 0 to 30 seconds. Under usual conditions a three-second delay is sufficient. Hence with the delay set for a pre-determined period, if the switch 56 is closed, nothing happens until the time delay switch 48 completes the circuit to the relay 44 and if within this time the excess pressure dies out, switch 56 opens and the time delay 48 is rendered inoperative so that the relay 44 remains unenergized. If the excess pressure persists indicating a dangerous build up in pressure for a period longer than that for which the time delay was set, the relay 44 will operate and thereby shift the linkage 42 and switches 38 and 40 to reverse the position of the slide valve 28. The shift will vent pressure from behind the piston 18 and supply it to the front side so as to retract the screw in the barrel and thus relieve the pressure until the fault can be found and corrected.

The pressure source 24 may be an adjustable valve interposed between a high pressure source of pressure fluid and the conductor 30 or may be a pump variably adjustable to increase or decrease the pressure which may be supplied to the motor cylinder. A pressure indicator *p* is mounted on the motor cylinder to enable accurate determination of the pressure within the cylinder at any time during operation of the injector.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. In injection apparatus comprising a barrel within which there is mounted a screw which is both rotatable in the barrel and reciprocable therein to effect plasticization and ejection of an elastomer in and from the barrel, said screw at its rear end projecting into a motor cylinder and having on it a piston fitting said motor cylinder, and said motor cylinder being provided at its opposite end with conductors by means of which a pressure fluid is alternately supplied from a source of pressure fluid to one side or the other of the piston and vented from the opposite to a sump; means for limiting injection pressure

to a predetermined maximum, comprising a slide valve operable, in one position, to connect the conductors, respectively, to said source of pressure fluid and to said sump to supply fluid pressure to one side of the piston and vent the other, and in another position to reverse the connections, pressure-responsive means connected to the motor cylinder at said rear side of the piston responsive to a pressure in excess of said predetermined maximum to effect shifting of the slide valve to supply fluid pressure to the motor cylinder at the front side of the piston and to vent said rear side, and means for delaying the operation of said slide valve an appreciable interval following response of said pressure-responsive means to said predetermined maximum pressure.

2. Apparatus according to claim 1, wherein there is a pressure regulator associated with the source of fluid pressure adjustable to regulate the pressure available to effect injection.

3. Apparatus according to claim 1, wherein there is a pressure indicator associated with the motor cylinder to indicate the injection pressure in the motor cylinder at the injection side of the piston.

4. Apparatus according to claim 1, wherein there is means yieldably resisting displacement of the control piston and means operable to adjust the degree of resistance of said control piston to displacement.

5. Apparatus according to claim 1, wherein the pressure-responsive means is a control cylinder containing a control piston, spring means bearing on the piston at one side normally holds the piston at one end of the control cylinder, a conductor connects said motor cylinder with said one end of the control cylinder so that an increase in pressure in excess of said predetermined pressure effects displacement of the control piston, and the means for effecting delay is interposed between said control piston and said slide valve.

6. Apparatus according to claim 1, wherein there is means operably connecting the pressure-responsive means to the slide valve comprising a circuit containing solenoids alternately operative to shift the slide valve, and delay is effected by a relay in said circuit between the pressure-responsive means and said solenoids.

7. Apparatus according to claim 1, wherein the means operably connecting the pressure-responsive means to the slide valve comprises a circuit containing solenoids connected to the slide valve, switches and switch-actuating means operable to move the switches in unison alternatively to energize one solenoid and de-energize the other to effect such movement of the slide valve, and a delay relay interposed between said pressure-responsive means and the switch-actuating means.

8. Apparatus according to claim 1, wherein the delay means is adjustable to change the period of delay.

9. Apparatus according to claim 1, wherein the delay means is adjustable to afford a period of delay of from 0 to 30 seconds.

References Cited

UNITED STATES PATENTS

3,001,233	9/1961	Ernst	18—30
3,140,332	7/1964	Brown	18—30 X
3,133,316	5/1964	Arpajian	18—30

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