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[54] **PRESSURE SWITCH WITH OPERATING LEVER HAVING MANUALLY ADJUSTABLE PRE-LOADING MEANS THEREFORE**

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[52] **U.S. Cl.** ..... **200/83 S,** 337/319

[51] **Int. Cl.** **H01h 35/34**

[58] **Field of Search** 200/83 S, 83 WM, 153 U, 153 T, 200/83 P, 83 R; 337/320, 319, 117

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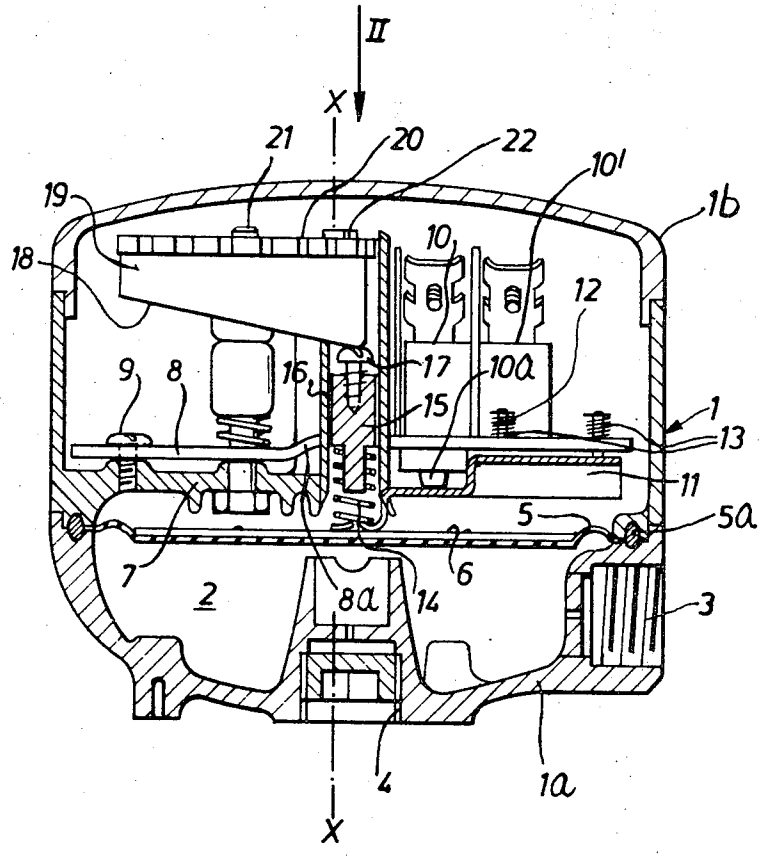
[57] **ABSTRACT**

An improved pressure switch unit according to this invention has a movable diaphragm which is connected to a switch within a casing by a lever which has a resilient connection to a mounting element for the switch, so that pressure overloading of the diaphragm is accommodated by the resilient connection, avoiding undue stress on the switch itself or its operating lever. The switch unit is readily adaptable for use in low and high pressure ranges by using the switch mounting element either as a fixed mounting, with adjustment means acting directly on the diaphragm, or as a floating mounting which is positionally adjustable to adjust the sensitive pressure range of the unit.

15 Claims, 4 Drawing Figures



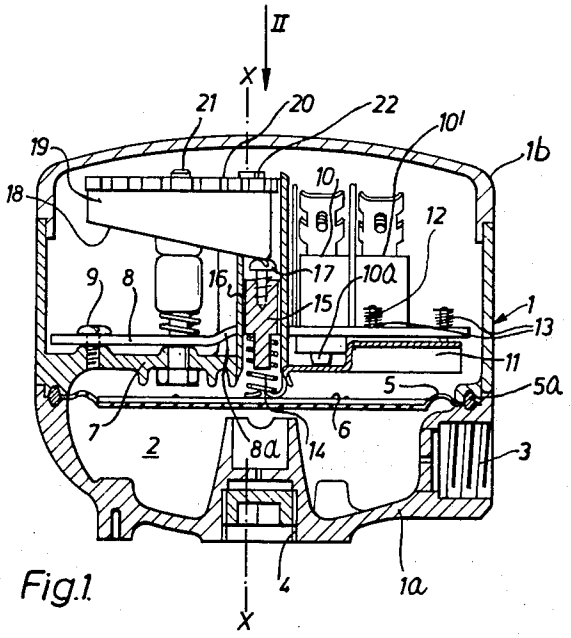

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Fig.1.

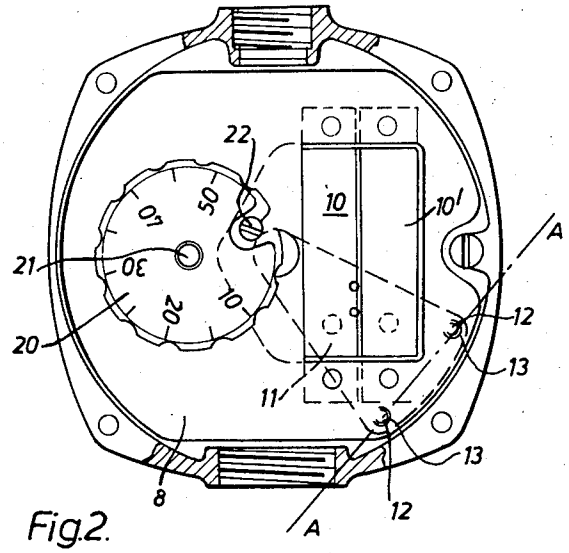
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Fig.2.

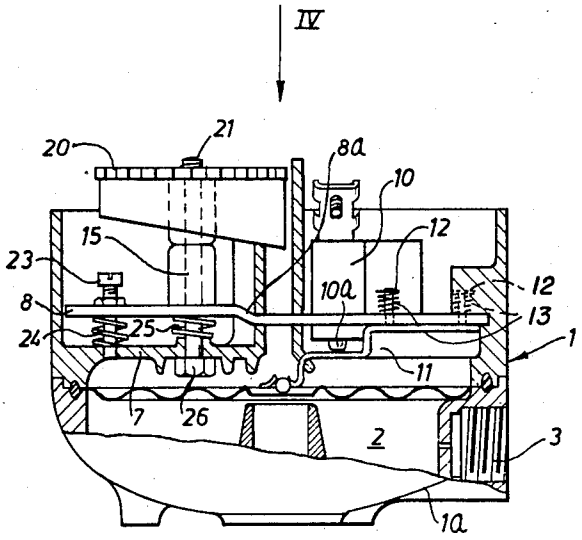
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Fig.3.

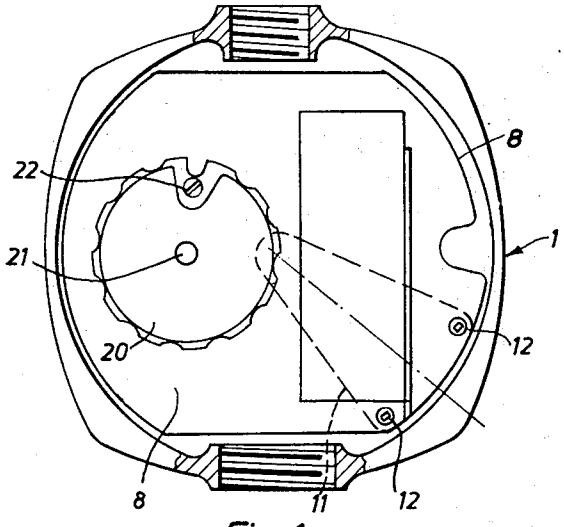
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Fig.4.

PRESSURE SWITCH WITH OPERATING LEVER HAVING MANUALLY ADJUSTABLE PRE-LOADING MEANS THEREFORE

This invention relates to pressure-sensitive switch units.

According to the invention in one aspect thereof, there is provided a pressure-sensitive switch unit comprising a casing, a flexible diaphragm located within the casing and defining therewith a chamber to which a pressure is applied in use of the unit, a switch operating lever connected to the diaphragm within the casing and having a resilient connection to a mounting element upon which a switch is mounted, the operating lever engaging an actuating element of the switch at a position spaced from the connections of the operating lever to the diaphragm and to the mounting element so that, upon loading of the switch actuating element by the diaphragm beyond a given limit the lever rocks about the switch actuating element, such rocking movement being accommodated by the said resilient connection to the switch mounting element.

The pressure-sensitive switch unit according to the invention has a built-in safety characteristic, in that when the diaphragm is subjected to a pressure beyond the said given limit, the switch operating lever rocks about the switch actuating element, preventing overloading of the switch itself. The unit can therefore accommodate pressure overloads within the maximum load limits of the diaphragm and the casing without the switch itself sustaining permanent damage.

Preferably the resilient connection between the lever and the switch mounting element comprises a spring or springs interposed between the lever and the said mounting element.

This first aspect of the invention, namely the accomodation of overload, is applicable both to switch units of the type in which the switch mounting element is fixed within the casing and to switch units of the type in which the switch mounting element is adjustably mounted within the casing by means permitting adjustment of the position and/or the orientation of the mounting element relative to the diaphragm. In general, the fixed type of mounting element is used for units which are designed to operate at low pressures, (of the order 0.2–70 inches water gauge) while the adjustable type of switch mounting element is used in switch units designed to operate at higher pressures, up to, say, 100 lbs per sq. in.

In a preferred embodiment of the invention the switch mounting element is in the form of a plate and the switch operating lever has two said resilient connections to the switch mounting plate at spaced apart positions defining the pivot axis of the operating lever below the loading limit of the switch actuating element. Preferably the switch operating lever has the shape of an isosceles triangle with the two resilient connections disposed symmetrically on opposite sides of an axis of symmetry passing through the connection of the lever to the diaphragm.

According to the present invention in another aspect thereof there is provided a pressure-sensitive switch unit having a flexible diaphragm located within a casing and defining a chamber to which a pressure is applied in use of the unit, a mounting element within the casing carrying a switch arranged for operation by a switch operating lever which is connected to the diaphragm

and which acts upon an actuating element of the switch, the mounting element having a shape and configuration which permits its mounting in the casing either in a first position as a fixed switch mounting or in a second position as a positionally adjustable switch mounting, and adjusting means adapted to act upon the diaphragm directly in the first position of the mounting element and to act upon the switch mounting element to adjust the position thereof in the second position of the mounting element, the setting of the adjusting means, in both said positions, predetermining the pressure in the chamber at which the switch is operated by the operating lever.

An important advantage of the switch unit according to this aspect of the invention is the fact that the unit is readily adaptable, with minimum modification, for operation at both low and high pressure ranges; for operation in lower pressure ranges, as stated previously, the mounting element would be installed in its first position and the adjusting means would engage the diaphragm itself by the preloading of a reaction spring to predetermine the pressure in the chamber at which the switch is operated by the operating lever, while for operation in higher pressure ranges the switch mounting element would be disposed in its second position and the adjusting means would then be arranged to adjust the position of the switch mounting element to predetermine the pressure at which the switch is operated.

It will be understood that the pressure sensitive switch unit may be constructed in accordance with the said second aspect of the invention irrespective of whether or not the switch unit incorporates an overload accommodation feature according to the first aspect of the invention.

In a preferred embodiment of the invention the adjusting means includes a rotatable knob which is provided with or connected to a cam element for adjusting the pre-loading of the diaphragm via a reaction spring in the first position of the switch mounting element to predetermine the pressure in the chamber at which the switch is operated. Thus in a preferred embodiment of the invention the adjusting means may include a spring bearing upon the diaphragm at the connection thereof to the switch operating lever, on the side of the diaphragm externally of the chamber, the loading of the spring being adjustable by the said cam element, or by means of any other convenient manually operable control member. By this arrangement it is ensured that no bending moment is applied to the lever by the spring, so that the lever does not have to withstand bending moments arising from diaphragm overloading.

The diaphragm of the unit for operation in lower pressure ranges preferably comprises a flexible non-metallic element, the lever being pivotally connected to the diaphragm at the center thereof. A rigid plate is pivotally attached to the diaphragm at its center, leaving an annular region of the diaphragm free to undergo flexing movements in response to pressure changes in the chamber.

When the switch mounting element is adjustably mounted within the chamber the adjusting means therefor may comprise a screw element rotatable by means of a knob, preferably the same knob as that previously referred to, to adjust the position and/or the orientation of the mounting element relative to the diaphragm.

For operation of the unit in the higher pressure ranges, the diaphragm is preferably fabricated in resilient sheet metal, for example stainless steel, preferably formed with annular concentric convolutions.

The switch mounting element in a preferred embodiment of the invention comprises a plate having a step portion interconnecting two parallel flat portions disposed in different planes, the switch being mounted on one of the flat portions, and the other flat portion being rigidly fixed relative to the casing in the first position of the switch mounting element and being positionally adjustable within the casing in the second position of the said mounting element, the two said positions of the mounting plate being inverted relative to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described, merely by way of example, with reference to the accompanying drawings in which:

FIG. **1** is a diagrammatic axial section through a pressure switch unit according to one embodiment of the invention, assembled for operation in a low pressure mode;

FIG. **2** is a diagrammatic plan view of the switch unit shown in FIG. **1**, viewed in the direction of arrow II, with one cover plate of the housing removed;

FIG. **3** is a diagrammatic axial section similar to that of FIG. **1**, showing the switch unit of FIG. **1** adapted for use in a higher pressure mode, and

FIG. **4** is an end view of the unit shown in FIG. **3**, in the direction of arrow IV, with the top cover of the casing of the unit removed.

Throughout the drawings, the same reference numerals are used to indicate the same or corresponding component parts.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring first to FIGS. **1** and **2**, the pressure sensitive switch unit according to the invention has a metal casing **1** provided with two end covers **1***a* and **1***b*. An internal chamber **2** is defined within the end cover **1***a* of the casing and has an inlet connection **3** by means of which a pressure to be sensed is applied to the chamber **2**. To increase the versatility of the unit installation the end cover **1***a* is also provided with a central alternative inlet **4** which is closed by a blanking plug, as shown, when not in use.

A circular diaphragm **5** is located within the casing and has a circular peripheral bead **5***a* which is sealingly clamped between the cylindrical body of the casing and the end cover **1***a* so that the diaphragm **5**, with the end cover **1***a*, defines the chamber **2**. In this low-pressure embodiment of the invention the diaphragm **5** consists of flexible non-metallic material, for example synthetic rubber moulded in a single piece and carrying a rigid circular reinforcing disc **6**, preferably of aluminium, arranged concentrically with the diaphragm **5** and attached thereto by the engagement of two or more resilient studs, moulded integrally with the diaphragm **5**, in respective holes in the disc **6**. The attachment of the disc **6** to the diaphragm **5** leaves an annular peripheral portion of the diaphragm **5** free to flex in response to changes in pressure in the chamber **2**.

The casing **1** is provided with an internal flange **7** to which, in this embodiment of the invention, a switch mounting plate **8** is secured by means of bolts **9** (one only of which is shown in FIG. **1**). The mounting plate **8** is generally flat but has a step portion **8***a* extending transversely and interconnecting two parallel flat portions disposed in different planes: in this embodiment of the invention the flat portion of the plate **8** on the side of the step portion **8***a* remote from the flange **7** is spaced further from the diaphragm **5** than the other flat portion of the plate **8**. This flat portion of the mounting plate **8** remote from the flange **7** supports at least one switch **10** having an actuating element **10***a* in the form of a spring loaded button disposed between the plate **8** and the diaphragm **5** and arranged for switch-actuating displacement in a direction parallel to the longitudinal axis X—X of the casing **1**.

A switch operating lever **11** is pivotally attached to the mounting plate **8** at the outer periphery of the plate **8** by means of a spring-loaded knife edge connection, defining a pivotal axis A—A (FIG. **2**). The knife edge connection is formed by raised protuberances on the lever **11** which engage the mounting plate **8** and which are held firmly in contact therewith by two pins **12** attached to the lever **11** and extending with clearance through respective apertures in the plate **8**. Each pin **12** has an enlarged head or carries a captive annular split clip at its free end forming an abutment for one end of a respective helical spring **13** surrounding the pin **12** and bearing against the surface of the plate **8** opposite to that against which the lever **11** bears.

The operating lever **11** has an isosceles triangular shape, the two pins **12** being provided near the opposite ends of the base of the triangle and the vertex of the triangle being formed with a cupped portion which fits over a central pip formed in the disc **6** attached to the diaphragm **5** to form a pivotal connection between the said disc and the lever **11**. In this embodiment the pivotal axis A—A of the lever **11** is perpendicular to the bisector of the vertex angle of the lever **11**.

The diaphragm **5** is pre-loaded by a helical reaction spring **14** which bears at one end against the cupped vertex portion of the lever **11**, urging the latter into engagement with the disc **6** and which is seated at its other end on a cam follower plunger **15**. The plunger **15** is arranged for sliding movement in the direction of the longitudinal axis X—X of the housing in a tubular guide **16** attached to or formed integrally with the flange **7**. The cam follower plunger **15** bears, through the intermediary of an adjusting screw **17**, against a cam surface **18** formed on the edge of a depending skirt **19** attached to or integral with a circular pre-setting knob **20**. The knob **20** is mounted for rotation about its axis upon a bearing post **21** which is attached to the flange **7** and which also serves to secure the mounting plate **8** to the flange **7**. The axis of rotation of the pre-setting knob **20** is parallel to the longitudinal axis X—X of the casing and, therefore, parallel to the direction of movement of the cam follower plunger **15**.

The operation of the switch unit shown in FIGS. **1** and **2** will be apparent from the preceding description. In use of the unit a pressure to be monitored or controlled is connected to the inlet **3** to pressurize the chamber **2**. The diaphragm **5** flexes under the influence of the pressure in the chamber **2**, in opposition to the influence of the reaction spring **14** and when a predetermined threshold pressure is reached in the chamber **2** the switch operating lever **11**, pivoting about the axis A—A, depresses the actuating element **10***a* of the switch **10**, operating the latter.

The pressure in the chamber **2** at which the switch **10** is operated can be pre-determined by adjusting the preloading force exerted on the diaphragm **5** by the spring **14.** Such adjustment can be effected with precision by means of the presetting knob **20,** rotation of which effects fine adjustment of the axial position of the plunger **15** in the guide **16,** through the action of the cam surface **18.** To assist the pre-setting of the knob **20** the periphery of the knob is calibrated as shown in FIG. **2,** preferably with divisions indicating the preset switch operating pressure in the chamber **2** when the division in question is located opposite a fixed fiduciary mark, which may conveniently be part of the guide **16.** A depending screw **22** attached to the knob **20** inwardly of the skirt **19** prevents rotation of the knob **20** through more than 360° by coming into engagement with the upstanding guide **16.**

The spring loaded knife edge pivotal mounting of the switch operating lever **11** serves an important overload function. Should the pressure in the chamber **2** exceed that necessary to operate the switch **10,** the diaphragm **5** and the disc **6** undergo further axial displacement, causing corresponding rocking movement of the lever **11,** which now rocks about its point of contact with the switch actuating element **10***a*, such rocking movement being accommodated by compression of the springs **13** incorporated in the pivotal mounting of the operating lever **11.** This rocking movement of the operating lever **11** about the switch actuating element in the overload condition avoids overstressing of the switch actuating element in the event of pressure overloads, which could otherwise cause damage to the switch.

The operating lever **11** can be arranged to operate more than one switch **10,** and in the embodiment illustrated diagrammatically in FIG. **1** a further switch **10** is mounted on the plate **8** alongside the switch **10** for operation by the lever **11.**

Although in the illustrated embodiment the operating lever **11** has a triangular shape and its pivot axis A—A is defined by two spring-loaded pivotal mountings **12, 13,** it will be appreciated that in practice operating levers of other shapes can be used, and the operating lever may be pivotable about a single resilient connection incorporating resilient means other than springs.

In its normal condition of use the unit is entirely enclosed within the casing **1.** The end cover **1***b* is attached to the casing by bolts which are removed to enable removal of the cover **1***b* for adjustment of the presetting knob **20.**

The switch unit as so far described with reference to FIGS. **1** and **2** is intended for operation at lower pressure ranges, typically between 0.2 and 70 inches water gauge. The unit is, however, readily adaptable, with minimum modification of the component parts, to operation in higher pressure ranges.

FIGS. **3** and **4** illustrate an embodiment of a pressure sensitive switch unit according to the invention which has been adapted for operation at higher pressure ranges, typically between 6 and 100 lbs. force per square inch. In this embodiment the diaphragm **5** consists of a resilient sheet metal diaphragm formed with concentric convolutions and adapted to withstand the higher working pressures in the chamber **2.**

The switch mounting plate **8** in this variant is inverted with respect to its positions shown in FIG. **1,** so that the flat portion which is disposed further from the diaphragm **5** is located directly above the fixed flange **7** within the casing. In this mode of operation, however, the switch mounting plate **8** is not bolted to the flange **7,** but is "floating" with respect thereto. The plate **8** has a pivotal connection to the flange **7** constituted, in effect, by bolts **23** passing with clearance through holes in the plate **8** and anchored in the flange **7,** the bolts **23** replacing the fixing bolts **9** shown in FIG. **1.** A helical spring **24** is interposed between the plate **8** and the flange **7.** In this variant the bearing post **21** of the rotatable knob **20** rests directly on the plate **8,** and a further helical spring **25** is interposed between the plate **8** and the flange **7,** loosely fitting over the bearing post **21.**

A spherical metal ball is secured to the cupped vertex portion of the lever **11** and forms a pivotal connection near the center of the diaphragm **5.** The switch operating lever **11** in other respects is identical with that of the variant shown in FIGS. **1** and **2,** has a sprung pivotal connection to the mounting plate **8** identical to that previously described with reference to FIGS. **1** and **2,** to prevent undue mechanical stress on the switch **10** or the operating lever **11** in the event of a pressure overload in the chamber **2.**

The variant shown in FIGS. **3** and **4** operates in an exactly analogous way to that described with reference to FIGS. **1** and **2,** and makes use of identical component parts, with the exception of the diaphragm **5.** In this high pressure variant, however, presetting of the operating pressure of the unit is effected by adjusting the position and orientation of the switch mounting plate **8** with respect to the diaphragm **5** and, therefore, the position relative to the diaphragm of the switch operating lever **11** connected to the mounting plate **8.** Such adjustment is effected by rotating the knob **20** as before, except that in this case the knob **20** causes rocking movement of the switch mounting plate **8** about the pivot axis defined by the bolts **23,** by virtue of the screw adjustment of the knob **20** which now bears directly against the floating mounting plate **8,** in opposition to the spring **25.** In this variant the cam surface **18** on the knob **20** is superfluous, and the cam follower plunger **15** is, of course, omitted.

It is a simple matter to disassemble a switch unit of the kind shown in FIGS. **1** and **2** and adapt it to the form shown in FIGS. **3** and **4** for operation at a higher pressure, or vice versa.

Where, as previously mentioned, more than one switch (**10, 22**) is mounted within the unit for operation by the switch operating lever **11,** these switches may be arranged for operation at the same pressure in the chamber **2,** or at different pressures, according to their mounting position relative to the switch operating lever.

I claim:

1. A pressure sensitive switch unit having a casing, a flexible diaphragm located within the casing and defining therewith a chamber to which a pressure is applied in use of the unit, and a switch operating lever connected to the diaphragm within the casing, wherein the improvement comprises: a mounting element upon which a switch is mounted; resilient connection means connecting said operating lever to said mounting element, said operating lever engaging an actuating element of the switch at a position spaced from the connections of the operating lever to the diaphragm and to the mounting element, whereby, upon loading of said switch actuating element by the diaphragm beyond a given limit said lever rocks about said switch actuating

element, such rocking movement being accommodated by the said resilient connection means to the switch mounting element, and adjustable pre-loading means acting on said diaphragm to predetermine the pressure in the chamber at which the switch is operated, said adjustable pre-loading means comprising a spring bearing upon the diaphragm at its connection to the switch operating lever, on the side of the diaphragm externally of the chamber, and a manually operable control member acting on said spring for adjustment of the loading thereof.

2. Switch unit according to claim **1,** wherein said resilient connection means between the lever and the switch mounting element comprises at least one spring interposed between said lever and said mounting element.

3. A switch unit according to claim **1,** wherein the control member comprises a rotatable knob provided with a cam surface, and a cam follower against which one end of the spring bears, urging said cam follower into engagement with said cam surface.

4. A switch unit according to claim **1,** wherein said diaphragm comprises a flexible non-metallic element, the switch operating lever being pivotably connected to the diaphragm at the center of the latter.

5. A switch unit according to claim **4,** including a rigid plate attached to said diaphragm at the center of the latter.

6. A switch unit according to claim **1,** including means fixing said switch mounting element within the casing.

7. A switch unit according to claim **1,** including means mounting said switch mounting element within said casing, said mounting means permitting adjustment of the position of the mounting element relative to the diaphragm, and further including adjustment means for effecting such adjustment to predetermine the pressure in the chamber at which the switch is operated.

8. A switch unit according to claim **7,** wherein said adjustment means comprise a manually adjustable screw acting on the switch mounting element.

9. A switch unit according to claim **7,** wherein the diaphragm is fabricated in resilient sheet metal.

10. A switch unit according to claim **1,** wherein the switch mounting element comprises a plate and the switch operating lever has two said resilient connection means connecting said lever to the switch mounting plate at spaced apart positions defining the pivot axis of the operating lever below the loading limit of the switch actuating element.

11. A switch unit according to claim **10** wherein the switch operating lever has the shape of an isosceles triangle with said two resilient connection means disposed symmetrically on opposite sides of an axis of symmetry passing through the connection of the lever to the diaphragm.

12. In a pressure sensitive switch unit having a casing, and a flexible diaphragm located within the casing and defining a chamber to which a pressure is applied in use of the unit, the improvement which consists in:

a. a mounting element within said casing;

b. a switch carried by said mounting element, said switch having a movable actuating element;

c. a switch operating lever connected to said diaphragm acting upon said switch actuating element;

d. said mounting element having means for mounting it in said casing selectively in a first position as a fixed switch mounting and in a second position as a positionally adjustable switch mounting, and

e. adjusting means acting upon said diaphragm directly in said first position of the mounting element and acting upon said switch mounting element to adjust the position thereof in said second position of the mounting element, the setting of said adjusting means, in both said positions, predetermining the pressure in said chamber at which the switch is operated by the operating lever.

13. Switch unit according to claim **12,** wherein said adjusting means includes a rotatable knob, resilient reaction means, and a cam element connected to said knob for adjusting the pre-loading of said diaphragm by said resilient reaction means in the first position of the switch mounting element.

14. Switch unit according to claim **12,** wherein said adjusting means includes a screw element and a knob connected to said screw element to adjust the position of said switch mounting element relative to the diaphragm in the second position of the mounting element.

15. Switch unit according to claim **12,** wherein said switch mounting element comprises a plate having two parallel flat portions disposed in different planes and a step portion interconnected in said flat portions, the switch being mounted on one of the flat portions, and the other flat portion being rigidly fixed relative to the casing in the first position of the switch mounting element and being positionally adjustable within the casing in the second position of the said mounting element, said two positions of the mounting plate being inverted relatively to each other.

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