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HERMETICALLY SEALED PRESSURE SWITCH

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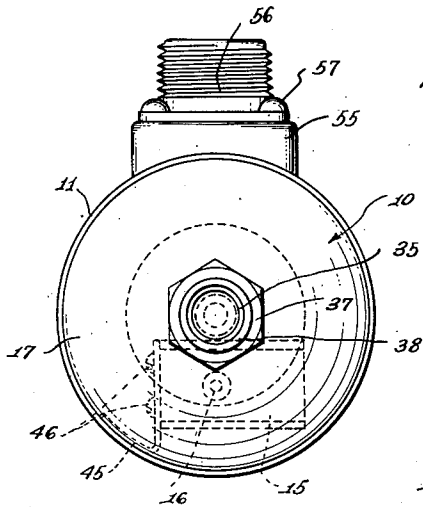


Fig. 1

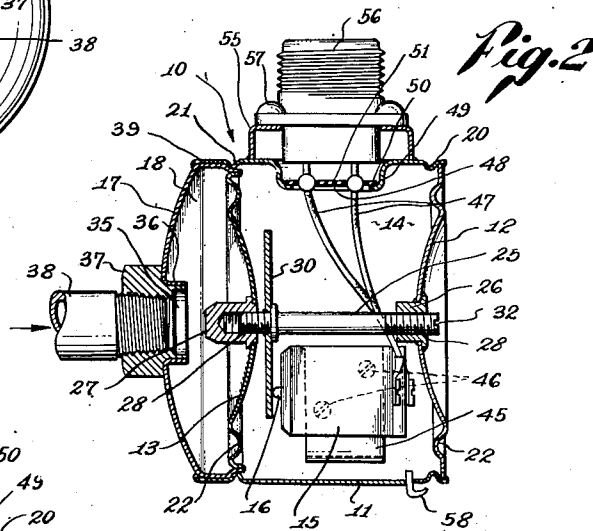


Fig. 2

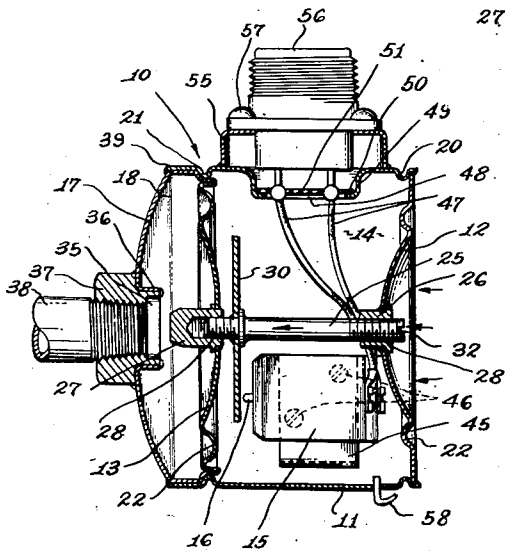


Fig. 3

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HERMETICALLY SEALED PRESSURE
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My invention relates generally to pressure-responsive switches, and more particularly to a pressure-responsive switch having the electrical contact elements located within a hermetically sealed chamber that is unaffected by variations in operating pressures so as to maintain optimum switching conditions.

Pressure-responsive switches are utilized in a wide variety of control systems, and have extensive application in high altitude aircraft to control motor driven mechanisms in accordance with a selected pressure relationship, as for example that existing between the cabin pressure and the reduced external pressure. Devices of this type include two major components, a pressure-operated actuator mechanism and an electrical contact switch of conventional design. In prior pressure-responsive switches, the electrical switch has been exposed to one or the other of the operating pressures, and as can be understood, may thus be subjected to a wide pressure variation.

As is well known in the electrical switch art, there is a direct relationship between the pressure and the dielectric strength of air. At reduced pressures there may be excessive arcing at the switch contacts causing pitting and a possible fire hazard. In addition, the moisture vapor of the air may be condensed upon a pressure or temperature change so as to collect around the switch contacts. This leads to further trouble such as insulation deterioration or fungus growth experienced under tropical conditions, and may render the switch completely inoperative. When it is further considered that many such switches are located in inaccessible positions on aircraft, it can be seen that expensive upkeep work may be necessitated unless the electrical switch contacts are properly protected. It can also be understood that a heavy and complex structure is highly undesirable in a device of this character and must be avoided particularly in aircraft installations.

It is therefore a major object of my invention to provide an improved pressure-responsive switch of light weight and durable construction which will overcome the aforementioned operational difficulties.

It is also an object of my invention to provide an improved pressure-responsive switch having the electrical switch located within a hermetically sealed chamber so as to be unaffected by changes in the operating pressures.

A further object of my invention is to provide an improved pressure-responsive switch which

may be easily adjusted and accurately calibrated to maintain a predetermined operating relationship between two different pressure conditions.

It is another object of my invention to provide a switch of the character described having a hermetically sealed chamber adapted to be pressurized with an inert gas for maintaining the electric switch under optimum operating conditions, unaffected by external moisture, dirt or other harmful substances.

A still further object of my invention is to provide a device of the character described having a light weight pressure-balanced housing construction which is capable of withstanding substantial pressure changes and yet remain sensitive to slight operating variations therein.

These and other objects and advantages of my invention will become apparent from the following detailed description of a preferred form thereof, and from an inspection of the accompanying drawings, in which:

Fig. 1 is an end elevation of a preferred embodiment of my improved pressure-responsive switch;

Fig. 2 is a vertical section taken along the longitudinal axis of the preferred device showing the operating plate in a position to actuate the switch button; and

Fig. 3 is a vertical section similar to Fig. 2 with the operating plate and switch button shown in a normal position.

Referring now to the drawings and particularly to Fig. 1 thereof, the numeral 10 indicates generally a cylindrical housing which encloses a preferred embodiment of my device. The housing 10 includes a horizontally disposed rigid shell 11 which is closed by a flexible end wall or diaphragm 12 and a central flexible diaphragm 13 to define an inner chamber 14. An electrical switch 15, preferably of the miniature snap-acting type, is mounted within the chamber 14 and is provided with an operating lever or button 16 which faces the central diaphragm 13. The button 16 is movable towards or away from the switch 15 to open and close electrical contacts within the switch, and is normally spring-urged to an outwardly projecting position. As can be understood, with the button 16 in its normal position the electrical circuit through the switch 15 may be either open or closed, depending upon the desired construction of the latter.

At the opposite end of the shell 11 from the diaphragm 12 is a cap or rigid outwardly convex end wall 17 which defines with the central diaphragm 13 a pressure chamber 18 that is adapted

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to be connected to a selected pressure source. Since the cap 17 is rigid while the diaphragm 13 is flexible, it can be seen that pressure variations within the chamber 18 will tend to cause movement of the diaphragm along the axis of the housing 10. This movement of the diaphragm 13 is utilized to actuate the switch button 16 for opening and closing the electrical contacts of the switch 15.

Likewise, it can be seen that since the flexible diaphragm 12 is exposed to the ambient or external pressure without the housing 10, variations in the ambient pressure will tend to cause movement of this diaphragm along the axis of the housing. Insofar as the pressure-responsive operation of the device is concerned, it is desired to control the operation of the switch 15 in response to the pressure differential between the ambient pressure and the pressure within the chamber 18. At the same time it is desired that the pressure within the chamber 14 be unaffected by pressure variations in either of the operating pressures. To accomplish this end I provide means linking the diaphragms 12 and 13 together for unitary or parallel movement. Thus the diaphragms 12 and 13 operate in effect as a single diaphragm wall and maintain a constant volume within the chamber 14 while moving axially of the housing 10 in response to the pressure differential between the chamber 13 and the ambient pressure.

The shell 11 is formed as a thin-walled rigid member having a pair of annular internal shoulders 20 and 21 pressed therein to provide opposed seats for the diaphragms 12 and 13, respectively. Preferably the diaphragms 12 and 13 are formed as flexible metal disks curved concavely towards the chamber 14 in opposed relationship, and having substantially equal areas to create a balanced total pressure thereon. The edges of the diaphragms 12 and 13 are brazed or otherwise suitably secured to the shell 11 to seal the chamber 14, and the center portion of each diaphragm is supported by an expansible arcuate rim portion 22 so as to be free for a greater amount of movement along the axis of the shell 11. The use of the expansible rim portion 22 permits a greater flexure of the diaphragm centers without exceeding the elastic limits of the diaphragm material and hence provides for a more accurate calibration of the device.

Extending axially through the chamber 14 is a linking means such as a shaft 25 which centrally connects the diaphragms 12 and 13 for unitary or parallel movement. To support the shaft 25 an internally threaded boss or sleeve 26 is mounted on the diaphragm 12 and an internally threaded socket or cap 27 is similarly mounted on the diaphragm 13. The shaft 25 is provided with threaded end portions 28 which engage within the sleeve 26 and socket 27 so as to lock the diaphragms 12 and 13 together. An operating plate or circular disk 30 is fixed to the shaft 25 adjacent the switch 15 and extends radially a sufficient distance to engage the switch operating button 16. As the shaft 25 moves in accordance with the movement of the diaphragms 12 and 13, the operating plate 30 causes movement of the button 16 to effect opening and closing of the switch contacts.

The outer end of the shaft 25 is provided with a tool-engaging slot 32 for adjustment of the shaft relative to the diaphragms 12 and 13. When the shaft 25 is rotated relative to the sleeve 26 and socket 27, the operating plate 30 is moved

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axially with respect to the operating button 16. Thus a simple means is provided for calibration of the device after assembly. After a proper adjustment of the device is obtained, the shaft 25 may be soldered or otherwise sealed within the sleeve 26 to fix the adjustment and prevent any pressure leakage across the diaphragm 12.

In order to connect the chamber 18 with an operating pressure source, the cap 17 has a central opening 35 defined by an intumed flange 36. A coupling boss 37 is welded within the flange 36 and projects outwardly for threaded engagement with the end of a conduit 38 which leads from the selected pressure source. The outer edges of the cap 17 are turned to form a rim 39 which fits tightly within the end of the shell 11 and is sealed into place by brazing or similar operation to seal the chamber 18 from external pressure. As can be understood, since the cap member 17 is of rigid construction the pressure within the chamber 18 will act only on the flexible diaphragm 13, and the movement of the latter will accurately reflect the pressure differential existing between the chamber pressure and the ambient pressure.

The switch 15 is mounted upon one end of a bracket 45 by fastening means such as screws 46, and the other end of the bracket is firmly secured to the wall of the shell 11. A pair of suitable electrical leads 47 is connected to the switch 15 and extends upwardly to pass through an opening 48 formed in the upper portion of the shell 11 by an intumed flange 49. Preferably the flange 49 is provided with a sealing lip 50 which supports a sealing gasket 51 fitted closely around the leads 47 to close the opening 48. Above the flange 49, a base ring 55 is secured to the shell 11 to project upwardly and provide a seat for a suitable electrical connector plug. To complete the assembly an electrical connector 56 is secured in place on the base ring 55 by fastening means such as the bolts 57. Preferably the connector 56 is of the so-called AN type, and in any event must be of a type providing a hermetic seal between the chamber 14 and the outside of the shell 11. Both the connector 56 and the gasket 51 provide pressure seals into the chamber 14, and there is little or no possibility of pressure leakage therein.

In the manufacture of my improved switch a capillary connection 58 is passed through the shell 11, and the chamber 14 is evacuated and filled with an inert gas. The choice of a suitable inert gas and the pressurization of the chamber 14 will be determined largely by the anticipated conditions under which the device is to be used. Moderate pressurization will be suitable for most uses, and will provide dielectric conditions such that there will not be any arcing at the contacts of the switch 15, or any deterioration of the switch because of moisture condensation, fungus growth or other well-known difficulties.

In operation, the pressure within the chamber 14 will be unaffected by variations in the operating pressures. The diaphragms 12 and 13 move as a unitary structure because of the provision of the linking means 25, and the volume of the chamber 14 remains constant. In Fig. 2 I have illustrated the condition under which the pressure within the chamber 18 is greater than that of the ambient pressure without the diaphragm 12. Under this condition the pressure acting against the diaphragm 13 overcomes the pressure acting against the diaphragm 12, and both diaphragms are flexed towards the right-hand end of the housing 10. The shaft 25 moves axially and the operating plate 30 pushes the switch

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button 16 inwardly to set the switch contacts into either an "on" or "off" position. In Fig. 3 I have illustrated the condition under which the ambient pressure exceeds the pressure within the chamber 18. The diaphragms 12 and 13 are flexed to the left and the operating plate 30 moves therewith, to allow the switch operating button 16 to return to its normal outwardly projecting position, and causes the switch contacts to be set in the opposite position to that of Fig. 2.

In the foregoing I have shown and described a preferred embodiment of my invention which is simply and durably constructed and is fully capable of accomplishing the objects and advantages of the invention. However, many changes of design and construction will be apparent to those skilled in the art, and I do not wish to be limited to the details herein described, except as defined in the appended claims.

I claim:

1. A switch of the class described which includes: a rigid housing having an open end; an outer flexible diaphragm closing said housing and sealed therewith; an inner flexible diaphragm mounted within said housing parallel to said outer diaphragm and having an area substantially equal to that of said outer diaphragm, said inner diaphragm dividing said housing into a first sealed chamber closed by said inner and outer diaphragms and a second sealed chamber between said inner diaphragm and the closed end of said housing, said second chamber being adapted to be connected to a selected fluid pressure source; a linking shaft disposed axially through said first chamber and extending outwardly through said outer diaphragm, said shaft being threadedly connected to said inner and outer diaphragms for axial adjustment therealong while holding said diaphragms spaced a constant distance apart for unitary parallel movement to maintain a substantially constant volume in said first chamber; switch means mounted in said first chamber and externally connectible through the wall of said housing, said switch means having an operating member operable to open and close switch contacts upon axial movement thereof; and a generally circular operating plate secured to said linking shaft adjacent said switch operating member to move said member in response to movement of said diaphragms, said plate rotating with said shaft as the latter is turned to adjust the axial position of said plate, whereby the operating range of said switch may be adjusted, and said plate at all times presents an area to said operating member.

2. A switch of the class described which includes: a rigid tubular housing; a rigid cap member sealed to one end of said housing and adapted to be connected to a selected fluid pressure source; an outer flexible diaphragm sealed at the other end of said housing and having an inwardly concave center portion capable of limited axial movement; an inner flexible diaphragm sealed across the interior of said housing to divide said housing into a first chamber closed by said diaphragms and a second chamber closed by said inner diaphragm and said cap member, said inner diaphragm being substantially equal in

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area to said first diaphragm and having an opposed concave center portion capable of limited axial movement; a linking shaft disposed axially through said first chamber and extending outwardly through said outer diaphragm, said shaft being threadedly connected to said inner and outer diaphragms for axial adjustment therealong while holding said diaphragms spaced a constant distance apart for unitary parallel movement to maintain a substantially constant volume in said first chamber; switch means mounted in said first chamber and having an operating button facing one of said diaphragms and operable to open and close switch contacts upon axial movement thereof; a sealed external connector mounted in the wall of said first chamber and connected to said switch means; and a generally circular operating plate secured to said linking shaft for movement therewith and extending outwardly therefrom to engage said switch operating button and move said button in response to the movement of said diaphragms as the pressure differential between the pressure of said second chamber and the ambient pressure changes, said plate being adjustable axially with respect to said button by external rotation of said shaft, and presenting an area to said button at all times regardless of the rotation of said shaft.

3. A switch of the class described which includes: a first chamber having a pair of movable walls at opposite ends thereof, said chamber being hermetically sealed; a second chamber adjacent said first chamber and closed by a rigid housing and one of the movable walls of said first chamber, said second chamber being adapted to be connected to a suitable fluid pressure source; an internally threaded socket centrally mounted on said one movable wall and opening into said first chamber; an internally threaded sleeve centrally mounted in the other of said movable walls; a threaded rod extending through said sleeve, through said first chamber, and into said socket, said rod being axially adjustable with respect to said movable walls by rotation of said rod, and holding said walls spaced a constant distance apart regardless of the axial position of said rod; switch means mounted in said first chamber and externally connectible through the wall of said first chamber; and a generally circular plate mounted on said rod for movement therewith, said plate at all times presenting an operating area to the actuating member of said switch means regardless of the rotation or axial position of said plate.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,480,495	Mejean et al.	Aug. 30, 1949
2,481,612	Nicholson	Sept. 13, 1949

FOREIGN PATENTS

Number	Country	Date
307,059	Germany	Oct. 17, 1919