United States Patent

Combes

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[54] **DEVICE FOR CONTROLLING DISPLACEMENT OF AN ELEMENT**

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[58] **Field of Search**.....91/399, 26, 25, 52, 459; 251/63.4; 92/129

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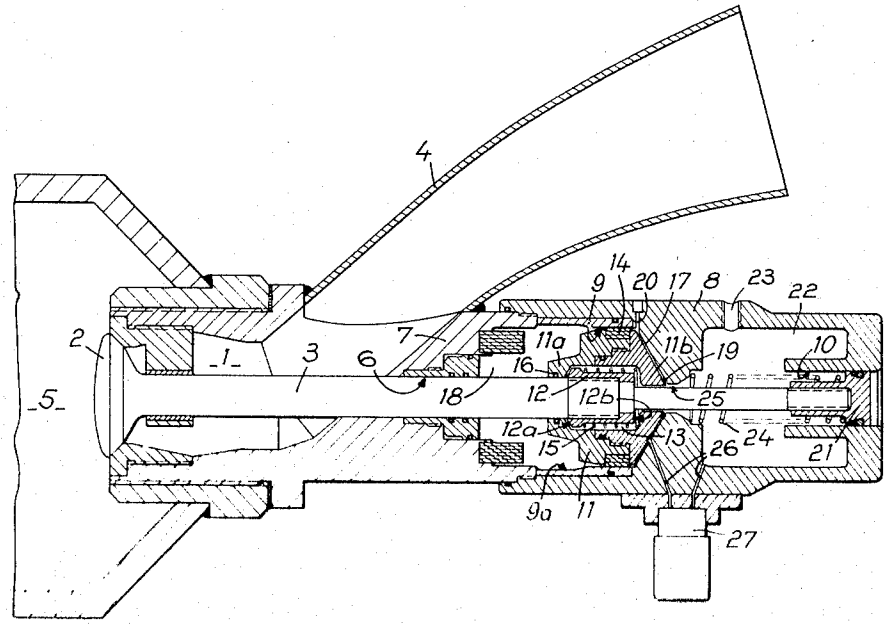
[57] **ABSTRACT**

A device for controlling the displacement of an element, the said device comprising a rod by means of which the element may be displaced, a first piston having a portion mounted for sliding movement on and sealed to the rod, a first cylinder within which the first piston is slidably mounted and which defines therewith an admission chamber whose volume changes on movement of the first piston, the admission chamber being adapted to be selectively brought into and out of communication with a source of fluid under pressure, the fluid in the admission chamber acting on a pressure surface of the first piston so as to urge the latter in a predetermined direction, means for urging the first piston in the opposite direction, an expansion chamber for the fluid under pressure, means establishing communication between the expansion chamber and the admission chamber when the volume of the latter exceeds a predetermined volume which is substantially less than its maximum volume, the minimum volume of the admission chamber being less than that of the said predetermined volume, stop means mounted on and secured to the rod, opposite faces of the stop means being respectively engageable by corresponding faces of the first piston to limit relative movement therebetween in the said predetermined and opposite directions, and resilient means which are interposed between the stop means of the first piston and which urge the latter in the said opposite direction, whereby the initial displacement of the first piston by the fluid corresponds to a relative displacement of said first piston with respect to the rod, the first piston and rod thereafter moving in unison only after the first piston has come to bear against one of the opposite faces of the stop means.

10 Claims, 2 Drawing Figures



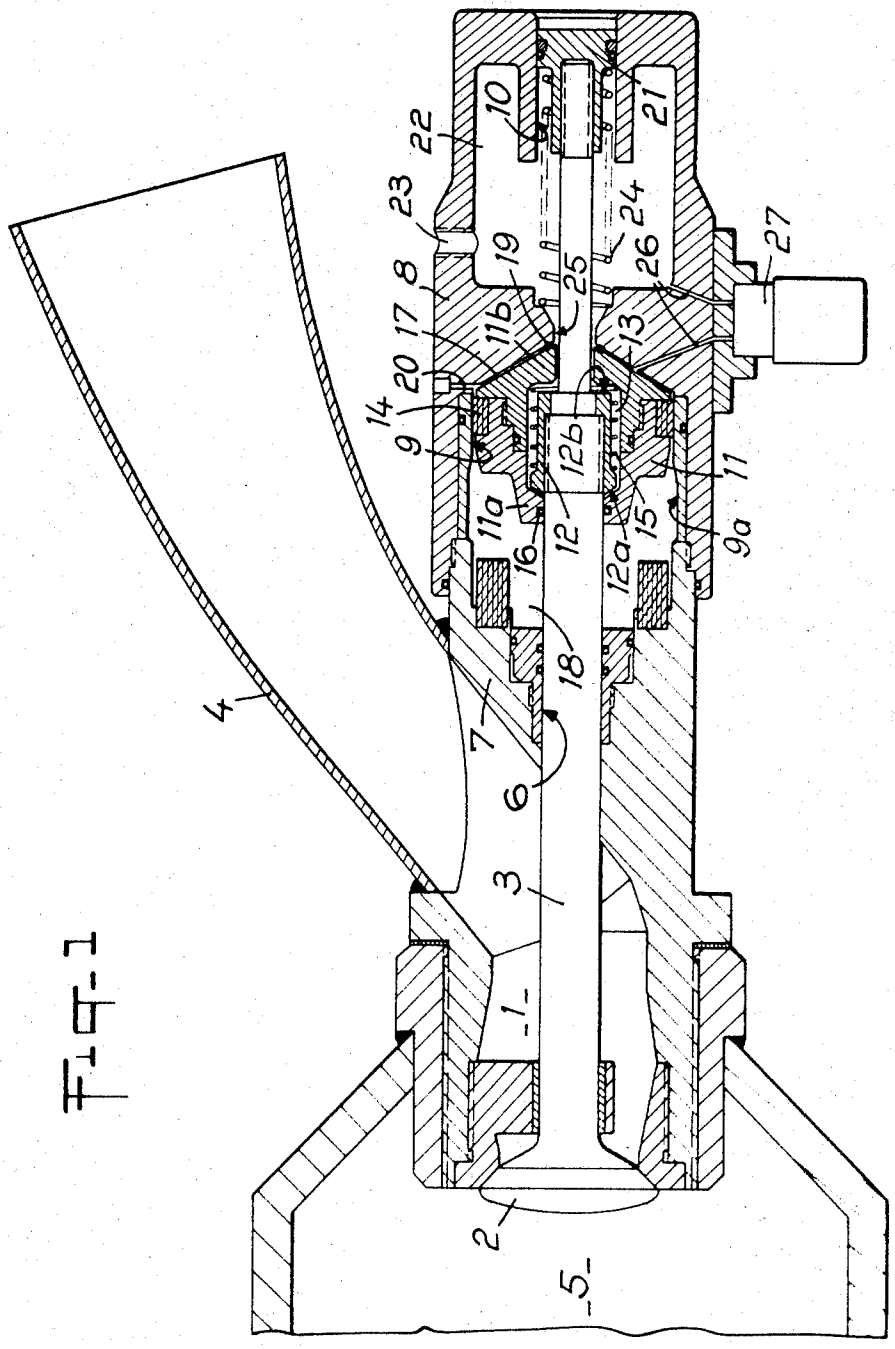

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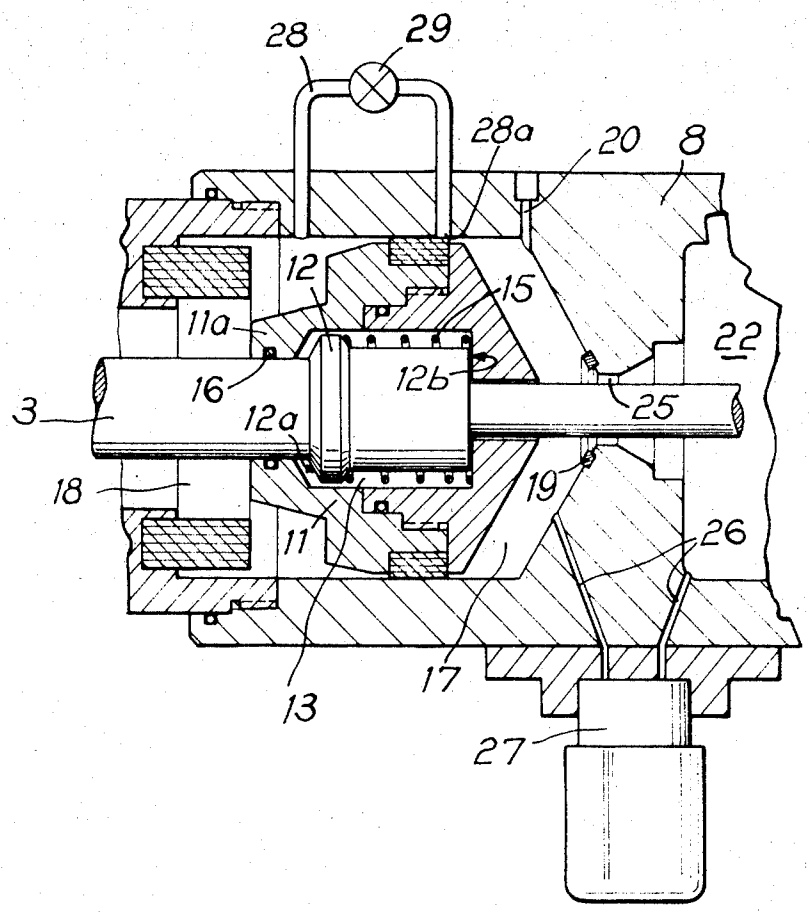
FIG. 1

Fig. 2



DEVICE FOR CONTROLLING DISPLACEMENT OF AN ELEMENT

This invention concerns a device for controlling the displacement of an element such, for example, as a valve member.

Valves are already known which are composed of a sealing element and a control device operated by a manual, electric, hydraulic, or pneumatic motor.

For certain uses necessitating rapid draining or by-passing of a fluid under pressure, for example for use as a remotely controlled safety valve or as a pressure wave generator, these control devices usually cannot be used because of their excessively long response time.

This lengthy response time arises from the fact that the very rapid displacement of the valve member requires great acceleration and very high power which is incompatible with motors known at the present time, whether these are mechanical, electrical, hydraulic, or pneumatic. The instantaneous power which has to be applied is of the order of hundreds or thousands of kilowatts for a valve with a passage section of some tens of square millimeters and pressures of the order of one hundred bars.

When in addition these valves have to carry fluids at high temperature, their construction is still more difficult.

In order to overcome this disadvantage, it is necessary to break with the usual technique of an energy converting motor and to conceive a new device, without being content with detail improvements which make it possible to increase the power and operating speed of known motors, particularly pneumatic power cylinders, but which nevertheless remain subject to the limitation of the energy source and energy transport lines.

It will moreover be noted that pyrotechnic valves, which are able to comply with the criterion of rapidity of opening, do not permit a plurality of successive operations and consequently are of limited interest.

The device according to the invention has the aim of obviating these disadvantages by making it possible, by liberating the potential energy of a gas under pressure, to effect definite and rapid opening, optionally followed by programmed reclosing of the valve.

According to the present invention, there is therefore provided a device for controlling the displacement of an element, the said device comprising a first piston having a portion mounted for sliding movement on and sealed to a rod by means of which the element may be displaced, the first piston being slidably mounted in a first cylinder and defining therewith an admission chamber whose volume changes on movement of the first piston and which is adapted to be selectively brought into and out of communication with a source of fluid under pressure, the fluid in the admission chamber acting on a pressure surface of the first piston so as to urge the latter in a predetermined direction, means for urging the first piston in the opposite direction, an expansion chamber for the fluid under pressure, means establishing communication between the expansion chamber and the admission chamber when the volume of the latter exceeds a predetermined volume which is substantially less than its maximum volume, the minimum volume of the admission chamber being less than that of the said predetermined volume, stop means mounted on and secured to the rod, opposite faces of the stop means being respectively engagable by corresponding faces of the first piston to limit relative movement therebetween in the said predetermined and opposite directions, and resilient means which are interposed between the stop means of the first piston and which urge the latter in the said opposite direction, whereby the initial displacement of the first piston by the fluid corresponds to a relative displacement of said first piston with respect to the rod, the first piston and rod thereafter moving in unison only after the first piston has come to bear against one of the opposite faces of the stop means.

The expansion chamber is preferably also defined by the first piston and the first cylinder, the expansion chamber and admission chamber being disposed on opposite sides of the first piston.

The means for establishing communication between the expansion chamber and the admission chamber may comprise at least one aperture provided in the body of the first cylinder. Alternatively, the means establishing communication between the expansion chamber and the admission chamber comprise ducting interconnecting said chambers, the ducting being provided with means for controlling flow therethrough.

The expansion chamber is preferably provided with a vent open to the atmosphere.

The first piston may be adapted to bear against the wall of the first cylinder with the interposition therebetween of a seal which bounds a central portion of the first piston, the diameter of the said seal being less than that of the portion of the first piston which is sealed to the rod, the said central portion being spaced from the rod by a clearance which is adapted to be in permanent communication with the source of fluid under pressure, whereby the action of the pressure of said fluid on the first piston, before the admission chamber is brought into communication with the source of fluid under pressure, urges the first piston against the said seal which is interposed between said first piston and the first cylinder.

Preferably a second piston is connected to the rod and is slidably mounted in a second cylinder, the second cylinder being adapted to communicate with the source of fluid under pressure and being fastened to the first cylinder, the arrangement being such that the fluid under pressure initially acts on a pressure surface of the second piston, so as to urge the latter in the said opposite direction, the pressure surface of the second piston being smaller than that of the first piston.

The said element may be a valve member which is connected to the rod, the valve member being movable in relation to a valve body which is secured to the first cylinder.

The valve member may be directly fastened to the rod, the first piston being mounted on the rod with sealingly compensated radial play.

The first and second cylinders are preferably disposed away from the valve body.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:

FIG. 1 is an axial section of a device according to the present invention, and

FIG. 2 is a broken away axial section of a modification of the device shown in FIG. 1.

In FIG. 1 there is shown a valve having a valve member movable by a control device. However, it should be understood that the control device may be employed to move elements other than a valve member.

The valve has a hot portion comprising a channel 1, a valve member fastened to one end of an axially displaceable cylindrical rod 3, and a discharge nozzle 4. This hot portion or valve body is fixed to a reservoir 5 containing a hot gas under pressure which has to be discharged.

The control device is separated from the said hot portion by a wall 7, on which there is mounted a bearing 6 through which the rod 3 passes.

The control device comprises a body 8 inside which there are disposed a first cylinder 9 and a second cylinder 10. A first piston 11, constructed in two parts to enable it to be placed in position, is mounted for limited sliding on the rod 3 on each side of a stop 12 mounted on and fastened to said rod, the stop 12 being disposed inside a cavity 13 provided in the piston 11. The piston 11 is slidably mounted in the cylinder 9 and sealed therein by means of a sealing ring 14. The stop 12 has opposite faces or shoulders 12*a* and 12*b* engagable with corresponding faces of the piston 11 to limit relative movement therebetween in each of the opposite axial directions, a spring 15 being interposed between the stop 12 and the piston 11 to urge the latter to move in a valve closing direction. The piston 11 is connected to the rod 3 at one of its ends 11*a* by a sealing ring 16, and at the other end 11*b* with radial clearance, this construction permitting a slight variation in the radial position of the rod 3 without the latter bearing against the walls of the cylinder 9.

The piston 11 and cylinder 9 respectively define both an admission chamber 17 and an expansion chamber 18 which re disposed on opposite sides of the piston 11, the expansion chamber 18 being nearer the valve member 2 than is the admission chamber. When he valve member 2 is closed, the initial volume of the admission chamber 17 is very small, this chamber being practically constituted by a sheet of fluid contained in the space existing between the piston 11 and the body 8, the piston 11 being sealed to the body 8 by means of a seal 19. This is the arrangement illustrated in FIG. 1. In addition, the chamber 17 is in communication with the atmosphere through a discharge vent. The diameter of the seal 19 is smaller than that of the sealing ring 16.

A second piston 21 is fastened to the end of the rod 3 opposite to the valve member 2, the piston 21 being slidably mounted in the cylinder 10. In the body 8 there is a chamber 22 constituting a reservoir for fluid under pressure and connected for this purpose to a source of fluid under pressure by means of a connection 23. The chambers 17 and 22 are separated by a partition having an aperture through which the rod 3 passes with clearance 25 and without sealing. A spring 24 reacts between the body 8 and the piston 21 to return the valve member 2 into the closed position in the absence, particularly, of fluid under pressure in the chamber 22. The pressure surface of the piston 21 open to the pressure in the chamber 22 is smaller than that of the piston 11 which is open to the pressure in the admission chamber 17.

When the valve member 2 is open, the piston 11 no longer bears against the seal 19 and the chambers 17 and 22 are freely in communication through the clearance 25. FIG. 2 illustrates this arrangement. On the other hand, when the piston 11 effectively bears against the seal 19, as in FIG. 1, the chambers 17 and 22 are interconnected by a duct 26 the flow through which is controlled by an electrically-operated valve 27.

In a first embodiment, illustrated in FIG. 1, in its portion closer to the valve member 2, the cylinder 9 has a widened section 9*a* constituting an aperture, so that when the piston 11 comes opposite said section 9*a* it brings the admission chamber 17 and the expansion chamber 18 into communication.

It will moreover be understood that other arrangements can be selected for forming the aforesaid aperture without there being any uniform widening of the section of the cylinder 9 over its entire periphery.

In a second embodiment, illustrated in FIG. 2, a duct 28 interconnects the admission chamber 17 and the expansion chamber 18 whenever the piston 11 passes opposite and beyond the end 28*a* of the duct 28. This arrangement is another possible way of providing an aperture. It will however be noted that in the example of FIG. 2 an electrically-operated valve 29 has been provided to controlled flow through the duct 28.

Some modifications of the valve described above will now be indicated.

Thus, it is not essential that the valve member and valve seat should have conical bearing surfaces. With the control device it is also possible to operate any type of valve known at the present time, and in addition even a device which is not a valve.

Furthermore, the piston 21 may be disposed otherwise than as shown, while the various chambers as well as the connection of the valve member 2 to the control device, or the relative arrangement of the stop 12 and the piston 11, may be different from what has been illustrated as an example.

The operation of the valve which has just been described is very simple. It is characterized essentially by high performance, rapidity of opening of the valve member 2 in particular, but also by good tolerance of unfavorable working conditions, including contact with the hot gases contained in the reservoir 5.

The chamber 22 having been filled with a fluid under pressure by any known means, the valve member 2 is opened as explained below in connection with FIG. 1. The opening of the valve 27 is effected, thereby bringing into communication the chamber 22 and the very small initial volume of the admission chamber 17. The small volume of the admission chamber 17 permits rapid movement of the piston 11, which moves away from the seal 19 and consequently permits communication between the chambers 17 and 22 through the wide passage constituted by the clearance 25. The speed of the piston 11 increases, and piston 11 then strikes against the shoulder 12*b* of the stop 12. The force of pressure applied to the piston 11, which is higher than the total of the forces acting on the valve member 2 and the piston 21, and the energy released by the impact against the shoulder 12*b*, permits an abrupt opening movement of the rod 3 and rapid opening of the valve member 2.

When the piston **11** comes into the widened section **9a**, or uncovers an alternative aperture which is provided, the pressures in the chamber **17** and the chamber **18** tend to become equalized and the resultant forces on the piston **11** tend to cancel one another. The axial force on the rod **3** then changes its sign and the opening movement slows down, ceases, and is replaced by a closing movement of the valve member **2**.

On completion of the closing movement, the fluid contained in the chamber **17** is discharged to the atmosphere through the vent **20**. A small orifice (not shown) which is pierced through the piston **11**, and which serves no role in dynamic operation, then brings the chamber **18** and the chamber **17** into communication and also permits the emptying of the chamber **18**.

It should be noted that in numerous practical cases it is not indispensable to provide sealing rings **14** on the outside of the piston **11**, if the clearance between the latter and the cylinder **9** is made very slight.

After closing, the valve is ready for another opening cycle.

In the example described above there are obtained opening times which may vary from ten milliseconds to several hours by changing the section of the ducts or apertures and the vent **20**.

In addition, it will be noted that it is possible to control the operation of the valve by a slight injection of fluid under pressure into the chamber **17**. The control of the injection may for example be effected by an excess pressure flap, the electrically-operated valve **27**, a mechanically operated valve, or by other means. Bringing the chamber **17** into communication with a variable pressure reservoir makes it possible to open the valve member **2** when a determined pressure threshold is reached. Thus the reservoir **5** and the chamber **17** may be brought into communication by means of a non-return valve, and the valve member **2** may be converted into that of an excess pressure valve with remarkable performance from the point of view of response time and open section.

The replacement of programmed closing through the position of the widened section **9a** by remotely controlled closing is easily obtained by adopting the arrangement shown in FIG. **2** and providing the electrically-operated valve **29**.

It will clearly be understood that for each operation the valve utilizes the energy of the fluid under pressure which is contained in the chamber **22**, said fluid expanding so that after the opening of the valve member **2** it occupies the chambers **17**, **22** and **18**. Consequently, the operation of the valve does not depend on an external source supplying a considerable instantaneous power and only its re-activation requires the application of pressure to the chamber **22** again, and this may be effected as slowly and gradually as desired. The same is true with regard to the discharge of the residual fluid through the vent **20** after the opening of the valve member **2**.

The difference in the diameters of the seal **19** and the sealing ring **16** is such that initially, before the admission chamber **17** is brought into communication with the chamber **22**, the effect of the pressure of the fluid, arriving in the cavity **13** in the piston **11**, on said piston **11** tends to cause said piston **11** to bear strongly against the seal **19**, thus providing good initial sealing.

A valve of the type which has just been described may in particular be employed as a remotely controlled safety valve and in pressure wave generators.

As has already been indicated, the device controlling this valve may in a general way be used for any mechanical control when it is desired to have a rapid displacement which requires very high instantaneous power, optionally followed by rapid return to the starting position.

It will further be noted that the fact that the control device is disposed away from the valve body constituting the hot part, leads to remarkable durability of said control device, which can operate under good environmental conditions.

I claim:

1. A device for controlling the displacement of an element, the said device comprising a rod by means of which the element may be displaced, a first piston having a portion mounted for sliding movement on and sealed to the rod, a first cylinder within which the first piston is slidably mounted and which defines therewith an admission chamber whose volume changes on movement of the first piston, the admission chamber being adapted to be selectively brought into and out of communication with a source of fluid under pressure, the fluid in the admission chamber acting on a pressure surface of the first piston so as to urge the latter in a predetermined direction, means for urging the first piston in the opposite direction, an expansion chamber for the fluid under pressure, means establishing communication between the expansion chamber and the admission chamber when the volume of the latter exceeds a predetermined volume which is substantially less than its maximum volume, the minimum volume of the admission chamber being less than that of the said predetermined volume, stop means mounted on and secured to the rod, opposite faces of the stop means being respectively engageable by corresponding faces of the first piston to limit relative movement therebetween in the said predetermined and opposite directions, and resilient means which are interposed between the stop means of the first piston and which urge the latter in the said opposite direction, whereby the initial displacement of the first piston by the fluid corresponds to a relative displacement of said first piston with respect to the rod, the first piston and rod thereafter moving in unison only after the first piston has come to bear against one of the opposite faces of the stop means.

2. A device according to claim **1** in which the expansion chamber is also defined by the first piston and the first cylinder, the expansion chamber and admission chambers being disposed on opposite sides of the first piston.

3. A device according to claim **1** in which the means establishing communication between the expansion chamber and the admission chamber comprise at least one aperture provided in the body of the first cylinder.

4. A device according to claim **1** in which the means establishing communication between the expansion chamber and the admission chamber comprise ducting interconnecting said chambers, the ducting being provided with means for controlling flow therethrough.

5. A device according to claim **1** in which the expansion chamber is provided with a vent open to the atmosphere.

6. A device according to claim 1 in which the first piston is adapted to bear against the wall of the first cylinder with the interposition therebetween of a seal which bounds a central portion of the first piston, the diameter of the said seal being less than that of the portion of the first piston which is sealed to the rod, the said central portion being spaced from the rod by a clearance which is adapted to be in permanent communication with the source of fluid under pressure, whereby the action of the pressure of said fluid on the first piston, before the admission chamber is brought into communication with the source of fluid under pressure, urges the first piston against the said seal which is interposed between said first piston and the first cylinder.

7. A device according to claim 1 in which a second piston is connected to the rod and is slidably mounted in a second cylinder, the second cylinder being adapted to communicate with the source of fluid under pressure and being fastened to the first cylinder, the fluid under pressure initially acting on a pressure surface of the second piston, so as to urge the latter in the said opposite direction, the pressure surface of the second piston being smaller than that of the first piston.

8. A device as claimed in claim 7 in which the said element is a valve member which is connected to the rod, the valve member being movable in relation to a valve body which is secured to the first cylinder.

9. A device according to claim 8 in which the valve member is directly fastened to the rod, the first piston being mounted on the rod with sealingly compensated radial play.

10. A device according to claim 8 in which the first and second cylinders are disposed away from the valve body.

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