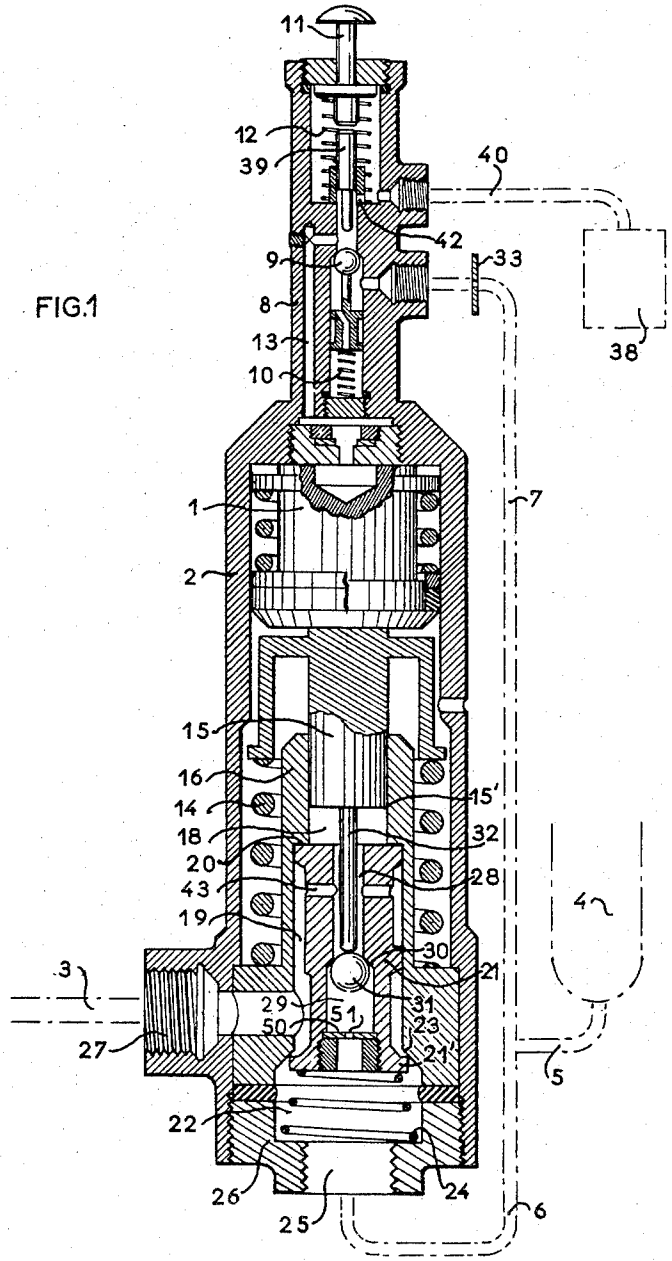
June 2, 1959 J. L. GRATZMULLER 2,888,953

VALVE SYSTEM TIMING DEVICE

Filed Jan. 7, 1957 2 Sheets-Sheet 1

FIG.1



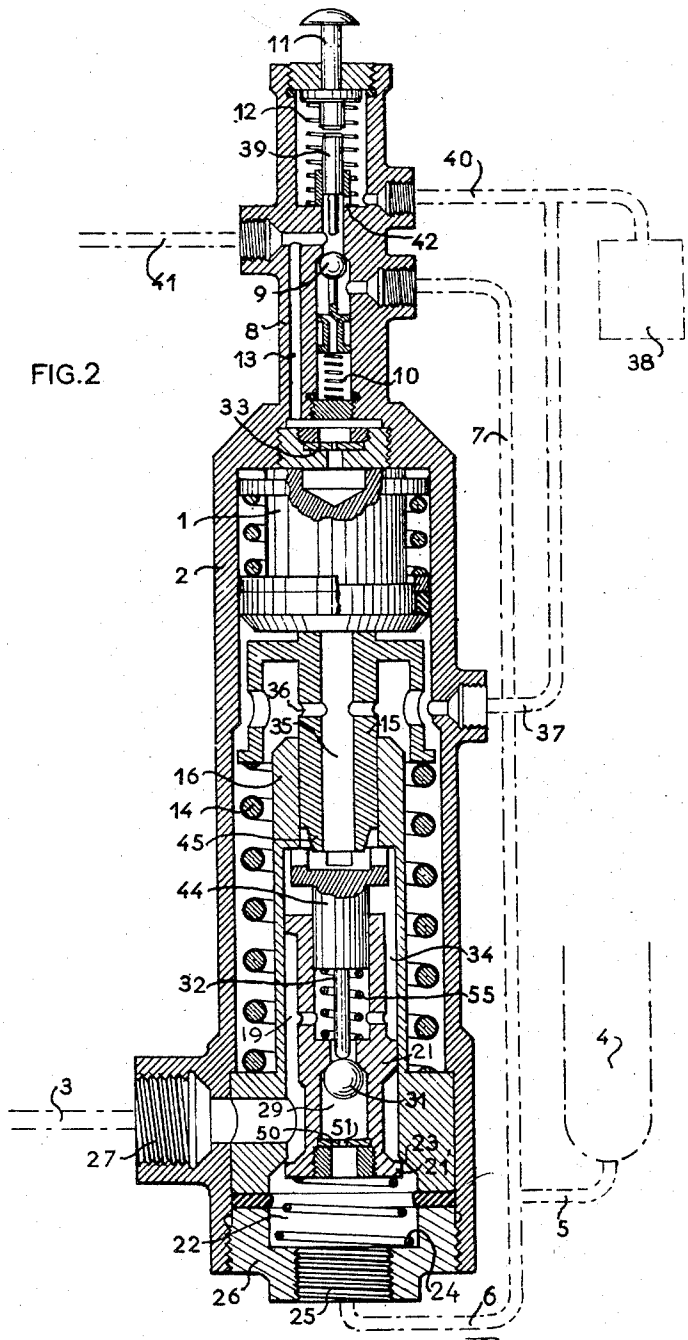
Inventor
J. L. Gratzmuller
By Flocard Downing & Seebold
Attys.

June 2, 1959 J. L. GRATZMULLER 2,888,953

VALVE SYSTEM TIMING DEVICE

Filed Jan. 7, 1957 2 Sheets-Sheet 2

FIG.2



Inventor

J. L. Gratzmuller

By Glascock Downing Seebold

Attys

United States Patent Office 2,888,953 Patented June 2, 1959

2,888,953

VALVE SYSTEM TIMING DEVICE

Jean Louis Gratzmuller, Paris, France

Application January 7, 1957, Serial No. 632,833

Claims priority, application France January 18, 1956

5 Claims. (Cl. 137—630.15)

This invention relates to a device for timing the operation of a valve system.

The main object of the invention is to provide a device of this type, wherein the timing is ensured by a liquid pressure responsive valve actuating piston associated with suitable return means having at least its active stroke hydraulically controlled by a preferably sharp-edged calibrated orifice through which hydraulic liquid flows as the valve actuating piston is displaced.

With this arrangement, the speed of displacement of the valve actuating piston is regulated and substantially proportional to the square root of the pressure of the said hydraulic liquid.

Another object of the invention is to associate the above-described liquid pressure responsive valve actuating piston with a valve system so as to actuate successively a number of valves as the valve actuating piston travels its active stroke and/or its return stroke.

Still another object of the invention is to provide such a time-controlled valve system with a primary control valve operatively connected with the abovementioned liquid pressure responsive valve actuating piston to control its feeding and/or the exhaust of hydraulic liquid therefrom. Under these conditions, the instant of actuation of said primary control valve constitutes the time origin for the timing of the valve system. More precisely, the origin of the timing operations during the active stroke of the valve actuating piston will correspond to the actuation of the primary valve for feeding the valve actuating piston, while the origin of the timing operations during the return stroke will correspond to the actuation of the primary valve for exhaust of liquid from the valve actuating piston.

Therefore, the present invention has for an object to provide a flow-controlling means interposed in a liquid utilization circuit between a source of liquid under pressure and a pressure-liquid receiving line which includes a chamber of a predetermined volume, a first conduit means between the source and the chamber and second conduit means between the source and the line. Calibrated restriction means are interposed in both said first and second conduit means so as to be effective to maintain similar flow characteristics therein, and valve means are operatively associated with said first and second conduit means and operable when open to establish two liquid flows through the restriction means. In addition, manually actuated means are provided to operate the valve means in the first conduit means to open position, whereupon responsive to fluid entering the chamber means are effective to substantially simultaneously operate the valve means in the second conduit means to open position. Further valve means are operably associated with said second conduit means to be capable of changing the flow conditions between the source and the line, and means are provided operable responsive to the filling of the chamber to open said further valve means to effect change of flow conditions, whereby a predetermined volume of liquid substantially proportional to the volume of the chamber is supplied to said line before said further valve means opens regardless of variations in the pressure of the source.

A more specific object of the invention is to provide a valve system including a timing device of the type described, wherein at least one of the controlled valves is interposed in a hydraulic circuit fed with pressure liquid from the same source as said valve actuating piston, sharp-edged orifices being interposed both in said circuit and in the pipe system of the valve actuating piston and wherein said valve actuating piston is operatively connected with said last-mentioned valve in such a manner that the said valve is open during a predetermined fraction of the stroke of said valve actuating piston.

In connection with the timing system or flow-controlling means of the invention, it is to be expressly pointed out that the pressure in the source, being constituted by an oleo-pneumatic accumulator, is so high that the effect of any back pressure load on the liquid-receiving line is negligible.

With this arrangement, the volume of liquid flowing in said circuit when said valve is open is well-defined. This results from the facts that the volume of liquid flowing to or from the chamber containing said valve actuating piston within the said stroke fraction is well-defined while said volumes are both proportional to the square root of the pressure drop in said source and hence, in a constant ratio.

p being the pressure in the source,

t the duration of the valve actuating piston stroke within which the said valve is open,

vo the amount of liquid flowing into or from the said valve actuating piston as the same effects the said stroke, due to the presence of the sharp-edged orifice in the pipe system of the valve actuating piston, the said amount of liquid may be expressed as follows:

$$vo=tK_1\sqrt{p}$$

K_1 being a constant.

Similarly, Uo being the volume of liquid flowing in the utilization circuit within the time t during which the valve is open, owing to the presence of a sharp-edged orifice in the said circuit is:

$$Uo=tK_2\sqrt{p}$$

K_2 being a constant.

The ratio between these two volumes is then:

$$\frac{vo}{Uo}=\frac{tK_1\sqrt{p}}{tK_2\sqrt{p}}=\frac{K_1}{K_2}=\text{constant}$$

Now,

$$vo=l\times S$$

l being the length of the above-mentioned valve actuating piston stroke and S being the cross-section of the valve actuating piston.

Thus, finally:

$$Uo=l\times S\times\frac{K_1}{K_2}$$

which formula exclusively includes fixed or constant values, so that Uo has a well-defined value that depends neither on the pressure in the source nor on the duration of the fraction of the valve actuating piston-stroke during which the valve is open.

In other words, this arrangement permits flowing through a utilization circuit a predetermined amount of liquid even if the pressure in the source of said liquid happens to vary. Thus a well-defined and limited flow of liquid will be obtained whenever the primary valve of the system is actuated. For example, this will permit imparting a stroke of well-defined amplitude and regulated speed to a liquid pressure responsive valve actuating pis-

ton by a mere push-button like actuation of a primary valve.

A more specific object of the invention is to provide a valve system of the type described, adapted to ensure feeding of a utilization circuit with pressure liquid in two successive steps corresponding to different rates of flow.

A still more specific object of the invention is to provide a valve system of the type described in the last paragraph, wherein the first step of feeding is controlled by a valve associated with a sharp-edged orifice, as described above, and wherein the feeding of the utilization circuit is ensured by the same source as the feeding of the actuating piston.

With this arrangement, during the said first step, the utilization circuit is fed with a predetermined amount of liquid.

In an embodiment of the invention, the two-step operation of the above-described valve system is preceded by the closing of a discharge valve for the liquid pressure responsive valve actuating piston, which valve is open when the said actuating piston is not fed with pressure liquid. In this embodiment, the operation of the valve system comprises three steps. Step 1: preliminary stroke during which the exhaust valve is closed; step 2: predetermined stroke within which only one valve is open; step 3: final stroke during which the second valve is opened, the first one remaining open or not.

Still another object of the invention is to control a second utilization circuit by means of the primary valve of the valve system described above, the said second utilization circuit being not, however, under the control of the liquid pressure responsive valve actuating piston. This permits disposing of a second control means actuated before the actions controlled by the valve system both during the active and the return strokes of the actuating piston.

Preferred embodiments of the invention will be hereinafter described with reference to the accompanying drawings, given merely by way of example.

In these drawings:

Figure 1 is an axial sectional view of a valve system controlled by a liquid pressure responsive valve actuating piston, according to the invention, for ensuring two different rates of feeding of a utilization circuit.

Figure 2 is a similar view of another embodiment in which the said valve system further ensures, prior to said feeding, the interruption of an exhaust circuit.

In both embodiments shown in the drawings, the liquid pressure responsive valve actuating piston provided for controlling the operation of the valve system comprises a piston **1** slidably mounted in a cylinder formed in a casing **2**. The valve system controls the feeding of a utilization circuit **3** from a source of hydraulic fluid constituted in the example shown, by an air-and-oil accumulator **4**.

The outlet pipe of the accumulator **4** is shown at **5** and **6** denotes a pipe feeding the utilization circuit **3** under the control of the valve system.

In the examples shown the actuating piston itself is fed from the accumulator **4** through the above-mentioned outlet pipe **5** and another pipe **7**, on which are interposed suitable means for controlling the feeding and/or exhaust of the said actuating piston. In both examples shown, said means are constituted by a primary valve **8** comprising a ball **9** continuously urged towards its seat by a spring **10**. The ball **9** may be taken off its seat by means of a manual control knob **11** of which the return spring is shown at **12**.

An exhaust controlling sliding valve **39** is interposed between the push knob **11** and the ball **9**.

When the knob **11** is depressed the sliding valve **39** first closes an exhaust outlet **42** and then the ball **9** is taken off its seat to establish a communication between the already mentioned feeding pipe **7** and a longitudinal passage **13** leading directly to the cylinder or chamber

accommodating piston **1**. Conversely, at rest, the ball **9** interrupts the said communication while the sliding valve **39** is clear of or uncovers the outlet **42**, so as to establish a communication through an exhaust pipe **40** between the longitudinal passage **13** and a tank **38**.

In the examples shown, the actuating piston **1** is continuously urged towards its resting position by a spring **14**. It carries a rod **15** tightly sliding in a hollow axial boss **16** of the casing **2**. The cylindrical bore **18** of the boss **16** communicates at its lower end with a counter-bore **19** of greater diameter, an annular shoulder **20** inter-connecting the inner walls of said bore and counter-bore.

In the counter-bore **19** is slidably mounted a hollow cylindrical valve **21**, provided with a reinforced end **21'**, which remains outside the counter-bore **19** in the cylindrical chamber **22**, which has a diameter greater than that of the said counter-bore, and which is connected therewith through a frusto-conical shoulder **23** that constitutes the seat of the movable valve **21**. The latter is continuously urged towards the said seat by a spring **24**. The chamber **22** communicates with the above mentioned pipe **6** through an axial passage **25** provided in the head **26** of the casing. The valve **21** controls the communication between the said chamber **22** and a radial outlet **27** that communicates with the utilization circuit **3** through the counter-bore **19**.

The valve **21** further comprises an axial cylindrical bore **28** opening in its upper face and a counter-bore **29** leading to its other face, i.e. to the chamber **22**; the said counter-bore **29** is connected with the bore **28** through an annular shoulder **30** acting as a seat for a ball **31**.

The freedom of the motion of the ball **31** in the counter-bore is limited by a thin partition **50** provided with a central calibrated hole **51** preferably constituting a sharp-edged orifice.

The rod **15** of the piston **1** is integral with a needle **32**, the lower end of which is adapted to actuate the ball **31**. For this purpose, the needle **32** is, of course, longer than the bore **28** to a predetermined extent of which the exact value will be defined later.

Finally, in the example shown in Figure 1, a sharp-edged orifice **33** is interposed on the pipe **7**, i.e. between the source of hydraulic fluid **4** and the primary valve **8**.

Under these conditions, the exhaust of liquid from the actuating piston through the outlet **42** is not opposed by the sharp-edged orifice **33** which only controls the feeding of the actuating piston.

This device operates as follows:

When the control knob **11** is depressed, it first closes the exhaust outlet **42** and takes the ball **9** off its seat to establish a communication between the actuating piston and the accumulator **4** under the control of the orifice **33**. Oil from the accumulator **4**, is then sent to the actuating piston with a rate of flow which, as indicated in the preamble, is substantially proportional to the square root of the pressure in said accumulator.

Immediately after leaving its resting position (or after a neutral stroke corresponding to the clearances existing in the mechanism), the piston **1** lifts the ball **31** through the rod **15** and the needle **32** to establish a communication between the accumulator **4** and the utilization circuit **3** under the control of the sharp-edged orifice **51** through the pipes **5** and **6**, the axial passage **25**, the chamber **22**, the sharp-edged orifice **51**, the counter-bore **29**, the bore **28**, the radial port **43**, the counter-bore **19** and the outlet **27**. From this moment, the circuit **3** is fed with a rate of flow which is substantially proportional to the square root of the pressure in the accumulator **4**. Under these conditions, the amount of oil sent into the utilization circuit within a given time, is proportional to the amount of oil sent into the chamber accommodating the actuating piston within the same time. These conditions prevail as long as the end **15'** of the

rod 15 does not come into contact with the valve movable member 21 as described hereafter.

As a result, during that portion of the stroke of piston 1, which is comprised between the opening of the valve 21 and the actuation of the valve 31, a predetermined amount of oil, independent of the pressure, is sent into the utilization circuit 3.

As it continues its stroke, the piston 1 after its rod 15 has come into contact with the valve member 21, lifts the latter off its seat, which establishes a second higher rate of feeding including, on the one hand, a direct flow from the accumulator 4 towards the utilization circuit 3 through the pipes 5 and 6, the axial inlet 25, the chamber 22, the counter-bore 19, and the outlet 27, and, on the other hand, a flow through the above described circuit passing through the sharp-edged orifice 51. This is due to the fact that in both examples shown, during this second step of the operation of the valve system both valves 31 and 21 are simultaneously open.

In the embodiment of Figure 2, the above described valve system ensures, further to the two previously described rates of feeding, the prior closing of an exhaust valve 44 integral with the needle 32 and co-operating with the seat 45 integral with the rod 15, the said valve 44 being open when the actuating piston is not fed to establish a communication between the utilization circuit 3 and an exhaust pipe 37 leading to a tank 38 through the counter-bore 19, a longitudinal passage 34 provided along generatrices of the valve 21, an axial bore 35 of the piston rod 15, a radial port 36 in the wall of the said rod and the main bore of the casing 2.

The closing of the valve 44 is ensured at the beginning of the stroke of the piston 1 by the seat 45 which is pressed against the said valve whereupon this pushing connection allows the opening of the valve 31 by the needle 32 against the action of a spring 55 which ensures both the return of the movable assembly 44—32 and the tightness of the exhaust valve.

This device is completed, in the example shown in Figure 2, by a derivation line 41 provided to feed a second utilization circuit in parallel with the circuit 3 without this second feeding being subjected to the control of the valve 21. On the other hand, in this example, the sharp-edged orifice 33 is interposed between the root of the line 41 and the actuating piston. Owing to this arrangement, the feeding and the exhaust of the actuating piston are both controlled by the sharp-edged orifice 33, while the latter has no action whatsoever on the second utilization circuit associated with the derivation line 41. The feeding and exhaust of this second circuit are however controlled by the primary valve 8.

In a general manner, while it has been, in the above description, disclosed what deemed to be practical and efficient embodiments of the invention, it should be well understood that it is not wished to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention.

Furthermore it should be pointed out that in this specification as well as the appended claims, the control of a rate of flow by means of a sharp-edged orifice as a function of a pressure in the source does not mean the absolute pressure in the source, but its relative pressure with respect to that of the system to be fed. This simplification is perfectly justified particularly in the example described since during the first time of the operation of the valve system the pressure in the assembly and the pressure in the utilization circuit are both practically negligible with respect to the absolute pressure in the source.

What is claimed is:

1. A flow-controlling means interposed in a liquid utilization circuit between a source of liquid under pressure and a pressure-liquid receiving line, comprising means defining a chamber of a predetermined volume, a first conduit means between the source and the chamber and a second conduit means between the source and the line, calibrated restriction means interposed in said first and second conduit means and effective to maintain similar flow characteristics therein, valve means operatively associated with said first and second conduit means and operable when open to establish two liquid flows through said restriction means, manually actuated means to operate the valve means in said first conduit means to open position, means operable responsive to flow of liquid into said chamber to substantially simultaneously operate the valve means in said second conduit means to open position, further valve means operable to change the flow conditions between said source and said line, and means operable responsive to the filling of said chamber to open said further valve means to effect said change of flow conditions, whereby a predetermined volume substantially proportional to the volume of the chamber is supplied to said line before said further valve means opens regardless of variations in the pressure of the source.

2. A flow-controlling means interposed in a liquid utilization circuit between a source of liquid under pressure and a pressure liquid-receiving line, comprising means defining a chamber of a predetermined volume, first conduit means between said source and chamber, second conduit means between said source and said line, calibrated restriction means interposed in said first and second conduit means and effective to maintain similar flow characteristics therein valve means between each restriction means and said chamber and line respectively and operable when open to establish two liquid flows through said restriction means, manually actuated means to operate the valve means in said first conduit means to open position, means operable responsive to flow of liquid into said chamber to substantially simultaneously operate the valve means in said second conduit means to open position, further valve means operable to change the flow conditions between said source and said line, and means operable responsive to the filling of said chamber to open said further valve means to effect said change of flow conditions, whereby a predetermined volume substantially proportional to the volume of the chamber is supplied to said line before said further valve means opens regardless of variations in the pressure of the source.

3. A flow-controlling means as claimed in claim 1 including a casing, said casing having a cylindrical piston-accommodating portion therein, a piston within said portion, said chamber being defined by the interior of said portion and a face of the piston, said first conduit means comprising an inlet port means associated with the casing in axially spaced relation with respect to said piston, said casing having passage means therein having one end in communication with said piston accommodating portion and the other end in communication with said inlet port means, said passage means further having a surface incorporated therewith defining a valve seating, said first-mentioned valve means including a first movable valve operatively associated with said passage means between said inlet port and said piston accommodating portion and means normally holding said first movable valve on said valve seating, means operably associated with said piston and normally urging the same axially of said casing to a position in which the interior of said piston accommodating portion of the casing has minimum volume, said second conduit means comprising an outlet port associated with said casing in axially spaced relation with respect to said piston, a second inlet port associated with said casing in axially spaced relation with respect to said first inlet port and means in the interior of said casing defining a further passage providing communication between said second inlet port and said outlet port, a second valve seating in said further passage, both said first and second mentioned inlet ports being in communication with said source of liquid under pressure, said further valve means being movable and operatively

associated with said second-mentioned valve seating, means normally urging said further valve means to closed position on said second valve seating, said further valve means having a chamber therein, one of said calibrated restriction means being incorporated with said further valve means between said chamber and said second inlet port, said first-mentioned valve means also including a second movable valve operably associated within said chamber for normally preventing the passage of liquid to said outlet port, said further valve means having a port means therein providing communication between said chamber and said outlet port when said second movable valve is open, the means operable responsive to the filling of said chamber including means operably coupled to said piston to engage said further valve means to move the same to open position in response to a predetermined piston movement toward said outlet port when said first movable valve is open and fluid flows from source to the piston accommodating portion of the casing, the expansion of the volume of said piston accommodating portion in response to piston movement sufficient to open said further valve means defining the predetermined volume of said chamber, the means operable responsive to the flow of liquid into said chamber including additional means coupled with said piston for initiating movement of said second movable valve in response to initial movement of said piston, the other of said calibrated restriction means being interposed between said source and said piston accommodating portion of the casing, and said manually actuated means including a movable member for initiating opening movement of said first movable valve whereby fluid flows from source into said piston accommodating portion to initiate movement of said piston toward said outlet port, so as to move said second movable valve to open position to substantially simultaneously establish communication between source and said outlet port whereby said two liquid flows of similar characteristics are established following which, in response to further movement of said piston, said further valve means is opened to establish different flow conditions from source through said outlet port.

4. A flow-controlling means as claimed in claim 3 in which said manually actuated means comprises a push button, spring means normally urging the same to inoperative position, said movable member being mounted in alignment with said push button so that upon depression of the push button said member engages said first movable valve to move the same to open position.

5. A flow-controlling means as claimed in claim 4 and further including a second outlet port for connection to a second line, said second outlet port being associated with said casing and with said first-mentioned passage means downstream of said first movable valve, an exhaust port operably associated with said casing and said first passage means, said movable member of the manually actuated means being adapted to close said exhaust port before opening said first movable valve, a second exhaust port associated with said casing between said piston and said first outlet port, said means in the interior of the casing defining said further passage means including a boss within the casing having a tubular extension accommodating said further valve means and said second valve seating, said further valve means having a diameter less than said tubular extension so as to define a fluid passage on the interior of said extension, the means extending between said piston and said second movable valve including a tubular portion having a port for communication with said second exhaust port and a spring biased valve member accommodated by said further valve means, said spring biased valve member being normally open, whereby with both said first and second mentioned movable valves closed fluid can flow to exhaust from said first-mentioned line through the tubular extension of said boss, past said last-mentioned movable valve member and out of the casing through said second exhaust port whereas in response to actuation of said push button said movable member moves said first movable valve to open position, fluid enters the piston accommodating portion after passing through one of said calibrated restriction means, said piston moves toward said first outlet port so as to substantially simultaneously close communication with said second exhaust port and move said second movable valve to open position to permit fluid to flow out of said outlet port through said other calibrated restriction means whereupon further piston movement initiates opening movement of said further valve means through which liquid flow continues from source through said first outlet port.

References Cited in the file of this patent

UNITED STATES PATENTS

1,592,951	McLaughlin	July 20, 1926
2,073,168	Newell	Mar. 9, 1937
2,564,896	Gustafsson	Aug. 21, 1951
2,663,500	Holtzclaw	Dec. 22, 1953
2,780,296	Heigis	Feb. 5, 1957