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DIFFERENTIAL PRESSURE SWITCH

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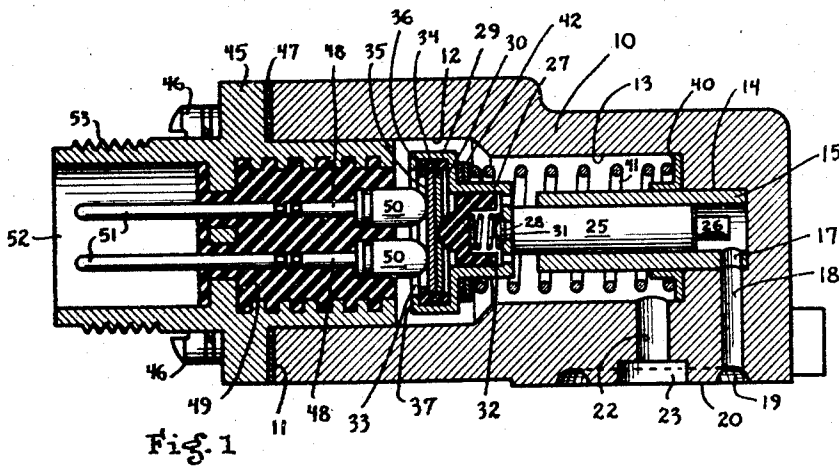


Fig. 1

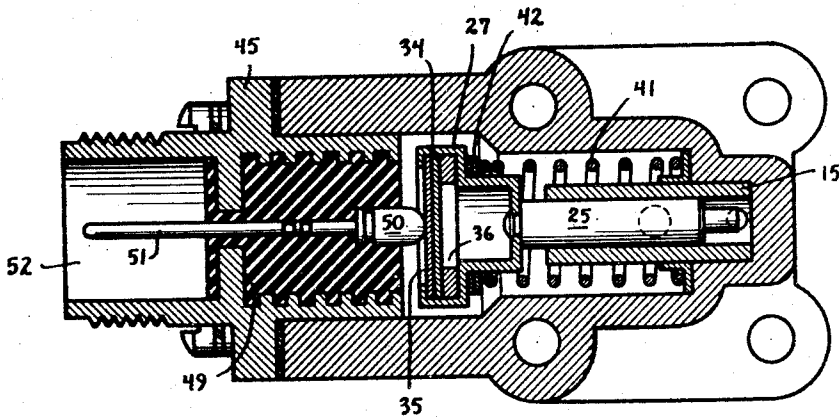


Fig. 2

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## DIFFERENTIAL PRESSURE SWITCH

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This invention relates to automatic switches which are actuated in accordance with the difference in pressure between two fluids.

One of the main objects of the invention is to design a differential pressure switch which is particularly adapted for use on airplanes where the switches are subjected alternately to the very low atmospheric pressures encountered at high altitudes and the relatively high atmospheric pressures encountered on the ground. It is customary to mount the switch contacts in a sealed chamber to prevent dirt and moisture from the air from dirtying or rusting the contacts. It has been found however that where this sealed chamber is subjected alternately to high and low external atmospheric pressures there is a tendency for the chamber to "breathe" slightly with the result that moisture gets into the chamber and rusts the contacts. It is therefore one of the objects of the invention to design a switch in which outside air cannot get at the contacts to corrode them.

Another object of the invention is to provide a pressure differential switch in which the contacts are mounted directly in the fluid, the pressure of which actuates the switch.

A further object of the invention is to provide a sleeve with a closely fitting rod responding to the difference in pressure at each end of the sleeve, the rod actuating a switch in a pressure chamber at one end of the sleeve.

A further object is to provide a switch of the above type in which there are two stationary contacts and a movable bridging contact operated by the differential pressure responsive rod, the bridging member being provided with a press back in order to align itself with respect to the two stationary contacts.

These and other objects will readily become apparent to those skilled in the art if the following specification is read in the light of the accompanying drawings in which:

Figure 1 is a cross-section of my switch housing enclosing two stationary switch contacts, and

Figure 2 is a cross-section of the single stationary contact switch, the switch housing being shown as rotated through an angle of 90° with respect to Figure 1.

Referring now to Figure 1, the reference numeral 10 indicates a switch housing having an open end 11, a main bore 12, a counterbore 13 having a smaller diameter than the main bore, and a second counterbore 14 having a smaller diameter than the first counterbore. One end of a hollow cylindrical sleeve 15 is fitted into the

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counterbore 14 and the other end of the sleeve 15 extends well within the counterbore 13. The inner end of the sleeve 15 is provided with an opening 17 which registers with a passageway 18 extending through the side of the switch housing 10. Passageway 18 communicates with an annular slot 19 in the face portion 20 of the switch housing 10. A second passageway 22 connects the chamber formed by the counterbore 13 with an opening 23 in the face 20 of the switch housing 10. The annular slot 19 and the opening 23 are designed for connection with a pressure fluid conducting member which may abut the face 20. This member will conduct a fluid, such as oil under pressure, to the annular slot 19 which pressure will be communicated through the passageway 18 and opening 17 to the inner end of the sleeve 15. Another fluid, such as oil, will be conducted to the opening 23 and hence through passageway 22 to the chamber formed by the counterbore 13. The slot 19 is made of annular formation so that the fluid conducting member may be mounted in any rotative position with respect to the switch housing 10 and still make the proper connections with the two passageways 18 and 22.

A differential pressure responsive member in the form of a rod 25 closely fits the interior of the sleeve 15 and is therefore responsive to the difference in the pressures existing in the chamber formed by the inner end of sleeve 15 and the chamber formed by the counterbore 13 and main bore 12. The rod 25 is provided with a reduced stem 26 which in one position of the rod will abut the inner end of the counterbore 13 to prevent the rod from closing off the opening 17.

At its outer end the rod 25 carries a cup 27 by any suitable connection such as shown at 28. The cup is hollow and is provided with an enlarged head 29 which forms a shoulder 30. Within the cup is a press back spring 31 which engages a press back button 32 which is made of some suitable molded insulating material such as Bakelite. The press back button 32 has a rounded head 33 which is received in an indentation in a steel disc 34 which in turn backs up an electrical bridging member in the form of a disc made of some suitable electrically conducting material, such as silver, indicated at 35. These two discs 34 and 35 are mounted in an annular holding member made of suitable insulating material, such as Bakelite, and indicated at 36. In order to hold these parts in assembled relation, the end of the enlarged head 29 of the cup 27 is turned over to form a lip as indicated at 37. It will be noted that the

two discs 34 and 35 may be pressed inwardly of the cup 27 a slight amount until the press back button engages the bottom of cup 27. This will prevent the disc 34 from ever making contact with the cup 27 and grounding the switch. When there is no external pressure applied to the discs 34 and 35, the press back spring 31 holds them in the position shown in Figure 1 with relation to the cup 27 and holding member 36.

Surrounding the sleeve 15 and abutting the inner end of the counterbore 13 is a spring retaining washer 40 against which one end of the main spring 41 rests. The other end of the main spring 41 surrounds the shank of the cup 27 and rests against a plurality of adjusting washers 42 which in turn are seated against the outer face of the shoulder 30. The function of the spring 41 is to oppose the action of the rod 25 in moving the contact head or cup 27 to the right as seen in Figure 1. The effective length and therefore the tension of the spring 41 may be adjusted by removing or inserting additional washers between the end of the spring 41 and the contact cup 27.

The open end 11 of the switch housing 10 is closed by the flanged member 45 which is suitably attached to the housing 10 by means of the screws 46 which tighten the annular flange on the member 45 against a gasket 47 located between it and the open end 11 of the switch housing 10. The closing member 45 is hollow and carries a pair of stationary contacts 48 which are sealed into and insulated from said closing member 45 and from each other by means of a suitable insulating material, such as Bakelite 49, which is molded into the hollow portion of the closing member 45. These two contacts 48 are provided with suitably rounded heads 50 which extend beyond the closing member 45 and into the chamber formed by the main bore 12. These contacts have elongated shanks 51 which extend through the Bakelite 49 and into a chambered portion 52 of the closing member 45. The chambered portion 52 may be externally threaded as at 53. The circuit to be controlled by this switch is connected to the shanks 51 of the two contacts 48 by a connector (not shown) engaging the external threads on the chambered portion 52.

It will be seen that the chamber formed by the inner end of the sleeve 15 is connected to one source of fluid pressure whereas the chamber formed by the two bores 12 and 13 is connected to another source of fluid pressure. Inasmuch as the rod 25 is subjected at one end to the pressure in the first mentioned chamber and at the other end to the pressure in the second mentioned chamber, it will respond to this differential pressure. In the specific embodiment herein disclosed, the fluid, whose differential pressure is being measured, is oil, and the higher pressure is within the chamber formed by the bores 12 and 13, which will hereinafter be referred to as the high pressure chamber. An increase in the difference in pressure between the high and low pressure chambers will therefore force the rod 25 to the right and separate the silver bridging contact 35 from the two stationary contact heads 50. When the pressure differential is reduced, the spring 41 will force the rod 25 to the left and the bridging member 35 will again close the circuit between the two stationary contacts 50. The slight amount of press back offered by the press back button 32 and spring 31 permits the bridging member 35 to align itself properly with the contacts 50, thereby assuring that both of

these contacts will always be engaged by the bridging member 35 on movement thereof to the left by the rod 25.

By mounting the two contacts 50 and the bridging member 35 directly in the oil, whose differential pressure is being measured, it is assured that no air will be able to get at the contacts and corrode them. The pressure within both the high and low pressure chambers will be above that of the external atmosphere and therefore there will be no breathing effect of this chamber as the switching device passes from low to high altitudes and vice versa.

Figure 2 shows a slight modification of the invention disclosed in Figure 1 wherein only a single stationary contact is used. The form of switch housing used in Figure 2 is exactly the same as that used in Figure 1, and in order to show its form more clearly the section of Figure 2 is taken looking directly down from the top of the sheet on the housing shown in Figure 1.

The sleeve 15, rod 25, opening 17, passageways 18 and 22, as well as the annular slot 19 and opening 23, are exactly the same in Figure 2 as in Figure 1. Inasmuch as there is but a single stationary contact in the modification shown in Figure 2, there is no need for the silver contact bridging member 35 to align itself and therefore the press back has been removed. A metal washer 36 has been substituted in order that the contact 35 may be well grounded through the cup 27, rod 25, sleeve 15 to the housing 10 or from the cup 27, through the washers 42 and coil spring 41.

The stationary contact in this modification is in exactly the same form as the two contacts 48 of Figure 1 except that it is located directly in the center of the closing member 45. Again this contact is sealed into the closing member 45 by means of Bakelite 49 and is provided with an inner rounded head 50 which extends into the high pressure chamber and is also provided with a shank 51 which extends through the closing member 45 and into the hollowed out portion 52 where it may be connected in an external circuit. The operation of the switch of this modification is exactly the same as the operation of the modification disclosed in Figure 1 and it will not be described in further detail.

As various modifications of this invention will occur to those who are skilled in the art, I intend to be limited only by the scope of the appended claims and not in accordance with the specific embodiments disclosed.

I claim as my invention:

1. A housing having a longitudinal bore extending partially therethrough to form a chamber having an open end and a closed end, a counterbore of smaller diameter than said main bore in the closed end of said housing, a hollow sleeve seated in said counterbore and extending into said main bore, a rod slidably mounted in and closely fitting said sleeve, a passageway connected at one end to the inner end of said counterbore beneath said rod and adapted to connect at its other to a fluid under pressure, the space between the inner end of said rod and the inner end of said counterbore forming a pressure chamber, a second passageway connecting at one end to said main bore and adapted to connect at its other end to another fluid under pressure, means for closing the open end of said housing to form a second pressure chamber, said rod being movable by the difference in pressure existing in said two chambers, stationary contact means in said second pressure chamber, a contact moved

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by said rod into and out of engagement with said stationary contact means, and a coil spring determining the pressure differential at which said contacts shall be engaged and disengaged, said spring surrounding said sleeve and seating at the inner end of said main bore.

2. A housing having a longitudinal bore extending partially therethrough to form a chamber having an open end and a closed end, a counterbore of smaller diameter than said main bore in the closed end of said housing, a hollow sleeve seated in said counterbore and extending into said main bore, a rod slidably mounted in and closely fitting said sleeve, a passageway connected at one end to the inner end of said counterbore beneath said rod and adapted to connect at its other to a fluid under pressure, the space between the inner end of said rod and the inner end of said counterbore forming a pressure chamber, a second passageway connecting at one end to said main bore and adapted to connect at its other end to another fluid under pressure, means for closing the open end of said housing to form a second pressure chamber, said rod being movable by the difference in pressure existing in said two chambers, stationary contact means in said second chamber, a contact head carried by said rod, a contact on said head moved by said rod into and out of engagement with said stationary contact means, and a coil spring resisting movement of said head by said rod, said spring surrounding said sleeve and being seated at the inner end of said main bore, and one or more washers between the end of said spring and said contact head, the number of washers predetermining the tension of said spring and hence the pressure difference at which said piston will actuate said contacts.

3. A housing having a longitudinal bore extending partially therethrough to form a chamber having an open end and a closed end, a counterbore of smaller diameter than said main bore in the closed end of said housing, a hollow sleeve seated in said counterbore and extending into said main bore, a rod slidably mounted in and closely fitting said sleeve, a passageway connected at one end to the inner end of said counterbore beneath said rod and adapted to connect at its other to a fluid under pressure, the space between the inner end of said rod and the inner end of said counterbore forming a pressure chamber, a second passageway connecting at one end to said main bore and adapted to connect at its other end to another fluid under pressure, means for closing the open end of said housing to form a second pressure chamber, said rod being movable by the difference in pressure existing in said two chambers, a pair of stationary contacts extending through said closing means and into said second chamber, said contacts being sealed to said closing member and insulated from each other, a contact head carried by said rod, an electrical conducting contact bridge moved by said rod into and out of bridging relationship with said stationary contacts, press back means associated with said bridge to provide for an aligning movement whereby it will always engage both of said stationary contacts, and a coil spring resisting movement of said contact head by said rod, said spring surrounding said sleeve and seating at the inner end of said main bore.

4. A pressure operated switch for use in airplanes, a switch chamber, a pair of relatively movable switch contacts mounted therein, pressure responsive means forming a movable wall

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of said chamber for actuating said switch contacts, an electrically non-conductive fluid filling said chamber at superatmospheric pressure, means connecting said chamber with a source of variable pressure whereby variations in the pressure of said fluid cause movement of said pressure responsive means to actuate said switch contacts, said fluid preventing the leakage of air into said chamber as said switch is moved from an area of low barometric pressure to one of high barometric pressure, said fluid being of a type which will not rust or otherwise harm said switch contacts.

5. A housing having a longitudinal bore extending partially therethrough to form a chamber having an open end and a closed end, a counterbore of smaller diameter than said main bore in the closed end of said housing, a hollow sleeve seated in said counterbore and extending into said main bore, a rod mounted in and closely fitting said sleeve, a passageway connected at one end to the inner end of said counterbore beneath said rod and adapted to connect at its other to a fluid under pressure, the space between the inner end of said rod and the inner end of said counterbore forming a pressure chamber, a second passageway connecting at one end to said main bore and adapted to connect at its other end to another fluid under pressure, means for closing the open end of said housing to form a second pressure chamber, said rod being movable by the difference in pressure existing in said two chambers, stationary contact means in one of said chambers, and contact means moved by said rod into and out of engagement with said stationary contact means.

6. An aircraft differential pressure switch for responding to the differential in two fluid pressures which are always maintained above atmospheric; comprising; in combination; means forming a relatively large pressure chamber, a smaller pressure chamber and a connecting bore therebetween having a relatively small diameter in respect to said large pressure chamber and a relatively long length in relation to its own diameter, one of said chambers having an opening therein; a differential pressure responsive assembly including a head larger than said bore located in said large pressure chamber and a cylindrical member of reduced size extending therefrom and into said bore, said cylindrical member having a diameter that closely fits said bore and a length such that it at least substantially fills said bore; a member closing said opening and sealing said chamber from the atmosphere; a movable contact carried by said assembly and located in one of said pressure chambers; a cooperating stationary contact sealed into and extending through said closing member; and a spring bearing upon said enlarged head biasing said assembly in a direction to close said switch and forming a part of the electrical circuit to said movable contact; whereby when said pressure chambers are connected to sources of super-atmospheric fluid pressure in an aircraft, the contacts are continuously subjected to a fluid pressure sufficiently high to prevent the infiltration of moisture regardless of the changes in altitude or atmospheric conditions to which said switch is subjected.

7. A differential pressure switch for aircraft comprising in combination, a body forming a pair of chambers of different cross-sectional area, each of said chambers having an opening therein for connection to a source of super-atmospheric pressure and one of said chambers having a further opening therein, a member closing said fur-

ther opening of said one chamber and sealing it from the atmosphere, electrical conducting means extending through said closing member and into one of said chambers, said electrical conducting means being sealed into said member, a movable contact in one of said chambers for engaging said electrical conducting means to permit the flow of current therethrough, spring means biasing said movable contact into engagement with said electrical conducting means, and means responsive to the differential pressure in said two chambers for moving said movable contact away from said electrical conducting means when said differential pressure increases to a predetermined value.

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