United States Patent

Love

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[54] TIMING VALVES AND FLUID CONTROLLERS

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[73] Assignee: **Harold Brown Company**

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[21] Appl. No.: **821,745**

[52] **U.S. Cl.** **137/102**, 137/624.14

[51] **Int. Cl.** **F16k 31/12**

[58] **Field of Search** 137/624.14, 102

[56] **References Cited**

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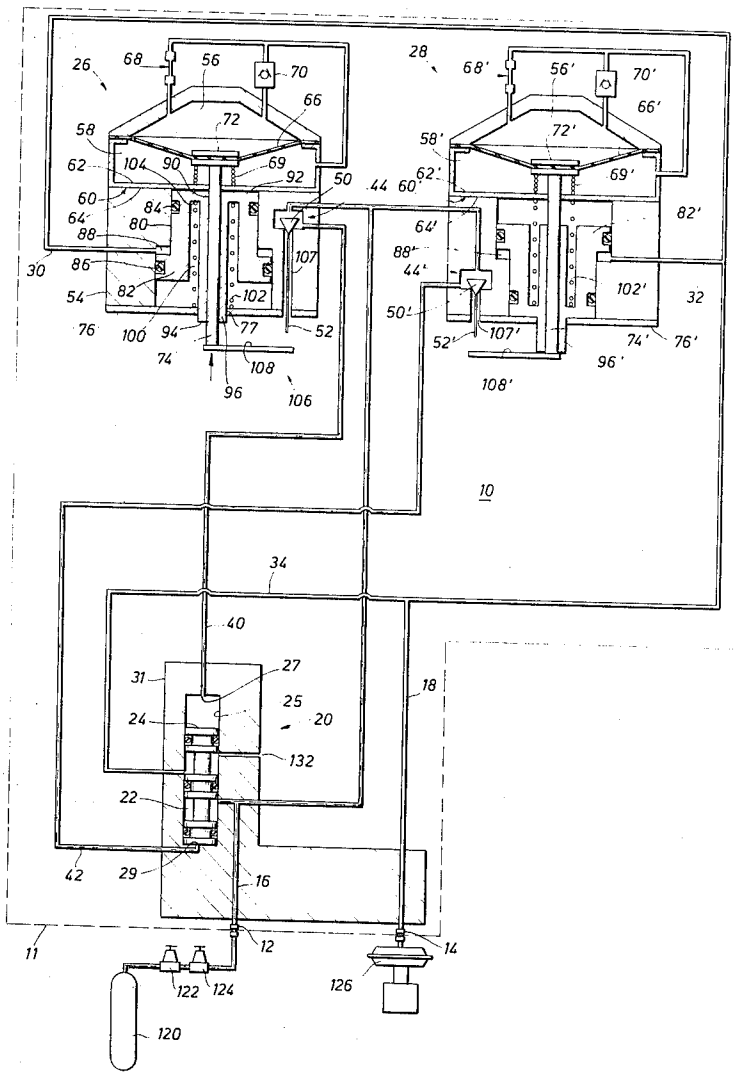
Primary Examiner—Alan Cohan

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[57] **ABSTRACT**

This invention relates to timing valves and to controllers using such timing valves for controlling the pressure fluid between a supply line and a utilization line servicing one or more pressure utilization devices with pressure signals of adjustable duration and frequency. The operation of a pair of complementary timing valves in the controller is synchronized by the pressure signals applied to the utilization line. One timing valve begins its predetermined delay period on the application of the pressure signal, while the other timing valve begins its delay period on the termination of the pressure signal. Each timing valve includes a time-calibrated variable orifice forming part of a timing chamber which includes fluid which is placed under pressure by a flexible diaphragm. A master control valve coupling the supply line to the utilization line is controlled by the successive displacements of the diaphragms.

10 Claims, 5 Drawing Figures



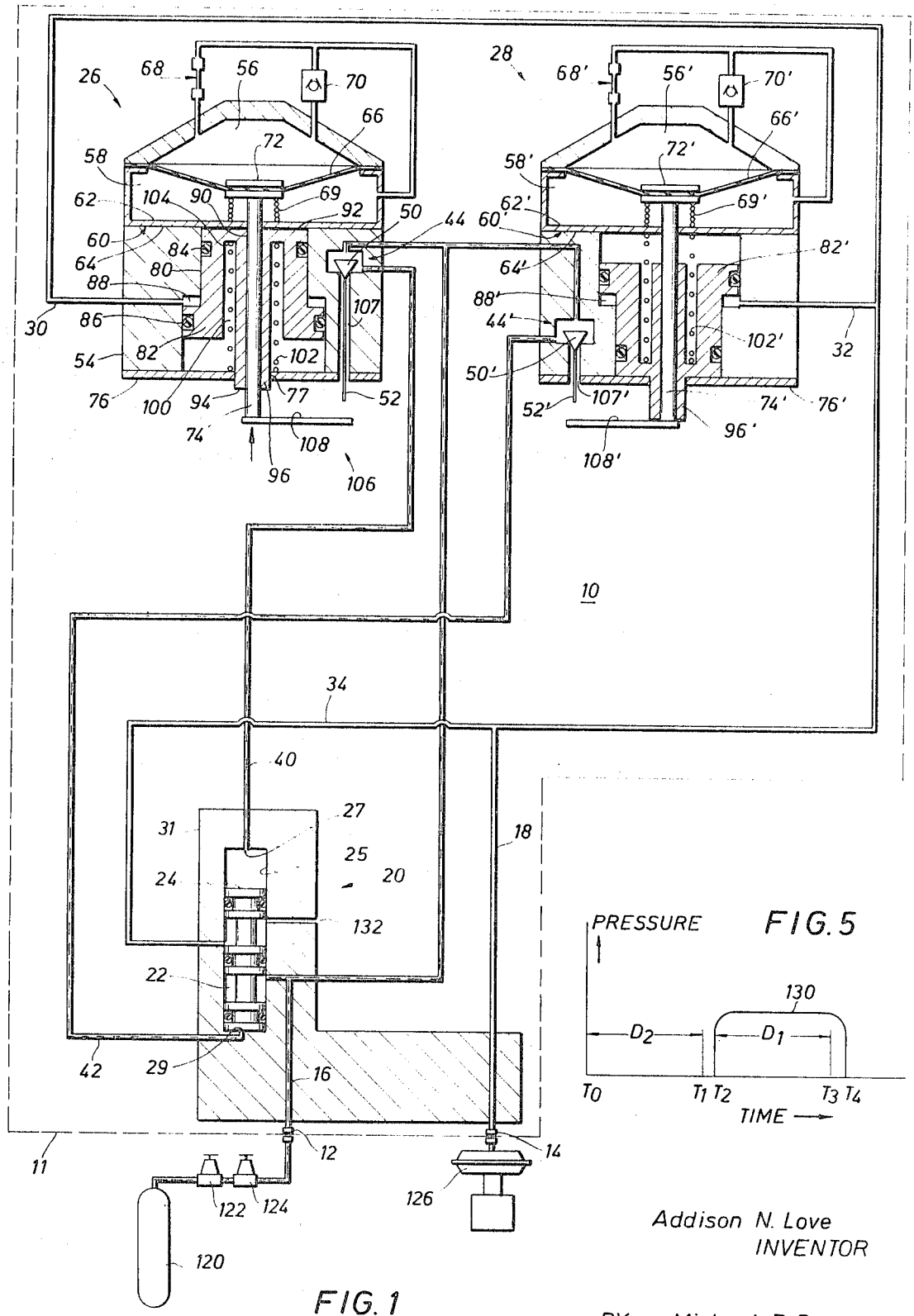


FIG. 1

FIG. 5

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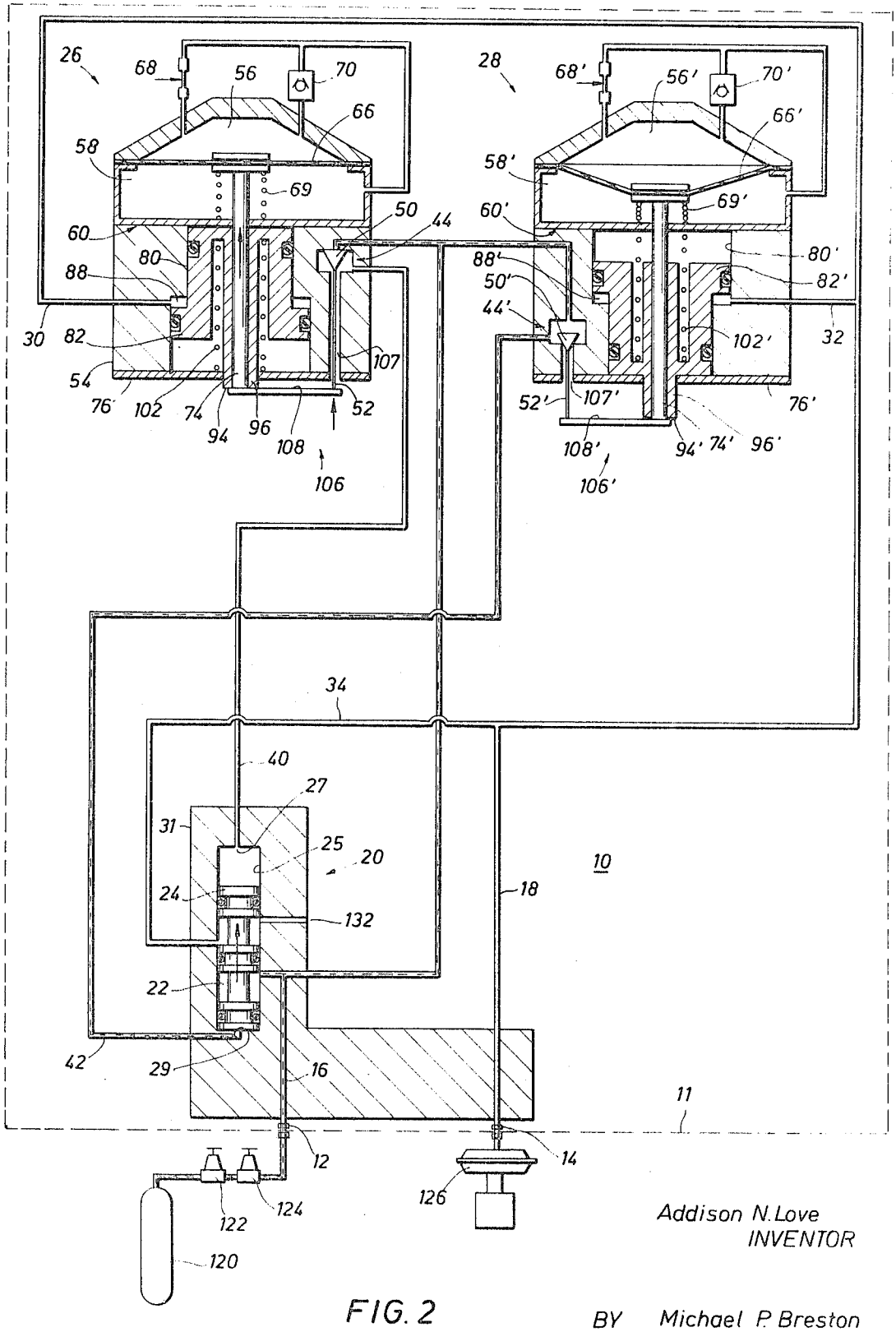


FIG. 2

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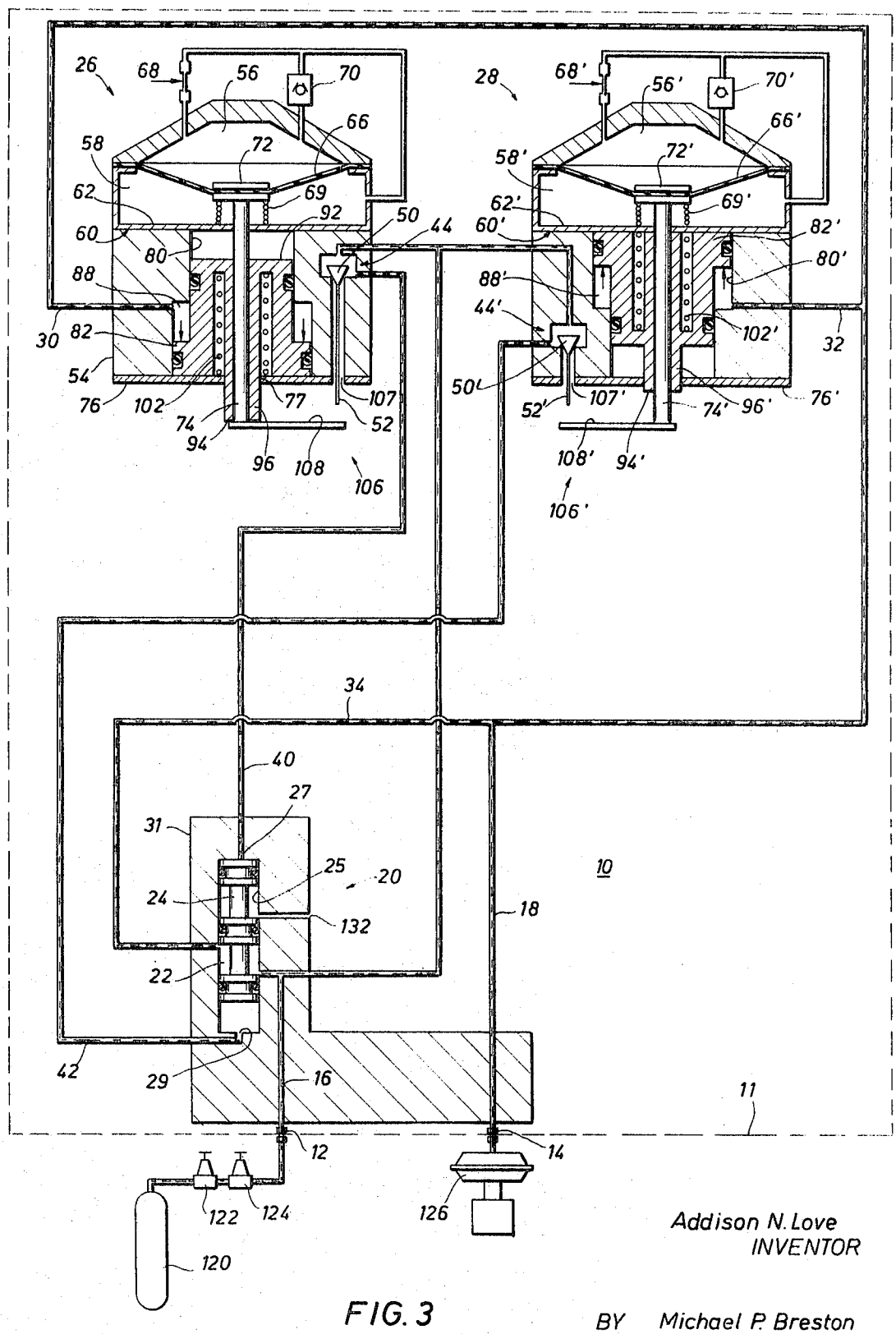


FIG. 3

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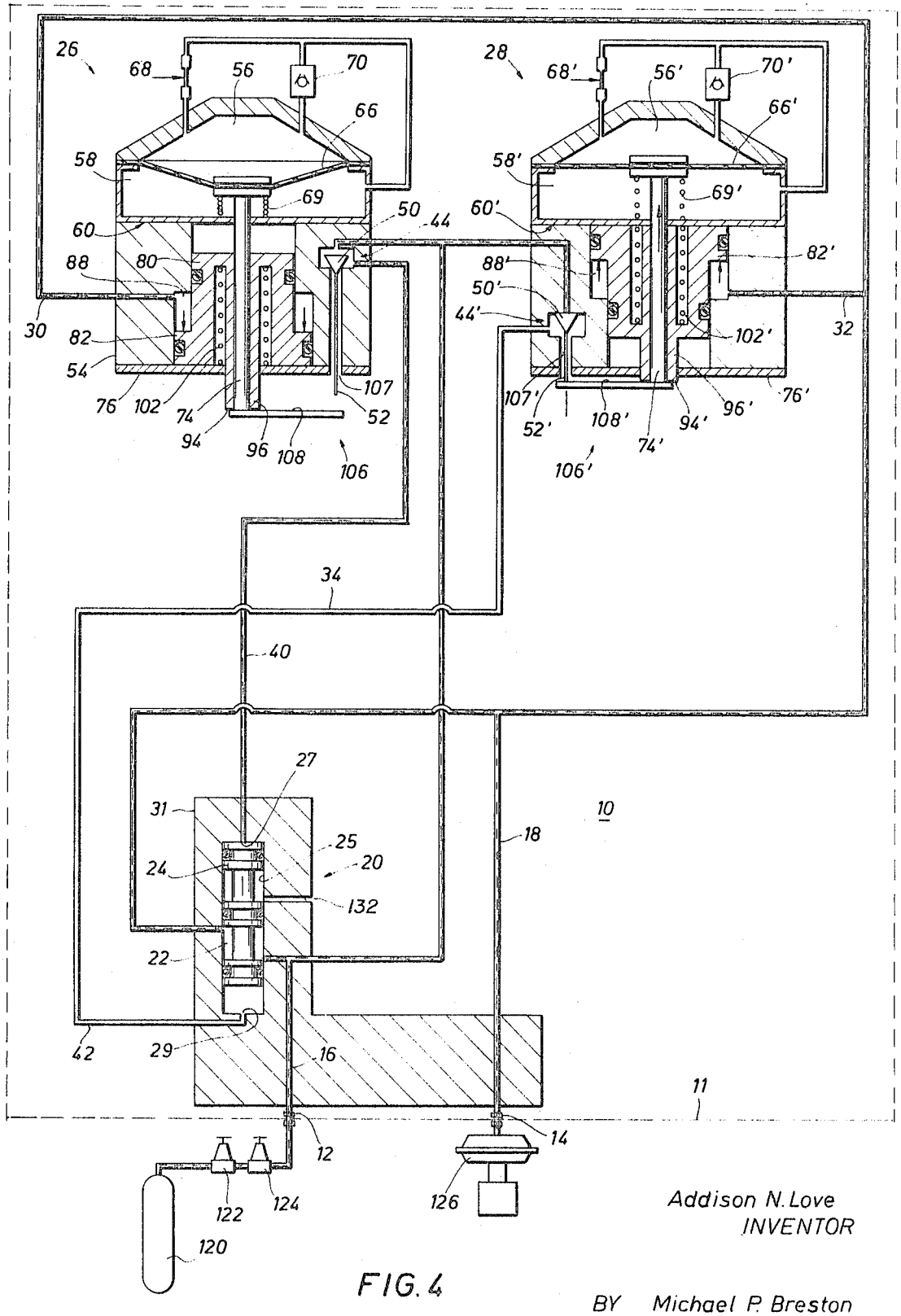


FIG. 4

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TIMING VALVES AND FLUID CONTROLLERS

BACKGROUND OF THE INVENTION

Pressure fluid utilization devices such as valves, motors, pneumatically operated fog horns, etc., are typically operated or controlled by fluid controllers providing pressure fluid signals having time adjustable ON and OFF intervals. Such controllers for extracting from a supply source pressure signals are well known. Typically they employ timing mechanisms which are recycled by solenoids or fluid-controlled valves. Thus, an independent source of either electric power or pressure fluid must be provided to operate such controllers.

In some installations the lack of electricity, while in others a serious safety hazard, make the utilization of solenoid-controlled timing mechanisms undesirable. While fluid-controlled timing mechanisms are preferred for such installations, in the past they have required independent pressure fluid control sources. When the same supply pressure fluid source was used both to provide the desired intermittent pressure signals and to control the timing mechanisms, it was found that the operating life and the reliability of such controllers were rather poor. Another frequent problem encountered with such controllers was the relative difficulty to accurately control and/or maintain the duration and/or the frequency of the pressure signals.

It is therefore a main object of this invention to provide new and improved fluid-operated timing valves and controllers using such valves which overcome the above-mentioned and other shortcomings of prior art controllers.

SUMMARY OF THE INVENTION

Improved fluid-operated timing valves are provided for controlling pressure fluid between a supply line and a utilization line. A pair of such timing valves acting in a complementary manner are employed in a controller including a master control valve. The timing interval of one timing valve is initiated at the start of the pressure signal while the timing interval in the complementary valve is initiated at the end of the pressure signal. The valve spool in the master control valve is responsive to the resultant effect of the pressures in two pressure fluid lines. The pressure in each line is controlled by a timing valve.

Each of the pair of complementary timing valves includes a housing defining a timing chamber and a re-circulating chamber separated from each other by a flexible diaphragm. A timing spring when unrestrained urges the diaphragm to compress the fluid in the timing chamber. A time-calibrated variable orifice provides an outlet for the pressure fluid from the timing chamber to the re-circulating chamber. A control rod is coupled to the diaphragm and is movable therewith. Fluid-operated means are coupled to the rod to periodically restrain the rod and hence the diaphragm.

In one timing valve the rod is restrained at the start and in the other valve the rod is restrained at the end of the pressure signal in the utilization line. By using a pair of such complementary fluid-operated, diaphragm-controlled timing valves, a fluid-operated utilization device can be provided with pressure signals of independently adjustable duration and frequency.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate preferred timing valves and pressure fluid controllers using such valves in accordance with this invention and wherein:

FIG. 1 is a more-or-less diagrammatic view of such a pressure fluid controller in one of its control positions when the pressure signal is OFF;

FIG. 2 shows the position of the controller immediately prior to the leading edge of the pressure signal;

FIG. 3 shows the position of the controller when the pressure signal is ON;

FIG. 4 shows the position of the controller immediately prior to the trailing edge of the pressure signal; and

FIG. 5 is a pressure time diagram helpful in understanding the operation of the controller.

Referring now more particularly to the accompanying drawings, wherein like reference characters are applied to like parts throughout the views, there is shown a fluid controller generally designated as **10** in a housing **11**. Controller **10** is adapted to continuously receive at an inlet port **12** pressure fluid and to periodically supply to an outlet port **14** pressure signals of adjustable duration and frequency. Inlet port **12** is connected to an inlet line **16**, and outlet port **14** is connected to a utilization or signal line **18**. Fluid communication between inlet line **16** and signal line **18** is governed by a master control valve, generally designated as **20**. Valve **20** defines a passageway **22** which is either open or closed depending on the position of its spool valve **24** in a bore **25**. Bore **25** is in fluid communication with two axially opposed control ports **27, 29** in the body **31** of valve **20**. To control the displacement of spool **24** there are provided two fluid-operated timing valves.

One timing valve, generally designated as **26**, is actuated by pressure fluid in a branch line **30**. The other timing valve, generally designated as **28**, is actuated by pressure fluid in a branch line **32**. Both branch lines **30, 32** and signal line **18** are connected to a main line **34** which receives pressure fluid from the master valve **20** when passageway **22** is open.

The displacement of spool **24** in bore **25** is controlled by the combined effect of pressure fluid in lines **40** and **42**, respectively coupled to control ports **27** and **29**. Inlet line **16** is connected to line **40** through a pilot valve **44** and to line **42** through a pilot valve **44'**. Timing valve **28** provides a timed delay interval D_1 on the application of pressure fluid through line **32**, whereas timing valve **26** provides a timed delay interval D_2 on the removal of pressure fluid from line **30**. At the end of interval D_2, the pressure in line **40** is reduced causing the upper (as shown in the drawings) displacement of spool **24**. At the end of interval D_1, the pressure in line **42** is reduced thereby allowing spool **24** to move downwardly. When both lines **40** and **42** are under substantially equal pressure, the acting forces on spool **24** are balanced and spool **24** remains in the same position it assumed prior to both lines **40, 42** being under equal pressure. When spool **24** is in its upper position, fluid passageway **22** is open to allow fluid pressure communication between inlet line **16** and main line **34**.

The timing valves **26, 28** will now be described in greater detail. Valve **26** will hereinafter be referred to as the "cycle timer" since it controls the OFF-time of the pressure signal, and valve **28** will hereinafter be referred to as the "signal timer" since it controls the ON-time of the signal. Cycle timer **26** controls the displacement of a valve element **50**, schematically represented by a triangle, in pilot valve **44**. Valve element **50** is connected to an elongated stem **52** which extends outwardly of housing **54** of timer **26**. Housing **54** defines a timing chamber **56**, a recycling chamber **58**, and includes a partition wall **60** having an upper face **62** and a lower face **64**. Separating the timing chamber **56** from the recycling chamber **58** is a flexible diaphragm **66**. The fluid from timing chamber **56** is allowed to vent out into the recycling chamber **58** through a time-calibrated orifice schematically represented as **68** contained in one or more dials (not shown). Fluid is allowed to enter the timing chamber **56** from the recycling chamber **58** through a suitable check valve **70**.

The timing mechanism portion of timer **26**, which includes the diaphragm, the timing and recycling chambers, the calibrated orifice and the check valve, forms no part of this invention and can be purchased commercially. One such timing device offers nine discrete ranges from 0.2 seconds to 60 minutes, adjustable by means of time-calibrated dials which control the opening of orifice **68**.

A brief description of the operation of the conventional diaphragm-operated timing mechanism will now be given. A spring **69** is positioned between a center head **72**, in the center of diaphragm **66**, and the upper face **62** of wall **60**. At the start of the timed interval D_2, diaphragm **66** is pulled downwardly toward wall **60**, thereby allowing fluid to enter timing chamber

56 through check valve 70. Spring 69 exerts an inward force on diaphragm 66 thereby compressing the fluid in timing chamber 56. The fluid is allowed to vent out from timing chamber 56 to the recycle chamber 58 at a rate depending on the time-calibrated opening of orifice 68.

In accordance with this invention to the center head 72 is secured a control rod 74 extending outwardly through an opening 77 in end wall 76 of housing 54. Between the lower face 64 of partition wall 60 and end wall 76 is provided a double-diameter cylinder 80 slidably receiving therein a double-diameter piston 82 having an upper O-ring 84 and a lower O-ring 86 to define therebetween a fluid-tight control chamber 88 which communicates with line 30. Piston 82 has an axial bore 90 which extends from its upper face 92 to its lower face 94. Lower face 94 terminates a control finger 96 which may be integral part of the body of piston 82, as shown in cross-section. Piston 82 includes a downwardly directed cylindrical opening 100 housing a piston bias spring 102 resting against end wall 76 and against the bottom wall 104 in the cylindrical opening 100. Spring 102 normally urges piston 82 upwardly whereas pressure fluid in chamber 88 urges piston 82 downwardly against the force of spring 102.

Coupled to the free end of actuating rod 74 is an actuation mechanism generally designated as 106, which, in its simplest form, may include a horizontal (as shown in the drawings) lever arm 108 having a sufficient length so that it can lift stem 52 when actuating rod 74 is in its raised position. Movement of stem 52 unseats the pilot valve element 50 of the three-way pilot valve 44 thereby discontinuing or throttling down the pressure fluid communication between inlet line 16 and control line 40, while at the same time allowing the pressure in line 40 to exhaust through vent 107 around stem 52.

The signal timer 28 is in all respects similar to the cycle timer 26 except that in timer 28 the double-diameter piston is inverted and the force exerted by the piston bias spring is in an opposite direction. Therefore, to facilitate the understanding of the timers 26 and 28 like reference characters added with a prime have been applied to like parts in timer 28. The difference in the operation of timer 28 from that of timer 26 will become apparent from the description of the operation which follows. For the sake of completeness, normally connected to the input 12 of controller 10 is a pressure fluid source 120 supplying pressure fluid to input line 16 via suitable valves 122, 124. To the output 14 of controller 10 is connected a suitable utilization device such as a motor valve 126. Obviously any other utilization device may be connected to controller 10.

DESCRIPTION OF OPERATION

In FIG. 5 an arbitrary initial time instance was selected and designated as T_0. The condition of controller 10 at time T_0 is shown in FIG. 1. Spool 24 is then at its lowermost position. Finger 96 is raised to allow spring 69 to initiate the time interval D_2. Finger 96' is at its lowermost position to prevent spring 69' from exerting a force against diaphragm 66'. As a result, lever 108 is disengaged from stem 52 and lever 108' is disengaged from stem 52'. Fluid communication between inlet line 16 and control lines 40 and 42 is established through the three-way pilot valves 44 and 44'. Since the same pressure fluid is in both lines 40, 42, spool 24 is not subjected to an unbalanced force and remains in its lowermost position thereby closing the fluid passageway 22 between inlet line 16 and main line 34.

Depending on the time set on the dial of the variable orifice 68, fluid from timing chamber 56 is allowed to vent out into the recycling chamber 58. The transfer of fluid from timing chamber 56 allows diaphragm 66 to move inwardly and actuating rod 74 to move upwardly.

At time $T_1 = D_2$, diaphragm 66 has traveled from its extended position to its relaxed position, as shown in FIG. 2. Since operating rod 74 also traveled with diaphragm 66, lever arm 108 will engage stem 52 causing pilot valve element 50 to become unseated, thereby reducing pressure fluid communication between lines 16 and 40 and allowing the pressure fluid in line 40 to escape through vent 107. A reduction in pressure in line 40 causes an upward force to become exerted on spool 24 by the pressure fluid in line 42. At time T_2, spool 24 will have shifted from its lowermost position to its uppermost position as shown in FIG. 3. The direction of the acting forces on the various parts are shown throughout the drawings by arrows.

When spool 24 is in its uppermost position, fluid communication is established between line 16 and main line 34 through the passageway 22 in the master control valve 20. As soon as pressure fluid is established in line 34 it is communicated through branch lines 30, 32 to the actuating chambers 88, 88', respectively. As a result, piston 82 moves downwardly and piston 82' moves upwardly.

Of course, pressure fluid in main line 34 provides pressure fluid to outlet 14 and hence to utilization device 126. Thus, at time T_2 starts the leading edge of the pressure signal or pulse, subsequent to time interval D_2 provided by cycle timer 26.

Since finger 96' is in its uppermost position, timing spring 69' is no longer restrained and is allowed to exert a force against the fluid in timing chamber 56'. Just as with cycle timer 26, the operating rod 74' moves upwardly until lever 108' is allowed to engage the stem 52'. The lifting of the pilot valve element 50' produces at time T_3 a reduction in the pressure in line 42, as shown in FIG. 4, and the ensuing downward displacement of spool 24 at time T_4, thereby marking the trailing edge of the pressure signal or pulse 130.

The position of the controller 10 thereafter will be the same as shown in FIG. 1. The controller 10 is ready to start its operating cycle all over again.

The entrapped fluids in master control valve 20 are vented through vent 132. As will be seen from FIG. 5, time interval $D_2 = T_1$ and time interval $D_1 = T_3 - T_2$.

What I claim is:

1. In a fluid controller having a fluid inlet and a fluid outlet, the inlet being connectable to a pressure fluid source, the outlet being connectable to a pressure fluid utilization device, the controller comprising:

a master control valve connected between said inlet and said outlet to provide to said outlet periodic pressure pulses,

said master control valve having a first control port and a second control port,

a valve element responsive to the resultant pressure between said first and second control ports thereby generating said pressure pulses;

a first pilot control valve connected between said inlet and said first port;

a first fluid-operated timer intermittently closing the first pilot valve;

a second pilot control valve connected between said inlet and said second port;

a second fluid-operated timer intermittently closing the second pilot valve;

a first fluid line connecting said outlet to said first fluid-operated timer;

a second fluid line connecting said outlet to said second fluid-operated timer;

said first pilot valve being normally open to allow fluid communication between said inlet and said first control port and being closed after a predetermined first time interval subsequent to the application of pressure fluid from said inlet to said outlet; and

said second pilot valve being normally open to allow fluid communication between said inlet and said second control port and being closed after a predetermined second time interval subsequent to the removal of pressure fluid from said outlet; and

each of said fluid-operated timers including:

a timing chamber,

a recycling chamber,

a flexible diaphragm separating said timing chamber from said recycling chamber,

a timing spring coupled to said diaphragm to urge said diaphragm in a direction to compress the fluid in said timing chamber when said spring is unrestrained, and

means including an adjustable orifice to allow the fluid from said timing chamber to flow into said recycling chamber.

2. The fluid controller of claim 1 and further including:

a control rod attached to said diaphragm and movable therewith,

fluid actuatable means responsive to the pressure fluid in said outlet for periodically restraining said diaphragm spring, and

actuating means coupled to said rod for controlling the fluid flow through said pilot control valve.

3. The controller of claim 2 wherein,

said fluid actuatable means include a piston having a center bore for slidably receiving said rod,

a piston-bias spring normally urging said piston toward said timing chamber, and

said piston moving away from said timing chamber in response to applied fluid pressure.

4. The controller of claim 2 wherein,

said fluid actuatable means include a piston having a center bore for slidably receiving said rod,

a piston-bias spring normally urging said piston away from said timing chamber, and

said piston moving toward said timing chamber in response to applied pressure fluid.

5. A fluid controller including:

at least one master control valve comprising a body having a fluid inlet, a fluid outlet, and a valve element adapted to move when actuated to control fluid communication between said inlet and said outlet;

at chamber, one fluid-operated timer comprising a timing chamber, a recycling chambjer, a flexible diaphragm separating said timing chamber from said recycling chamber, timing means including an adjustable orifice to allow the fluid from said timing chamber to flow into said recycling chamber, and a control element coupled to said diaphragm and movable therewith;

actuating means coupled between the control element and said valve element for moving said valve element in response to the movement of said control element thereby providing to said outlet periodic fluid pulses;

a timing spring coupled to said diaphragm to urge said diaphragm in a direction as to compress the fluid in said timing chamber when said spring is unrestrained, and

restraining means for periodically restraining said diaphragm spring.

6. The fluid controller of claim 5 wherein the body of said master control valve defines a bore, and said valve element is a spool slidable in said bore.

7. The fluid controller of claim 6 wherein said restraining means are responsive to the fluid in said outlet.

8. A fluid controller including:

at least one master control valve comprising a body having a fluid inlet, a fluid outlet, and a valve element adapted to move when actuated to control fluid communication between said inlet and said outlet;

a first fluid-operated timer;

a second fluid-operated timer;

each of said first and second timers comprising a timing chamber, a recycling chamber, a flexible diaphragm separating said timing chamber from said recycling chamber, timing means including an adjustable orifice to allow the fluid from said timing chamber to flow into said recycling chamber, and a control element coupled to said diaphragm and movable therewith;

first actuating means coupled between the control element of said first timer and said valve element;

second actuating means coupled between the control element of said second timer and said valve element;

said valve element being movable in response to the resultant effect produced by said first and second actuating means to provide to said outlet periodic fluid pulses;

each timer including;

a timing spring coupled to the diaphragm to urge the diaphragm in a direction as to compress the fluid in said timing chamber when said spring is unrestrained, and

restraining means for periodically restraining the diaphragm spring.

9. The fluid controller of claim 8 wherein the body of said master control valve defines a bore, and said valve element is a spool slidable in said bore.

10. The fluid controller of claim 9 wherein said restraining means are responsive to the fluid in said outlet.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,653,393 Dated April 4, 1972

Inventor(s) ADDISON N. LOVE

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 35, "chamber," should read -- least --;

line 36, "chambjer" should read -- chamber --.

Signed and sealed this 8th day of May 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.