Dec. 6, 1966 J. V. OLIVEAU 3,290,466

PRESSURE SWITCH WITH HIGH AND LOW LIMITS

Filed Sept. 16, 1964

Figure 1

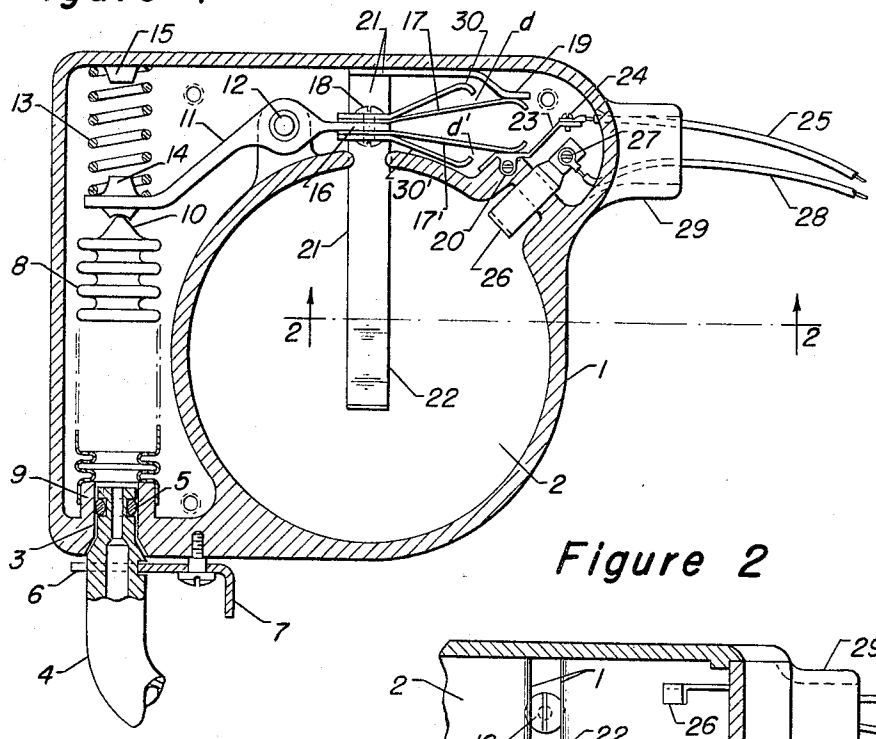


Figure 2

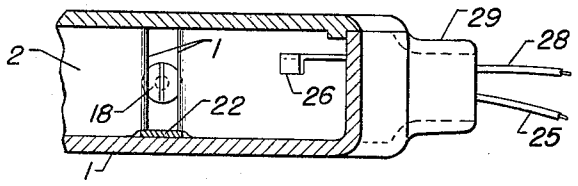


Figure 3

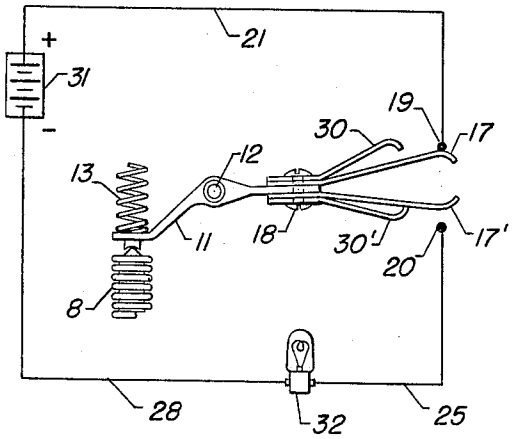
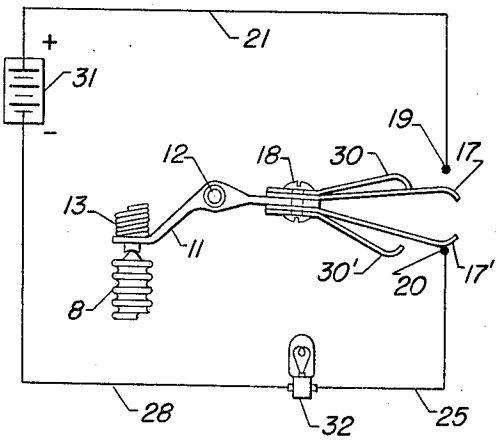


Figure 4



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PRESSURE SWITCH WITH HIGH AND LOW LIMITS

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The present invention relates to an improved simplified and compact form of pressure sensitive switch and more particularly to a pressure operated switch means which will maintain a closed circuit for a given fluid pressure range but will break the circuit for both a predetermined low pressure limit and a predetermined high pressure limit.

This present simplified form of switch may be used in connection with various types of pressure control problems and at varying differential pressures. For example, the device may be used in a processing plant in combination with a storage chamber or with a reaction chamber to show that a desired fluid pressure range is existent within such chamber. Alternatively, the present switch means may provide a warning signal where the fluid pressure approaches undesired low or high levels. There are numerous types and forms of pressure switch constructions which embody a movable diaphragm or bellows member to in turn make or break an electrical circuit; however, there has been a lack of simplified forms of pressure switch means which will make or break a circuit at both high and low pressure levels.

It is thus a principal object of the present invention to provide a pressure switch which will effect the switching of an electrical circuit for both high and low pressure conditions by utilizing a special movable switch arm with both the electrical conductive means and the circuit breaking means in direct attachment thereto.

It is also an object of the invention to provide a unitary pressure switch device which combines pressure sensitive bellows means, a movable switch arm, dual circuit breaker means on the switch arm and battery power supply means all within a compact case which may be of a diminutive size such that it could for example be attached to an aircraft pilot's helmet to give a signal of a critical change in his oxygen supply pressure.

Broadly, the present improved pressure switch for operating a circuit responsive to both a predetermined low pressure limit and a predetermined high pressure limit comprises in combination, a switch housing, an expansible and contractable bellows member with fluid pressure inlet means thereto and a movable exterior portion, a pivoted switch arm within said housing, said switch arm having a first extended arm portion shaped and positioned to engage the movable exterior portion of said bellows member and a second extended arm portion with a bifurcated electrical conductor member, the latter having flexible spring-like spaced apart end contact elements that are positioned to spring against electrical contact means in turn fixedly positioned in said housing, a pair of prong-like circuit breaking members also attached to said second extended arm portion of said switch arm and positioned to be adjacent said flexible contact elements of the conductor member, whereby one prong-like member thereby is effective to engage and move its closely adjacent flexible contact element with respect to said electrical contact means responsive to a given pressure change and increment of expansion of said bellows member with an accompanying movement of the switch arm, and the other prong-like circuit breaking member is effective to engage and move its closely adjacent flexible contact element with respect to said electrical contact means responsive to a given pressure

decrease and an increment of contraction of said bellows member and the resulting opposite movement of said switch arm.

A particular advantage in the present improved unitary design is the use of relatively stiff or rigid breaker members which are arranged to straddle or separate a forked and flexible electrical conductive means, with all being mounted on one end of movable switch arm. The ends of the rigid breaker members are thus operative to push the ends of the electrical conductive means from one or more fixed contact points in the switch housing. As will be pointed out more clearly hereinafter the spacings of the ends of the breaker members at the sides of the electrical conductive means will provide a variation in pressure ranges for which a given circuit can remain closed. Variations in the size and design of the bellows member can also provide adaptability to different ranges of pressure from atmospheric or subatmospheric to substantially high pressure ranges.

Reference to the accompanying drawing and the following description thereof will serve to more clearly set forth the novel design and construction of the present pressure switching means.

FIGURE 1 of the drawing is a plan view, with a cover removed from a holding case or housing, of a compact form of pressure switch means embodying the present invention.

FIGURE 2 of the drawing is a partial sectional view, as indicated by the line 2—2, showing that the pressure switch means may be mounted within a relatively thin or shallow enclosing case.

FIGURE 3 is a diagrammatic drawing showing an electrical circuit, with a signal light and the breaking of such a circuit responsive to a contracted bellows member connective with a low pressure level.

FIGURE 4 is also a diagrammatic drawing indicating a breaking of the electrical circuit responsive to an expanded bellows member connective with a fluid supply that is above a high pressure limit.

Referring now more partciularly to FIGURES 1 and 2 of the drawing, there is shown a housing or casing **1** which may be of a relatively flat or thin configuration adapted to hold all of the parts of a pressure sensitive switching means, including a circular or disc form of battery within the cavity **2**. The case **1** may be formed of one of the various plastics, Bakelite, hard rubber, and the like, or of a lightweight metal that may be readily cast and machined, such as of aluminum. A fluid inlet port **3** is provided in one side of the case **1** to accommodate a fluid pressure tube **4**. The latter is indicated as having a seal ring **5** around an end portion thereof within the interior of port **3** and, in addition, as having a groove or notch **6** to accommodate a slide type of holding member **7**. The slide member **7** is sized to engage with the notch or groove means **6** on the tube **4** and provides for a rapid and easy attachment of the latter into the the case **1**. The open end of the tube **4** and the internal end of the inlet port **3** discharges interiorly within an expansible bellows member **8** which in turn is sealed and connected to an internal shoulder member **9**. Thus, in operation the bellows member **8** will expand or contract within the case **1** responsive to increasing or decreasing pressure changes at the fluid supply to which the tube **4** connects.

The free end of the bellows **8** is sealed and has a bearing tip or end member **10** which is in turn adapted to engage or contact a movable switch arm **11**. The latter is pivotly or rotatably mounted on a pivot shaft **12** within the interior of the case **1** such that the one end portion may be contacted by and moved by the end of the bellows **8** and, in addition, by a compression spring **13**. The spring **13** is held in position by a shoulder **14** on the end of the arm **11** and by a shoulder **15** within the case or

housing 1. An opposing end portion 16 of the switch arm 11 has connected thereto a bifurcated electrical conductive means which in this embodiment is formed by contact elements 17 and 17'. The latter are connective with one another through bolting or riveting means 18 at their connection with the arm section 16 such that an electrical circuit may be continuous between 17 and 17'. Each of the contact elements 17 and 17' are preferably formed as cantilevering leaf-spring like flexible members of a suitable metallic material such that they can maintain a desired bridging contact between two spaced electrical contact points 19 and 20. The contact point 19 through an electrical conductive band 21 connects to a central terminal section 22 in the battery section 2 where there may be direct contact with one terminal of a battery means (not shown in the present drawing). The other contact point 20 is positioned and adapted to effect electrical contact with flexible element 17' and in turn connects through conductor arm 23 with power supply terminal 24 and wire 25 such that as long as both the flexible elements 17 and 17' are in a generally central position, by virtue of the positioning of the switch arm 11, there is maintained a completed circuit between contacts 19 and 20. In an alternative construction, the elements 17 and 17' may be formed from one continuous piece with a throat or reverse bend section being attached to the side of the arm section 16, rather than having two separated elements 17 and 17' riveted or bolted together by connector means 18. For the electrical circuit of the unit, provision is made for the other terminal of the battery (not shown) to connect through a conductor bar member 26 to a second power supply terminal 27 and from the latter to a wire 28. The wires 25 and 28 are permitted to pass through the side of the housing or case 1 by way of opening or port means 29 and to extend to a signal light, warning buzzer, or a motor means which in turn may control a valve or other regulating mechanism.

In accordance with the present invention, connecting to the switch arm 11 and straddling the flexible elements 17 and 17' is a pair of prong-like circuit breaker members, indicated as 30 and 30'. The latter are formed of relatively stiff or rigid material and have end portions adapted to be able to bear against the sides of the spring-like conductor elements 17 and 17', such that the latter may be moved away from their respective contact points 19 and 20 responsive to a given movement of the end of the bellows member 8 and an accompanying movement of switch arm 11. In other words, when the pressure exerted within bellows member 8 is at a median level within a given pressure range for which it is desired to maintain a closed circuit, then the flexible contact elements 17 and 17' will both be in a bearing contact against their respective contact points 19 and 20 and the adjustment of the switch arm portion 16, as well as the attached breaker members 30 and 30', will be such that the ends of the latter are spaced short distances d and d' away from the respective adjacent sides of conductor elements 17 and 17'. The actual spacings d and d', will determine the limits for which the arm 11 may move responsive to pressure variations within the bellows member 8 and still maintain a closed circuit. However, pressure above or below the predetermined range, working through the positioning of the rocker arm 11, will cause one of the breaker members to effect a pushing of a contact element away from its adjacent fixed position contact, either 19 or 20, to in turn break the electrical circuit.

Referring now more particularly to the diagrammatic wiring drawing of FIGURE 3, there are shown various parts numbered in accordance with FIGURES 1 and 2, including the switch arm 11 with contact elements 17 and 17' and breaker member 30 and 30'. An electric power supply for the circuit is provided by battery means 31 and is shown with its positive terminal connecting through conductor means 21 to contact point 19. The opposing contact 20 connects through bar 23 and wire 25 to the signal light 32. The negative pole of the battery is shown connecting through conductor bar 26 and wire 28 to signal light 32. The bellows 8 and the compression spring member 13 are also indicated diagrammatically as acting upon the end of the switch arm 11 in the manner of FIGURE 1.

In FIGURE 3 the positioning of switch arm 11 is slightly rotated as compared with the positioning of FIGURE 1, with such rotation being responsive to a contraction of the bellows member 8 and an expansion of the compression spring 13. The movement of switch arm 11 in turn carries the stiff breaker members 30 and 30' in a movement away from the contact point 20. Actually, the contact elements 17 and 17' both stay in electrical contact with respective points 19 and 20 until such time as the breaker member 30' rotates and moves sufficiently to bear against the flexible element 17' and lifts it away from the contact point 20. The distance d', as shown in FIGURE 1, thus controls breaking of the circuit responsive to a reduction in pressure and an accompanying movement of the end of bellows member 8. In other words, relatively wide spacings d and d' will permit maintaining a closed circuit between points 19 and 20 for a relatively wide range of pressures, while conversely close minimal spacings d and d' will effect a breaking of the circuit for small pressure changes within bellows member 8 and corresponding small movements of the switch arm 11.

By way of a specific example, there may be a selection of a suitable movable bellows 8 to accommodate pressures in the range of from atmospheric to about 200 p.s.i.g., or the like, the positioning of the end of such bellows member in contact with the switch arm 11, flexible conductor elements 17 and 17' arranged to spring against spaced fixed contacts 19 and 20 and the spaced straddling of breaker arms 30 and 30' each side of flexible elements 17 and 17', such that there is a closed circuit for a pressure range of about 20 to 60 p.s.i.g. In this case, breaker members 30 and 30' are spaced distances d and d' away from elements 17 and 17' so as to permit a variation of pressure of about 20 pounds each way from a median level of 40 p.s.i.g. Thus, where the pressure in the fluid supply connecting to bellows 8 falls to a level below about 20 p.s.i.g. there is a contraction of bellows 8, a movement of switch arm 11 as shown in FIGURE 3, to cause breaker member 30' to engage conductor elements 17' and lift it away from terminal 20 to break the circuit. As the pressure level in the fluid system connecting with bellows 8 again increases to a point above about 20 p.s.i.g. there is a reversal of movement in the arm such that the contact element 17' will again bear against contact terminal 20 to provide a closed electrical circuit. Such circuit will stay closed until such time as there is again a decrease of pressure or conversely an increase in pressure to a high limit above about the 60 p.s.i.g. level.

In accordance with the present invention, the present switching means is operative to make or break the electrical circuit for both high and low pressure limits. As best shown in FIGURE 4 of the drawing, there is indicated diagrammatically an example of the operating position causing a breaking of the electrical circuit for a predetermined high pressure limit. Specifically, in the case of the foregoing example, an expanded bellows positioning for a pressure level above about 60 p.s.i.g. range there will be a reverse movement of switch arm 11 such that the breaker members 30 and 30' moving therewith will cause bearing between the end of member 30 and the side of contact element 17 such that the latter is moved out of contact with terminal 19 to cause a breaking of the circuit. At all pressures above this given predetermined pressure range, i.e. in the present example, above about 60 p.s.i.g., there will be a continued open circuit; however, as the pressure level changes at the bellows member 8 there will be a gradual contraction of the latter member and the urging of the switch arm 11 by the compression spring 13 such that the movement is toward a

midway positioning and in the direction of a median pressure level range between 20 and 60 p.s.i.g. This will provide a recontacting of the element **17** with terminal **19** and the closing of the electrical circuit such that the signal light **32** provides the desired indication of the existence of the desired pressure range.

It may be pointed out that the adjustment of the present device to accommodate varying pressure ranges can be accomplished by the adjustment of the positioning of the ends of breaker members **30** and **30'** with respect to the conductive elements **17** and **17'**, i.e., the distances *d* and *d'*. The bellows shall, of course, be of the type suitable for the pressure ranges to be encountered with sufficient corrugations and a construction which will give the desired movement to the switch arm. The lengths of the respective arms of the pivoted switch arm **11** can, of course, also determine the amount of movement in the breaker members **30** and **30'**, for example, a long arm portion in contact with the bellows member **8** and a short arm portion **16** connective with relatively short breaker members **30** and **30'** and flexible elements **17** and **17'** will decrease the comparative movement at the zone of the latter. Conversely, a short arm portion in contact with the bellows member **8** and elongated breaker members and contact elements will amplify the incremental movements of the end of the bellows member, with such movements being proportional to the lengths of the arms each side of the pivot **12**.

The present embodiment indicates the use of a small disc or button type or power supply means, such as the use of a small round nickel-cadmium or silver-zinc battery; however, it is not intended to limit the shape of the case or arrangement of the device to the use of a circular power supply member. Small square or rectangular forms of battery means may be accommodated within a case having a modified design and configuration.

The breaker members **30** and **30'** may be of electrical conductive or non-conductive materials since the material will have no effect on the making and breaking of the circuit; however, in all instances such members shall be sufficiently stiff or rigid to effect the ready movement of the contact elements **17** and **17'** upon the movement of the switch arm and their bearing contact with the side of the element. If the breaker members are permitted to deflect they will not give the desired immediate lifting of a conductive element from its adjacent contact point and cause the breaking of the electrical circuit at the desired level. It may be further pointed out that the present basic construction or system may be modified slightly, as for example, by moving the prong-like circuit breaker members between the contact elements and having an electrical terminal positioned between the flexible contact elements, such that the circuit can become closed for the low and high pressure values and is open while in the intermediate pressure range.

It may be still further noted that there may be various types of bellows members embodied within a particular device and it is not intended to limit the present invention to the use of any one size or type of bellows. As used herein, the term "bellows member" shall include expansible and contractable members of all types. In other words, any one of the various means for translating fluid pressure into motion, such as pistons, diaphragms, Bourdon tubes and the like, may be used in lieu of the corrugated tubular type of member.

I claim as my invention:

1. A pressure switch for operating a circuit responsive to both a predetermined low pressure limit and a predetermined high pressure limit, which comprises in combination, a switch housing, an expansible and contractable bellows member with a fluid pressure inlet means thereto and a movable exterior portion, a pivoted switch arm mounted in said housing, said switch arm having a first extended arm portion shaped and positioned to contact with the movable exterior portion of said bellows member

and a second extended arm portion with a bifurcated electrical conductor member, the latter having flexible spring-like spaced apart end contact elements that are positioned to spring against electrical contact means in turn fixedly positioned in said housing, a pair of prong-like circuit breaking members attached to said second extended arm portion of said switch arm and positioned to be adjacent said flexible contact elements of said electrical conductor member, said circuit breaking members having their free end portions a short spaced distance from the respective flexible contact elements when the latter are in a central position with respect to said electrical contact means, whereby one prong-like member is effective to engage and move its closely adjacent flexible contact element with respect to said electrical contact means responsive to a given pressure increase with an increment of expansion of said bellows member and an accompanying movement of the switch arm, and the other prong-like circuit breaking member is effective to engage and move its closely adjacent flexible contact element with respect to said electrical contact means responsive to a given increment of contraction of said bellows member and the resulting opposite movement of said switch arm.

2. The switch of claim **1** further characterized in that said flexible elements are formed as cantilevering leaf spring-like metallic electrical conductive elements.

3. The switch of claim **1** further characterized in that a compression spring is mounted in said housing in a position to engage the end of said switch arm and to oppose the moving portion of said bellows member such that said arm follows the contraction of said bellows member.

4. A pressure switch for operating a circuit responsive to both a predetermined low pressure limit and a predetermined high pressure limit, which comprises in combination, a switch housing, an expansible and contractable bellows member with a fluid pressure inlet means thereto and a movable exterior portion, a pivoted switch arm mounted in said housing, said switch arm having a first extended arm portion shaped and positioned to contact with the movable exterior portion of said bellows member and a second extended arm portion with a bifurcated electrical conductor member, the latter having flexible spring-like spaced apart end contact elements that are positioned to spring against and bridge between two spaced electrical contacts in turn fixedly positioned in said housing, a pair of prong-like circuit breaking members attached to said second extended arm portion of said switch arm and positioned to closely straddle the flexible end elements of said electrical conductor member when such elements are in turn centrally positioned in contact with and between said electrical contacts, said circuit breaking members having their free end portions a short spaced distance from the respective flexible contact elements when the latter are in said central position, with one prong-like member effective to engage and move its closely adjacent flexible contact element away from its adjacent electrical contact responsive to a given pressure increase with an increment of expansion of said bellows member and an accompanying movement of the switch arm, and the other prong-like circuit breaking member is effective to engage and move its closely adjacent flexible contact element from its electrical contact responsive to a given increment of contraction of said bellows member and the resulting opposite movement of said switch arm.

5. A compact unitary pressure switch and electrical circuit device operative to break a circuit for both a predetermined low pressure limit and a predetermined high pressure limit, which comprises in combination, an enclosed housing with a fluid inlet port extending through the wall thereof, an expansible and contractable bellows member having a movable exterior portion positioned in said housing, said bellows member having its interior connective with said fluid inlet port whereby fluid pressure variations at said inlet port effect a movement of said

movable exterior portion of said bellows member, a movable and pivoted switch arm mounted within said housing and having an extended arm positioned to engage said movable portion of said bellows member, a second extended arm portion on said switch arm which moves through an arc responsive to movement from said arm portion and said bellows member, a bifurcated electrical conductor member having flexible spring-like end contact elements extending from said second arm portion, said flexible elements positioned to respectively spring against and bridge in between two spaced electrical contacts fixedly positioned in said housing, and a pair of prong-like circuit breaking members also connecting with second said arm portion that are positioned to exteriorly straddle said contact elements, said circuit breaking members having their free ends a short spaced distance from the respective external sides of said flexible contact elements when the latter are in a median position bridging between said electrical contacts, whereby one prong-like circuit breaking member effects engagement and the moving of its

closely adjacent flexible contact element away from its electrical contact responsive to a given pressure change and an increment of expansion of said bellows member, with an accompanying movement of the switch arm, and the other prong-like member engages and moves its adjacent flexible contact element away from its electrical contact responsive to a given pressure change contracting said bellows member with a resulting opposite movement of said switch arm.

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