United States Patent

[11] **3,566,060**

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[21] Appl. No. **735,339**
[22] Filed **June 7, 1968**
[45] Patented **Feb. 23, 1971**
[73] Assignee **F. W. Dwyer Mfg. Co., Inc.**

[54] **PRESSURE RESPONSIVE SWITCH WITH IMPROVED DIAPHRAGM OPERATING MEANS**
9 Claims, 14 Drawing Figs.

[52] **U.S. Cl.** **200/83,** 200/153
[51] **Int. Cl.** **H01h 35/40**
[50] **Field of Search** ..... 200/81.9, 83 (all); 92/99, 100; 200/153.19; 73/407

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Assistant Examiner—J. R. Scott
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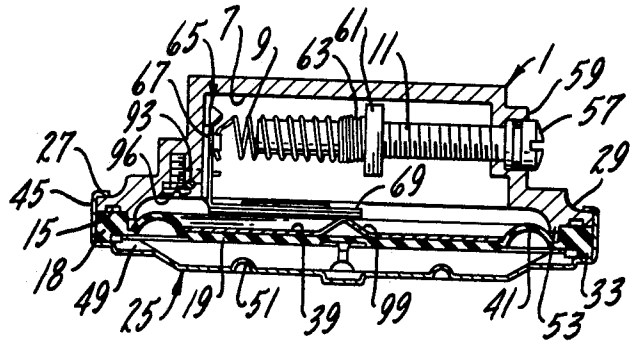
ABSTRACT: A differential pressure-sensitive microelectric switch of low profile made possible by placing both high and low pressure connections on the same side of a flexible diaphragm and utilizing a range spring mounted to undergo tension and contraction in a direction perpendicular to the motion of the diaphragm. The spring is connected to the short arm of a bellcrank lever, the longer arm of which is engaged by the diaphragm and in turn operates the switch. Because of the leverage, the spring travel is small as compared to diaphragm and switch operating arm travel. By providing annular grooves in the housing members on each side of the diaphragm, aligned with passageways through the rim of the diaphragm and by providing a passageway from the high pressure connection to the groove on the same side of the diaphragm as the connection, the unit can be assembled without the necessity of lining up the parts of the device.



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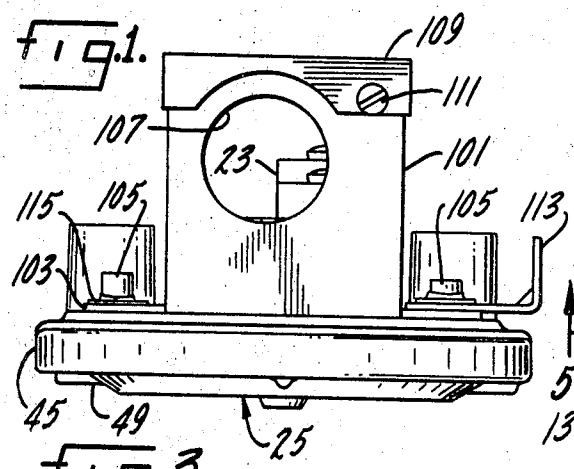

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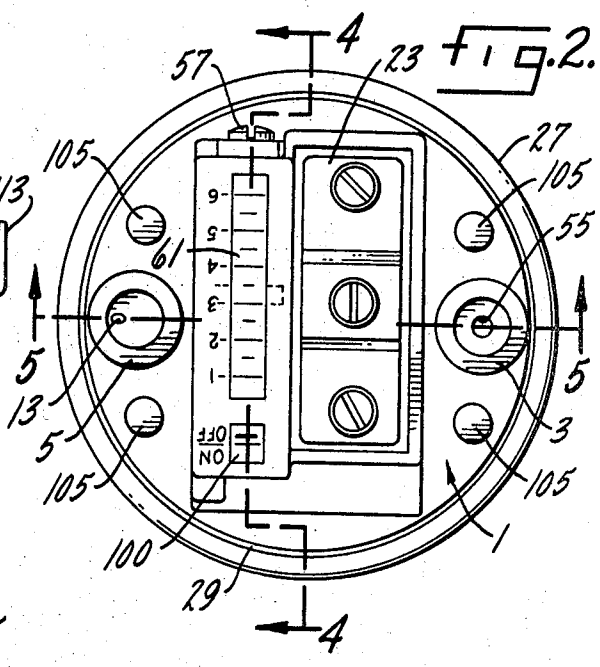

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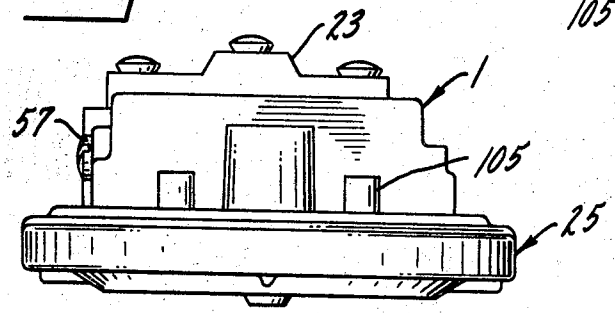

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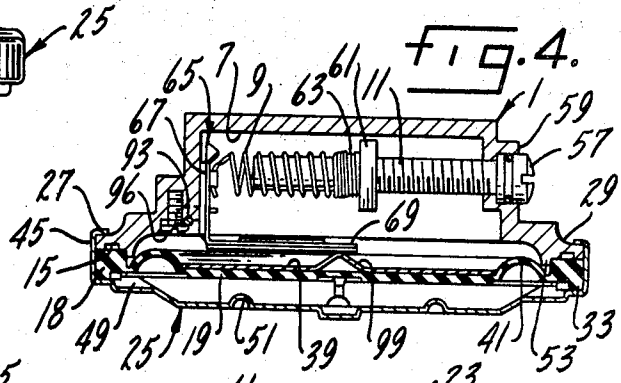

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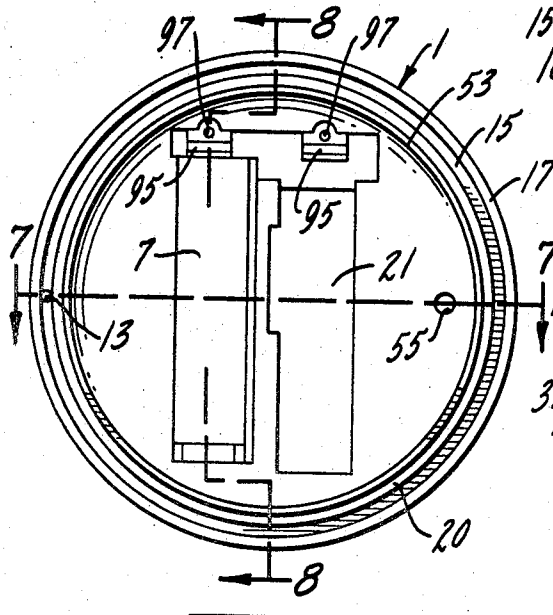

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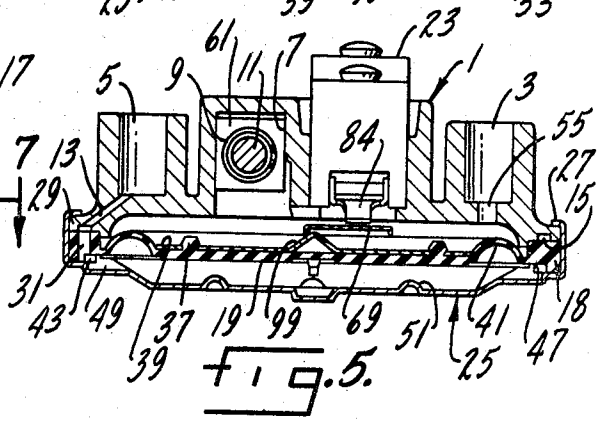

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Fig. 7.

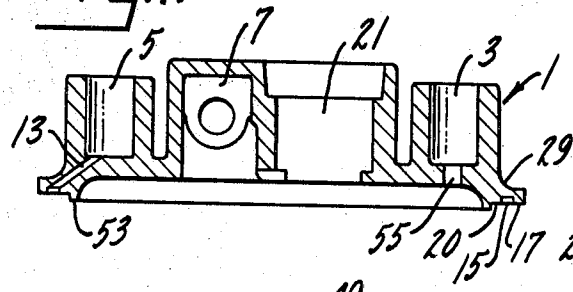


Fig. 8.

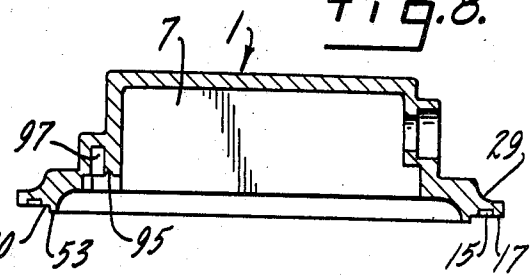


Fig. 9.

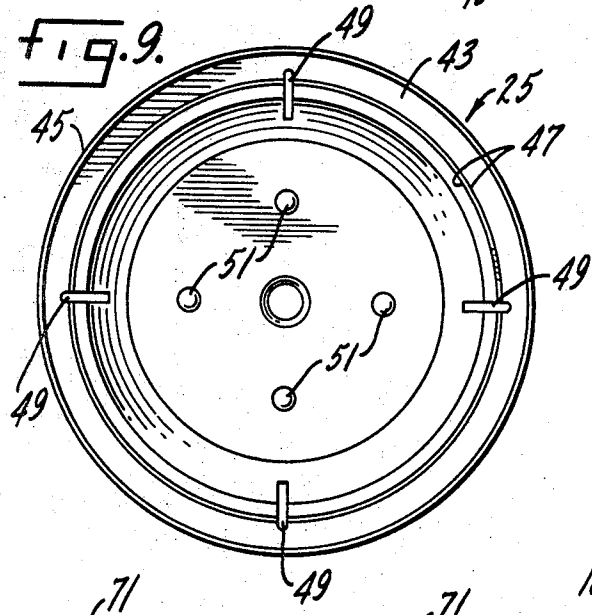
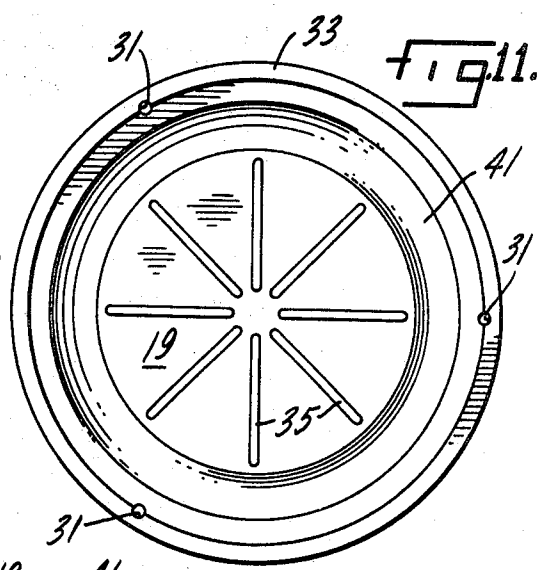


Fig. 11.



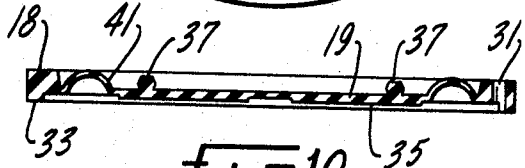


Fig. 10.

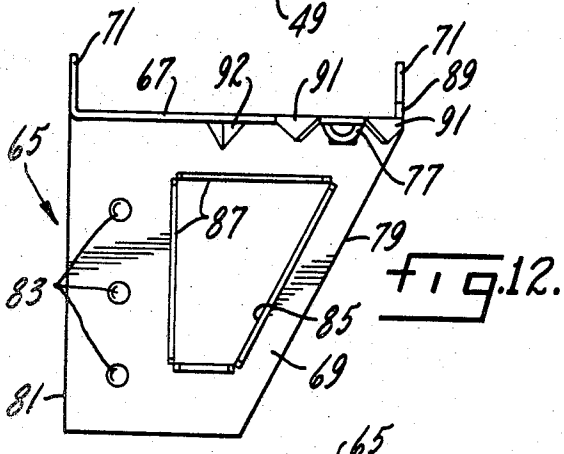


Fig. 12.

Fig. 13.

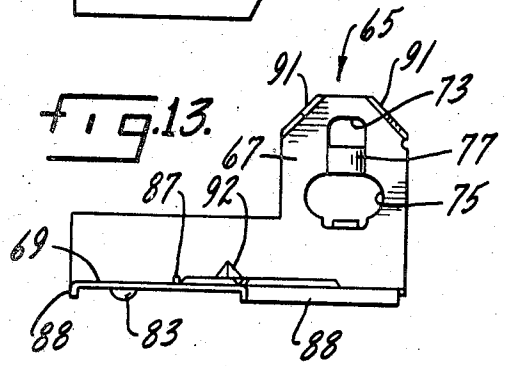
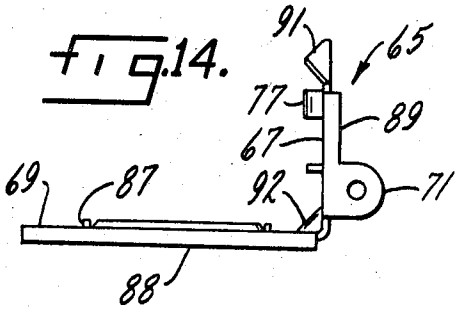


Fig. 14.



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PRESSURE RESPONSIVE SWITCH WITH IMPROVED DIAPHRAGM OPERATING MEANS

BRIEF SUMMARY OF THE INVENTION

Conventional pressure-sensitive microelectrical switches customarily are fabricated with the high pressure and low pressure connections on opposite sides of the diaphragm and with the range spring mounted between the diaphragm and switch so that the spring expands and contracts in the same direction of movement as the diaphragm. This construction necessitates a high profile and also introduces an element of inaccuracy because of the change in spring rate with change in elongation of the spring.

The differential pressure-sensitive switch of this invention has a low profile due to the novel construction features involving placing the high and low pressure connections on the same side of the diaphragm and mounting the spring so that it expands and contracts in a direction perpendicular to the direction of movement of the diaphragm. This is made possible by using a bellcrank lever having a short and long arm with the spring attached to the short arm and the long arm being engaged by the diaphragm and in turn operating the switch. A mechanical advantage is realized by virtue of which the range spring expands and contracts over a shorter distance than the travel of the switch operating arm.

By the novel construction of the diaphragm and diaphragm housing in which the housing on each side of the diaphragm is formed with an annular groove communicating with each other through passageways in the rim of the diaphragm, the fluid pressure from the high pressure connection is able to pass from one side of the diaphragm to the other without the necessity of having to line up the parts during assembly.

It is an object of the invention to provide a low profile differential pressure-sensitive switch. It is another object of the invention to provide a switch which can be assembled without the necessity of aligning the components. It is a further object of the invention to provide a snap switch in which an element is interposed between the diaphragm and the switch to amplify the movement of the diaphragm. A still further object of the invention is to provide a construction in a differential pressure switch which permits the use of either a tension or compression spring thereby enabling different characteristics to be achieved. Still another object of the invention is to provide a differential pressure-sensitive switch having adjusting means exteriorly available to change either the tension or compression of the spring. Another object of the invention is to provide a pressure-sensitive switch having visible means for determining the set point for the switch and for observing the on and off positions of the switch. Other objects of the invention will become apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of a switch in accordance with the invention;

FIG. 2 is a top plan view of a pressure switch in accordance with the invention with the conduit enclosure removed;

FIG. 3 is an elevational view of a switch in accordance with the invention rotated through 90° from FIG. 1 and with the conduit enclosure removed;

FIG. 4 is a cross-sectional view of the pressure switch taken along line 4–4 of FIG. 2;

FIG. 5 is a cross section taken along the line 5–5 of FIG. 2;

FIG. 6 is a bottom plan view of the base of the pressure switch;

FIG. 7 is a vertical cross section of the base of the novel pressure switch taken along line 7–7 of FIG. 6;

FIG. 8 is a cross section of the base forming part of the switch structure taken along the line 8–8 of FIG. 6;

FIG. 9 is a plan view looking at the inner surface of the housing forming part of the pressure switch;

FIG. 10 is a vertical cross section through the center of the diaphragm forming part of the pressure switch;

FIG. 11 is a plan view of the high pressure side of the diaphragm;

FIG. 12 is a plan view of the input lever forming part of the switch;

FIG. 13 is a front elevational view of the input lever; and

FIG. 14 is a side elevational view of the input lever.

DETAILED DESCRIPTION

Referring to the drawings particularly FIGS. 3, 4, 5 and 7 the numeral 1 indicates the pressure switch base which may be die cast from zinc or other suitable metal or the base may be molded from suitable plastic material, preferably one that is transparent. The base 1 is formed with low pressure inlet or connection 3 and high pressure inlet or connection 5 and with an elongated recessed portion 7 in which is mounted the range spring 9 and range spring adjusting screw 11 (FIG. 4). High pressure connection 5 is connected to a diagonal passageway 13, the other end of which opens into an annular groove 15 formed in the surface 17 adapted to seat against the rim 18 of the diaphragm 19 (FIG. 10). The base 1 is also formed with an elongated opening 21 in which is mounted an electric microswitch 23. As shown in FIG. 2 microswitch 23 has three terminals in order to enable the switch to be connected so that it is normally in open position or normally in closed position. Housing 25 is fastened to the base 1 by bending the end portion 27 over the flange 29 of the base 1. Housing 25 may be stamped out of cold rolled steel or may be molded from suitable plastic material.

Mounted in housing 25 is a flexible diaphragm 19 formed with small spaced passageways 31 in the rim portion of the diaphragm communicating the surfaces with each other. As shown in FIG. 11 there are three such passageways 31 equally spaced around the rim portion of the diaphragm although this number may be greater or less. The diaphragm 19 is preferably made of neoprene but can be made of any other elastomer which has the desired flexibility and resistance to the chemical action of the fluid housing pressure to which it is to be regulated and which has the requisite mechanical properties. As shown in FIGS. 10 and 11, the diaphragm is formed with an annular rib 33 at the periphery of the diaphragm and with a series of radial ribs 35 to impart additional mechanical strength thereto. On the opposite surface are two upstanding projections 37 to hold diaphragm plate 39 (FIG. 5) secure to the upper surface of the diaphragm. The diaphragm plate 39 is formed with two holes coincident with the projections 37, the holes being slightly smaller in cross-sectional area than the heads of the projections 37 so that the plate can be pressed down against the diaphragm with the heads of the projections 37 extending through the plate and holding it firmly against the face of the diaphragm. Interiorly of the rim portion of the diaphragm the diaphragm is formed with a thin convoluted annular portion 41 to allow the diaphragm to move easily with small changes in pressure.

Referring to FIGS. 5, 7 and 8 it will be seen that the rim portion 17 of the base 1 has an annular groove 15 into which the passageway 13 extends from the high pressure connection 5. As shown more clearly in FIG. 5, the annular groove 15 is directly in line with the passageways 31 of the diaphragm when the switch is assembled.

Referring more particularly to FIGS. 5 and 9, it will be seen that the housing 25 has an annular recess 43 adjacent the wall 45. Inwardly of the recess the housing is formed with two closely spaced upstanding annular walls 47 on which the rim of the diaphragm is adapted to seat. Four equally spaced radial grooves 49 connect the recess 43 with the high pressure space between the central portion of the diaphragm and housing 25. The housing is formed with the four spaced semispherical protuberances 51 to prevent the diaphragm from snugly contacting the inner face of housing 25.

The base 1 is formed with the downwardly projecting annular flange 53 and flat surfaces 17 and 20. Surfaces 17 and 20 together with the upstanding walls 47 of the housing form a fluidtight seal with the diaphragm. The outer diameter of

flange 53 is slightly less than the diameter of inner wall 47 and serves as a locator. It will be evident that the fluid pressure from fluid entering the low pressure connection 3 and then passing through port 55 is impressed only on the low pressure side of the diaphragm by virtue of the leakproof seal formed by the flat surfaces 17 and 20 and upstanding walls 47 with the rim of the diaphragm. It will also be apparent that since the diagonal passageway 13 through the base 1 connects with groove 15 which is outside of the flat surface 20, the high pressure fluid cannot enter the low pressure side of the diaphragm but can pass only from groove 15 through the passageways 31 in the diaphragm into the recess 43 of the housing and thence through radial recesses 49 into the space on the opposite or high pressure side of the diaphragm.

Referring more particularly to FIGS. 4, 5 and 7. mounted in the recess 7 of the housing 1 is adjusting screw 11 and range spring 9. The adjusting screw may be made of steel, brass, nylon or another suitable material. The screw 11 is formed with an exteriorly exposed adjusting head 57 having a kerf in order to enable it to be rotated by a screw driver in an opening formed in the end wall 59 of recess 7. The head 57 is sealed by an O-ring to prevent leakage. Adjusting nut 61 is screwably mounted on screw 11. The head of adjusting nut 61 is adapted to ride in recess 7 and is shaped to that it will not turn. As shown, the recess 7 has a rectangular cross section. The head of the adjusting nut 61 is therefore preferably of rectangular cross section but slightly smaller than in cross-sectional area than the recess 7 so that it can move back and forth with binding against the walls of the recess.

Range spring 9 is a coil spring fastened at one end to adjusting nut 61. One method of fastening is to provide the adjusting nut 61 with helical grooves 63 onto which one end of the spring is turned. The other end of the range spring 9 is fastened to input lever 65 (FIG. 4).

As shown in FIGS. 12, 13 and 14, input lever 65 is made in the form of a bellcrank with a short arm 67 and a long arm 69. The input lever 65 is preferably made lightweight so as to offer the least resistance possible to movement. The input lever is preferably stamped out of thin sheet metal with two eyelets 71 formed integrally with the bellcrank and extending rearward from the short arm 67 to act as a pivot or fulcrum. The short arm 67 is formed with openings 73 and 75 with a band of metal 77 therebetween to which the other curved end of the range spring is attached by inserting one end through opening 73 around the back of band 77 and thence through opening 75. As shown in FIG. 12, the long arm 69 has one edge 79 cut on the bias to remove unnecessary metal. The other edge 81 lies directly under the microswitch and has three contact knobs 83 which may be welded onto the long arm or they may be small screws inserted in spaced openings in the arm. By providing more then one contact point, the differential of the device can be increased or decreased by virtue of the different positions of the diaphragm at which the long arm contacts the microswitch actuating lever 84. The long arm of the input lever has a center portion 85 removed to reduce weight. The walls 87 of the center portion are bent at right angles to the plate in order to impart rigidity thereto. Similarly the long sides 88 of the long arm are bent in the opposite direction to impart rigidity. Portions of the short arm 67 are also bent out of the plane of the arm as shown at 89 and 91, preferably at right angles thereto, in order to impart additional rigidity. A rib 92 also acts as a reinforcing member to retain the two arms at an angle of 90° to each other.

Input lever 65 is mounted on the inside of the base by means of a rod 93 passing through eyelets 71 and seated in grooves 95 (FIGS. 6 and 8). Threaded holes 97 are tapped in the base adjacent to the rounded grooves 95 through which screws 96 can be threaded, the heads of which bear against the shaft 93 and hold it securely in place. It will be seen from FIGS. 4 and 5 that the long arm 69 of the input lever 65 is always in contact with the spherical protuberance 99 in the center of the diaphragm plate.

In the event that it is desired to provide an adjusting screw which is calibrated and can be visually seen, base 1 may be made of a transparent plastic material or the recess 7 may have a separate top wall which is transparent and which may be fastened to the base in any suitable way as by means of screws. As shown in FIG. 2, where the top wall of the recess is transparent it will have calibration marks thereof shown as numbers 1 to 6 inclusive so that the tension on the range spring can be determined by the position of the adjusting nut 61. There may also be a visible switch position indicator 100 to indicate when the switch is on or off.

The device of this invention preferably has a conduit enclosure 101 which is preferably a rectangular shaped enclosure formed of cold rolled steel or other suitable material having four laterally extending tabs 103, integral with enclosure 101 and adapted to fit on studs 105 cast integrally with the base. The enclosure 101 has an opening 107 through which the electrical conduits can be attached to the terminals of the microswitch. A removable lid 109 is fastened to the enclosure by means of screw 111. A suitable bracket 113 may be mounted on two of the studs 105 for mounting the guage on a wall or other suitable place. The enclosure 101 and the bracket 113 are held on the studs by means of suitable nuts 115.

The operation of the device should be apparent from the following description. By turning the screw head 57, the adjusting nut 61 is set to open or close the switch at the desired pressure differential and thereby control the operation of a compressor, evacuating pump or other system involving differential pressure. Due to the fact that the device can be used with a normally open or normally closed switch and due to the fact that the range spring can either be a spring which is normally under compression or normally under tension, the switch has universal application.

We claim:

1. In a low profile differential pressure sensitive electric switch wherein a flexible diaphragm is mounted in a housing with means for applying low pressure on one side and high pressure on the other side of the diaphragm and means activated by the diaphragm for opening and closing an electric switch, the improvement wherein said activating means comprises:

a bellcrank pivotally mounted in said housing, one arm of said crank being substantially longer than the other arm thereof and extending in a direction generally parallel to said diaphragm;

calibrated range spring means positioned in said housing;

said spring means comprising a coil spring, the axis of which is perpendicular to the axis of movement of the diaphragm;

one end of said spring engaging the shorter arm of said crank and the other end of said spring being engaged by means for adjusting the tension or compression of said spring; with the longer arm of said crank being in operative engagement with the diaphragm and the switch.

2. A differential pressure sensitive electric switch in accordance with claim 1 in which:

said adjusting means comprises a threaded element rotatably mounted in and operable from the exterior of said housing;

a nut threadedly received on said element;

said nut being mounted for movement longitudinally of said element;

means for restraining said nut against rotational movement on rotation of said element;

and means for securing said other end of said spring to said nut;

the axis of said element being substantially coincident with that of the spring.

3. A differential pressure sensitive switch in accordance with claim 1 in which:

said housing being provided with low and high pressure connections on the same side of said diaphragm;

said diaphragm having at least one passageway through the rim thereof;

one of said connections communicating with the passageway through the diaphragm rim;

means being provided for clamping said diaphragm rim in fluidtight relationship between the top and bottom of said housing; and

means being provided for communicating the space on the side of the diaphragm opposite the side on which said inlet and outlet are placed, with said passageway in said rim.

4. A differential pressure sensitive switch in accordance with claim 3 in which:

said means for communicating said passageway through the rim of said diaphragm with one of said connections includes an annular groove in the surface of the top and bottom housing members between which the rim of the diaphragm is clamped;

said passageway communicating between said grooves.

5 A differential pressure sensitive switch in accordance with claim 4 in which: the annular groove in the housing member on which said connections are not mounted, is connected by at least one radially directed passageway to the space between the diaphragm and said member.

6. A differential pressure sensitive switch in accordance with claim 5 in which: the rim of the diaphragm is clamped in fluidtight relationship between the top and bottom housing members inwardly of the location of said passageway in the diaphragm rim.

7. A differential pressure sensitive switch in accordance with claim 6 in which:

there are a plurality of spaced passageways in the rim of said diaphragm; and

a plurality of spaced radially directed passageways connecting the annular groove to the space between the diaphragm and housing member.

8. A differential pressure sensitive switch in accordance with claim 3 in which:

said spring means is a coil spring the axis of which is perpendicular to the axis of the diaphragm; and

the other end of said spring is engaged by means for adjusting the tension or compression of said spring.

9. A differential pressure sensitive switch in accordance with claim 8 in which: said adjusting means is a threaded element operable from the exterior of said housing, the axis of said element being substantially coincident with that of the spring, said threaded element being movable axially in opposite directions.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,566,060 Dated February 23, 1971

Inventor(s) James W. Phillips et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On identification page for Attorney read -- MANN, BROWN, McWILLIAMS & BRADWAY --.
Column 5, line 21, after " : " begin a new paragraph.
Column 6, line 1, after " : " begin a new paragraph.
Column 6, line 19, after " : " begin a new paragraph.

Signed and sealed this 13th day of July 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER
Commissioner of Pat