United States Patent [19]

Cohen

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[54] DIGITAL VALVE

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[51] **Int. Cl.**.....**F16k 31/365**

[58] **Field of Search**.....137/625.6, 625.66, 137/596.14, 625.65; 251/28, 29

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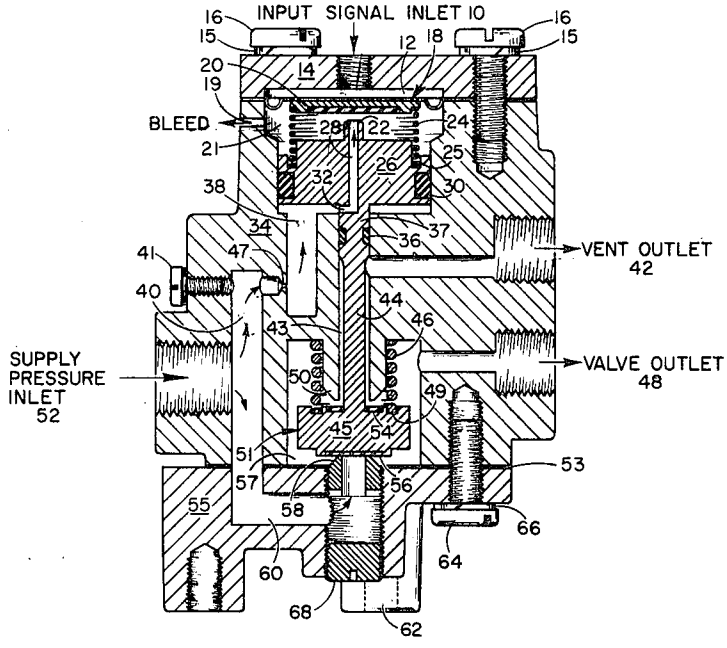
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[57] **ABSTRACT**

A snap-acting, fluid amplifying valve having an input pressure chamber actuating a spring loaded diaphragm. Depending on whether the input pressure is higher or lower than a preset level, the diaphragm, respectively, expands or contracts to restrict or relive a nozzle assembly mounted on a slidable piston, within the body of the valve, causing the piston to act in a digital manner. This digital action results from the positive feedback of pressure from the nozzle restriction to the driving side of the piston which forces the piston and nozzle to move farther in the direction of initiated motion. The slidable piston is rigidly connected to a second piston which alternately seals either a supply pressure port or a vent port of the outlet chamber and, in this way, a digital signal of supply pressure is obtained. The spring loading of the diaphragm is determined of nozzle restriction and consequently digital action occurs at pressure levels preset by the stiffness of the spring used.

7 Claims, 2 Drawing Figures



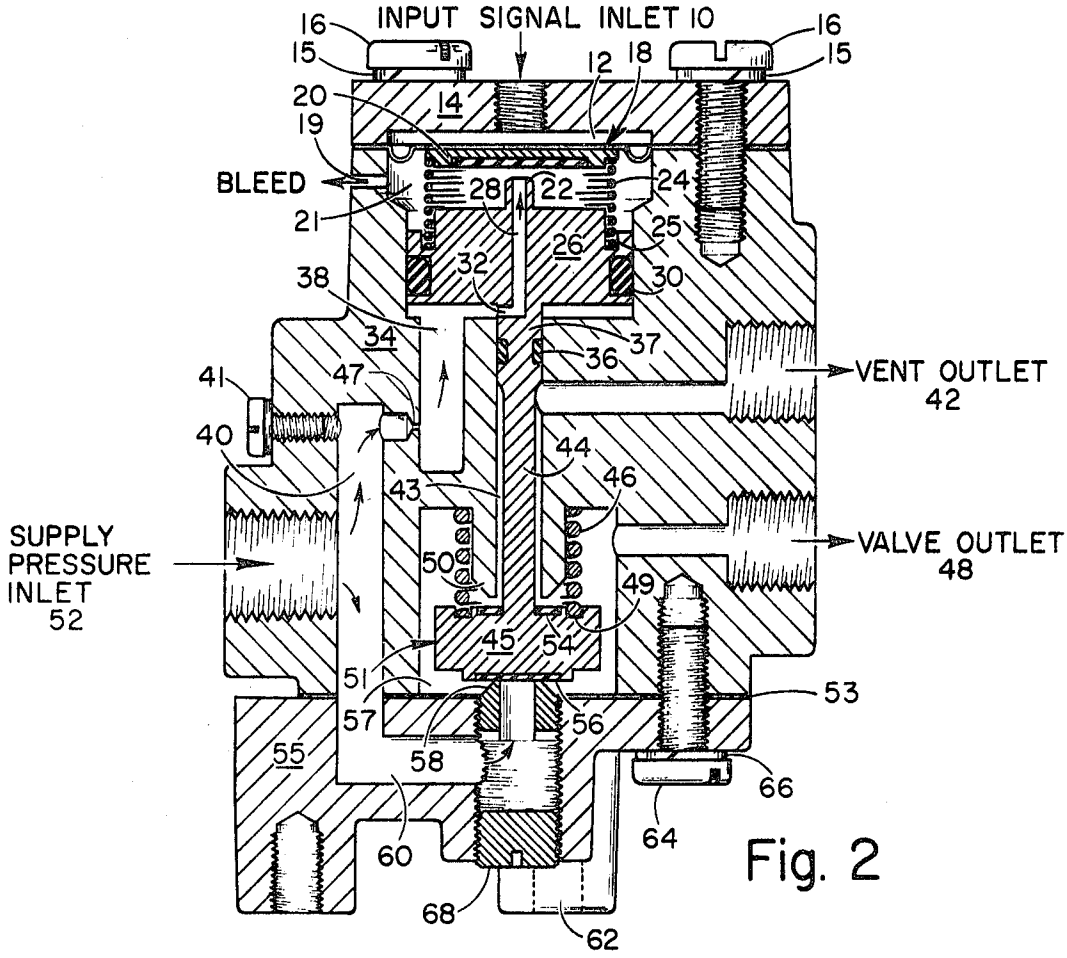


Fig. 2

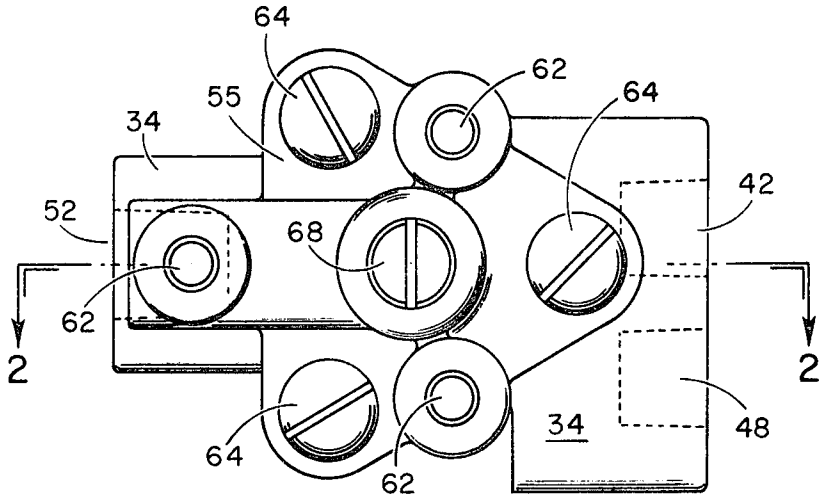


Fig. 1

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DIGITAL VALVE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to snap-acting, or digital pressure amplifying valves in general and more specifically to valves wherein this snap action is obtained through a restriction or relief of a nozzle used to vent a connected pressure chamber.

The invention is particularly applicable for use in fluidic control systems employing relatively low pressure digital logic signals and will be described with particular reference thereto although it will be appreciated that the invention has broader applications such as in pneumatic systems of various configurations.

2. Description of the Prior Art

Fluid amplifying valves presently known comprise a nozzle which is stationary and an input pressure diaphragm which moves toward the nozzle to restrict this venting means and thereby build up switching pressure. In this type of apparatus, the problem is that full closure of the nozzle is a relatively slow action. Since there is no positive feedback of the nozzle pressure to drive the nozzle toward the diaphragm, digital action depends on a rapidly increasing signal applied to the input diaphragm through some external means. The valve is only then able to perform the necessary signal amplification in a digital manner.

Some other known fluid amplifying valves provide positive feedback of nozzle back pressure by using a common supply chamber for the amplifying valve output as well as for the driving pressure to a nozzle. This common chamber is connected directly to the nozzle which acts as a vent, and the common chamber generally has an aligned second nozzle supplying pressure to it with the second nozzle outlet arranged to input into the vent nozzle. This arrangement causes a negative pressure in the common chamber when the vent nozzle is unrestricted since chamber air is induced into the vent nozzle along with the supply pressure stream.

The problem here is that a characteristic non-zero "off" condition of the valves exists in one state of operation.

The principle of operation used in some of the devices known is where the supply pressure is constantly being inputed into an output chamber from which it is vented through a vent port during the off condition and outputed through an outlet port during the "on" condition. Static pressure regain during the on condition converts the velocity pressure into static pressure resulting in an amplification of static pressure. This results in a waste of supply air during the valve off condition due to the required venting of the output chamber to relieve static pressure.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided a snap-acting, fluid amplifying valve where a low pressure input signal, such as obtained from a fluidic logic device, activates a piston assembly thereby amplifying the input signal to produce a high pressure digital output signal. The piston assembly is positioned in a pressure housing between a supply chamber and a venting chamber. The piston assembly is capable of sliding within the pressure housing to either cause the valve to provide the high output signal or to seal the supply chamber and cut off the output signal of the valve.

After the supply chamber is sealed, the output is restored to supply pressure level by a means for breaking this seal in a snap-acting manner. This is accomplished by pressurizing a driving chamber in response to an increased signal input level to drive the piston assembly so as to break the seal. The piston assembly movement causes increased driving chamber pressure and consequently snap-action switching.

The invention provides for positive feedback through a nozzle located on the face of the piston assembly projecting into the venting chamber to present a back pressure to a driving chamber which drives the nozzle in a direction to cause a greater force in the direction of motion. This configuration eliminates the problem requirements heretofore necessary of rapidly increasing input signals because digital action occurs at a certain input signal level irrespective of the nature of the input signal being applied. Above a preselected input level, the more the valve opens the more it is driven open, and below the same input level the more it closes, the more it is driven closed.

The present invention solves the non-zero off condition problem by providing a positive seal for a supply pressure nozzle supplying the output chamber. This seal is directly coupled to the movement of the piston assembly which operates in a digital manner. The positive feedback pressure as earlier mentioned is isolated from the valve output chamber and supply pressure input and drives only the piston assembly which in turn provides an output which is either zero or full supply pressure and never negative.

The present invention conserves supply air because it maintains supply pressure to the output chamber mechanically sealed during the off position and communicates to the output chamber only during the on position. Since there is no dependence upon static regain it is possible to obtain a lower air consumption rate over the devices heretofore known.

The principal object of the invention is to provide a device with valve action which results in an output signal from the valve that is either ambient pressure or full supply pressure. The positive feedback of nozzle back pressure results in digital action occurring within a fraction of a second.

A further object of the invention is to maintain supply pressure sealed during the zero pressure output condition and minimize air consumption.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a bottom plan view of a preferred embodiment of the digital valve.

FIG. 2 is a cross-sectional elevational view of the digital valve of FIG. 1 taken along section 2—2 and rotated 90°out of the plane of the paper.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings wherein the showings are for purposes of illustrating the preferred embodiment of the invention only and not for the purpose of limiting same, FIG. 1 shows a lower valve body 55 having threaded mounting holes 62 used to secure the valve to a mounting surface. The valve body 55 is secured to the rest of the valve by connecting screws 64. A supply pressure inlet 52 is located on one side of the valve body 55, and on the opposite side are located a vent outlet 42 and a valve outlet 48 adjacent to each

other. A slotted seal plug 68 is centrally located and is threaded so as to be readily removable.

Referring now to FIG. 2, a cover plate 14 is fastened to a main valve body 34 by means of connecting screws 16 having lock washers 15. Bottom lock washers 66 are also used on the screws 64 connecting the lower valve body 55 to the main valve body 34. The cover plate 14 has a threaded input signal inlet 10 which accesses to an input chamber 12. A diaphragm assembly 18 is interposed between the cover plate 14 and the main valve body 34.

The main valve body 34 includes a driving pressure chamber 38, a vent passageway 43, and an output chamber 57. The threaded supply pressure inlet 52 is in communication with a connecting supply chamber 40 which supplies an orifice 47, communicating with the driving pressure chamber 38, and also supplies the chamber 60. The threaded vent outlet 42 communicates with the vent passageway 43 to prevent pressure buildup therein. The main valve body 34 seals to the lower valve body 55 by way of a gasket 53. An orifice clean-out plug 41 provides access to the orifice 47 should it become clogged with contaminants from the supply line and require cleaning.

A dual piston assembly 51 is positioned within the main valve body 34. This assembly includes an upper piston 26, located in the driving pressure chamber 38, an integral piston step 37, connected to the upper piston 26 and located in the vent passageway 43, a tapered connecting stem 44 extending from step 37 and through passageway 43 and a lower piston 45, connected to the stem 44 and located in the output chamber 57.

The upper piston 26 includes a nozzle 22 projecting from the face of the piston toward a diaphragm plate 20. The nozzle 22 communicates with a passageway 28, internal to the piston 26. This passageway 28 terminates with a port 32 communicating with the driving pressure chamber 28. Supply air from the driving chamber 38 vents through the port 32 and passageway 28, and through the nozzle 22 into a vent chamber 21 which is open to ambient pressure by way of an external bleed port 19. An O-ring seal 30 prevents any leakage between the driving chamber 38 and the vent chamber 21. A spring 24 fits into a groove 25, located in the upper piston 26, and rests against the plate 20 keeping the nozzle 22 unrestricted until an input signal is applied to the input chamber 12 of sufficient force to overcome the force of the spring 24.

The piston step 37 has an O-ring seal 36, which prevents leakage between the driving chamber 38 and the passageway 43.

The lower piston 45 includes a vent nozzle seal 54 on the face viewing a vent nozzle 50, and a supply nozzle seal 56 on the face opposite a supply nozzle 58. The supply seal 56 is shown sealing the supply nozzle 58. This seal is maintained by a piston spring 46, which rests in a groove 49 in the lower piston 45. This spring 46 has a greater spring constant relative to that of spring 24 in order to maintain this seal. This effected seal is made adjustable by virtue of the supply nozzle being threaded and thus allowing for adjustment with respect to the supply seal 56. This adjustment is accomplished by removing the plug 68, aligned with the supply nozzle 58, and rotating the supply nozzle 58 in the appropriate direction.

The valve is depicted with the supply nozzle 58 sealed, and the output signal from the threaded valve output 48, therefore, zero. In operation, an input signal is communicated to the input chamber 12 causing a resultant force against the spring 24 of a magnitude equivalent to the product of the signal pressure and the area of the diaphragm. Should this force be greater than the spring 24 force opposing it, the diaphragm plate 20 will start to move toward the nozzle 22. As the nozzle 22 is thus restricted, the pressure in the driving chamber 38 will start to rise due to restricted venting through the nozzle 22. This added pressure exerts a force on the face of the upper piston 26 communicating with the driving chamber 38 of a magnitude equivalent to the product of the face area and driving chamber 38 pressure. The above mentioned force is opposed by the force of the piston spring 46 acting against the lower piston 45.

The nozzle 22 must be restricted to a point where the pressure in the driving chamber 38 will result in a force greater than the opposing force of the piston spring 46. Once this point is reached the dual piston assembly 51 begins to move toward the diaphragm assembly 18. As this occurs, the nozzle 22 is further restricted and a greater force drives the assembly 51 toward the diaphragm assembly 18. A condition occurs where the more the assembly 51 moves the more it is forced to move or in short, snap action. This motion will stop when the lower piston 45 is sealed against the vent nozzle 50 and supply pressure is then communicated to the valve outlet 48 through nozzle 58. The output signal will in this way change from a zero state to full supply pressure in a fraction of a second.

The piston assembly 51 is maintained against the vent nozzle 50 by the pressure in the driving chamber 38 as well as the output chamber 57 pressure acting on the face of the lower piston 45. As the input signal drops in level to a point where it is less than the force of the compressed spring 24, the plate 20 is moved by the spring 24 away from the nozzle 22 to relieve the pressure in the driving chamber 38. The force of the piston spring 46 drives the piston assembly 51 against the supply nozzle 58. This reverse movement occurs in a snap-acting manner because as the assembly moves away from the plate 20 the driving chamber 38 is further relieved of pressure causing the force of the piston spring 46 to further dominate. Thus the piston assembly 51 is returned to its original position sealing the supply nozzle 58.

Obvious modifications and alterations will be evident to persons familiar with the art upon reading and understanding of this specification. As an example, the supply pressure chamber 60, as well as the driving chamber 38, may be made to have separate distinct pressure levels by providing adjustable venting passages for these chambers either through the seal plug 68 and the clean out plug 41 or other distinct ports. The previous description of the embodiment is meant to be inclusive of all such modifications and additions and not a limitation of the embodiment as specified. It is my intention to include all these obvious modifications and alterations insofar as they come within the scope of the appended claims or the equivalence thereof.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A snap-acting, fluid amplifying valve comprising:

a pressure housing having a supply chamber, a driving chamber, a venting chamber and a signal input chamber;

a piston assembly slidably positioned in said housing between the supply chamber and the venting chamber, said piston assembly including means for sealing the supply chamber to cut off the output signal therefrom;

means, responsive to the pressure level in the input signal chamber, for pressurizing the driving chamber to drive said piston assembly so that the seal of said sealing means with the supply chamber is broken and the output signal therefrom is turned on;

wherein said input chamber is sealed from said venting chamber by a diaphragm assembly responsive to the pressure in said input chamber;

including a vent passageway open to the outside of said pressure housing and an output chamber open to said vent passageway when the output signal is cut off from said supply chamber to provide a vented output signal thereby; and

wherein said piston assembly includes a first piston slidably positioned between said venting chamber and said driving chamber, a second piston located in said output chamber and a connecting stem slidably positioned through part of said vent passageway and extending to join said first and second piston to provide that said first and second piston slide as an assembly.

2. A snap-acting, fluid amplifying valve as set forth in claim **1** wherein said means for pressurizing the driving chamber includes: a nozzle located on said first piston facing said diaphragm assembly to provide communication between said driving chamber and said venting chamber therethrough;

first spring means for retaining said piston assembly in a position sealing said supply chamber; below a preset pressure level in said driving chamber;

second spring means regulating the motion of said diaphragm assembly to restrict said vent nozzle and pressurize said driving chamber thereby to co-ordinate the input signal level to driving chamber pressure required to break the seal of said piston assembly to said supply chamber.

3. A snap-acting fluid amplifying valve as set forth in claim **2** wherein said first piston has a groove with an O-ring therein around the periphery of said first piston rolling inside the groove and along the wall of the driving chamber of said pressure housing during movement of said piston assembly to seal said driving chamber from said venting chamber.

4. A snap-acting fluid amplifying valve as set forth in claim **3** wherein said connecting stem has a groove with an O-ring therein around the periphery of said stem rolling inside the groove and along the wall of said vent passageway with any movement of said piston assembly to seal said driving chamber from said vent passageway.

5. A snap-acting fluid amplifying valve as set forth in claim **4** including means, in said pressure housing for connecting said supply chamber and said driving chamber to a common supply pressure.

6. A snap-acting fluid amplifying valve as set forth in claim **5** wherein said means for sealing the supply chamber include a seal located on the face of said second piston suitable for sealing said output chamber from said supply chamber.

7. A snap-acting, fluid amplifying valve comprising:

a pressure housing having a supply chamber, an output chamber, a driving chamber, a venting chamber, a vent passageway open to atmosphere, and a signal input chamber;

a piston assembly slidably positioned in said housing between the supply chamber and the venting chamber, said piston assembly including means for sealing the vent passageway to prevent venting the output chamber therethrough;

means, responsive to the pressure level in the input signal chamber, for relieving the driving chamber to drive said piston assembly to move so that the seal of said sealing means with the vent passageway is broken and the output chamber is vented thereby;

wherein said input chamber is sealed from said venting chamber by a diaphragm assembly responsive to the pressure in said input chamber; and

wherein said means for pressurizing the driving chamber includes:

a nozzle located on said piston assembly facing said diaphragm assembly to provide communication between said driving chamber and said venting chamber therethrough;

first spring means for driving said piston assembly away from a position sealing said vent passageway;

second spring means regulating the motion of said diaphragm assembly to relieve said vent nozzle and relieve said driving chamber thereby to co-ordinate the input signal level to driving chamber pressure required to break the seal of said piston assembly to said vent passageway.

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