

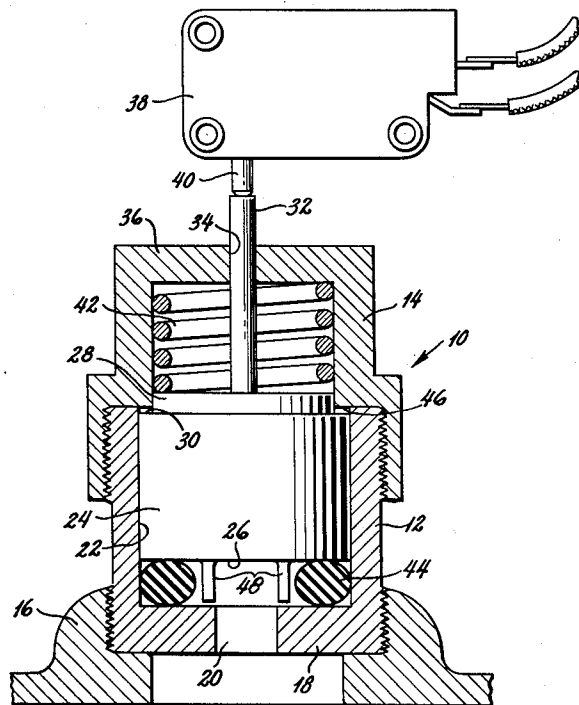
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FLUID PRESSURE RESPONSIVE SWITCH ACTUATOR

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FLUID PRESSURE RESPONSIVE SWITCH ACTUATOR

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This invention relates to an improved fluid pressure responsive switch actuator.

In many applications of pressure responsive switch actuators, it is essential that the actuator respond accurately to a relatively low fluid pressure to operate its switch and yet be capable of withstanding much higher fluid pressures without detrimental effects such as excessive leakage. It may be desired, for example, to operate a switch at a fluid pressure of 10 p.s.i. in an installation where the switch actuator is subjected to pressures as high as 1000 p.s.i.

Actuators of the type which include a fluid pressure responsive actuating piston and an associated seal in sliding engagement with the piston or the walls of its chamber have not been found entirely satisfactory under the aforementioned conditions of operation. When an actuator of this type is designed to withstand the high fluid pressures to which it is subject in use, excessive seal friction is encountered and the response of the actuator to low fluid pressures is unsatisfactory. That is, the actuator does not operate its associated switch with the desired degree of accuracy at low fluid pressures. Under the aforementioned exemplary conditions, where the actuator must withstand 1000 p.s.i. and operate its switch at 10 p.s.i., the friction induced errors encountered in an actuator of this type may be as high as 20 percent, i.e., the actuator may operate its switch anywhere between 8 and 12 p.s.i.

Fluid pressure responsive switch actuators of the type which utilize lapped actuating pistons are also found lacking under the aforementioned conditions of operation. In many instances, the amount of leakage encountered with this type of actuator is unacceptable particularly at extremely high pressure levels and where the actuator is operated by gas rather than liquid pressure.

Similarly, actuators which employ bellows and diaphragms as pressure responsive actuating means are found unsatisfactory in some respects. When the actuator bellows or diaphragm is made rugged enough to withstand the high pressures encountered, the sensitivity thereof is lowered and inaccurate operation at the lower pressure levels results. Conversely, a light bellows or diaphragm having a high sensitivity is subject to possible rupture at the higher pressure levels.

It is the general object of the present invention to provide a fluid pressure responsive actuator for a switch or the like which is capable of withstanding relatively high fluid pressures with insignificant leakage and, which is yet extremely accurate in actuation of its associated switch or the like at much lower fluid pressures.

The drawing shows a preferred embodiment of the invention and such embodiment will be described, but it will be understood that various changes may be made from the construction disclosed, and that the drawing and description are not to be construed as defining or limiting the scope of the invention, the claims forming a part of this specification being relied upon for that purpose.

In the single FIGURE of the drawing, a preferred construction of the improved pressure responsive actuator of the present invention is shown somewhat schematically in association with a micro-switch operated thereby.

Generally speaking, the pressure responsive actuator

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of the invention comprises a means defining a chamber which is adapted to receive fluid under pressure and which has an actuating piston means disposed therein. The actuating piston means is resiliently biased in one direction and urged in an opposite direction by the pressure of fluid in the chamber. A resilient sealing means in the chamber is adapted to be engaged and compressed by the piston means whereby to provide a fluid-tight seal between said piston means and the walls of the chamber. The said sealing means is not employed in the usual manner so as to be in sliding engagement with the piston means or the chamber walls, but is instead arranged so as to be continuously in engagement with a selected portion of the surface of the piston means and a selected portion of the chamber walls and so that its compression is varied by movement of the piston means in said one and opposite directions. There is no relative sliding movement between the sealing means and the portion of the surface of the piston means adjacent thereto and there is likewise no relative sliding movement between the sealing means and the portion of the chamber walls adjacent thereto. Thus, friction is reduced to a minimum in the actuator and the errors in actuator operation caused by friction are avoided. Suitable stop means associated with the piston means limit the movement thereof so that the resilient sealing means is continuously maintained under sufficient compression for effective sealing operation.

In the preferred construction of the pressure responsive actuator shown in the drawing, an actuator housing is indicated generally by the reference numeral 10. The housing 10 may obviously take a variety of forms, but is shown as comprising lower and upper generally cup-shaped members 12 and 14. The lower cup-shaped housing member 12 is in an upright attitude and is threaded into a boss 16 which may be formed on a conduit or other enclosure containing fluid under pressure. The base or lower end wall 18 of the housing member 12 has a substantially radial inner surface and is provided with a port 20 for the introduction of pressurized fluid from the enclosure to the interior of said member.

The upper cup-shaped housing member 14 is in an inverted attitude and has its lower and open end portion threaded onto the upper and open end portion of the lower housing member 12. A generally cylindrical chamber 22, defined cooperatively by the lower and upper housing members 12 and 14, contains a piston 24 which is movable axially therein and which has a lower radial end surface 26 which is acted upon by the pressurized fluid entering the port 20.

The piston 24 has a reduced diameter upper portion 28 defining an annular shoulder 30 and formed integrally with the said portion 28 is a piston extension 32. The piston extension 32 extends upwardly through a suitable opening 34 in the base or end wall 36 of the upper cup-shaped housing member 14. A micro-switch 38 has its actuating element 40 disposed adjacent the upper end of the piston extension 32.

From the foregoing, it will be apparent that in the construction shown the piston 24 will be urged upwardly in the housing chamber or cylinder 22 by the pressure of fluid on its lower end surface 26 to cause the piston extension 32 to actuate the switch 40. The piston 24 is resiliently biased downwardly in the preferred actuator construction by a spring 42, but it is to be understood that said piston may be otherwise biased in opposition to the fluid pressure. In one obvious alternative construction, the piston 24 may be biased in opposition to the fluid pressure merely by a gravity force, i.e., the piston may be constructed and arranged so that the force of gravity thereon tends to hold the piston in its down-

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ward position until the fluid pressure on its lower surface exceeds a predetermined level and urges the same upwardly to actuate the switch.

In the preferred actuator construction shown, a resilient sealing means comprising an annular sealing element 44 of the O-ring type is employed. The said sealing element is disposed in the chamber 22 between the lower end surface 26 of the piston 24 and the substantially radial inner surface of the base or lower end wall 18 of the lower cup-shaped housing member 12. It is to be understood, however, that the invention is not limited to sealing elements of the particular configuration shown, nor is the invention limited to the illustrated location of the sealing element with respect to the actuating piston and the walls of its chamber or cylinder. Obviously, a resilient sealing means may be similarly arranged with respect to adjacent substantially radial surfaces on the piston and the walls of its chamber at the opposite end of said piston or, the piston and the walls of its chamber or cylinder may be constructed to accommodate a similarly arranged sealing means disposed between the ends of the piston. It is also to be observed that the sealing means, by virtue of its resiliency, is adapted to be utilized as a means for biasing the actuating piston in opposition to the fluid pressure forces exerted thereon.

With the sealing element 44 arranged as shown, the spring 42 urges the piston 24 downwardly into engagement with the said element and compresses the same when the fluid pressure on the piston surface 26 is below the selected operating pressure for the actuator and the micro-switch 40. When the pressure on the lower end surface 26 of the piston 24 increases and reaches the operating pressure of the actuator, the piston moves upwardly against the bias of the spring 42 to actuate the micro-switch 40 and suitable stop means terminates the upward movement thereof.

The stop means for terminating upward movement of the piston 24 shown in the drawing comprises an inwardly extending annular shoulder 46 formed internally on the upper generally cup-shaped housing member 14. The said shoulder is spaced axially from the aforementioned shoulder 30 on the piston 24 so that the necessary upward piston movement for actuating the switch 40 is obtained with the annular sealing element 44 continuously under sufficient compression for effective sealing operation. That is, the sealing element 44 is sufficiently compressed between the piston end surface 26 and the end wall 18 throughout the movement of the piston 24 to effectively prevent fluid flow radially or in a transverse direction with respect to the direction of movement of said piston.

It will be apparent that the position of the stop means or shoulder 46 relative to the shoulder 30 on the piston 24 is somewhat critical. In the drawing, the piston 24 is shown in an intermediate position and the axial space between the shoulders 30 and 46 is somewhat exaggerated for purposes of illustration. With a conventional type of natural or synthetic rubber O-seal having a cross-sectional diameter or thickness of approximately .07 inch, a piston travel of from .001 to .004 inch can be obtained while maintaining sufficient compression of the seal for substantially drop-type sealing operation. The piston travel obtained with seals of other sizes and types of course varies and the selection of a sealing means will be dependent upon the actuating motion required by the switch or other means operated by the actuator. Obviously, increased actuating motion can be provided for where necessary by utilizing a suitable motion multiplier or the like in connection with the piston extension 32.

The actuator preferably also includes a suitable means for limiting the movement of the piston in the downward or seal compressing direction. In the drawing a pair of stop pins 48, 48 project from the lower end surface 26 of the piston 24 and are adapted to engage the end wall 18 of the cup-shaped housing member 12. By limiting the

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downward or seal compressing movement of the piston 24, the stop pins 48, 48 prevent excessive distortion of the annular sealing element 44 which might result in a loss of resiliency of said element.

The principal features and advantages of the fluid pressure responsive actuator of the present invention should be apparent from the foregoing description and it is necessary only to mention some of the less apparent features and advantages in summary. It will be observed that the particular arrangement of the sealing means provided eliminates relative sliding movement between the said means and the surface engaged thereby so that seal friction in the actuator is reduced to a minimum. As a result, an extremely high degree of accuracy in the operation of the actuator at relatively low fluid pressure levels is obtainable. Under the aforementioned conditions of operation where the actuator encounters fluid pressures as high as 1000 p.s.i. and is required to operate its switch at 10 p.s.i., it has been found that the error encountered in an actuator constructed in accordance with the invention may be on the order of 3 percent or lower. This is to be compared with the previously mentioned 20 percent error encountered with actuators having seals in sliding engagement with their adjacent surfaces.

Although the improved actuator of the present invention has been shown and described in association with a micro-switch, it will be apparent that actuators constructed in accordance with the invention may be used for a wide variety of purposes in addition to switch actuation. Obvious additional uses of the fluid pressure responsive actuator of the invention are in the operation of valves of various types and in the actuation of pressure indicating devices.

The invention claimed is:

1. In a fluid pressure responsive actuator for a switch or the like, the combination of means defining a chamber adapted to receive fluid under pressure, actuating piston means biased in one direction in said chamber, the pressure of fluid in said chamber urging said piston means in an opposite direction, resilient sealing means in said chamber adapted to be engaged and compressed by said piston means whereby to provide a fluid-tight seal between the piston means and the walls of the chamber, the arrangement of said sealing means in said chamber being such that movement of said piston means in said one and opposite directions varies the compression thereof, and stop means limiting such movement of said piston means whereby to continuously maintain said sealing means under sufficient compression for effective sealing operation.

2. In a fluid pressure responsive actuator for a switch or the like, the combination of means defining a chamber adapted to receive fluid under pressure, actuating piston means in said chamber resiliently biased in one direction and urged in an opposite direction by the pressure of fluid therein, resilient sealing means in said chamber adapted to be engaged and compressed by said piston means whereby to provide a fluid-tight seal between the piston means and the walls of the chamber, the arrangement of said said sealing means in said chamber being such that movement of said piston means in said one and opposite directions varies the compression thereof, and stop means limiting such movement of said piston means whereby to continuously maintain said sealing means under sufficient compression for effective sealing operation.

3. In a fluid pressure responsive actuator for a switch or the like, the combination of means defining a chamber adapted to receive fluid under pressure, actuating piston means in said chamber resiliently biased in one direction and urged in an opposite direction by the pressure of fluid therein, resilient sealing means in said chamber adapted to be engaged and compressed by said piston means whereby to provide a fluid-tight seal between the piston means and the walls of the chamber, the arrange-

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ment of said sealing means in said chamber being such that movement of said piston means in said one and opposite directions varies the compression thereof, and stop means limiting movement of said piston means in said one and opposite directions whereby to continuously maintain said sealing means under sufficient compression for effective sealing operation and to prevent excessive distortion of the said means.

4. In a fluid pressure responsive actuator for a switch or the like, the combination of means defining a chamber adapted to receive fluid under pressure, actuating piston means in said chamber resiliently biased in one direction and urged in an opposite direction by the pressure of fluid therein, resilient sealing means in said chamber adapted to be engaged and compressed by said piston means whereby to provide a fluid-tight seal between the piston means and the walls of the chamber, said sealing means being arranged in said chamber so that movement of said piston means in said one and opposite directions varies the compression thereof and so as to prevent fluid flow in a transverse direction with respect to the direction of movement of said piston means, and stop means limiting such movement of said piston means whereby to continuously maintain said sealing means under sufficient compression for effective sealing operation.

5. In a fluid pressure responsive actuator for a switch or the like, the combination of means defining a cylinder adapted to receive fluid under pressure, an axially movable actuating piston in said cylinder resiliently biased in one direction and urged in an opposite direction by the pressure of fluid therein, a resilient annular sealing element in said chamber adapted to be engaged and compressed by said piston whereby to provide a fluid-tight seal between the piston and the walls of said chamber, said sealing element being arranged in said chamber so as to prevent fluid flow in a generally radial direction and so as to have its compression varied by movement of said piston in said one and opposite directions, and stop means limiting the movement of said piston whereby to continuously maintain said sealing element under sufficient compression for effective sealing operation.

6. In a fluid pressure responsive actuator for a switch or the like, the combination of means defining a cylinder adapted to receive fluid under pressure and having at least one wall which includes a substantially radial surface, an axially movable actuating piston in said cylinder resiliently biased in one direction and urged in an opposite direction by the pressure of fluid therein, said piston having a substantially radial surface adjacent said substantially

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radial surface of said cylinder wall, a resilient annular sealing element disposed between said adjacent surfaces and compressed to provide a fluid-tight seal, and stop means limiting the axial movement of said piston whereby to continuously maintain said sealing element under sufficient compression for effective sealing operation.

7. In a fluid pressure responsive actuator for a switch or the like, the combination of means defining a cylinder which is adapted to receive fluid under pressure and which has at least one substantially radial end wall, an axially movable actuating piston having at least one substantially radial end surface disposed with its said end surface adjacent said substantially radial cylinder end wall, resilient means biasing said piston in one direction against the pressure of fluid in said cylinder tending to urge said piston in an opposite direction, a resilient annular sealing element disposed between said adjacent piston surface and cylinder wall and compressed to provide a fluid-tight seal, and stop means limiting the axial movement of said piston whereby to continuously maintain said sealing element under sufficient compression for effective sealing operation.

8. In a fluid pressure responsive actuator for a switch or the like, the combination of means defining a cylinder which is adapted to receive fluid under pressure and which has at least one substantially radial end wall, an axially movable actuating piston having at least one substantially radial end surface disposed in said cylinder with its said end surface adjacent said substantially radial cylinder end wall, spring means biasing said piston toward said substantially radially cylinder end wall against the pressure of fluid in said cylinder tending to urge said piston in an opposite direction, a resilient annular sealing element disposed between said adjacent piston surface and cylinder end wall and compressed to provide a fluid-tight seal, and stop means limiting the movement of said piston whereby to continuously maintain said sealing element under sufficient compression for effective sealing operation and to prevent excessive distortion of said element.

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