United States Patent

Gamble

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[54] **DEPTH SENSING SWITCH WITH TUBULAR HOUSING HAVING A DIAPHRAGM ENCOMPASSING A PORTION OF SAID HOUSING**

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[52] **U.S. Cl.**.....**200/83 B,** 200/166 BA, 200/168 G

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

[58] **Field of Search**.....200/83 W, 83 V, 83 R, 83 B, 200/83 N, 166 BA, 168 G

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[57] **ABSTRACT**

A depth sensing device has an extensible resilient switch contact, contraposed behind a diaphragm, said contact having the form of a helical spring with both ends fixed and having its axis parallel to the surface of the diaphragm; said contact further flexes inwardly and establishes contact with a fixed contact when liquid pressure deflects the diaphragm. The diaphragm is formed by a flexible sheath that encompasses a portion of the tubular housing that houses the switch contacts, thereby sealing the contacts from the environment.

5 Claims, 5 Drawing Figures

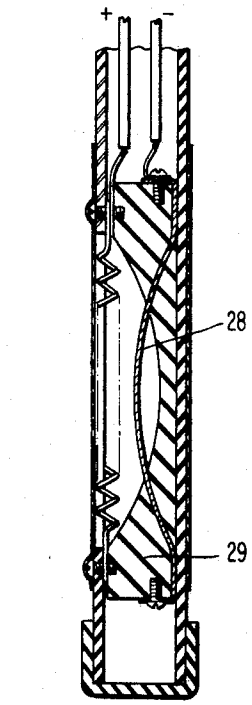

FIG. 1

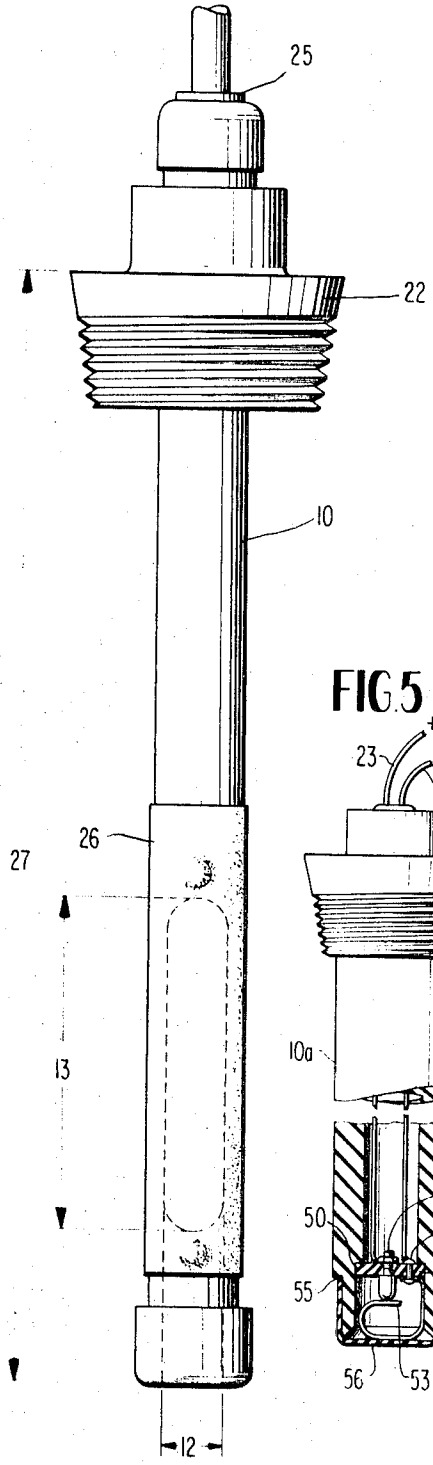

FIG. 2

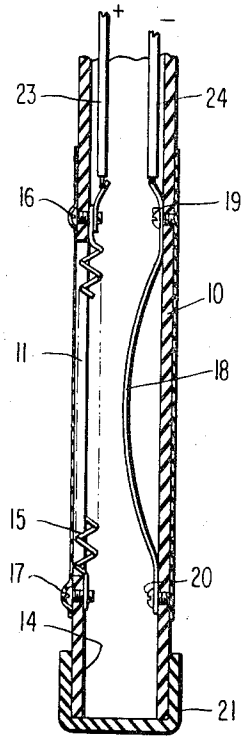

FIG. 3

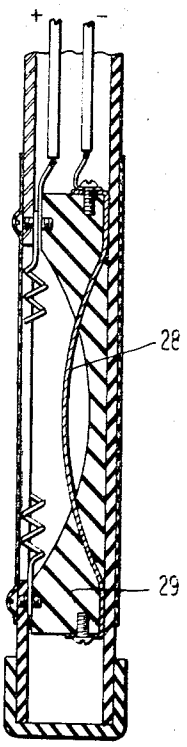

FIG. 5

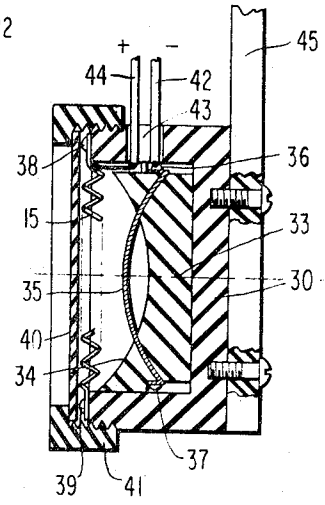

FIG. 4

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DEPTH SENSING SWITCH WITH TUBULAR HOUSING HAVING A DIAPHRAGM ENCOMPASSING A PORTION OF SAID HOUSING

The present invention relates to depth sensing sensitive switches, and more particularly, to those types of switches in which a diaphragm is deflected inwardly causing a displacement which forces a movable contact into contact with a stationary contact.

Heretofore, pressure diaphragm switches responding to liquid or fluid pressure have been designed in such a manner that the diaphragm is deflected in an axial direction with the perimeter of said diaphragm being rigidly disposed in a plane normal to the axis of displacement. In this type of diaphragm switch, the diaphragm is usually of thin flexible metal and may be covered with a fluid-tight material such as rubber or a plastic. The diaphragm usually bears against a contact arm disposed behind the diaphragm, the arm being mounted resiliently so that as the diaphragm deflects, it causes the switch contact arm to move towards and finally engage a stationary contact; the resistive force of the diaphragm and resilient contact arm, together with the contact spacing, determine at what pressure the contacts will close. Characteristic of this type of switch is that: the diaphragm being thin, it is susceptible to damage if it comes in contact with sharp or solid materials, and also, it is susceptible to being stretched by pressures above that for which the switch may have been designed. Further, the switch diaphragm must be subjected to substantially uniform pressures or pressures near its center to cause actuation and to prevent localized stresses from buckling or destroying the diaphragm as well as the contact arm beneath the diaphragm. The switch, which is to be described later herein, is of such a design that it may be used with fluids which include solid materials, without being susceptible to damage from such materials, and may be actuated by localized pressures, as well as uniform pressures, which may occur with the sensing of such materials.

In view of the foregoing, it is a principal object of this invention to provide a pressure-sensitive switch for fluids which is insensitive to the abusive effects of solids disposed within the fluids, and which is otherwise sturdy and strong.

It is a further object of this invention to provide a pressure-sensitive switch having a resilient movable contact which cannot be damaged by lateral forces and motions of the diaphragm, which are not along the axis of the contact points.

It is still a further object of this invention to provide a pressure switch which is inexpensive and easy to manufacture.

It is yet another object of this invention to provide an additional support surface for the movable contact.

The invention will be better understood and further objects and advantages will become more apparent from a reading of the following specification, taken in conjunction with the drawing in which:

FIG. 1 shows a front elevational view of this invention with the construction built into a standard tube;

FIG. 2 shows, in vertical cross section, the structure of FIG. 1 after rotating said structure 90°, with the internal mechanical support for the diaphragm illustrated in its deflected position; and

FIG. 3 shows another vertical cross-sectional view in which is included a support for the movable contact;

FIG. 4 shows another switch utilizing a round flexible diaphragm; and

FIG. 5 is a fragmentary vertical cross-sectional view showing still another embodiment of this invention.

Turning now to FIG. 1, there is shown a plastic tube 10 which functions as the case or carrier means for the switch which, as shown, is provided with a longitudinal aperture 11 cut into one side, the width 12 of the severed area being approximately as wide as the inner diameter of the tube, and its length 13 being substantially greater than its width. Mounted rigidly to the internal wall 14 of the plastic tube by screws 16 and 17 or other means is an extensible, movable metal contact means 15 which may take the form of an extensible spring, its axis being longitudinal of the cylinder described by the internal surface of the tube and midway between the longitudinal edges of aperture 11, so that the contact is freely supported, adjacent to both ends of the aperture and located within and behind said aperture.

As best shown in FIG. 2, a curved stationary contact 18, supported within the plastic tube 10 by suitable means 19 and 20, is arranged to extend inwardly toward, but not to touch, the movable contact 15, e.g., when in an inoperative condition as shown in the figure. The stationary contact 18 has some degree of flexibility by virtue of its being a thin piece of metal, but is essentially to be considered rigid.

Attached to the lower end of plastic tube 10 is tube cap 21 which is affixed by any suitable waterproof means such as cement; alternatively, the cap may be threadedly secured or clamped and provided with a suitable seal. The upper end of plastic tube 10 is covered by plastic pipe plug means 22, which has been bored to receive a plastic tube and is affixed thereto in any waterproof manner, such as described relative to tube cap 21. The plastic pipe plug means 22 is further provided with a bore to allow conductor wires 23 and 24 to pass therethrough with the conductor being suitably sealed by a seal means indicated at 25.

The conductor wire 23 is attached at point 16 while conductor wire 24 is affixed at point 19, the upper ends of each wire arranged to be suitably connected to the power supply means and indicating means, neither of which is shown.

The flexible boot means 26 is stretched over the plastic tube 10 in such a manner that it circumferentially encompasses the tube in the area of the longitudinal aperture 11 and thereby effectively seals the entire area, by surface contact around the aperture, to prevent fluids from gaining access to the contacts when the switch is immersed in a liquid. It is evident that the switch is designed to be placed into the top of a fluid tank with plastic tube 10 extending downwardly to any desired length, such as indicated at 27, to the level at which fluid pressure is to be sensed. When said fluid pressure is of sufficient force to urge the flexible boot 26 into aperture 11 into contact with movable contact 15, said contact will touch stationary contact 18, and a signal will be transmitted through wires 23 and 24 to an indicator (not shown).

FIG. 3 illustrates an additional embodiment of this invention, showing support surface 28 added to the

construction of FIG. 2. Plastic rod 29 is closely fitted to the inner diameter of plastic tube 10, suitably slotted to receive stationary contact 18, and oppositely dished to the approximate shape that boot 26 will assume when subjected to fluid pressure. The rod 29 is suitably slotted to receive the ends of movable contact 15, and stationary contact 18, which is affixed to rod 29 instead of plastic tube 10 in this embodiment.

Rod 29 is assembled with stationary contact 18 held by screws 19 and 20 to rod 29, screw 19 also being arranged to hold the lug end of wire 24 in electrical contact with contact 18, and movable contact 15 is assembled in its proper position and affixed to rod 29 by screws 16 and 17 which extend through plastic tube 10 holding the assembly in place, including the electrical connection of the lug end of wire 23 to contact 15 by screw 16. The flexible boot 26 and the end caps and seals are assembled as hereinbefore described in connection with FIG. 1.

It will be now clear to those skilled in the art that surface 28 has been added to give support to the flexible diaphragm after contact between movable contact 15 and stationary contact 18 has been made. Once the contacts are closed, there is no requirement for the diaphragm to deflect and farther; however, with a further increase in fluid pressure and no support, the flexible boot 26 will be forced farther into the aperture 11 in plastic tube 10 causing stretching and high localized stresses to develop in the boot 26 at the edges of said aperture. By the addition of the suitably shaped support surface 28, the flexible boot will deflect only until it is held in intimate contact with this support surface; at that time fluid pressure will be supported both by the support surface and by the compressive strength of the boot material, which is considerably greater than its strength as a membrane, allowing the switch to be used at great pressures without the damage which could otherwise be sustained.

There are other conceivable configurations into which the basic switch form may be assembled, one of which is shown in FIG. 4.

Referring now to FIG. 4, there is shown case 30, which is generally cylindrical about axis 31 with concentric cavity 32 within which is housed cylindrical solid support block means 33, this latter element being suitably provided with a concave surface 34 for the purposes described in earlier embodiments and oppositely slotted to accept stationary contact means 35 which is bent and suitably affixed to the block means by screws 36 and 37. The coiled movable contact means 15 is affixed by both ends to case 30 by means of screws 38 and 39 which enter suitable threaded recesses which have been provided into the edge of case 30 in diametrically opposed positions. Diaphragm 40 is made of flexible non-metallic material and is held in place over the edge of case 30 by clamping ring 41, which is suitably screw-threaded and attached to case 30. In this switch the diaphragm also acts as a seal between the case 30 and the clamping ring 41. A wire 42 which enters perforation 43 in the case 30 is secured as at 36 and the wire 44, which also extends through the perforation, is attached at 38. The point of entry of the wires 42 and 44 into the casing is later suitably sealed in any convenient manner.

The switch means and its case 30 are supported by means 45 which can be made of any length to support the switch means at any required depth position within a body of fluid.

A still further embodiment of this invention is shown in FIG. 5, wherein the carrier means for the switch is not provided with the aperture in the side wall as previously explained, but instead has a smooth uninterrupted exterior as shown and the contacts are suitably positioned in the end wall, as shown. In this concept the plastic pipe is formed with an annular recess 50 into which is frictionally and tightly received the insulation member 51, the latter forming a support for an adjustable contact member 52 that is threadedly secured therein, as well as serving as a support for a flexible contact 53 which is secured thereto by means 54. The perimeter of the wall is provided with a leak-proof cement or other adhesive and thereafter the flexible cup-shaped diaphragm 56 is secured thereto completely encompassing the operative elements. It will be apparent that the cup-shaped diaphragm can be retained to the tubular body also by a clamping ring member.

It will be evident to those skilled in the art that any number of switches may be supported within a body of fluid to sense pressures at various points within the body of fluid. Also, it is to be understood that the actuation pressure is a function of the tension in the movable coiled contact, spacing between the contacts, and the boot thickness which can be adjusted during design or at assembly or, by adding suitable known means, may be made adjustable after assembly.

It will be also recognized that the embodiments shown encompass only a few of those which can be devised using the basic principles taught in this disclosure and that other physical changes may be made therein which do not depart from the spirit of this invention.

What is claimed is:

1. A fluid-operated switch comprising a tubular plastic casing provided at its upper end with plug means capable of supporting the switch in a receptacle, electrical lead means extending axially through said plug means and terminating in a pair of spaced terminals insulatively mounted within said tubular plastic casing and having their inner ends exposed to the interior of the casing, means defining an opening in said plastic tubular means, a first metallic spring member in said casing associated with one of said spaced terminals and arranged for flexure and a second relatively rigid member associated with another of said spaced terminals with each of said members being in proximity to the means defining said opening, a flexible sheath-like diaphragm encompassing a portion of said tubular plastic casing and sealing the contacts therewithin, said flexible sheath being in close proximity to the first metallic spring member and bowing said spring member against said rigid member when pressure is exerted against said diaphragm.

2. A fluid-operated switch as claimed in claim 1, wherein the means defining said opening in said tubular plastic casing extends longitudinally of said casing.

3. A fluid-operated switch as claimed in claim 1, wherein the means defining said opening in said tubular plastic casing is disposed at the terminal end thereof.

4. A fluid-operated switch as claimed in claim 1, wherein the metallic spring member consists of a coil spring.

5. A fluid-operated switch as claimed in claim 1, wherein the plastic tubular casing includes a plastic rod element adapted to support the relatively rigid member, said plastic rod further including a concave surface approximating the curvature assumed by the flexible sheath when pressure is applied thereagainst.

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