United States Patent

Abdo

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[45] **Oct. 31, 1972**

[54] **SLIDE VALVE**

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[51] **Int. Cl.** **F16k 11/06**

[58] **Field of Search** 137/625.43, 625.48; 251/325, 251/324

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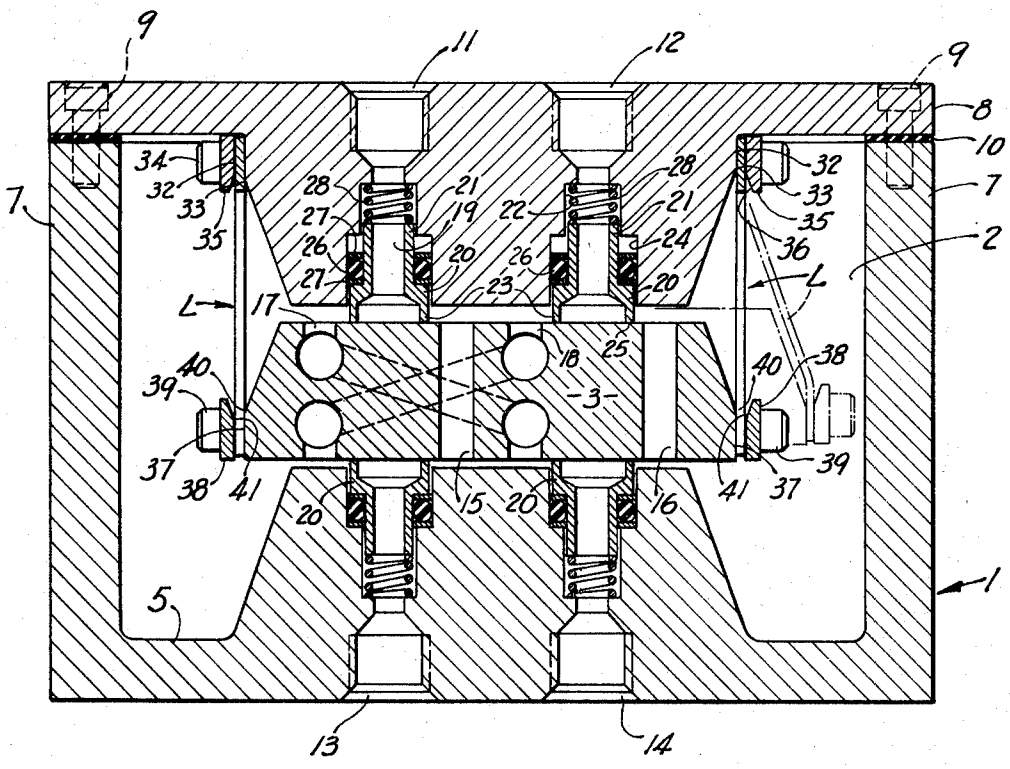
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[57] **ABSTRACT**

A slide valve in which the slide is supported in the valve chamber on links interengaged between the ends of the slide and the body, the body and slide having fluid passages, and the body passages having tubular seals having face-to-face sealing engagement with the slide. The slide is actuated by a lever extending through a wall of the body and engaged with the slide between its ends.

21 Claims, 10 Drawing Figures



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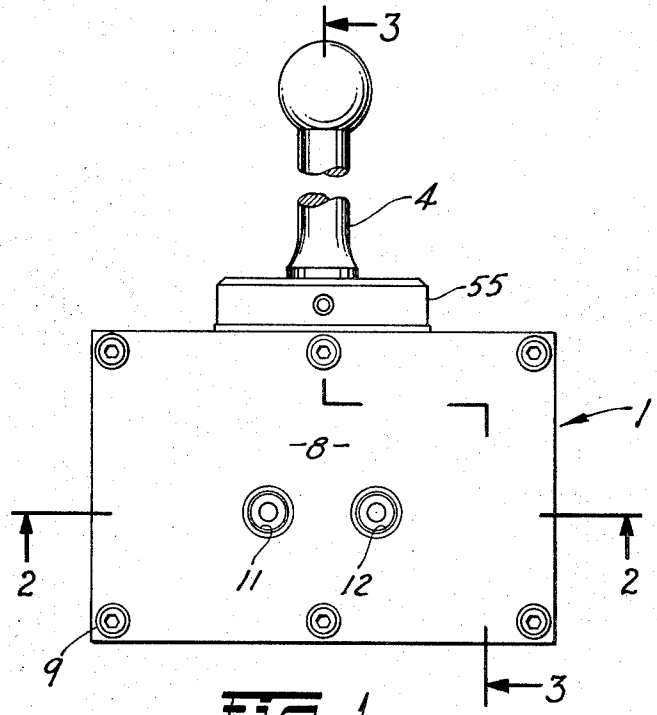


FIG. 1.

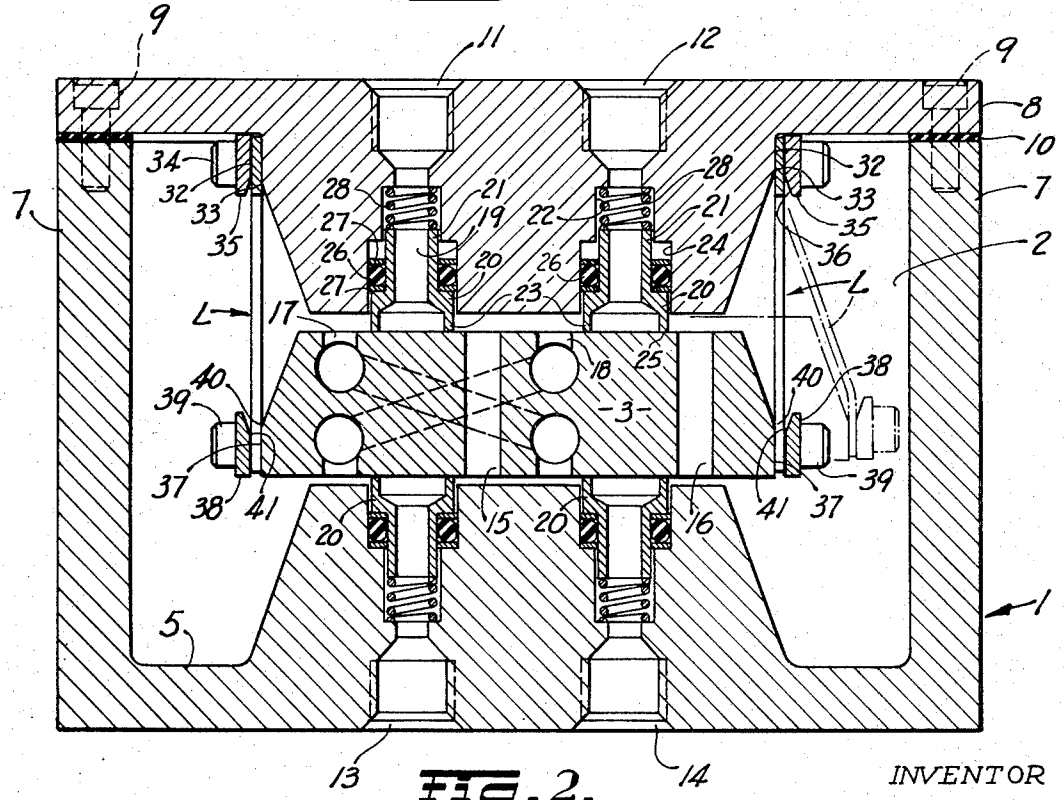


FIG. 2.

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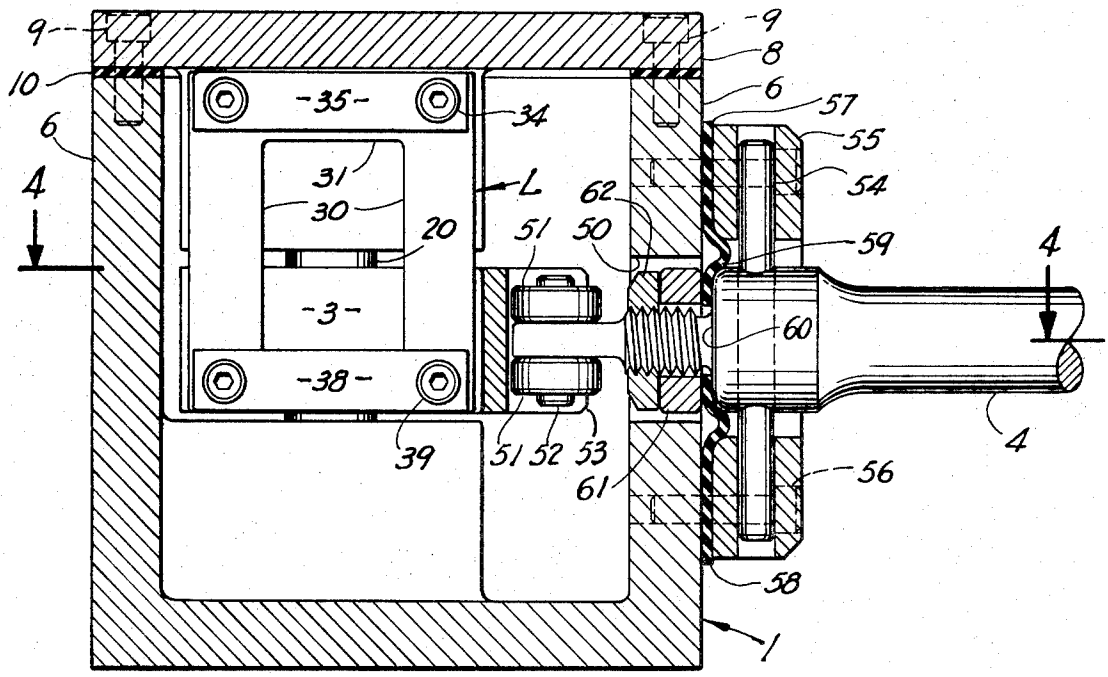


FIG. 3.

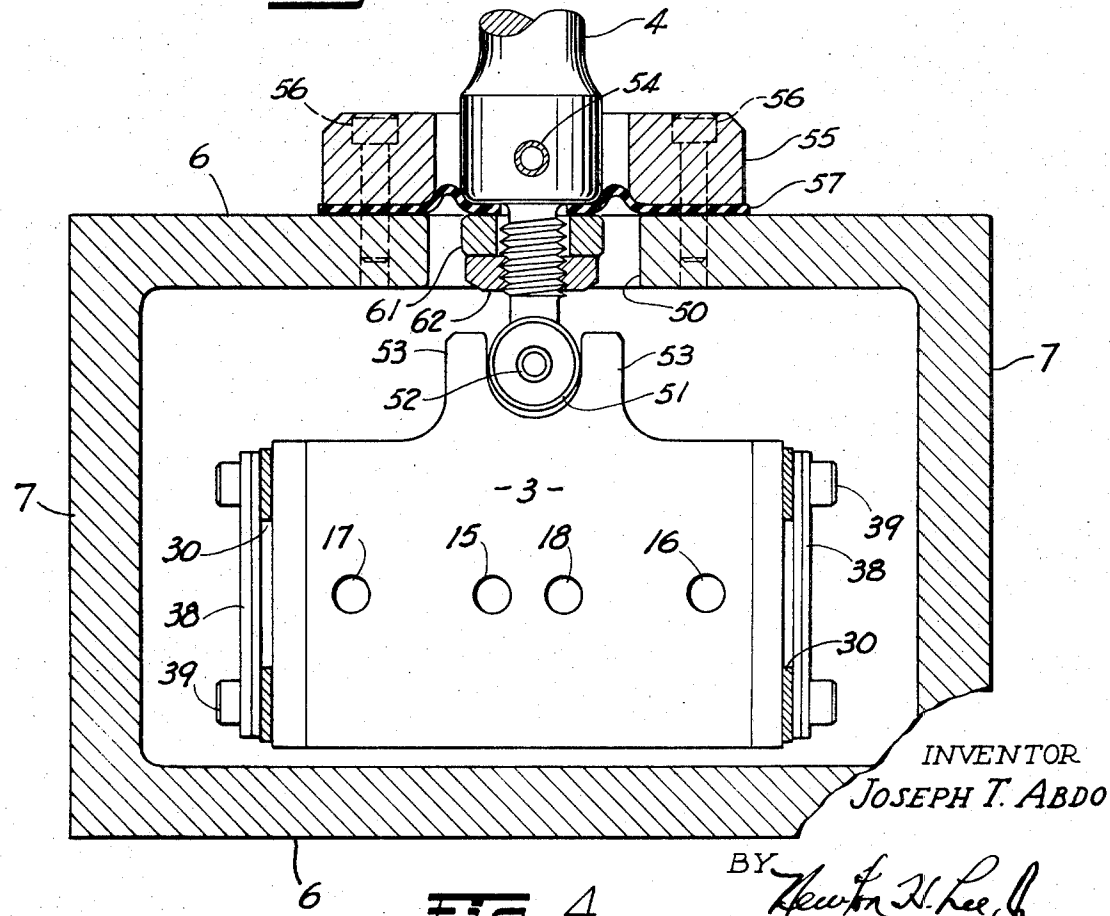


FIG. 4.

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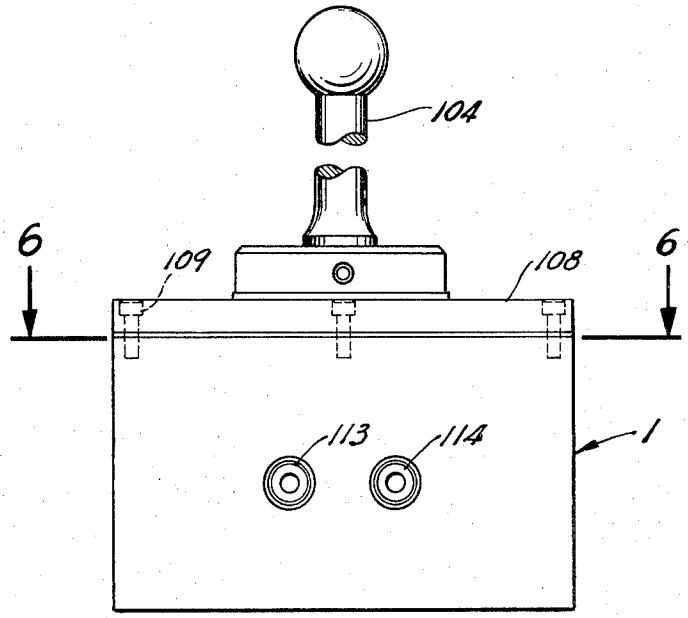


FIG. 5.

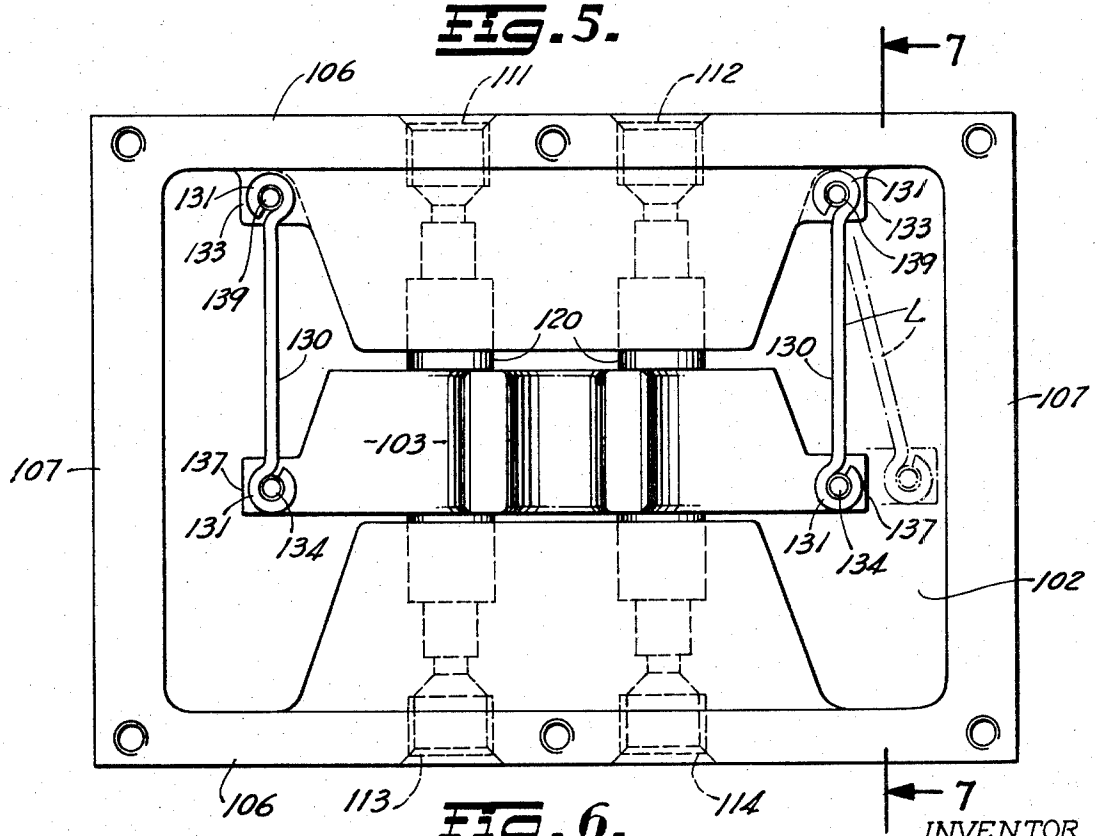


FIG. 6.

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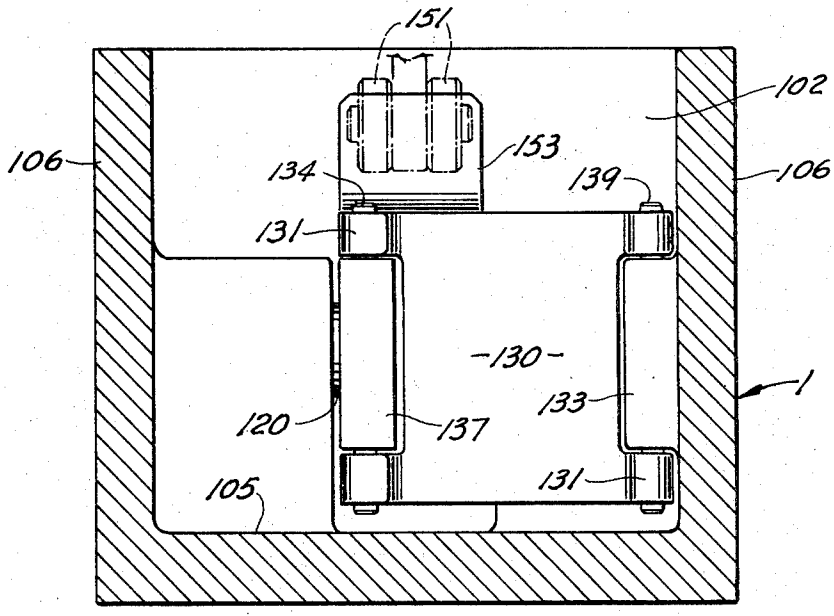


Fig. 7.

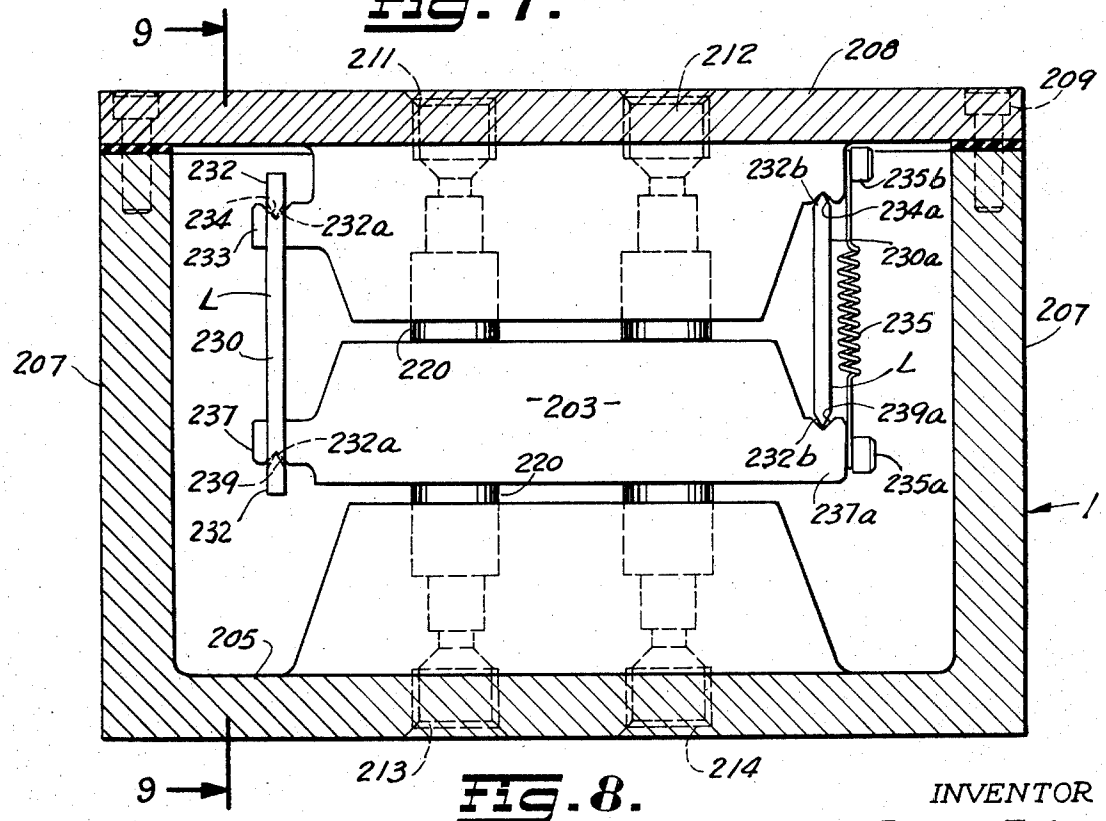


Fig. 8.

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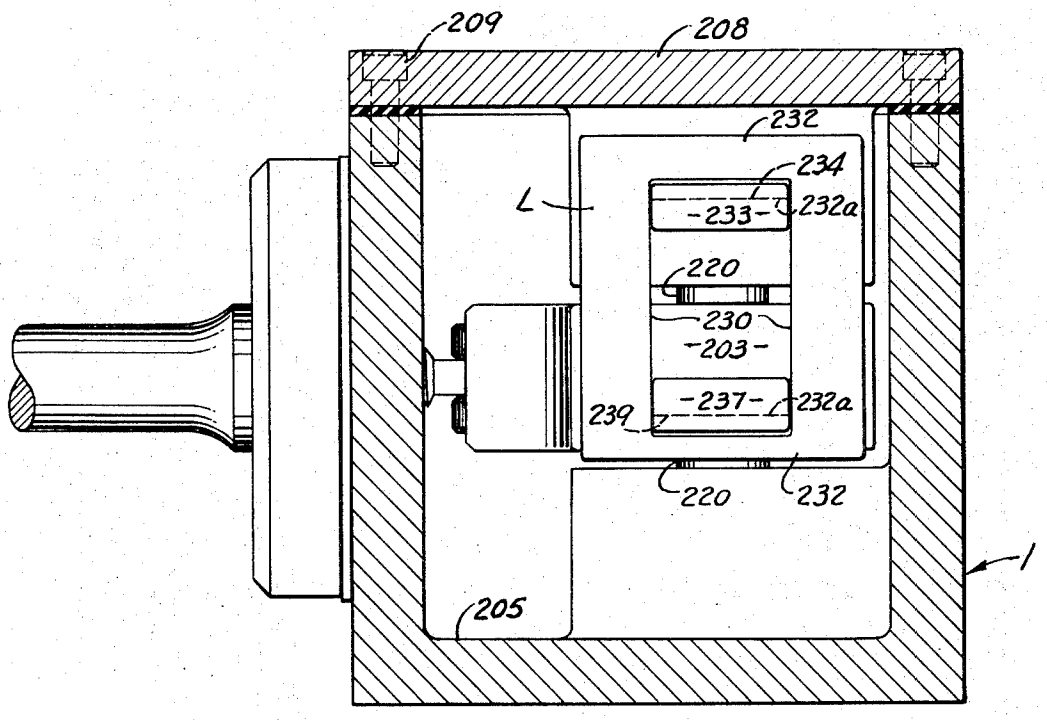


FIG. 9.

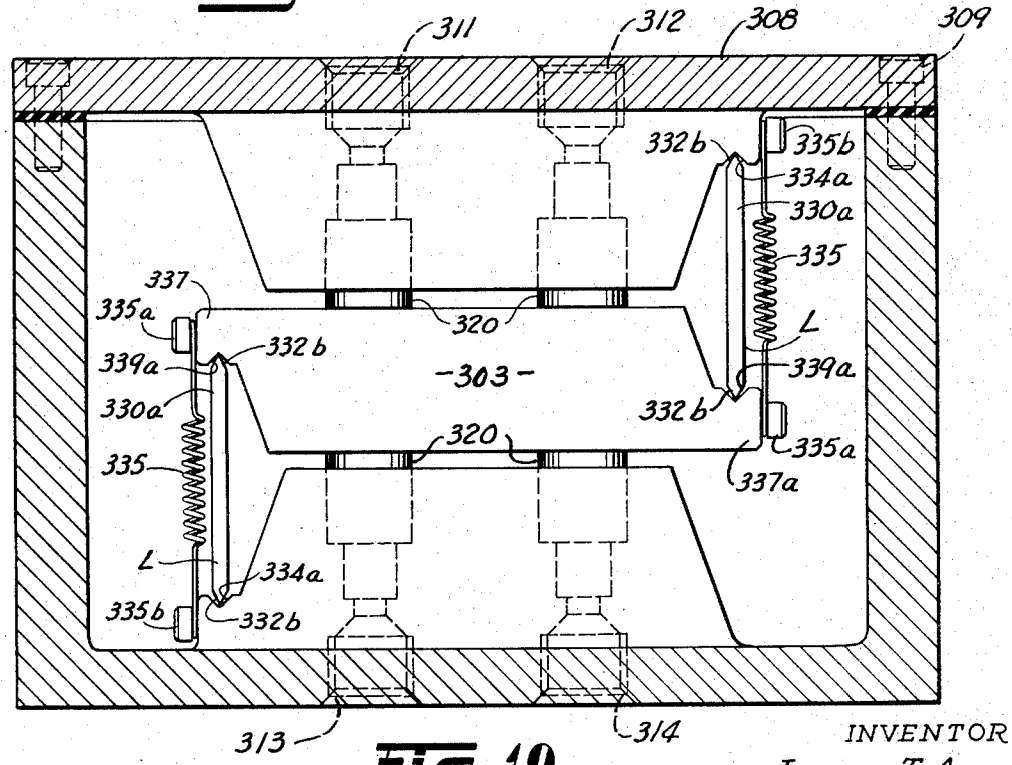


FIG. 10.

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SLIDE VALVE

BACKGROUND OF THE INVENTION

Typical valves useful in fluid pressure systems to control flow have included a slide reciprocable in a valve chamber between different positions to control flow through passages in the body and in the slide, leakage of fluid being prevented by tubular seals circumscribing the body passages and having sealing end faces slidably engaged with the slide.

The forces derived from fluid pressure have notoriously rendered the slide difficult to shift when the valve is employed in high pressure service, unless actuator means were employed which were capable of overcoming the friction of the slide in the body and the seals on the slide. Such actuators were usually either powerful pressure actuators or solenoids or long levers.

While bearings interposed between the slide and the body are capable of reducing the actuating force required to shift the slide, by reducing friction between the slide and the body and distributing the forces, the use of bearings, in the form of balls or rollers, also poses problems of manufacture, and in some cases, the bearings themselves produce friction which must be overcome.

SUMMARY OF THE INVENTION

The present invention is directed to slide type valves, wherein tubular seals with sealing faces engage the slide, and wherein the slide is supported in the valve chamber in a novel manner whereby the slide is easy to shift. The present invention also provides a valve assembly, as aforesaid, which is easy to manufacture. Thus, simple actuator means may be employed and the valve, as a whole, is comparatively inexpensive, yet efficient and easy to operate, either manually or automatically.

In accomplishing the foregoing, the valve of the present invention has link means which support the slide in the valve chamber and which are relatively friction free, so that the slide is easy to shift and the main frictional resistance to movement of the slide is the friction caused by pressure acting on the tubular seals to maintain their end faces in sealing engagement with the companion face on the slide. Since the friction of such seals is a function of the pressure of the fluid medium, the seals may be constructed so as to minimize this friction under various pressure conditions.

More particularly, the slide, in accordance with the invention is supported in the valve chamber adjacent to the ends of the slide by links which pivot or flex on axes transverse to the direction of slide movement and normal to the direction that force is applied to the slide by the tubular seals. These links may comprise tension elements or compression elements supporting the slide or a combination of tension and compression elements. These pivot or flexible links essentially suspend the slide in spaced relation to the body walls forming the valve chamber and the links are so constructed and araanged as to offer little resistance to movement, notwithstanding that fairly large forces may be acting to force the slide towards a body wall, say the force derived from a number of thousands of pounds of fluid pressure acting across an area on the slide determined by the cross-sectional area of the passage through the tubular seal in the inlet port when the valve is in the

closed condition. With the increased use of relatively high pressure fluid systems, say between 1000 and 6000 PSI, more or less, reduction in the friction caused by deflecting forces applied to the slide becomes ever more important.

The present invention also provides a novel and simple actuator means for shifting the slide longitudinally in the valve chamber, without requiring that any portions of the slide extend from the body, so that the slide is free to move laterally to the extent and in the direction required by the links which support the slide in the chamber.

This invention possesses many other advantages, and has other purposes which may be made more clearly apparent from a consideration of forms in which it may be embodied. These forms are shown in the drawings accompanying and forming part of the present specification. They will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed descriptions are not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plane of a valve made in accordance with the invention;

FIG. 2 is an enlarged vertical section, as taken on the line 2—2 of FIG. 1, showing the slide in a closed center condition in full lines, and showing the slide partially in broken lines in a position shifted to the right;

FIG. 3 is an enlarged vertical section, as taken on the line 3—3 of FIG. 1;

FIG. 4 is a horizontal section, as taken on the line 4—4 of FIG. 3;

FIG. 5 is a side elevation of another valve made in accordance with the invention;

FIG. 6 is an enlarged horizontal section, as taken on the line 6—6 of FIG. 5, showing the slide in a center position in full lines, and showing the slide partially in broken lines in a position shifted to the right;

FIG. 7 is a vertical section as taken on the line 7—7 of FIG. 6;

FIG. 8 is a view corresponding to FIG. 2, showing still another valve made in accordance with the invention;

FIG. 9 is a vertical section, as taken on the line 9—9 of FIG. 8;

FIG. 10 is a view corresponding to FIG. 2 and showing still another valve made in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 through 4, the valve of the invention will be seen to comprise a body 1 of generally rectangular form and providing an internal valve chamber 2 in which is disposed a reciprocable slide 3 adapted to be actuated between various selected positions by actuator means including a lever 4. In this form of the valve assembly, the body 1 has a bottom wall 5, side walls 6, and end walls 7 formed as a casting, for example, to which a top wall 8 is applied by suitable fasteners 9, with suitable sealing means 10 being interposed between the top 8 and the side and end walls 6 and 7.

The present invention is directed to valves of the type in which the flow of fluid through the valve is controlled by tubular seals which have sealing end faces slidably engageable with opposed sealing faces on the slide. Thus, in the embodiment now being described, one typical flow pattern is shown by way of illustration, but it will be understood that other flow patterns are possible, and indeed, substantially the entire range of flow patterns may be availed of which are typically found in either reciprocating slide valves of the type here involved, or the more complex and less efficient spool valves.

More particularly, the illustrative flow pattern is the usual closed center, three position pattern involving an inlet port **11** and return port **12** on one side of the valve body, namely, the top side **8** in the present embodiment, and a pair of ports **13** and **14** are at the opposite side or bottom **5** of the body. The slide **3** has a pair of parallel ports or passages **15** and **16** extending therethrough and spaced apart a distance corresponding to the spacing of the ports **11, 12** and **13, 14**, so that these ports are aligned upon longitudinal movement of the slide **3** to the left, as seen in FIG. **2**, and in addition, the slide has crossed ports **17** and **18** spaced from one another and from the ports **15** and **16** for communication with the ports **11, 12** and **13, 14**, upon movement of the slide to the right, as seen in FIG. **2**.

Each of the ports **11, 12** and **13, 14** communicates with the passage **19** which extends through a tubular seal element **20**. These seal elements each comprise a tubular body **21** disposed in a bore **22** and an enlarged annular head **23** disposed in an enlarged bore **24** having an end face **25** slidably and sealingly engageable with the opposing flat face of the rectangular slide **3**. Annular sealing means are interposed in the bore **24** between the tubular body **21** and the wall of bore **24**, in the illustrated form of an O-ring seal **26** which is disposed between a pair of back up rings **27**. In the bore **22** is a coiled compression spring **28** seating at the bottom of the bore and on the inner end of the tubular seal **20** to provide a bias to maintain initial sealing engagement of the end face **25** with the slide **3**. These tubular seals **20** have clearance in the bores **22** and **24** so as to be capable of cocking in the bores, and in addition, these bores are of sufficient depth, relative to the length of the seal body **21** and heads **23**, as to allow the seals to move axially to the necessary extent, all without disturbing the sealing engagement between the end faces **25** and the engaged faces of the slide **3**, as the slide shifts longitudinally, and as will be later described, also moves laterally in the plane of the tubular seals **20**.

Essentially, it will now be recognized, that the slide **3** is interposed between the opposing seal elements **20** in such a manner that forces acting axially on the seals **20** have a tendency to cause friction between the seals **20** and the slide **3**, and in addition, unbalanced forces applied to the slide have a tendency to cause the slide **3** to cock in chamber **2**. It is these forces in conventional valves which cause problems in the actuation of the slide between its selective positions. If the slide is directly guided on surfaces of the body, the drag friction is so high under most useful pressures that the actuating forces become so high as to require complex and/or powerful actuator means. Under some conditions, even the use of bearings interposed between the slide and the walls of the body may not be wholly satisfactory even though an improvement.

Thus, the present invention involves the concept of essentially suspending or supporting the slide within the cavity in such a manner that friction is minimized, and this is accomplished by the use of pivot links now to be described.

In the embodiment shown in FIGS. **1** through **4**, such links are generally denoted at L. These links L may be characterized as flexible pivot links and are of generally U-shaped configurations, including spaced arms **30** and a bight portion **31**. The top wall **8** provides a pair of vertical shoulders **32** having arched edges **33**, and the bight portions **31** of the links L are secured to the shoulders **32**, by suitable fastenings **34** and clamping bars **35** which engage and clamp the bight portions **31** to the shoulders **32**. The bars **35** have a bevel **36** opposing the arched edges **33** to reduce the tendency of the links L to fail along a line of flexure. The ends of the arms **30** of the flexible links L are secured to opposite end portions **37** of the slide **3** by a clamp bar **38** and fasteners **39**. The end portions **37** of the slide have arched edges **40** and the bar **38** is bevelled at **41** to minimize flex failure.

Various other flexible link configurations and fastenings may be availed of, it being understood that the object is to support the slide **3** against engagement with internal body surfaces, whereby the only resistance to movement of the slide due to its support is the resistance caused by flexing of the pivots, when the slide moves to the right to one open position, as shown in broken lines in FIG. **2**, from the closed center position, or to the left to the other open position.

The seal elements **20** are capable of axial excursions sufficient to compensate for vertical movement of the slide caused by the link supports L when the slide is shifted longitudinally by the actuator means now to be described.

The actuator means comprising the lever **4**, are so constructed that the slide is not unbalanced in the body by an actuator rod extending coaxially from the slide and so that the slide can move in the compound manner illustrated in FIG. **2** and just described above.

Thus, the lever **4** extends through an opening **50** in a side wall **6** of the body **1**, substantially normal to the slide **3** in its center position. At its inner end, the lever supports suitable rollers **51** on a supporting pin **52**, or other low friction means, engageable with the slide **3** to shift the latter. The slide **3**, in the illustrated form, has a pair of laterally projecting ears **53** providing a slot opening towards the lever **4** and extended parallel to the axis of rotation of the rollers **51**. The lever **4** is pivotally supported on the body **1** by means of a pivot pin **54** carried by a plate **55** which is secured to the body **1** by suitable fasteners **56**.

Means are provided to form a seal between the body **1** and the lever **4**, comprising a suitable bellows or diaphragm **57**, the outer periphery **58** of which is clamped against the body side wall **6** by the plate **55** and the inner periphery **59** of which is clamped against a shoulder **60** on the lever **4** by a clamp ring **61** and a nut **62** threaded on the lever **4**. Now it is apparent that the lever **4** is shiftable between a center position and either selected alternate position to move the slide **3** longitudinally in the valve chamber **2**, and that the slide can also move relative to the lever as required by the links L.

A modified construction is shown in FIGS. **5** through **7**. In this embodiment, the link means L support the slide **103** on a side wall of the body **1** and are in the form of pivotal links.

More particularly, the body **1** has the valve chamber **102** formed therein, as in the previously described embodiment, as by casting the body unit, including the bottom **105**, side walls **106** and end walls **107**. However, the ports **111**, **112** and **113**, **114** are in the sides **106**, and the actuator lever **104** is supported on the top **108** of the body secured to the body by fasteners **109**. In each of the ports **111**, **112** and **113**, **114** is a tubular seal element **120**, the details of which require no further illustration. Since these ports are horizontally disposed and the slide moves in a compound motion horizontally, the actuator lever receiving ears or lugs **153** are on the top of the slide for receiving the lever rollers **151**.

In this embodiment, the links are pivotal links, in the nature of hinge plates, including a body **130** having looped ears **131** adapted to straddle complemental portions **133** and **137** of the body and the slide and to be pivotally connected thereto by pivot pins **134** and **139** extending through the looped ears **131** of the links and through the portions **133** and **137** of the body.

The operation of the valve of FIGS. **5** through **7** is essentially the same as the first described embodiment, and the only drag friction which need be overcome by virtue of the supporting of the slide **103** will be the friction of the pivotal connection, as the slide is shifted to the right, to the broken line position in FIG. **6**, or to the left from the closed center position. The various passages, not shown, for causing changes in flow between the various ports will be understood without further illustration or description.

Still another modification is shown in FIGS. **8** and **9** wherein the links are pivot links having a knife edge pivot.

More particularly, the valve assembly is generally similar to that of FIGS. **1** through **4**, wherein the ports **211** and **212** are in the cover **208**, and the ports **213** and **214** are in the bottom **205** of the body. In each port **211**, **212** and **213**, **214** is one of the tubular seals **220**, and here again, the specific porting of the slide **203** requires no specific illustration or description.

One significant point in this modified construction is that the links L are a combination of tension link means and compression link means. More particularly, the tension link means comprises a pair of spaced link arms **230** connected at their ends by cross pieces **232**. On the body top **208** is a transversely extended lug **233** and an opposed lug **237** projects from the end of the slide **203**, these lugs **233** and **237** project between the link arms **230** and are pivotally engaged by the respective cross pieces **232**. The lug **233** has an upwardly divergent notch extending lengthwise of the lug, and the lug **237** has a similar downwardly divergent notch **239**, and the opposing edges of the cross pieces **232** have V-shaped or knife edges **232a** engaged in the respective notches **234** and **239**, whereby to pivotally support this end of the slide **203** with minimum friction.

At the other end of the slide **203**, the compression link means L comprises a plate **230*a*** pivotally engaged at its upper end with the top **208** and at its lower end with the slide **203**. The top **208** has a downwardly divergent notch **234*a*** extending transversely therein, and the slide **203** has a lug **237*a*** formed with an upwardly divergent notch **239*a***. On the upper and lower ends of the link plate **230*a*** are oppositely facing V-shaped or knife edges **232*b*** engaged in the respective notches **234*a*** and **239*a***. A coiled tension spring **235** provides means normally biasing this end of the slide **203** towards the top **108** to retain the compression pivot link plate **230*a*** in the notches just described. One end of the spring **235** is connected to the slide **203** by a fastener **235*a*** and the other end of the spring is connected to the body by a fastener **235*b***.

It will be recognized that in accordance with the embodiment of FIGS. **8** and **9**, knife edges are described, but, equivalently arched seats and link ends may be employed, and the only friction necessary to be overcome during actuation of the slide is the negligable friction of the knife edge pivots.

In FIG. **10**, still another embodiment of the invention, will be seen to involve the use of a pair of compression links L acting to resist movement of the slide into engagement with the body in opposite directions at opposite ends of the slide.

More particularly, the valve assembly of FIG. **10** is also generally similar to that of FIGS. **1** through **4**, and includes ports **311** and **312** in the top **308** of the valve body and ports **313** and **314** in the bottom wall **305**. As in the previously described embodiments, each of the ports **311**, **312** and **313**, **314** has therein a tubular seal **220**, and the specific porting by which fluid communicates through the slide **303** with the respective seals **320** requires no specific illustration.

In this embodiment, the link means L comprises a pair of compression pivot links in the form of plates **330*a***, like the link **230*a*** in FIGS. **8** and **9**, at the opposite ends of each of which is a knife edge **332*a*** engaged in opposed divergent slots **334*a*** in the respective body walls **305** and **308** and opposed divergent slots **234*a*** in transversely extended flanges **337** on opposite ends of the slide **307**. Tension springs **335** are interconnected between the slide end flanges **337** and the body walls **305** and **308** by respective fasteners **335*a*** and **335*b***.

It is now apparent that the links **330*a*** support the slide **330** in such a manner that it is not biased into engagement with either the top or the bottom of the valve body, and thus, other than the friction between the end faces of the seals **320** and the slide **303**, the only frictional resistance to shifting of the slide is the negligable friction at the knife edges of the links.

In this embodiment, it will be understood that the slide will cock slightly on its axis end-to-end since the opposed links cause opposite vector motions, but the seals **320** will nevertheless maintain sealing engagement with the slide **303** when they are caused to cock in their respective bores, as is well known.

From the foregoing, it is apparent that the present invention provides an efficient valve from components which need not be made to close tolerances, it merely being necessary that the slide faces of the sealing members be flat to prevent leakage past the seal faces. The seals will compensate for wear, as well as misalignment or lack of parallelism. Most importantly, the valve will be easy to operate, due to comparatively low friction at the slide supports or link means L. In addition, the con-

struction of the actuator means and its connection to the slide is such that no forces derived from the pressure fluid are applied to the actuator means to create a load which must be overcome.

I claim:

1. A control valve comprising a body having top, bottom and side walls and ends forming a closed chamber, a slide disposed in said chamber, inlet and outlet ports providing inlet and outlet passage means in said walls, said slide having ports providing passage means for conducting fluid between said ports, sealing means interposed between said body and said slide including tubular seal elements circumscribing certain of said ports and having end faces sealingly engaged with opposing faces through which other ports open for controlling the flow of fluid through said passage means upon shifting of said slide in said chamber, said seal elements each having its other end exposed to pressure of fluid in its port to force the end face of said sealing element into engagement with said opposing face, pivot link means interengaged with said slide and said body supporting said slide in said chamber in spaced relation to said walls of said body for movement of said slide, and actuator means for shifting said slide.

2. A control valve as defined in claim 1, wherein said inlet port is in one wall of said body and said actuator means includes a lever extending through an adjacent wall at a right angle to the axis of said inlet port.

3. A control valve as defined in claim 1, wherein said inlet port is in one wall of said body and said actuator means includes a lever extending through an adjacent wall at a right angle to the axis of said inlet port, and including a pair of ears carried by said slide and roller means on said lever engaged between said ears.

4. A control valve as defined in claim 1, wherein said inlet port is in one wall of said body and said actuator means includes a lever extending through an adjacent wall at a right angle to the axis of said inlet port, said latter wall having an opening in which said lever is disposed, and including a bellows seal clamped to said latter wall and to said lever.

5. A control valve as defined in claim 1, wherein said link means comprises a pair of tension links respectively connecting the ends of said slide to a wall said body having said inlet port.

6. A control valve as defined in claim 1, wherein said link means comprises a tension link and a compression link respectively at opposite ends of said slide and engaged with opposing walls of said body.

7. A control valve as defined in claim 1, wherein said link means comprises a pair of compression links respectively at opposite ends of said slide and engaged with a wall of said body.

8. A control valve as defined in claim 1, wherein said link means comprises flexible link members connected to the ends of said slide and to said body.

9. A control valve as defined in claim 1, wherein said link means comprises a flexible link member connected to one end of said slide and to said body and another link member connected to the other end of said slide and to said body.

10. A control valve as defined in claim 1, wherein said link means comprises a pair of link plates respectively pivotally connected to the ends of said slide and to said body.

11. A control valve as defined in claim 1, wherein said link means comprises a link plate pivotally connected to one end of said slide and to said body and another link member connected to the other end of said slide and to said body.

12. A control valve as defined in claim 1, wherein said link means comprises a pair of link members respectively having knife edge pivotal engagement with the ends of said slide and with said body.

13. A control valve as defined in claim 1, wherein said link means comprises a link member having knife edge pivotal engagement with one end of said slide and another link member connected to the other end of said slide and to said body.

14. A control valve as defined in claim 1, wherein said link means comprises a tension link member having knife edge pivotal connection with one end of said slide and said body and another link member connected to the other end of said slide and to said body.

15. A control valve as defined in claim 1, wherein said link means comprises a compression link member having knife edge pivotal connection with one end of said slide and with said body and another link member connected to the other end of said slide and to said body.

16. A control valve as defined in claim 1, wherein said top wall has one of said inlet and outlet ports therein, said bottom wall having the other of said inlet and outlet ports therein, and including means for removably securing said top wall on said body, said link means being interengaged with said slide and said top wall.

17. A control valve as defined in claim 1, wherein said top wall has one of said inlet and outlet ports therein, said bottom wall having the other of said inlet and outlet ports therein, and including means for removably securing said top wall on said body, said link means being interengaged with said slide and said top wall, and said actuator means including a lever extending into said chamber through a side wall of said body.

18. A control valve as defined in claim 1, wherein one of said side walls has one of said inlet and outlet ports therein, the opposing side wall having the other of said inlet and outlet ports therein, said link means being interengaged with one of said side walls and said slide.

19. A control valve as defined in claim 1, wherein one of said side walls has one of said inlet and outlet ports therein, the opposing side wall having the other of said inlet and outlet ports therein, said link means being interengaged with one of said side walls and said slide, and said actuator means including a lever extending into said chamber through one of said top and bottom walls.

20. A control valve as defined in claim 1, wherein one of said walls has one of said inlet and outlet ports therein and an opposing wall has the other of said inlet and outlet parts therein, said link means being interengaged between said slide and said one of said walls.

21. A control valve as defined in claim 1, wherein one of said walls has one of said inlet and outlet ports therein and an opposing wall has the other of said inlet and outlet ports therein, said link means being interengaged between said slide and said one of said wall and said opposing wall.

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