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S. GREENE

3,133,997

FLUID-PRESSURE ACTUATED SWITCH

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2 Sheets-Sheet 1

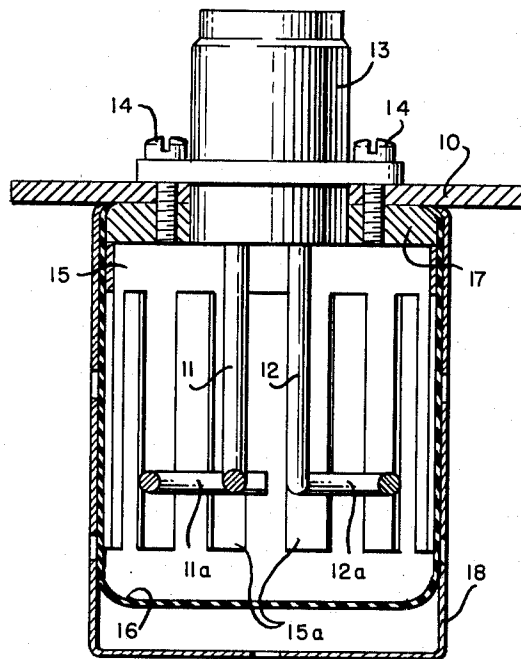


FIG. 1

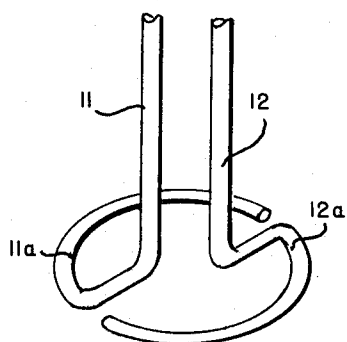


FIG. 2

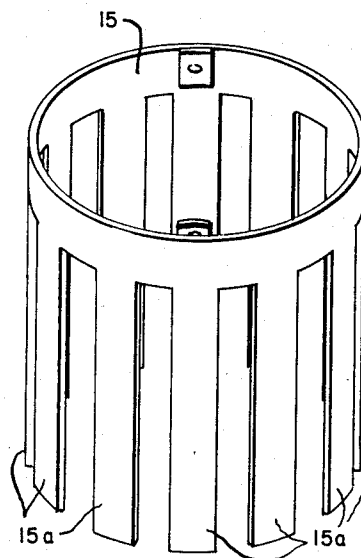


FIG. 3

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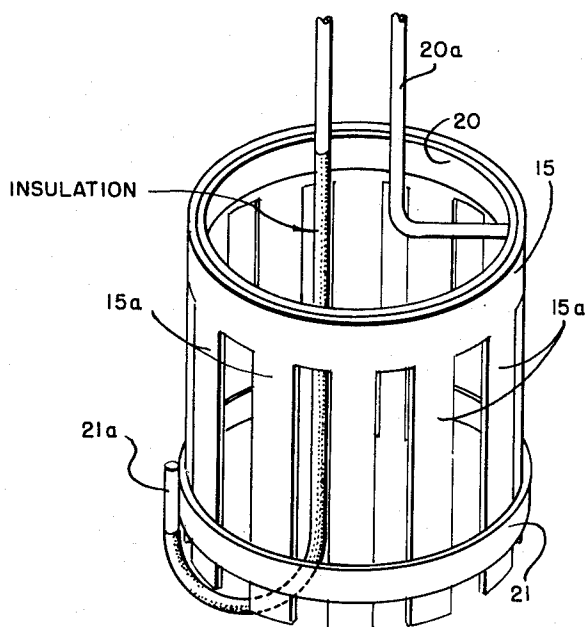


FIG. 4

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FLUID-PRESSURE ACTUATED SWITCH

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11 Claims. (Cl. 200—83)

This invention relates to fluid-pressure actuated switches and, while it is of general application, it is particularly suitable for embodiment in an immersion switch, that is, a switch which is actuated when, but only when, immersed in a liquid such as water to signify the abnormal presence or level of the liquid in an internal compartment or at some external portion of a body to which it is attached.

Heretofore, there have been devised numerous types of electrical switches designed to be actuated to give a controlling or indicating signal upon abnormal occurrence of water or other fluid. One important application of such a switch has been to trans-oceanic aircraft automatically to give a distress signal in the event any substantial portion of the craft should be submerged or any compartment flooded. Many of such switches of the prior art have depended for their operation upon the mere presence of abnormal moisture as, for example, by responding to variation in the electrical characteristic of some hydroscopic material. However, this type of switch has suffered the disadvantage that frequently it is actuated improperly due to rain, fog, splashing, or spray.

Another type of prior alarm switch is of the immersion type comprising a single rigid contact element and a single resilient contact element enclosed in, or actuated by, a fluid-pressure-responsive diaphragm. This type of switch suffers the disadvantage that it is subject to improper actuation by the forces of acceleration in particular directions.

It is an object of the present invention, therefore, to provide a new and improved fluid-pressure actuated switch which obviates one or more of the above-described disadvantages of prior switches of this type.

It is another object of the invention to provide a new and improved fluid-pressure actuated switch of the immersion type which is unresponsive to rain, fog, splashing, and spray as well as to acceleration forces and one that is characterized by low inertia and consequent high speed of operation as well as high repeatability.

In accordance with the invention, a fluid-pressure actuated switch comprises a support, a pair of longitudinally extending substantially parallel spaced fixed rigid contact elements extending from the support, at least two longitudinally extending resilient contact fingers electrically interconnected and normally disposed on opposite sides of, substantially parallel to, and in a predetermined relation to the rigid contact elements, and a fluid-impervious flexible membrane means enclosing all of the contact elements and with the support forming a fluid-tight enclosure, whereby the application of fluid pressure to the membrane means causes the same directly to engage said contact fingers and changes the relation between the contact fingers and the rigid contact elements.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, while its scope will be pointed out in the appended claims.

Referring now to the drawings:

FIG. 1 is a longitudinal view, partly in section, of a fluid-pressure-actuated normally open switch embodying the invention;

FIG. 2 is a detailed perspective view of the rigid fixed conductors of the switch of FIG. 1;

FIG. 3 is a detailed perspective view of the resilient contact element of the switch of FIG. 1, while

FIG. 4 is a perspective view of the contact structure of

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a modified form of switch embodying the invention and of the normally closed type.

Referring now more particularly to FIGS. 1, 2, and 3 of the drawings, there is represented a fluid-pressure actuated switch of the normally open type comprising a support, such as a plate 10, from which extend a pair of elongated spaced fixed rigid contact elements 11 and 12. The elements 11 and 12 terminate at their ends remote from the support 10 in opposed arcuate portions 11a, 12a preferably lying in a common transverse plane.

The contact elements 11, 12 are mounted from the support plate 10 by means of a fluid-tight connector 13 secured to a disc 17 of insulation material, such as molded nylon, as by cap screws 14, 14, while disc 17 is secured to the support 10. The connector 13 provides external electrical connections to the contact elements 11, 12. The connector 13, per se, forms no part of the present invention and may be of any well-known fluid-tight type but preferably having its outer end vented to ambient pressure to prevent building up a differential pressure across diaphragm 16 which might give a false signal. One such connector is represented by Military Specification AN3102A105L-4P.

The switch of the invention further includes a contact element including at least two elongated resilient contact fingers normally disposed in a predetermined relation to the rigid contact elements 11, 12. This latter contact element is preferably in the form of a cylindrical cage 15, shown in perspective in FIG. 3, and includes a plurality of elongated resilient contact fingers 15a surrounding the arcuate terminal portions of the rigid contact elements 11, 12 but spaced therefrom. The term "cylindrical" is used in its generic sense to apply to surfaces having cross-sections of any desired configuration including circular, as illustrated.

The switch of the invention further comprises a fluid-impervious flexible membrane 16, for example of natural or synthetic rubber, enclosing all of the contact elements and, with the support 10, forming a fluid-tight enclosure. The cage 15 may be supported from the disc 17, as shown, or may be inserted in the membrane 16 loosely. A fluid-pervious protective casing, such as a perforated rigid casing 18, encloses the membrane 16 and tightly engages the insulator 17 as by crimping its upper end, thereby effectively clamping the upper open end of the membrane 16 to form a fluid-tight joint.

With the construction described, it is clear that the application of fluid pressure to the membrane 16, as by immersing the unit, is effective to change the relationship between the resilient contact fingers 15a and the rigid contact elements 11, 12, specifically to force them radially inwardly so that all of them tend to contact the arcuate terminal portions of the rigid contact elements 11, 12. Since, as shown in FIG. 3, the cage 15 is an integral conductive element, the fingers 15a are effective to bridge the contact elements 11, 12, thus completing the electrical circuit and closing the switch.

It will be apparent that the switch will be actuated similarly in any altitude by fluid pressure. Furthermore, the spring constants of the fingers 15a may be made so light that the fluid pressure resulting from immersion of the unit in water up to the support plate 10 is adequate to actuate the switch. At the same time, it is obvious that the switch cannot be actuated by rain, fog, splashing, or spray. Again, should the switch be on a vehicle subject to large acceleration forces, the result would be that all of the fingers 15a would be deflected in one direction so that, while the fingers might make contact with one of the rigid contact elements 11, 12, those fingers on the opposite side of the switch would separate further from the rigid contact elements and the switch would not be

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closed. It has been found that the switch construction described will operate at extremely high speeds due to the very small inertia of the flexible diaphragm 16 and the spring contact fingers 15a. Furthermore, due to the natural resilience of these elements, the switch is characterized by a high degree of accuracy and repeatability.

The switch, as described and illustrated in FIG. 1, is suitable for use only when the fluid cannot rise above the vented connector 13 as, for example, when the support 10 comprises a wall of a compartment in which the presence of fluid is to be detected. In the event that it is desired to apply the switch to an installation which may be completely submerged, a fluid-tight tube may be connected to the connector 13 or to the supporting member and the electrical connections to the contact elements 11 and 12 completed by means of conductors extending through the tube.

Alternatively, in the event that it is desired to utilize the switch for remote indication of the fluid level in a compartment, the perforated casing 18 may be replaced by a nonperforated casing having a fluid connection to the remote compartment.

Referring now to FIG. 4 of the drawings, there is shown, in perspective, a contact structure which may be substituted for the contact structure 11, 12, 15 of FIG. 1 to change the switch from one which is of the normally open type to one of the normally closed type. In this embodiment, there is provided a pair of axially spaced rigid contact elements in the form of circular rings or annuli 20, 21 having leads 20a, 21a, respectively, for making connections to the connector 13.

The cylindrical contact cage 15, having extending resilient fingers 15a, may be of the same form as in the embodiment shown in FIGS. 1 and 3. However, in this embodiment, the upper continuous annular portion of the cage 15 is proportioned to fit closely over the upper rigid contact element 20 and is soldered or otherwise conductively secured thereto so that, in effect, each of the resilient contact fingers 15a is secured to the element 20 and extends axially therefrom. The resilient contact fingers 15a extend inside of, but normally resiliently engage, the lower rigid contact element 21. The portion of the lead 21a within the cage 15 is insulated to avoid accidental contact with any of the resilient fingers 15a upon deflection.

The operation of the switch of the invention embodying the contact structure of FIG. 4 will be clear from the foregoing description. Upon the application of fluid pressure to the flexible membrane 16, the resilient fingers 15a are forced inwardly, disengaging the rigid contact element 21 and opening the switch. It is to be noted that the switch will not be opened unless all of the fingers 15a disengage the rigid contact 21. This precludes faulty operation due to acceleration forces which, while causing some of the fingers 15a to disengage the contact 21, would effect a firmer engagement of those fingers on the opposite side of the cage.

While there have been described what are at present considered to be the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A fluid-pressure actuated switch comprising: a support; a pair of longitudinally extending substantially parallel spaced fixed rigid contact elements extending from said support; at least two longitudinally extending resilient contact fingers electrically interconnected and normally disposed on opposite sides of, substantially parallel to, and in a predetermined relation to said rigid contact elements; and fluid-impervious flexible membrane means enclosing said contact elements and with said support

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forming a fluid-tight enclosure, whereby the application of fluid pressure to said membrane means causes the same directly to engage said contact fingers and changes the relation between said fingers and said rigid contact elements.

2. A fluid-pressure actuated switch comprising: a support; a pair of longitudinally extending substantially parallel spaced fixed rigid contact elements extending from said support; at least two longitudinally extending resilient contact fingers electrically interconnected and supported by and extending from said support and normally disposed on opposite sides of, substantially parallel to, but normally spaced from said rigid contact elements; and fluid-impervious flexible membrane means enclosing said contact elements and with said support forming a fluid-tight enclosure, whereby the application of fluid pressure to said membrane means causes the same directly to engage said contact fingers and actuates said fingers to bridge said rigid contact elements, thereby closing the switch.

3. A normally-open fluid-pressure actuated switch comprising: a support; a pair of longitudinally substantially parallel spaced fixed rigid contact elements extending from said support; at least two longitudinally extending resilient contact fingers electrically interconnected and individually disposed on opposite sides of but normally spaced from said rigid contact elements; and fluid-impervious flexible membrane means enclosing said contact elements and with said support forming a fluid-tight enclosure, whereby the application of fluid pressure to said membrane means causes the same directly to engage said contact fingers and actuates said fingers to bridge said rigid contact elements, thereby closing the switch.

4. A normally-open fluid-pressure actuated switch comprising: a support; a pair of spaced fixed rigid contact elements extending from said support and terminating in opposed arcuate portions lying in a common transverse plane; at least two resilient contact fingers electrically interconnected and individually disposed adjacent but normally spaced from said rigid contact elements; and a fluid-impervious flexible membrane enclosing said contact elements and with said support forming a fluid-tight enclosure, whereby the application of fluid pressure to said membrane actuates said fingers to bridge said rigid contact elements, thereby to close the switch.

5. A normally-open fluid-pressure actuated switch comprising: a support; a pair of spaced fixed rigid contact elements extending from said support and terminating in opposed arcuate portions lying in a common transverse plane; a contact element comprising a cylindrical cage including a plurality of extending resilient contact fingers surrounding but normally spaced from said rigid contact elements; and a fluid-impervious flexible membrane enclosing said contact elements and with said support forming a fluid-tight enclosure, whereby the application of fluid pressure to said membrane actuates said fingers to bridge said rigid contact elements, thereby to close the switch.

6. A fluid-pressure actuated switch comprising: a support; a pair of spaced fixed rigid contact elements extending from said support; at least two resilient contact fingers electrically interconnected and normally disposed in a predetermined relation to said rigid contact elements; fluid-impervious flexible membrane means enclosing said contact elements and with said support forming a fluid-tight enclosure, whereby the application of fluid pressure to said membrane means causes the same directly to engage said contact fingers and changes the relation between said fingers and said rigid contact elements; and a fluid-pervious protective casing enclosing said membrane.

7. A fluid-pressure actuated switch comprising: a support; a pair of spaced fixed rigid contact elements extending from said support; at least two resilient contact fingers electrically interconnected and normally disposed in a predetermined relation to said rigid contact elements;

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fluid-impervious flexible membrane means enclosing said contact elements and with said support forming a fluid-tight enclosure, whereby the application of fluid pressure to said membrane means causes the same directly to engage said contact fingers and changes the relation between said fingers and said rigid contact elements; and a perforated rigid casing mounted on said support and enclosing said membrane.

8. A fluid-pressure actuated switch comprising: a support; a pair of spaced fixed rigid contact elements extending from said support; at least two resilient contact fingers electrically interconnected and normally disposed in a predetermined relation to said rigid contact elements; fluid-impervious flexible membrane means enclosing said contact elements and with said support forming a fluid-tight enclosure, whereby the application of fluid pressure to said membrane means causes the same directly to engage said contact fingers and changes the relation between said fingers and said rigid contact elements; and a fluid-tight connector secured to said support and providing external electrical connections to said rigid contact elements.

9. A normally-closed fluid-pressure actuated switch comprising: a support; a pair of axially spaced fixed rigid contact elements extending from said support; at least two resilient contact fingers extending between opposite sides of and normally bridging said rigid contact elements; and a fluid-impervious flexible membrane enclosing said contact elements and with said support forming a fluid-tight enclosure, whereby the application of fluid pressure to said membrane causes the same directly to engage said contact fingers and actuates said fingers to disengage said rigid contact elements, thereby to open the switch.

10. A normally-closed fluid-pressure actuated switch comprising: a support; a pair of spaced fixed circular rigid

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contact elements extending from said support; at least two resilient contact fingers, each secured to one of said rigid contact elements and resiliently engaging the other; and a fluid-impervious flexible membrane enclosing said contact elements and with said support forming a fluid-tight enclosure, whereby the application of fluid pressure to said membrane actuates said fingers to disengage said other of said rigid contact elements, thereby to open the switch.

11. A normally-closed fluid-pressure actuated switch comprising: a support; a pair of spaced fixed circular rigid contact elements extending from said support; a contact element comprising a cylindrical cage conductively secured to one of said rigid contact elements and including a plurality of extending resilient contact fingers disposed inside of and resiliently engaging the other of said rigid contacts; and a fluid-impervious flexible membrane enclosing said contact elements and with said support forming a fluid-tight enclosure, whereby the application of fluid pressure to said membrane actuates said fingers to disengage said other of said rigid contact elements, thereby to open the switch.

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