Jan. 14, 1964 P. H. PALEN 3,118,030

PRESSURE CONTROL SWITCH

Filed July 22, 1959

Fig. 1.

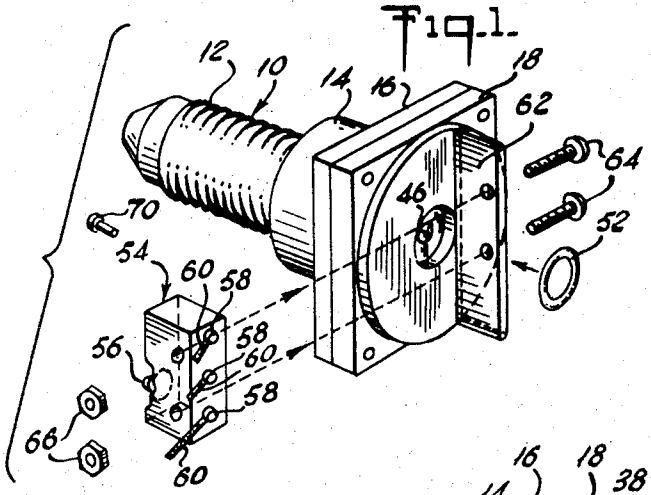


Fig. 2.

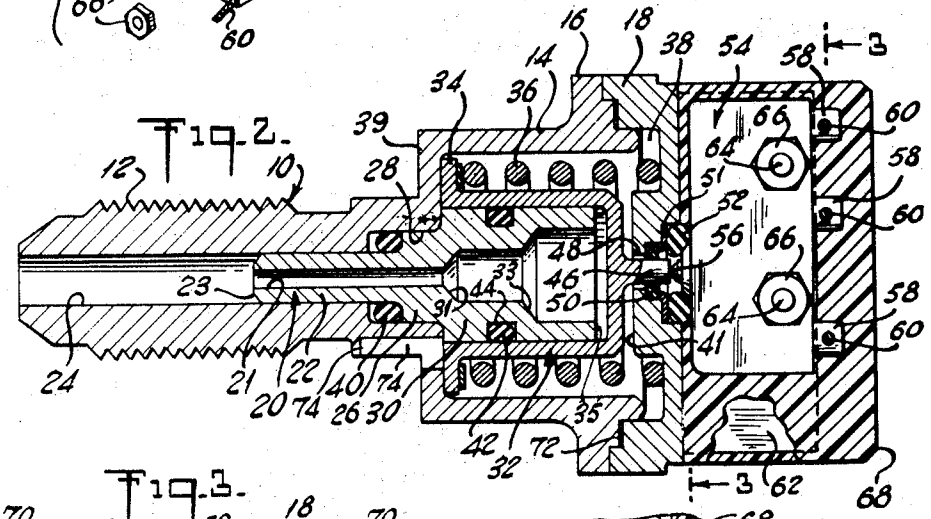


Fig. 3.

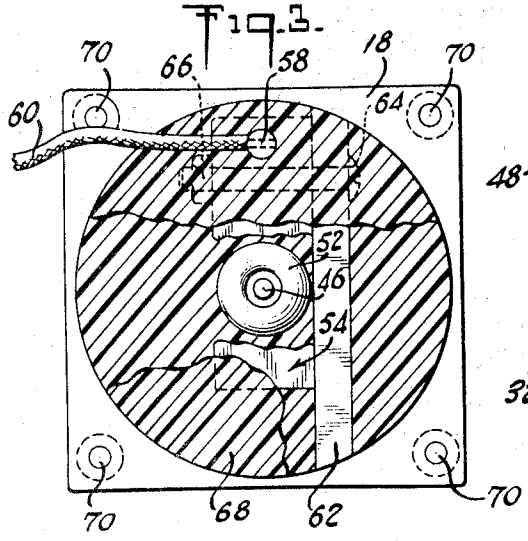
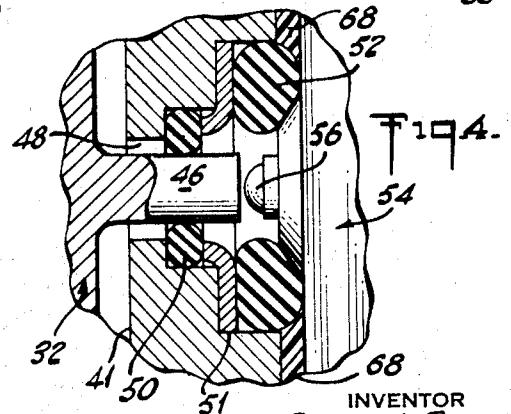


Fig. 4.



INVENTOR
PETER H. PALEN

BY
Moses, Nolte & Nolte
ATTORNEYS

United States Patent Office 3,118,030 Patented Jan. 14, 1964

3,118,030

PRESSURE CONTROL SWITCH

Peter H. Palen, 165 Morris Ave., Mountain Lake, N.J.

Filed July 22, 1959, Ser. No. 828,886
9 Claims. (Cl. 200—82)

This invention relates in general to pressure actuated electrical switches and particularly to a new and useful highly accurate switch of this character which is sensitive for actuation at precise predetermined pressures under severe conditions and without the incorporation of levers, hinges or other mechanical elements subject to wear, backlash or cocking.

In switches of this character difficulty has been encountered in constructing the mechanical parts for actuation at predetermined pressures and so that they are not subject to fatigue failure or misalignment which might cause inaccuracy of actuation pressure during future periods of use.

With previous pressure actuated switches it was difficult to construct the switches so that actuation would occur at a predetermined pressure and not over a wide and variable pressure range, and do so repeatedly and without breaking down after being subject to overload pressure conditions or extremes of environmental conditions. In addition, it was not always possible to obtain positive switch actuating movement of the parts.

Previous constructions of pressure actuated switches of this type had disadvantages such as: signal chatter due to severe vibration; drift in calibration due to mechanical fatigue or the shifting of adjusted parts; permanent damage due to over-pressure or to mechanical shock; and finally, there would be a breakdown of the electrical switching mechanism when subjected to high altitudes. A primary requisite of switches of this character is that the switch operates with a high degree of reliability and without malfunctioning in severe environmental conditions.

The present invention includes an improved construction of a pressure actuated switch in which a spring-biased reciprocable cylindrical or cup shaped member or actuator is utilized to actuate the button of a small precision snap switch placed in line with it. The spring-biased cylindrical member surrounds a fixed hollow member which is open to actuating pressure. A resilient O-ring is maintained in contact with the walls of the cylindrical member in order to aid in controlling its actuating movement. With such an arrangement, it was found that the O-ring provides a static friction force of a minor amount which in conjunction with the spring force prevents motion of the cylindrical actuator until a definite predetermined pressure was reached. Once the predetermined actuation pressure is reached, the static friction between the O-ring and the walls of the cup shaped member is suddenly overcome and the friction drops immediately to the lower dynamic friction value. At this point, the pressure induced forces exceed the combination of spring biasing load plus dynamic friction, and the cup-shaped member tends to snap over to its terminal position to actuate the switch and come to rest against an abutment or shoulder before the switch actuator button is moved to the end of its travel but after the button is moved beyond an actuating position. The arrangement permits positive controlled movement of the actuator as well as uniform repeat application or duplication of actuation. The actuator is extremely insensitive to vibration and fatigue and will function repetitively at the desired operating pressures.

A feature of the present invention is a construction which provides a mounting plate means for a small precision snap switch requiring actuation, and a recess adjacent thereto cut into the housing of the actuator in which is positioned an O-ring. With the O-ring positioned in the recess, the switch is mounted on a mounting plate,

and the bottom of the switch is placed into tight sealing contact with the O-ring. With the parts thus positioned the complete switch is encapsulated in a heat sealing resin, the leads being suitably conducted outwardly through the resin material. The switch is thus very easy to fabricate and the resin encapsulation provides a shock proof and an explosion proof switch.

A switch constructed in accordance with the present invention has no levers, hinges or other linkages but is operated by the direct reciprocation of a cylindrical or hat-shaped actuator of a pressure cell which in one embodiment depresses a push button of a miniature precision snap switch placed in alignment therewith. The actuator is movable within a hollow cylinder and is held in engagement with an interior piston-shaped portion thereof by means of a resilient O-ring. A preload spring, having a relatively low force rate bears upon a flange brim of the cylindrical actuator and prevents the latter from moving until a predetermined actuator pressure is reached. The actuator is located so that it only travels a relatively short distance to depress the button of the electrical switch past its trip point. The actuator comes to rest against a rigid structural shoulder positioned at the end of the outer cylinder and cannot overtravel to harm the switch mechanism. Actuation of the switch button is through a pin-like member at the end of the cylindrical actuator which protrudes through a small diameter O-ring seal.

The arrangement permits precise positioning of the switch in relation to the actuator before the switch is encapsulated at the end of the switch device. The parts are arranged to insure that the switch will be actuated during each travel of the actuator but that the switch will be protected against an over-travel of the actuator. After the switch is encapsulated the alignment of the parts is fixed and the assembly becomes incapable of becoming unadjusted, regardless of the vibration to which it is subjected and regardless of the severe conditions which it may encounter.

Accordingly, it is an object of this invention to provide an improved pressure actuated switch.

A further object of the invention is to provide a pressure actuated switch which is simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

In the drawings:

FIG. 1 is an exploded perspective view of a pressure actuated switch constructed in accordance with the invention;

FIG. 2 is a transverse section of the switch indicated in FIG. 1;

FIG. 3 is a vertical section taken on the line 3—3 of FIG. 2; and

FIG. 4 is an enlarged fragmentary detail of a portion of the switch indicating the alignment of the actuating rod and the switch actuating button.

Referring to the drawings in detail, the invention as embodied therein includes a housing member generally designated **10** externally threaded as at **12** to permit its being secured to a suitable pressure actuating means (not shown). The housing **10** includes a widened portion **14** having a flange **16** adapted to receive a structural mounting and cover plate **18**.

A hollow stationary member generally designated **20** having a bore **21** is fitted within the housing **10**. The member **20** includes an elongated cylindrical portion **22**

located within a cylindrical bore 24 of the housing 10. The member 20 also includes an intermediate larger diameter portion 26, which is located within an intermediate larger diameter bore 28 of the housing 10 and an end portion 30 which is surrounded by a substantially cylindrical flanged cup or hat-shaped actuaitng member generally designated 32. While the member 20 and the housing 10 are indicated as separate parts, there is no relative movement therebetween and they may be advantageously made of unitary integral construction. In the present instance, they are made of two parts for ease of manufacture and assembly purposes.

The actuating member 32 includes an externally flanged portion 34 upon which is positioned a compression spring 36 which is biased between the flange portion 34 and an internal recessed portion 38 of the cover plate 18. The spring 36 urges the cup-shaped actuating member in a direction toward a wall 39 of the sleeve housing 10.

The cover 18 is provided with a raised shoulder portion 41 which forms a stop to limit movement of the actuating member 32. An O-ring 40 of a resilient material such as rubber, plastic or the like is positioned between the elongated cylindrical portion 22 and the walls of the intermediate bore 28 of the housing 10 for pressure sealing purposes.

The actuating pressure which, of course, is the same throughout the internal system prevents member 20 from moving relative to member 10 because the areas on which the pressure acts tending to move member 20 to the left (as indicated in FIG. 2, i.e., faces 31, 33 and 35) are greater in area than the area of face 23 on which the pressure acts to move it to the right.

In accordance with the invention, an O-ring 42 is positioned in a recess 44 defined in the outer wall of the portion 30 of member 20, forming a static friction contact between member 20 and the highly polished inner surface of the actuating member 32, which together with the spring 36, prevents movement of actuator 32 until a pressure force is exerted in the system against actuator 32 sufficient to overcome the major restraining force of the spring 36 and the minor static restraining force of the O-ring 42. By choosing a low rate spring 36, the actuating member 32 does not move at all until a pressure is applied approximately 1 to 1½ percent below the required actuating pressure. Once movement starts the static friction of the O-ring is suddenly overcome and the forces exceed the combination of the spring load plus the dynamic friction, and the cylinder snaps over to its terminal position where the cylinder comes to rest against a shoulder 41 of the cover plate 18. As pressure continues to rise, there is no further motion of the cylinder.

In accordance with the invention the actuating member 32 is provided with an actuating rod or pin 46 of precise predetermined length which extends outwardly through a central opening 48 in the cover plate 18. The outer portion of the cover plate 18 is provided with a central recess in which is positioned a small diameter O-ring 50 backed by a retaining washer 51 which provides sealing contact with the actuating rod 46.

The cover plate 18 is also provided with an outer larger recess in which is positioned an O-ring 52. The O-ring 52 is arranged in the recess to form bearing contact for the mounting of a small, precision snap switch generally designated 54 having a control button 56 which is centrally aligned over the O-ring 52. O-ring 50 and O-ring 52 seal off the cavity accommodating the pin 46 and the push button 56 to effect an explosion proof cavity for the switch 54, which is in communication with the interior of the switch only via the clearance space surrounding button 56. The switch 54 contains the usual contact making portions in the interior thereof, which are not illustrated since they form no part of the present invention. The switch 54 contains typically three terminals 58 which are electrically connected by individual leads 60. The switch 54 is connected to an upstanding mounting plate 62 which is formed on the outer face of the cover plate 18 as by bolts 64 and nuts 66. Care is taken to locate the button 56 of the switch 54 in position at a precise distance from the inner end of the pin 46 in order to insure that the switch will always be tripped when the actuator 32 is moved to an actuating position but that the actuator will be arrested by the shoulder 41 without exceeding the overtravel design limits of the switch button. As the actuating member travel is limited by the shoulder 41, the length of the pin 46 is made of a length to insure proper actuating movement of the pin against the switch button 56 without overtravel. This feature permits subjecting the instrument to overload actuating pressure conditions without in any way damaging the switch 54.

Once the switch 54 is mounted on the mounting plate 62 the area surrounding the switch is encapsulated with a resin material 68 of high dielectric quality, such as an epoxy-resin. The resin is thereafter heat cured to a hard finish. The terminal wires 60 are positioned before encapsulation so that they extend outwardly through the finished hardened resin material.

During the casting process, O-ring 52 prevents the resin from seeping into the chamber containing the button 56 and hence into the interior of the switch 54. Casting or encapsulating is performed with the upper portion of the structural cover 18 clamped in a cylindrical mold. After encapsulation the unitized head plate assembly, including the encapsulated switch 54 is attached to the flange 16 of the housing 10 such as by screws 70. A sealing gasket 72 is interposed between the flange 16 of the housing and the cover plate 18.

The whole assembly may be connected to a pressure control source, the threaded end extending in a similarly internally threaded member. Ventilation to the atmosphere of the cavity surrounding the actuator 32 is accomplished through a passage 74 which extends through a portion of the wall 39 of the housing member 10.

It should be appreciated that in accordance with the requirements of the particular application, the head assembly may be provided with two or more switches actuated together by one pressure cell, or independently by two or more pressure cells. Head assemblies may be provided with electric connectors, or may include, within the encapsulation, such other electrical components and wiring as may be advantageous. Various configurations of body assemblies and cylinders and pistons may be interchanged for any desired pressure connections, mounting arrangements or pressure range. Small changes in the desired pressure settings are obtained by using different springs or adding shims to a given spring.

The switch constructed in accordance with the invention is highly vibration and shock resistant. The parts are assembled in a manner in which the micro-switch is permanently and securely positioned and the connections are prevented from loosening. The complete switching environment is sealed against contamination by moisture, sand, etc. The switch is effectively explosion proof, since the contact elements are sealed in with a resin material.

The advantages which derive from such a design are many. Since there is only one motion at the trip pressure or head point of the pressure switch, and since the motion tends to be similar to sensitive snap action, the assembly is completely insensitive to vibration forces below and above the trip point. Over pressure in the range of several hundred to one, for example, has absolutely no effect on the repeatability of the unit, since the spring or force reference element in the pressure switch cannot be overstressed. Long life is assured and wearing of the O-ring seal is negligible because of the very high surface finish maintained in the cylinder bore.

Furthermore, the switch itself is not subject to overload since the actuator is mechanically stopped before the over-travel limit of the switch is reached.

While a specific embodiment of the invention has been

shown and described in detail to illustrate the application of the invention principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

I claim:

1. For use with a miniature precision snap switch, a fluid responsive actuating device comprising a hollow sleeve member including an elongated tubular member adapted for connection to a source of actuating fluid, a hollow bearing wall inside one end of said tubular member spaced inwardly from the interior wall thereof and extending through the interior beyond the other end of said tubular member, a substantially cup-shaped actuator slidable on the extended portion of said internal hollow bearing wall and located in said sleeve member, the closed end of said actuator covering the adjacent end of said bearing wall, a cover arranged to substantially close the end of said sleeve member close to said actuator, said cover having an opening therein, means to bias said actuator in a direction away from said cover, said actuator including a portion which extends through the opening in said cover, means on said cover for mounting said switch in alignment with the portion of said actuator extending through said opening, and a substantially stationary seal member of resilient material arranged on the exterior wall of said internal hollow bearing wall in slidable contact with the interior wall of said actuator and establishing a static friction retarding force which immediately changes to a lower dynamic friction retarding force upon initiation of movement of said actuator.

2. A fluid responsive actuating device according to claim 1, wherein said internal hollow wall is provided with an annular recess in its outer face and said seal member is an annular ring positioned in said recess.

3. For use with a miniature precision snap switch, a fluid responsive actuating device comprising a hollow sleeve having a portion at one end of relatively small internal diameter and a portion at the opposite end of relatively large diameter, a stationary hollow cylindrical member located within said small diameter portion, a substantially cup-shaped actuating member having an inner surface slidable on an outer surface of said hollow cylindrical member and located in the large diameter portion of said sleeve, said cup-shaped actuator having an outwardly extending protuberance on the exterior thereof projecting away from said hollow cylindrical member, a cover having a central opening therein in alignment with and accommodating said protuberance and closing the large diameter end of said sleeve member, and means on said cover for mounting an electrical switch having a contact member in a position to be actuated by said protuberance.

4. A fluid responsive actuating device according to claim 3, wherein said hollow cylindrical member includes a large diameter portion and a small diameter portion and including a resilient substantially stationary sealing member on said last named small diameter portion in sealing contact with the walls of the interior of said sleeve.

5. A fluid responsive actuating device according to claim 3 wherein said hollow cylindrical member includes unequal surface areas on each end exposed to actuation pressure to hold said member against axial movement.

6. A fluid responsive actuating device according to claim 3 wherein said cover has an inwardly projecting interior wall arranged to arrest said actuating member during actuating movement thereof.

7. A fluid responsive actuating device according to claim 3, wherein said cover is provided with an annular recess adjacent said opening and including a cover ring of resilient material positioned in said recess and extending into said opening in slidable sealing engagement with the protuberance on said cup-shaped actuating member.

8. The device of claim 3, including spring means biased with a predetermined force to urge said cup-shaped actuator in a direction away from said cover, said cylindrical member having an annular recess, a resilient ring in said annular recess in substantially stationary contact with the interior of said recess and in slidable contact with the interior walls of said cup-shaped actuating member whereby application of pressure to the interior walls of said cup-shaped member through the central bores of said hollow sleeve and said hollow cylindrical member is effective to overcome the predetermined force of said spring means and the static friction of said resilient ring to move said cup-shaped actuator impulsively to an actuating position.

9. A pressure responsive switch according to claim 8 wherein said actuating member includes a rod-like projection extending through the opening in said cover and including a substantially stationary resilient ring positioned around said opening and having an inner portion in slidable sealing contact with said projection.

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