July 23, 1968 J. E. GORGENS ET AL 3,393,612

PRESSURE RESPONSIVE DEVICE

Filed May 12, 1966

Fig. 1.

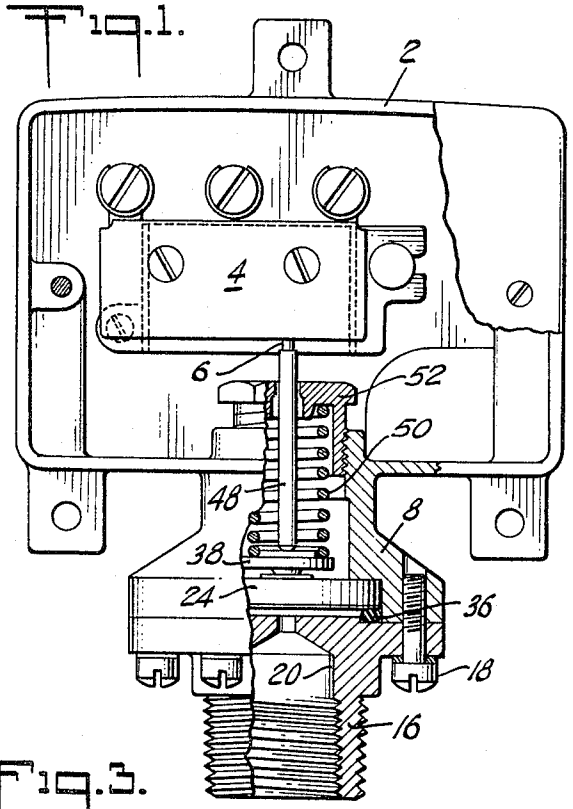


Fig. 2.

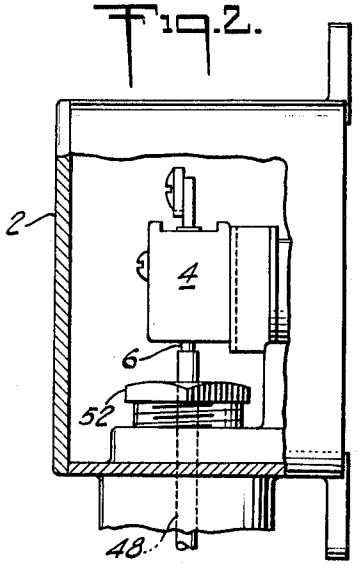


Fig. 5.

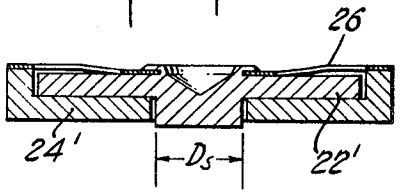


Fig. 3.

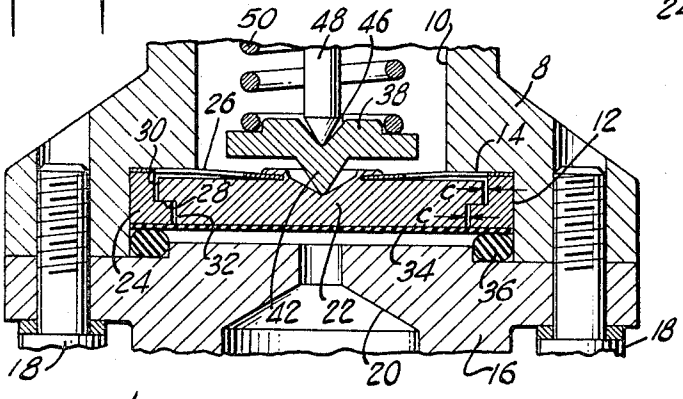


Fig. 6.

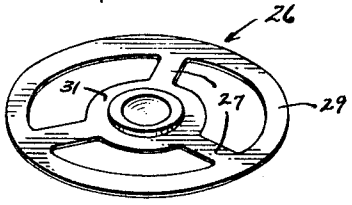
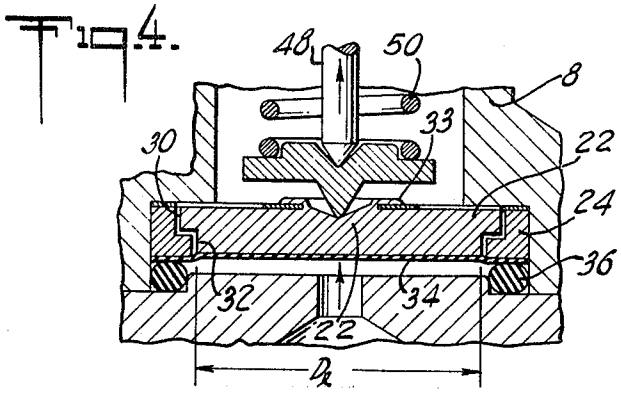


Fig. 4.



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PRESSURE RESPONSIVE DEVICE

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ABSTRACT OF THE DISCLOSURE

A pressure operable electrical switch including a piston movable in response to a condition pressure applied against a contiguous pressure responsive diaphragm. The piston is maintained directionally aligned by a connected and laterally secured leaf spring and transmits its movement to the switch controller through a coaxial rod aligned in the face of the piston. Pressure sensitivity ranges are interchangeable by substituting a piston having different effective dimensions.

This invention resides in an improved pressure-responsive means for actuating a sensitive control device such as a switch.

In process control applications it is common to turn a switch on or off by means such as a bellows or diaphragm which is responsive to the pressure of a fluid medium in a vessel or conduit. In certain cases the accuracy and sensitivity of the device are critical, and hence it is necessary to avoid all mechanical elements which can introduce the slightest error or time lag into the responsive system. Friction between rubbing parts, for example, can introduce such error. A simple form of pressure responsive device comprises a fluid tight housing having a diaphragm exposed to line pressure at one side, and a plunger or the like at the other side of the diaphragm for transmitting pressure-induced displacement of the diaphragm to the switch for operation thereof. The means of connecting and guiding the plunger or piston as heretofore arranged has been found to be capable of introducing a small but objectionable percentage of inaccuracy into response sensitivity of the entire unit. Accordingly, a first object of this invention is to provide a pressure-responsive device wherein these adverse influences on the accuracy of the instrument are effectively eliminated.

A further object of this invention involves the adaptability of a commercial device to operation in response to pressures in a variety of pressure ranges. For example, in one application a device may be required to operate in response to changes in pressure within the range of 1 to 50 p.s.i., whereas in another application this range may extend up to pressures in the region of 3,000 p.s.i. In most cases, it is desirable that provision be made to enable a change of the operating pressure range of the device in the field by personnel who are not specially trained. In the common types of devices produced heretofore, this change has necessarily involved practically complete disassembly and the careful substitution of properly matched sets of loose parts, thereby increasing the possibility of errors which can lead to malfunction and reduce reliability.

Accordingly, a further object of the invention is to provide a device of the character described, in which the operating pressure response range can be changed very simply, without the necessity of complete disassembly and without handling sets of individual parts.

Briefly, in accordance with this invention, the above objects are attained by providing a permanently integrated piston and cylinder unit wherein the piston is movably

mounted in spaced and centered relation within the fixed cylinder by means of a symmetrical leaf spring. Because of this simple spring mounting, there is no frictional contact between the piston and any other parts, and thus any error due to such contact is completely eliminated. The diaphragm overlies the cylinder and acts against the exposed area of the piston therein in opposition to a coil spring acting against the other end of the piston, and changes in the force balance in response to changes in fluid pressure are transmitted to operate a sensitive switching means or other control element. A preassembled unit having a relatively larger piston area is used in a device operating at low fluid pressures, and one having a quite small area is used for high pressures. However, the exterior dimensions of all such units are the same, so that they are completely interchangeable. As will be seen hereafter, the installation of a permanently assembled unit having a piston size matched to a given operating pressure is all that is involved in adapting a device for service at that pressure, and this installation does not necessitate its complete disassembly.

Further objects, advantages and details will become evident from the following description when read in conjunction with the accompanying drawings, in which:

FIGURE 1 is a partially sectional view of a complete pressure responsive switch mechanism according to this invention;

FIGURE 2 is a side view of the structure shown in FIGURE 1;

FIGURE 3 is an enlarged axial section through the portion of the mechanism containing the piston and cylinder unit, these parts being shown under a first condition;

FIGURE 4 is a view as in FIGURE 3, except showing a second condition wherein pressure has increased;

FIGURE 5 is an axial section through a piston and cylinder unit having a relatively smaller exposed area, being adapted for high pressure service;

FIGURE 6 is a perspective view of the symmetric leaf spring for mounting the piston in the cylinder in freely centered relation.

Referring now to the drawings, in the specifically illustrated embodiment of the invention a metal casting provides a box-like housing **2** in which a sensitive switch **4** is mounted. Switch **4** has an actuating plunger **6**, the slight movement of which (measured in thousandths of an inch) serves to open and close one or more sets of switch contacts. At one side of the housing **2** there is formed a neck **8** having a bore defining a through passage **10**. At the bottom of the neck **8** there is a larger cylindrical counterbore **12** which terminates in a circular flat seat **14**. A head **16**, threaded as shown to accommodate an appropriate conduit or fitting, has a central fluid passage **20** therein and is adapted to be drawn tightly against the housing neck **8** by means of a series of cap screws **18**.

Referring to FIGURES 3–6, the significant feature of this device resides in an assembled unit comprising a piston **22**, a cylinder ring **24**, and a spring means **26** in the form of a symmetrical spider-shaped metal element. The cylinder **24** is annular and has an L-shaped rim, the radially inwardly directed flange of which presents a flat seating surface **28**. The piston **22** is stepped in two diameters, the larger being indicated at **30** and the smaller being indicated at **32**. In the radial dimension, there is a clearance *c* between the piston and cylinder of at least .002 to .050 of an inch to insure complete freedom from contact between these two parts. Referring to FIGURE 6, the spring **26**, which is formed of thin gauge spring sheet metal, is stamped in a form having an annular outer ring **29**, symmetrically arranged spokes **27**, and an inner hub **31**. In

the assembly of this three-part unit, a thin-flange or rim **33** is staked and deformed over the inner ring **31** to secure the spring and piston in firmly clamped relation. The outer ring **29** is preferably tack-welded or otherwise secured to the cylinder **24**. By virtue of these connections, the cylinder **22** is held in centered and spaced relation within the cylinder **24**, but is axially movable therein within the limits illustrated in FIGURE 3. Overlying the lower parts of the piston **22** and cylinder **24** is a fluid impervious rubber diaphragm **34**, sealed and clamped at its edges by an O-ring **36**. The pressure of a fluid medium communicating through the passage **20** acts against diaphragm **34**. The total force transmitted to the piston **22** is a function of the diameter D_l of the piston (the notation "*l*" being intended to mean "large"), as is discussed more fully hereafter.

At the other side of the piston **22**, there is a disc **38** having a conically pointed end **42** which centrally engages the piston **22** within a conical cavity **40**. Disc **38** has flat extensions **44** providing a seat anchoring one end of a compression coil spring **50**. The opposite end of spring **50** acts against a fitting **52** threaded into the neck **8**. It will be seen, therefore, that spring **50** urges piston **22** downwardly against the seating surface **28** in opposition to the force against the piston **22** by fluid pressure at the outer side of diaphragm **34**. Displacement of piston **22** from that position is transmitted to the switch actuating plunger **6** by a push rod **48** received in a central cavity **46** in the disc **38**. In operation, the piston **22** will be lifted from the seating surface **28** and switch **4** will be actuated only when the cumulative force of the fluid pressure transmitted across the diameter D_l exceeds the downward force exerted principally by the spring **50**. This critical pressure level is, therefore, a function of the diameter D_l and the spring constant of spring **50**.

Referring to FIGURE 5, there is shown a piston and cylinder unit which is basically the same as that shown in FIGURES 3 and 4, except that the exposed piston diameter D_s of the piston **22'** is much smaller, and the radially inward extent of the flange of the cylinder **24'** is correspondingly greater. Hence, it follows that the operating pressure range of this device can be changed simply by interchanging units having exposed piston diameters ranging between D_l (large) and D_s (small). Depending upon the particular operating specifications, of course, the same spring **50** may be suitable for use with a variety of different piston and cylinder units, but may also be changed if desired.

In operation, a unique advantage of the device described is that all that need be done to change the operating pressure range is to remove the screws **18**, diaphragm **34** and ring **36**, and to substitute another piston and cylinder unit having an exposed piston diameter selected to effect the desired performance. Because the piston **22**, cylinder **24** and spring **26** are permanently preassembled, these parts cannot become mismatched and the device is essentially foolproof against error on the part of field personnel. Secondly, because the piston and cylinder do not touch in the course of displacement axially, there is an absence of rubbing contact which can introduce frictional force which would be reflected as errors in operation of the device. In summary, as compared to prior art devices, the device provided according to this invention is more simple, more accurate and more easily adjustable for operation at different pressure ranges.

It will be understood that various departures from the specifically disclosed embodiment of the invention can be effected without departing from the scope thereof as defined by the following claims.

What is claimed is:

1. A pressure responsive device comprising a housing, a yieldable diaphragm mounted in said housing, said housing providing a chamber at one side of said diaphragm adapted to be connected to a source of fluid pressure, a piston having a first face engageable with said diaphragm at the other side thereof, symmetrically arranged leaf spring means connected to and extending laterally from said piston, said connected leaf spring means includes a plurality of spoke-like elements extending radially along the second face of the piston, said spring means being also laterally secured to said housing to directionally maintain the piston for movement responsive to fluid pressure at said one side of the diaphragm, means resiliently urging said piston against said diaphragm, and means directionally aligned by the second face of said piston for transmitting movement of said piston to a sensitive control device, said piston being spaced from and free of contact with the surface of laterally surrounding structure.

2. A pressure responsive device comprising a housing, a yieldable diaphragm mounted in said housing, said housing providing a chamber at one side of said diaphragm adapted to be connected to a source of fluid pressure, a piston having its face engageable with said diaphragm at the other side thereof, symmetrically arranged leaf spring means including a plurality of radially extending spoke-like elements connected to and extending laterally from the side of the piston away from said diaphragm and positioning the piston for movement responsive to fluid pressure at said one side of the diaphragm, means resiliently urging said piston against said diaphragm, a cylinder ring stationarily mounted within said housing enclosing said piston at the sides but being laterally spaced therefrom, said cylinder ring being connected to the other ends of said spoke-like elements, and means for transmitting movement of said piston to a sensitive control device.

3. A device according to claim **2**, wherein said cylinder ring has an outer face engageable with portions of said other side of the diaphragm surrounding the area of engagement with said piston.

4. A device according to claim **2**, wherein said piston, cylinder ring and spring means are integrally secured together to constitute a unitary removable and interchangeable assembly, said housing including a removable head portion defining a wall of said chamber whereby removal of said head permits removal of said unitary assembly.

5. A pressure responsive device comprising a housing, a yieldable diaphragm mounted in said housing, said housing providing a chamber at one side of said diaphragm adapted to be connected to a source of fluid pressure, a cylinder ring stationarily mounted within said housing against the other side of said diaphragm and having a central opening therein, a disc-shaped piston movable within said opening in radially closely spaced and centered relation thereto and contacting said other side of the diaphragm, a leaf spring element connected between the central portion of the piston and the cylinder ring, said element resiliently maintaining said closely spaced and centered relation of the piston and cylinder ring, means resiliently urging said piston against said other side of the diaphragm, and means transmitting movement of said piston to a sensitive control device, said piston, cylinder ring and leaf spring element constituting a unitary removable and interchangeable assembly.

6. A device according to claim **5**, wherein said cylinder ring has an L-shaped cross-section, the lower side of the radially inwardly directed flange of said L being in contact with the diaphragm and the upper side providing a seating surface on which said piston is bottomed, said piston having a central portion projecting through the central opening defined by said flange, the area of said portion being exposed to the pressure force transmitted by said diaphragm.

7. A device according to claim **6**, wherein said housing includes a removable section defining the chamber at said one side of the diaphragm and clamping said diaphragm in overlying relation to the piston and cylinder ring assembly, said diaphragm and assembly being removable after removal of said housing section.

(References on following page)

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References Cited

UNITED STATES PATENTS

19,177	1/1858	Young	73—408
2,223,976	12/1940	Van Nest	92—101
2,319,011	5/1943	Meredith	73—406
3,043,929	7/1962	Guthrie	200—83.51
3,119,910	1/1964	Meisenheimer et al.	200—83.51
3,254,573	6/1966	Prell	92—101

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FOREIGN PATENTS

1,146,271	5/1957	France.
739,398	10/1955	Great Britain.

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