

July 7, 1970

KWANGHO CHUNG ET AL

3,519,022

LOW PRESSURE OPERATOR

Filed May 31, 1968

2 Sheets-Sheet 1

FIG. 1

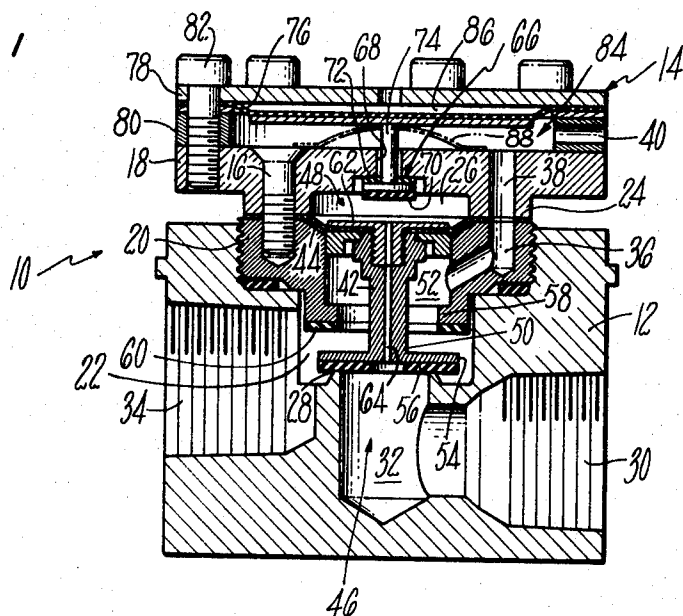


FIG. 2

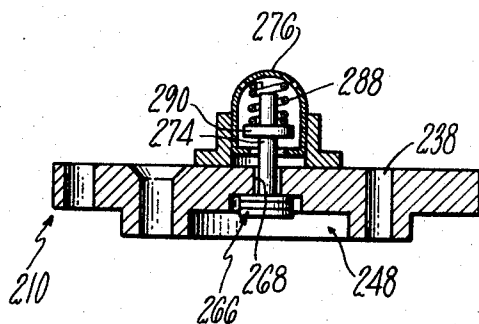
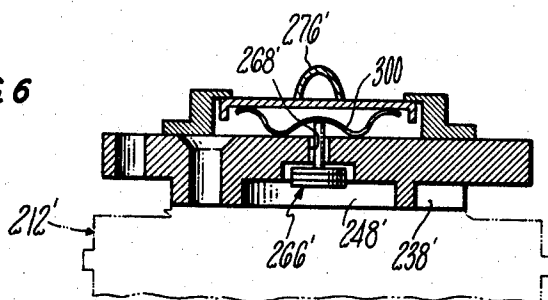


FIG. 6



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FIG. 3

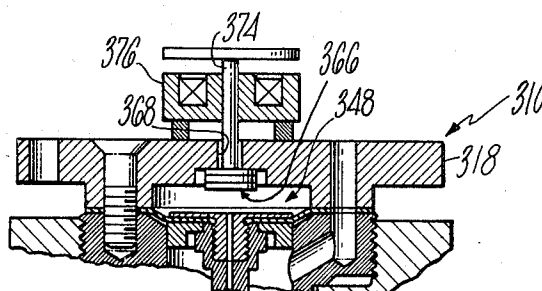


FIG. 4

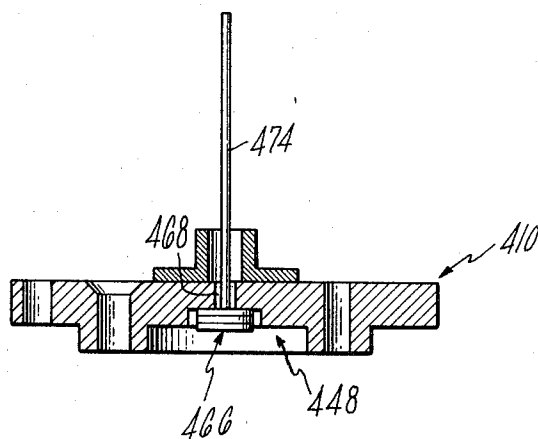
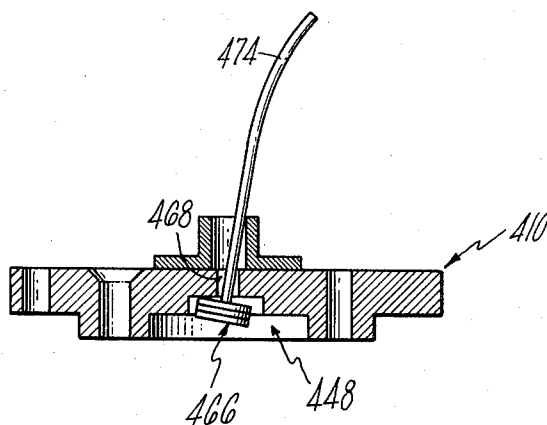


FIG. 5



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LOW PRESSURE OPERATOR

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U.S. Cl. 137—625.64

12 Claims

ABSTRACT OF THE DISCLOSURE

A housing having an inlet, an outlet and a cavity therebetween wherein a plunger is received for movement between open and closed positions, and a supply fluid passage communicating with opposite ends of the plunger for exposing them to fluid under supply pressure, one end of the plunger having an effective area greater than that of the other end, and a bleed passage for venting and sealing the cavity adjacent said one end of the plunger for controlling its movement, the bleed passage having a flow area greater than that of the supply fluid passage.

This invention generally relates to valves and particularly concerns bi-positional valves of a type operable under the force of the supply fluid being controlled.

A principal object of this invention is to provide an improved valve utilizing the force of supply fluid under high pressure for operating the valve responsive to a low power control signal.

Another object of this invention is to provide a valve of the above-described type particularly suited for applications wherein operating requirements include low power actuation to provide a positive valve action which is highly responsive to the application of a control signal.

A further object of this invention is to provide an improved valve of compact construction which is quick and easy to manufacture and assemble and which has minimal service requirements while providing reliable operation over a prolonged period of time.

Still another object of this invention is the provision of an improved valve of the above-described type usable in a variety of applications to effect significantly improved versatility.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application which will be indicated in the appended claims.

In the drawings:

FIG. 1 is a side view, partly in section and partly broken away, showing a preferred embodiment of a valve constructed in accordance with this invention;

FIG. 2 is a view, partly in section and partly broken away, showing a different embodiment of a valve operator suitable for use with a normally closed valve;

FIG. 3 is a view, partly in section and partly broken away, showing another embodiment of a valve operator;

FIG. 4 is a view, partly in section and partly broken away, showing still another embodiment of a valve operator shown in sealing position;

FIG. 5 is a view similar to FIG. 4 with the valve operator shown in venting position; and

FIG. 6 is a view, partly in section and partly broken away, showing a valve operator similar to that of FIG. 2 for use with a normally open valve.

Referring now in detail to the drawings, a fluid valve housing 10 is shown having a valve body 12 upon

which a valve operator 14 is removably secured by screws such as at 16 connecting a base plate 18 of the valve operator 14 to a mounting flange 20 threadably secured within a cavity 22 formed in the valve body 12. In a lower face 24 of the base plate 18, a compartment 26 is formed in concentric relation to the cavity 22 and to an annular valve seat 28 formed by the body 12 surrounding a reduced intermediate portion of the cavity 22. An inlet passage 30 formed in the body 12 leads to an inlet port 32 which will be understood to be coupled in a well-known manner to a suitable source of pressurized fluid, not shown, such as compressed air.

Also provided in the body 12 is an outlet port 34 which may be connected, e.g., to a working cylinder having a piston, not shown, controlled by the valve. The outlet port 34 directly communicates with the cavity 22 on a downstream side of the valve seat 28, which is disposed between the inlet and outlet ports 32, 34, and the mounting flange 20 is shown having an exhaust passage 36 connected with another passage 38 formed in the base plate 18 leading to a vent 40 in the valve operator.

To connect the outlet port 34 alternatively with the inlet port 32 and exhaust passage 36, a plunger 42 is received in the cavity 22 for movement toward and away from the valve seat 28. In the specific illustrated embodiment, the plunger 42 is supported on a diaphragm 44, formed of a suitable durable and resilient material such as urethane, secured between the base plate 18 and the mounting flange 20. The plunger 42 divides the cavity 22 into a flow chamber 46 and a control chamber 48, and a reduced stem portion 50 of the plunger 42 in conjunction with the surrounding wall portions of the body 12 define an exhaust chamber 52 which is in continuous communication with the exhaust passage 36. At its end opposite the diaphragm 44, the plunger 42 has an outwardly directed radial flange which serves as a valve member 54. The lower face of the valve member 54 carries an annular seal 56 of rubber or the like which acts as a valve upon engaging the valve seat 28 to close off the outlet port 34 from the inlet port 32.

On a lower face of the mounting flange 20, an inwardly directed radial flange 58 is provided with a seal or second valve seat 60 formed of rubber or other suitable material to establish an open position for the valve member 54 in axially spaced concentric relation to the annular valve seat 28.

The seal 60 on the mounting flange 20 is designed such that the effective area on the lower face of the valve member 54 exposed to line pressure when the plunger 42 is in open position, is approximately equal to that area defined by the inside perimeter of the seal 60 and is of reduced size relative to an opposite upper face 62 of the plunger 42.

The plunger 42 is normally maintained in its illustrated lower or closed position by the provision of a supply air passage 64 extending axially through the plunger 42 for connecting the inlet port 32 to the control chamber 48, the supply air passage 64 having a flow area of reduced size relative to the effective area of the valve member 54 exposed to line pressure. With the supply air passage 64 continuously exposed to the inlet, a flow of supply air through the plunger 42 equalizes the pressure in the control chamber 48 with that in the flow chamber 46. The plunger 42 is then forced downwardly toward closed position since the upper plunger face 62 is of greater area than that of the aforementioned effective area of the valve member 54. It will be seen that once the plunger 42 is moved into closed position, that portion of the annular seal 56 exposed to the full line supply pressure within the confines of the valve seat 28 is approxi-

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mately equal to the aforementioned effective area of the valve member 54 and is less than the area of the upper plunger face 62 exposed to supply air whereby the plunger 42 will normally remain closed.

To operate the valve and raise the plunger 42 into open position, a pilot valve 66 is provided in the control chamber 48 for controlling air flow through a bleed passage 68 formed in the base plate 18 shown in FIG. 1 leading to the vent 40. The pilot valve 66 comprises a pair of annular seals 70, 72 fixed to opposed faces thereof and a stem 74 of pilot valve 66 is shown projecting into the bleed passage 68 through the base plate 18. The supply air pressurizing the control chamber 48 normally maintains the pilot valve 66 in a raised position thereby sealing off the control chamber 48 from the bleed passage 68.

The pilot valve stem 74 and the bleed passage 68 are dimensioned to provide a predetermined flow area in the bleed passage 68 of enlarged size relative to that of the supply air passage 64 to ensure that the control chamber 48 can be quickly vented through the bleed passage 68 at a rate considerably greater than that at which air flows through the supply air passage 64. The latter is of a preselected size to likewise ensure a sufficient flow of air into the control chamber 48 to effect positive sealing by the pilot valve 66.

An abrupt pressure reduction in the control chamber 48 is effected upon applying a signal to urge the pilot valve 66 downwardly to open the bleed passage 68. The control chamber 48 vents to atmosphere, and the supply line pressure acting on the valve chamber 54 overcomes the pressure in the control chamber 48 and thrusts the plunger 42 upwardly to connect the inlet port 32 to the outlet port 34 and seal off the exhaust chamber 52. With the plunger 42 in open position, the pilot valve 66 in a lowered position acts to seal off the supply air passage 64. The plunger 42 remains in open position until the control signal is deactivated and the pilot valve 66 again seals off the control chamber 48 under the force of the line pressure, whereby the plunger 42 returns to closed position as previously described.

A control signal of approximately 0.1 pound per square inch has been found to satisfactorily control operating line pressures over a wide range, e.g., from a minimum design pressure of, say about 20 p.s.i., to a maximum operating pressure in the order of 100 p.s.i. It will be understood that variations such as a restriction in the outlet port 34 or a change in the size of the upper face 62, e.g., will affect the operating range of the valve. The maximum operating pressure also can be raised by slight increases in the pressure of the control signal. In any event, more positive valve action is effected in response to increased line pressures, valve actuation typically being within approximately 25 to 50 milliseconds after application of the control signal to the valve operator 14.

To effect the control signal, a variety of signal means may be provided in the valve operator 14. For example, the preferred embodiment shown in FIG. 1 incorporates a diaphragm 76 for actuating the pilot valve 66. The diaphragm 76 is fixed between an upper plate 78 and a suitable spacer such as at 80 maintained by machine screws 82 in assembled relation to the base plate and defining an operating cylinder 84 in the valve operator 14. The diaphragm 76 extends transversely across the operating cylinder 84 for flexural movement and is formed preferably of urethane rubber or other durable, resilient material. The upper plate 78 is shown having a central opening for supplying an upper chamber 86 of the operating cylinder 84 with a control fluid and exhausting it therefrom to reciprocate the pilot valve 66 for venting and sealing the control chamber 48. If it is desired to increase the speed and sensitivity of the diaphragm 76 to a deactivating control signal, a return leaf spring 88 shown in broken lines in FIG. 1 may be used to apply a biasing return

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force on the diaphragm 76 for ensuring quick exhaust of the upper chamber 86. To assure that pilot valve 70 is maintained closed and that the valve is fully operable even under low pressure conditions, spring 88 is preferably attached to stem 74 of the pilot valve 66.

In FIGS. 2-5, like parts are identified by like numbers, the first numeral of which corresponds to the related figure.

FIG. 2 shows a manually operated embodiment wherein a stem 274 projects upwardly into a bleed passage 268 and through a housing 210. The stem 274 has a radial flange 290 disposed externally thereof but inside a push button capsule 276 enveloping a projecting portion of the stem 274. A coil spring 288 seated between the flange 290 and the push button capsule 276 continuously urges the latter away from the housing 210. Upon pressing the push button capsule 276, the pilot valve 266 vents the control chamber 248 which is thereafter sealed, upon releasing the push button capsule 276 under the force of the supply air in the control chamber 248 and the return force of the coil spring 288.

FIG. 3 depicts an electromagnetically operated embodiment wherein a low power solenoid 376 is mounted on a base plate 318 in alignment with a bleed passage 368. A stem 374 of a pilot valve 366 extends through a housing 310 and is employed as an armature for the solenoid 376. The solenoid 376 is connected to a suitable source of electrical power, not shown, which upon being energized and de-energized, will shift the stem-armature 374 for venting and sealing the control chamber 348. It has been found that satisfactory actuation has been obtained under the power of only about 2 watts.

FIGS. 4 and 5 show an elongated stem or "wire whisker" 474 projecting a substantial distance upwardly from a pilot valve 466 and externally of a housing 410 to provide an air switch for controlling the valve as described above in connection with the first embodiment. The air switch may act in response to a discrete flow of air, e.g., in a fluid logic circuit. In FIG. 4 the pilot valve 466 is shown in sealing position under the fluid bias of the supply air. FIG. 5 shows the stem 476 being acted upon by an air stream, causing the pilot valve 466 to open a bleed passage 468 and vent the control chamber 448.

FIG. 6 shows a valve operator 214' similar to that illustrated in FIG. 2 but adapted for use with a normally open valve. By virtue of a leaf spring 300, the pilot valve 266' is continuously biased toward the valve body 212' to normally maintain the bleed passage 268' in communication with the control chamber 248'. The valve 210' thus will be seen to be maintained in normally open condition, subject to being closed upon actuating the push button 276', causing the pilot valve 266' to seal the control chamber 248' which is then pressurized by the supply fluid which acts to close the valve. Obvious modifications can also be effected in connection with the embodiments of FIGS. 3 and 4 to reverse the valve being controlled from normally closed to normally open condition.

The valve of this invention is particularly suited for operation in a wide variety of different applications with demanding operating requirements. Although different means may be employed to effect the control signal to provide versatility, minimal power is required, and a single operator may also be employed to control a variety of orifice sizes and flow rates without changing the signal characteristics. In addition, the valve is compact, economical to manufacture and assemble, virtually service-free and reliable for operation over extended periods of time.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above-described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

We claim:

1. A valve comprising a housing including a cavity, a plunger received in the cavity and dividing it into

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a plunger received in the cavity and dividing it into a flow chamber and a control chamber, the flow chamber having an inlet, an outlet and a valve seat therebetween, the plunger carrying a valve member for movement toward and away from the valve seat between closed and open positions, a supply fluid passage formed in the plunger connecting the inlet to the control chamber and continuously exposed to the inlet, the effective area of the plunger exposed to supply fluid being greater in the control chamber than in the flow chamber, a bleed passage connected to the control chamber and being of enlarged flow area relative to the supply fluid passage, and signal means for effecting movement of the plunger, the signal means including a pilot valve controlling fluid flow in the bleed passage for venting and sealing the control chamber to effect actuation of the plunger under differential forces of supply fluids, the pilot valve being positioned in operative alignment with the plunger, and means for engaging the plunger and sealing its supply fluid passageway to the control chamber when the signal means is activated and the plunger is in open position.

2. The valve of claim 1 wherein the housing includes a body and a separable valve operator removably mounted on the body, the valve operator having a fluid compartment communicating with the cavity and jointly defining therewith said control chamber, and wherein the signal means and the bleed passage are provided in the valve operator independently of the body.

3. The valve of claim 1 wherein the pressure range of the supply fluid controlled by the signal means is of a magnitude of approximately 200 to 1,000 times the control pressure used in actuating the signal means.

4. The valve of claim 1 wherein the pilot valve is received in the control chamber, and wherein the supply fluid pressurizing the control chamber applies a fluid bias to the pilot valve continuously urging it into engagement with the housing for sealing the control chamber.

5. A valve comprising a housing including a cavity, a plunger received in the cavity and dividing it into a flow chamber and a control chamber, the flow chamber having an inlet, an outlet and a valve seat therebetween establishing a closed valve member position, the housing providing a second valve seat establishing an open valve member position, the plunger carrying a valve member for movement between said first and second valve seats between closed and open positions, the plunger having an intermediate portion of reduced cross section relative to its end portions and cooperating with the housing to define an exhaust chamber in the cavity between the flow chamber and the control chamber, an exhaust passage formed in the housing and continuously communicating with the exhaust chamber, the exhaust chamber connecting the outlet to the exhaust passage upon movement of the valve member into closed position, a supply fluid passage connecting the inlet to the control chamber and continuously exposed to the inlet, the effective area of the plunger exposed to supply fluid being greater in the control chamber than in the flow chamber, a bleed passage connected to the control chamber and being of enlarged flow area relative to the supply fluid passage, and signal means for effecting movement of the plunger, the signal means including a pilot valve controlling fluid flow in the bleed passage for venting and sealing the control chamber to effect actuation of the plunger under differential forces of supply fluids.

6. The valve of claim 5 wherein the pilot valve is received in the control chamber and has a stem projecting through the bleed passage.

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7. The valve of claim 6 wherein the signal means further includes a push button means on the stem disposed externally of the housing for manually operating the pilot valve.

8. The valve of claim 5 wherein the signal means further includes a solenoid mounted on the housing in alignment with the bleed passage, and wherein the pilot valve is received in the control chamber and includes a stem projecting through the bleed passage and constituting an armature of the solenoid.

9. The valve of claim 5 wherein said effective area of the plunger exposed to supply fluid in the flow chamber is greater than the flow area of the supply fluid passage.

10. The valve of claim 5 wherein the pilot valve is normally biased to seal the control chamber, providing a normally closed valve.

11. The valve of claim 5 wherein the pilot valve is normally biased to vent the control chamber, providing a normally open valve.

12. A valve comprising a housing including a body and a cavity therein, a plunger received in the cavity and dividing it into a flow chamber and a control chamber, the flow chamber having an inlet, an outlet and a valve seat therebetween, the plunger carrying a valve member for movement toward and away from the valve seat between closed and open positions, a supply fluid passage connecting the inlet to the control chamber and continuously exposed to the inlet, the effective area of the plunger exposed to supply fluid being greater in the control chamber than in the flow chamber, a bleed passage connected to the control chamber and being of enlarged flow area relative to the supply fluid passage, signal means for effecting movement of the plunger, the signal means including a pilot valve controlling fluid flow in the bleed passage for venting and sealing the control chamber to effect actuation of the plunger under differential forces of supply fluids, and a separable valve operator removably mounted on the body, the valve operator having a fluid compartment communicating with the cavity and jointly defining therewith said control chamber, the signal means and the bleed passage being provided in the valve operator independently of the body, the valve operator including an operating cylinder in communication with the bleed passage, and a pressure operated diaphragm extending transversely across the operating cylinder for flexural movement therein, the pilot valve having a stem projecting through the bleed passage and into the operating chamber, flexural movement of the diaphragm effecting reciprocable movement of the pilot valve for venting and sealing the control chamber.

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ARNOLD ROSENTHAL, Primary Examiner

U.S. Cl. X.R.

137—625.27; 251—28, 30, 46