March 5, 1968 R. C. BUELER 3,371,686

MULTI-POSITION CONTROL VALVE

Filed Dec. 22, 1966

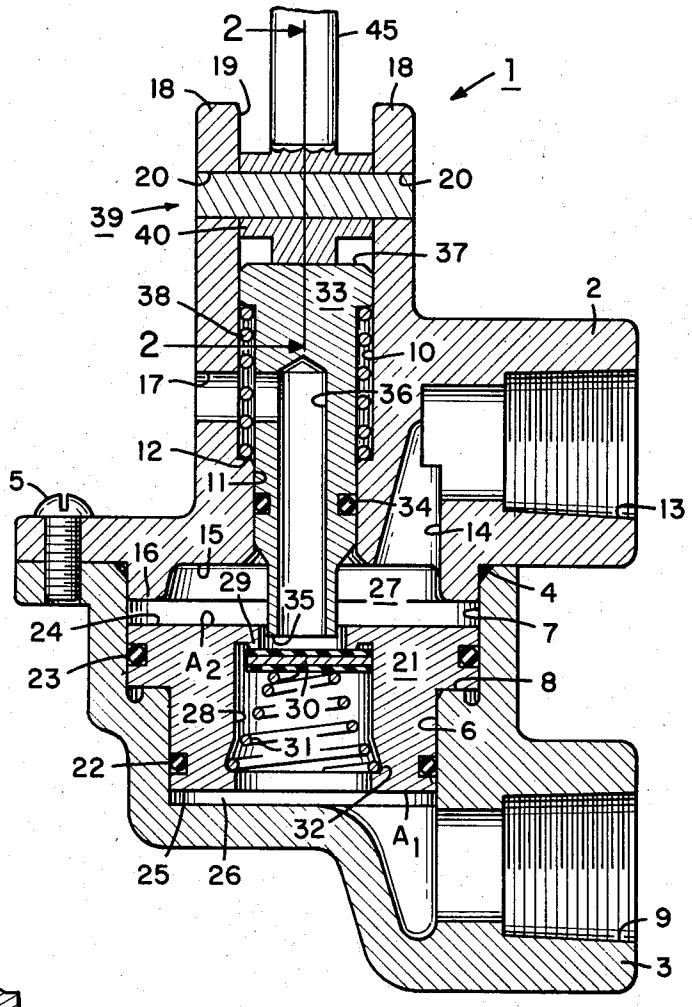


FIG. 1

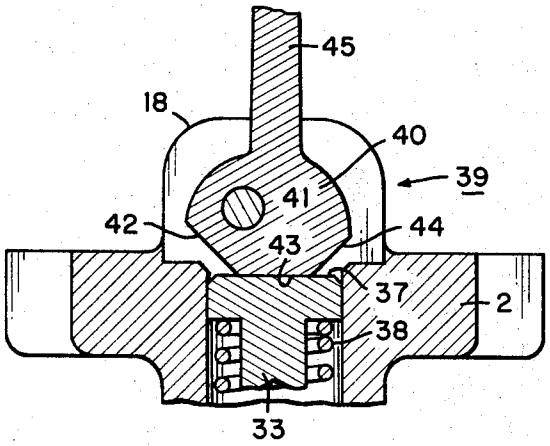


FIG. 2

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MULTI-POSITION CONTROL VALVE

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ABSTRACT OF THE DISCLOSURE

A multi-position control valve including a fluid pressure responsive member movable toward an operative position in response to fluid pressure supplied thereto, and when in said operative position, a cam actuated valve operator can be moved toward a "dumping" position opening a valve element carried by said member to effect a "dumping" application of the supplied fluid pressure and toward an exhausting position disengaged from said valve element to vent the applied fluid pressure. Opposed differential areas are provided on said member in a predetermined ratio, and the valve operator and said member are cooperatively movable to a metering position establishing an applied fluid pressure in a ratio with the supplied fluid pressure substantially equal to the ratio between the differential areas on which the supplied and applied fluid pressures respectively act.

Background of the invention

This invention relates in general to control valves and in particular to those which are selectively actuated between a plurality of predetermined positions.

In the past, two-way or push-pull valves operable between charging and venting positions were utilized in conjunction with a variable application valve to effect the ratio change thereof, as shown in United States Patent No. 3,288,539 issued to Richard C. Bueler on Nov. 29, 1966; however, one of the disadvantageous features of said prior art two-way or push-pull valves was their inability to effect an infinitely variable ratio change when positioned to effect a ratio application for said variable application valve. One of the objects of the present invention is to provide a control valve which overcomes the aforementioned undesirable or disadvantageous features, as well as others, and another object of the present invention is to provide a toggle-actuated valve in which a predetermined ratio, different than a 1:1 ratio and in addition thereto, can be effected between the supplied and applied fluid pressure supplied to said control valve and that applied therefrom. These and other objects and advantageous features will become apparent hereinafter.

Summary

Briefly, the present invention embodies a multi-position control valve including a housing having a pair of application members movable therein between operative and inoperative positions for controlling the application through said housing of fluid pressure supplied thereto, one of said application means being selectively movable between its operative and inoperative positions to respectively effect and obviate the application of the supplied fluid pressure through said housing when the other of said application means is urged toward its operative position in response to the fluid pressure supplied thereto. The invention also embodies opposed differential areas on said other application means for predetermining the ratio between the magnitudes of the supplied and applied fluid pressures.

Description of the drawings

Referring now to the drawings wherein like numerals refer to like parts wherever they occur:

FIG. 1 is a sectional view showing the multi-position control valve embodied in the present invention in cross-section, and

FIG. 2 is a partial sectional view taken along lines 2—2 of FIG. 1.

Description of the preferred embodiments

Referring now to FIGS. 1 and 2 in detail, a multi-position or toggle-type control valve **1** is shown having upper and lower housings **2, 3** with a seal **4** interposed therebetween, said housings being interconnected against displacement by suitable means, such as a plurality of studs **5**.

The lower housing **3** is provided with a stepped bore and counterbore **6, 7** having a shoulder **8** therebetween, and an inlet port **9**, which is adapted to receive fluid pressure selectively supplied thereto, such as from an application valve (not shown), is also provided in said lower housing intersecting said bore at the lower end thereof. The upper housing **2** is provided with stepped bores **10, 11** therethrough which are substantially coaxial with the lower housing bore and counterbore **6, 7**, and a shoulder **12** is defined at the juncture of said stepped bores. An outlet port **13**, which is adapted for connection with a motor (not shown), is provided in the upper housing **2**, and a passage **14** has one end connecting with said outlet port and the other end thereof intersecting with the lower end portion **15** of said upper housing in pressure fluid communication with the lower housing counterbore **7**, said end portion **15** also having an abutment flange **16** thereon in said lower housing counterbore. An exhaust port or passage **17** is also provided in said upper housing intersecting with the stepped more **10** adjacent to the shoulder **12**. A pair of opposed toggle mounting ears or flanges **18** are integrally provided in the upper housing **2** having a toggle receiving slot **19** therebetween, and aligned mounting or bearing receiving apertures **20** are provided in said flanges, respectively.

A stepped application member or piston **21** is slidably received in the lower housing bore and counterbore **6, 7** and is provided with peripheral seals **22, 23** for sealing engagement with said lower housing bore and counterbore, respectively. The piston **21** is movable between the motion limiting abutments defined by the shoulder **8** and the upper housing abutment flange **16**, and said piston is provided with opposed ends **24, 25** which define with the end wall of the bore **6** and the upper housing end portion **15** opposed inlet and outlet chamber **26, 27** in open pressure fluid communication with the inlet and outlet ports **9, 13**, respectively. A stepped connecting passage or bore **28** is axially provided between the opposed piston ends **24, 25** having an annular shoulder or valve seat **29** defined therein, and a valve member or element **30** is urged by a valve spring **31** into seating engagement with said valve seat normally closing said stepped passage to interrupt pressure fluid communication between the inlet and outlet ports **9, 13**, said valve spring being seated against displacement in an annular spring receiving groove **32** provided in said stepped passage adjacent to the lower end thereof. It should be noticed that the opposed piston ends **24, 25** define cross-sectional, effective fluid pressure responsive areas A_1, A_2 for subjection to fluid pressure at the inlet and outlet ports **9, 13**, respectively, and that the area A_2 is predeterminately larger than the area A_1.

Another stepped application member or valve stem **33** is slidably received in the upper housing stepped bores **10, 11** and is provided with a seal **34** for sealing engagement

with the stepped bore **10**. The lower or free end of the stem **33** extends coaxially into the lower housing counterbore **7** defining a valve seat **35** for operative engagement with the valve element **30**, and an exhaust passage **36** is provided in said stem having one end extending coaxially through the valve seat **35** and the other end thereof opening into the upper housing stepped bore **10** in pressure fluid communication with the exhaust port **17**. A cam bearing or follower surface **37** is provided on the upper end of the stem **33**, and a return spring **38** biased between the upper housing shoulder **12** and said stem normally urges said cam follower surface toward following engagement with a multi-position or toggle mechanism, indicated generally at **39**.

The multi-position mechanism **39** is provided with a hub or eccentric portion **40** which is received in the housing slot **19** in guiding engagement between the housing flanges **18** and eccentrically rotatably mounted about a fixed axis on a bearing **41** fixedly received in the bearing mounting apertures **20** of said housing flanges. Eccentric cams or cam surfaces **42**, **43** and **44** are defined generally at the lower end of the hub portion **40** for positioning engagement with the cam follower surface **37** of the stem **33**, and a manually operated, force applying lever or arm **45** is integrally provided at the upper end of said hub portion.

In the operation, if it is desired to effect a ratio between the fluid pressure supplied to the control valve **1** and the fluid pressure applied therefrom, the toggle arm **45** is manually positioned to engage the cam **43** with the cam follower surface **37**, as shown, whereby the stem **33** and valve seat **35** thereof are moved downwardly against the return spring **38** to a predetermined ratio or metering position. Supplied fluid pressure P_1 at the outlet port **9** acts on the effective area A_1 of the piston **21** to create a force $P_1 A_1$ to move said piston from its inoperative position in engagement with the housing shoulder **8** upwardly toward an operative position, and the upward movement of said piston initially sealably engages the valve element **30** with the stem valve seat **35** closing the exhaust passage **36** and thereafter disengages the piston valve seat **29** from said valve element to establish pressure fluid communication between the inlet and outlet ports **9**, **13**. The fluid pressure flows from the inlet port **9** through the lower housing bore **8**, the piston stepped passage **28**, the lower housing counterbore **7** and the upper housing passage **14** to the outlet port **13**. The established or applied fluid pressure P_2 at the outlet port **13** acts on the effective area A_2 of the piston **21** to create another force $P_2 A_2$ in opposition to the force $P_1 A_1$ and opposing further upward movement of said piston. When the magnitude of the applied fluid pressure P_2 attains a value so that the force $P_2 A_2$ is substantially equal to the opposing force $P_1 A_1$, the piston **21** is moved downwardly toward a lapped position wherein the valve element **30** is in lapped engagement with the piston and stem valve seats **29**, **35**. Since the differential areas are defined in a predetermined ratio, it is apparent that the applied fluid pressure P_2 acting on the larger area A_2 is of lesser magnitude than the supplied fluid pressure P_1 acting on the smaller area A_1, and it is also apparent that the ratio between the magnitudes of the supplied and applied pressures P_1, P_2 is substantially inversely proportional to the ratio between the areas A_1, A_2.

Of course, if the supplied fluid pressure P_1 is increased, the component parts of the control valve **1** will function as described hereinbefore to attain a proportionally increased applied fluid pressure P_2. If the supplied fluid pressure P_1 is reduced, the force $P_1 A_1$ is correspondingly reduced so that the force $P_2 A_2$ then moves the piston **21** downwardly to disengage the valve element **30** from the stem seat **35** and effect a metered reduction of the applied fluid pressure P_2 to the atmosphere through the stem exhaust passage **36**, the housing bore **10**, and the exhaust port **17**. When the magnitude of the force $P_2 A_2$ is reduced to a value substantially equal to that of the opposing force $P_1 A_1$ due to the reduction of the applied fluid pressure P_2, the piston **21** is again moved upwardly toward its lapped position with the valve element in lapped engagement between the piston and stem valve seats **29**, **35**, respectively.

When the supplied fluid pressure P_1 at the inlet port **9** is exhausted or eliminated, the force $P_1 A_1$ is also eliminated, and the force $P_2 A_2$ returns the piston **21** toward its inoperative position disengaging the valve element **30** from the stem valve seat **35**, and in this manner, the applied fluid pressure P_2 is exhausted through the stem exhaust passage **36**, the housing bore **10** and the exhaust port **17** thereby eliminating the force $P_2 A_2$.

In the event the operator desires a non-ratio or dumping application wherein the supplied and applied fluid pressures are substantially in a 1:1 ratio, the toggle arm **45** is manually moved to position the cam **44** with the stem follower surface **37**, and in this manner, the stem **33** is moved further downwardly in the housing bores **10**, **11** and counterbore **7** to initially engage the valve seat **35** thereof with the valve element **35** closing the stem exhaust passage **36** and thereafter move said valve element to a wide open or non-metering position disengaged from the piston valve seat **29** to establish wide open pressure fluid communication between the inlet and outlet ports **9**, **13**. In other words, the supplied and applied fluid pressures P_1, P_2 at the inlet and outlet ports **9**, **13**, respectively, have substantially equal magnitudes, i.e., substantially in a 1:1 ratio since the predetermined non-metering position of the stem **35** and valve element **30**, as described hereinbefore, precludes metering movement of the piston **21** so that the supplied fluid pressure P_1 is dumped from the inlet port **9** to the outlet port **13**. With the stem **33** and valve **30** in their non-metering positions, it is, of course, obvious that the substantially equal supplied and applied fluid pressures P_1, P_2 acting on the smaller and larger effective areas A_1, A_2 creates opposing forces $P_1 A_1$ and $P_2 A_2$, respectively, wherein the magnitude of force $P_2 A_2$ is greater than that of the force $P_1 A_1$; therefore, the larger force $P_2 A_2$ urges the piston **21** toward its inoperative position in engagement with the housing shoulder **8** against the smaller force $P_1 A_1$.

In the event the operator desires to obviate flow through the control valve **1** and positively isolate the supplied fluid pressure P_1 while venting the applied fluid pressure P_2, the toggle arm **45** is manually moved to position the cam **42** with the stem follower surface **37**, and in this manner, the force of the stem spring **38** moves the stem **33** upwardly toward a venting or exhausting position wherein the stem valve seat **35** is concertedly moved upwardly in the housing counterbore **7** toward a position completely disengaged from the valve element **30**; and in this manner, the outlet port **13** is vented to the atmosphere, as described hereinabove. With the stem **33** and valve seat **35** thereof predeterminately maintained in their venting positions, the supplied fluid pressure P_1 at the inlet port **9** acts on the piston area A_1 to create the force $P_1 A_1$ which urges the piston **21** upwardly from its inoperative position in engagement with the housing shoulder **8** into abutting or motion limiting engagement with the abutment flange **16** on the lower end **15** of the housing **2**; however, this upward movement of said piston is predeterminately limited by the engagement thereof with the flange **16** to obviate operative engagement between the valve element **30** and stem valve seat **35** and thereby prevent pressure fluid communication between the inlet and outlet ports **9**, **13**. Therefore, with the piston **21** urged into engagement with the housing flange **16** by the force $P_1 A_1$ and the stem **33** in its venting position, it is obvious that the stem valve seat **35** and the valve element **30** are maintained in predetermined spaced relation to positively vent the outlet port **13** to atmosphere and that the engagement between the piston valve seat **29** and valve element **30** positively isolates the supplied fluid pressure at the inlet port **9**.

From the foregoing, it is obvious that a novel multi-position control valve is provided meeting the objects and advantages therefor set forth hereinbefore, as well as others, as defined by the claims which follow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A control valve comprising a housing, fluid pressure responsive means and selectively operable means relatively movable in said housing between inoperative and operative positions and between a plurality of preselected positions, respectively, for controlling the application through said housing of fluid pressure supplied thereto, said selectively operable means being movable relative to said fluid pressure responsive means in response to an applied force between one and other preselected positions to respectively effect and obviate the application of the supplied fluid pressure through said housing when said fluid pressure responsive means is urged toward its operative position, and a fluid pressure responsive area on said fluid pressure responsive means, said fluid pressure responsive means being urged toward its operative position upon the subjection of said area to the supplied fluid pressure.

2. The control valve according to claim 1, comprising another area on said fluid pressure responsive means and opposed to said first named area, said other area being responsive to the applied fluid pressure to urge said fluid pressure responsive means toward its inoperative position.

3. The control valve according to claim 2, wherein said other area is predeterminately greater than said first named area to predetermine the ratio between the magnitudes of the supplied and applied fluid pressures respectively acting on said first named and other areas.

4. The control valve according to claim 1, comprising another fluid pressure responsive area on said fluid pressure responsive means in opposition to and predeterminately greater than said first named area, said selectively operable means also being selectively movable relative to said fluid pressure responsive means in response to an applied force toward a third preselected position to establish the applied fluid pressure when said fluid pressure responsive means is in its inoperative position, the supplied and applied fluid pressures acting on said first named and other areas, respectively, to establish a differential force for urging said fluid pressure responsive means toward the inoperative position thereof.

5. A control valve comprising a housing having a pressure fluid flow passage therethrough, means movable in said housing and defining therewith said flow passage including valve means controlling pressure fluid flow through said flow passage, an effective fluid pressure responsive area on said means, said means being urged toward an operative position in said flow passage upon the subjection of said area to fluid pressure supplied in said flow passage, and valve control means selectively movable in said housing and relative to said first named means between a plurality of predetermined positions, said valve control means being selectively movable toward one predetermined position in response to an applied force to engage and move said valve means toward a position in said flow passage effecting the application therethrough of the supplied fluid pressure and being selectively movable toward another predetermined position in response to an applied force disengaged from said valve means to vent the applied fluid pressure to the atmosphere when said first named means is urged toward the operative position thereof.

6. The control valve according to claim 5, comprising another fluid pressure responsive area on said first named means in opposed relation with said first named area, said other area being responsive to the applied fluid pressure to create another force in opposition to the first named force of the supplied fluid pressure acting on said first named area and urging said first named means toward its operative position.

7. The control valve according to claim 6, wherein said other area is predeterminately greater than said first named area to predetermine the ratio between the magnitudes of the supplied and applied fluid pressures.

8. The control valve according to claim 5, comprising another fluid pressure responsive area on said first named means opposed to and predeterminately greater than said first named area, and other means within said housing for abutment with said first named means and defining the inoperative position thereof, said valve control means also being selectively movable relative to said first named means in response to an applied force toward a third predetermined position to actuate said valve means when said first named means is in its inoperative position, the supplied and applied fluid pressures acting on said first named and other areas, respectively, to establish a differential force urging said first named means toward its inoperative position.

9. The control valve according to claim 5, wherein said first named means comprises piston means slidable in said housing and having opposed ends in said flow passage, one of said opposed ends defining said effective area and the other of said opposed ends defining another effective area responsive to the applied fluid pressure and being opposed to and in a predetermined ratio with said first named area wherein the magnitude of the applied fluid pressure is in a predetermined ratio with that of the supplied fluid pressure, passage means in said piston means between said opposed ends and defining a portion of said flow passage, and a valve seat on said piston means in circumscribing relation with said passage means, said valve means being normally urged into engagement with said valve seat to close said passage means and being disengaged from said valve seat upon actuation by said valve control means.

10. The control valve according to claim 5, wherein said valve control means comprises a stem slidable in said housing and having a free end portion defining a valve seat for operative engagement with said valve means, exhaust passage means in said stem having one end extending through said valve seat and the other end thereof in open pressure fluid communication with the atmosphere, said exhaust passage being closed upon the engagement of said valve seat with said valve means, and an applied force receiving end on said stem opposite said free end portion.

11. The control valve according to claim 5, wherein said first named means comprises stepped piston means slidable in said housing and having opposed ends, one of said opposed ends defining said area and the other of said opposed ends defining another effective area responsive to the applied fluid pressure and being opposed to and predeterminately greater than said first named area wherein the magnitude of the applied fluid pressure is inversely proportional to that of the supplied fluid pressure, passage means in said piston means between said opposed ends thereof, a valve seat on said piston means about said passage means, said valve means being normally urged into engagement with said valve seat closing said passage means, said valve control means comprising a stem member having an intermediate portion slidable in said housing and opposed end portions, one of said end portions defining another valve seat for operative engagement with said valve means and the other of said ends defining an applied force receiving portion, return spring means urging said stem in a direction to disengage said other valve seat from said valve means, and an exhaust passage in said stem extending through said other valve seat, said exhaust passage being closed upon the engagement of said other valve seat with said valve means.

12. The control valve according to claim 5, comprising opposed ends on said first named means, one of said opposed ends defining said effective area and the other of said opposed ends defining another effective area responsive to the applied fluid pressure and being in a predetermined ratio with said first named effective area, said flow passage including opposed inlet and outlet chambers re-

spectively adjacent to said first named and other effective areas, passage means in said first named means between said inlet and outlet chambers, and inlet and outlet ports in said housing and respectively connected with said inlet and outlet chambers, said valve means being normally urged toward a position in said passage means interrupting pressure fluid flow therethrough, an exhaust port in said housing, and said valve control means including a portion extending into said outlet chamber and defining a valve seat for operative engagement with said valve means, and exhaust passage means in said valve control means extending through said valve seat for venting said outlet port to said exhaust port, said exhaust passage means being closed upon the engagement of said valve seat with said valve means.

13. The control valve according to claim 5, comprising selectively operable means pivotally mounted on said housing and having a plurality of eccentric cam means thereon, a surface on said valve control means urged into following engagement with said cam means, said selectively operable means being pivoted in response to an operator applied force to engage one of said cam means with said surface and effect the applied force movement of said valve control means toward its one predetermined position and to also engage another of said cam means with said surface to effect the applied force movement of said valve means toward its other predetermined position.

14. The control valve according to claim 8, comprising applied force transmitting means pivotally mounted on said housing and having three eccentric cam means thereon, a surface on said valve control means for following engagement with said cam means, said applied force transmitting means being selectively movable in response to an operator applied force thereon to respectively engage said three cam means with said surface and effect the applied force movement of said valve control means toward its one, other and third predetermined positions.

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