Dec. 29, 1959 J. F. EDWARDS, JR., ET AL 2,919,320

DIAPHRAGM-TYPE PRESSURE-ACTUATED SWITCH AND METHOD OF FABRICATING SAME

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FIG. 1.

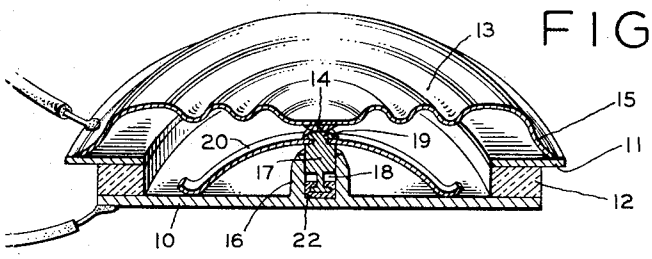


FIG. 2.

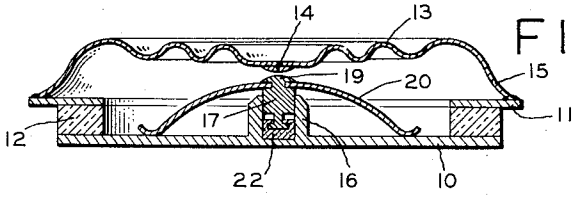


FIG. 3.

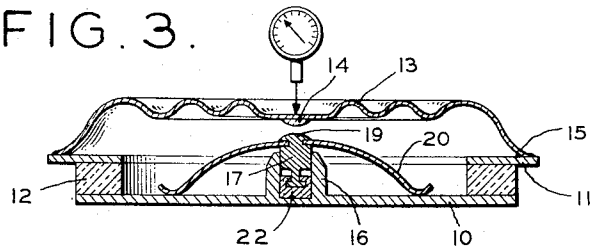


FIG. 4.

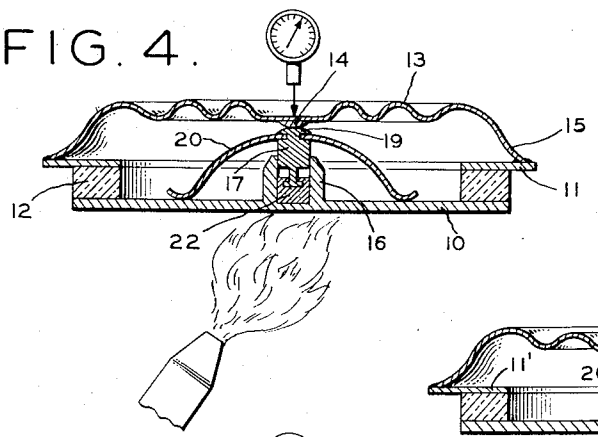


FIG. 5.

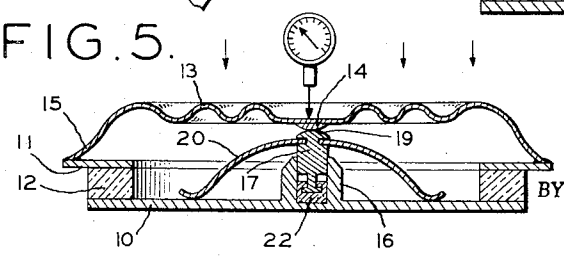


FIG. 6.

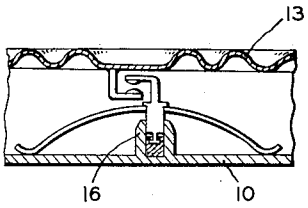
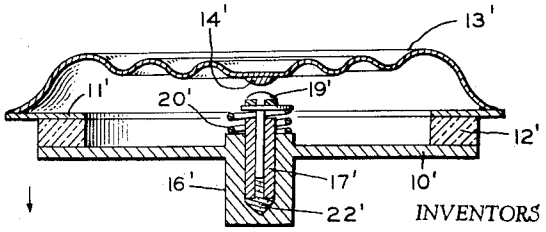


FIG. 7.



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DIAPHRAGM - TYPE PRESSURE - ACTUATED SWITCH AND METHOD OF FABRICATING SAME

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This invention relates to switches of that type wherein electrical contacts forming part of an electrical circuit to be controlled are enclosed in a sealed chamber having a pressure-responsive movable wall, the chamber being evacuated or filled with a gas at some selected pressure, in order that switching may be accomplished automatically at some predetermined value of pressure over a known range of ambient fluid pressures, such as at varying altitudes.

In the fabrication of a switch of this type, problems arise with respect to the provision of dependable contacts within the sealed chamber. It is usually desirable to maintain the overall structure light in weight and as simple as possible and to also avoid any fabricating operations on the switch after assembly which may disturb its accuracy. At the same time, the switch must be capable of standing up under shocks and acceleration and deceleration stresses in many types of installations.

One of the primary objects of the present invention, therefore, is to provide a switch of the type specified involving a minimum of structure which may be fabricated by means of a series of relatively simple operations without damaging the diaphragm or other sensitive switch parts, and which after being set to operate at some predetermined pressure, will remain in its set position despite rough handling and even though it may be subjected to shocks such as acceleration and/or deceleration stresses.

Another object is to provide a switch of the type specified which is comprised of relatively few parts, the internal switch contacts being readily set to close or open at some predetermined operating pressure after the parts have been assembled, whereupon the contacts remain definitely fixed in preset relation.

A further object is to provide an improved method of fabricating pressure-responsive switches of the internal contact type.

The foregoing objects and advantages will become apparent in view of the following description taken in conjunction with the drawing wherein:

Fig. 1 is a sectional perspective view of a diaphragm-type pressure-actuated switch in accordance with the invention, the switch contacts being arranged to open upon a predetermined decrease in external pressure;

Figs. 2, 3, 4 and 5 are substantially central transverse-vertical sectional views, illustrating the successive steps which may be adopted in fabricating the switch;

Fig. 6 is a fragmentary view of a switch of the type shown in Figs. 1 to 5, inclusive, except that the contacts are arranged to open upon a predetermined increase in external pressure; and

Fig. 7 is a substantially central transverse-vertical section of a modification.

Referring to the drawing in detail and first to Fig. 1, the switch assembly comprises a base or back plate **10**, which may be made of electrical conductive material, such for example as brass, having a diameter conforming to specifications on weight and space requirements.

A ring **11**, also of conductive material, overlies the plate **10**, and interposed therebetween is an insulating ring **12**, which may be made of material such as aluminum oxide capable of being welded or fused to the plate **10** and ring **11**. A diaphragm **13**, here shown as of the corrugated type, has a central flat area carrying a contact **14**, and a peripheral edge portion **15**, fused, welded or otherwise suitably connected to the ring **11**.

The center of the plate **10** is provided with an upstanding hollow boss **16**, which may be cast on the plate, assuming the latter is made of cast material. A contact member **17**, in this instance comprising a slug of metal, is telescoped into the guide bore defined by the boss **16**, said member at its lower or inner end terminating in a solder-lock in the form of an undercut or recess **18** and at its upper end in a contact head **19**. The sole remaining part of the assembly comprises a bowed spring **20**, having a substantially centrally located hole or opening **21**; the upper end of the member **17** having a necked portion projecting through said hole and being swaged over the spring at this point to lock the member **17** to the spring and provide the contact head **19**.

Figs. 2, 3, 4 and 5 illustrate successive steps which may be adopted in fabricating the switch, it being understood that the respective steps may be arranged in any order found most convenient in arriving at the desired end result. The diaphragm **13**, ring **11** and insulation ring **12** may be joined as by brazing, fusing or soldering or a combination of same. With the base **10** supported on a flat horizontal plane, a slug of solder is deposited in the base of the guide bore provided by the hollow boss **16** and the contact member **17** telescoped in said bore, the spring **20** having been assembled to the said member prior to insertion. Heat is then applied to the base **10** immediately beneath the boss **16** until the solder melts. When the member **17** drops down into the hollow boss, the solder is permitted to harden to thereby temporarily lock the contact member in its "down" position. In this latter position, the opposite ends of the spring **20** bear against the base **10** and exert an upward spring force on the contact member **17**. The base **10** may now be connected to the insulation ring **12** by fusing or in any other manner found convenient or desirable.

When the parts are thus assembled, the switch is ready for the setting operations. If it is assumed that the switch contacts are to remain closed at sea-level pressure and open when some predetermined lower pressure (or higher altitude) is attained, the setting operations may proceed as shown in Figs. 2 to 5, inclusive. Thus in Fig. 2 the solder **22** is hard, holding the contact member **17** securely in its "down" position. It will be assumed that the switch is now subjected to sea-level pressure, although it could be subject to any pressure other than sea level to conform to specified setting requirements.

Fig. 3 shows the next step. The diaphragm **13** is now being subjected to a deflecting pressure corresponding to the pressure at which the contacts **14** and **19** are to separate. This position may be noted by an electronic micrometer or like instrument so as not to disturb the diaphragm. To maintain the diaphragm in this position, it may be located in a pressurized chamber such as that afforded by the conventional bell jar.

Figs. 4 and 5 show the final steps. With the diaphragm held at a position corresponding to that shown in Fig. 3, heat is applied to the base **10** in the area of the boss **16**. This may be done by a torch or other suitable heating means. The temperature in the area of the boss **16** is brought to the point where the solder **22** melts, whereupon the spring **20** moves the contact member **17** upwardly until contact **19** engages **14**, as in Fig. 4. This action may displace the diaphragm slightly in an upward direction. However, by keeping the heat applied and increasing

the pressure against the diaphragm until it is forced back to the position noted in Fig. 5, such displacement may be rectified. While holding the parts in the position shown in Fig. 5, the heat is removed and the solder **22** allowed to reharden. The switch is now set and ready for installation.

In the form of switch shown in the drawing, the contacts **19** and **14** are closed at sea level pressure and will remain closed until some predetermined altitude is reached, whereupon they will open. However, it will be apparent that the opposite setting could be adopted, i.e. the contacts could be set open at some predetermined low pressure and arranged to close as the pressure increased.

As an example, let it be assumed that it is desired to have the contacts remain closed at a given pressure below atmospheric and to open when the atmospheric pressure attains a value, say equal to that existing at sea level. In such case, the contact arrangement would be reversed with respect to that shown in Figs. 1 to 5, inclusive, as illustrated in Fig. 6. However, the process would be substantially the same as that heretofore described except that the initial step would be taken at a given low pressure with the contacts together, at which point the solder would be permitted to harden and definitely locate the back plate contact. Then as the pressure increases to some selected value, the contacts would separate.

It may be well to explain for the benefit of those not familiar with the operation of switches of the diaphragm type, that when a corrugated diaphragm of the type herein shown is subjected to a selected pressure such as would move the contacts into engagement before the pressure attains the selected value, the area around the center portion of the diaphragm continues to deflect after the contacts engage. Hence when the pressure is decreased, the contacts will not immediately separate but will remain in engagement until the selected value of pressure is attained.

Fig. 7 illustrates a modified type of internal contact pressure-responsive switch with respect to that heretofore described. In this instance, parts which correspond to those in Figs. 1 to 5, inclusive, are given similar reference numbers except that a prime (') has been added. The general arrangement is similar except that in Fig. 7 the base or back plate **10'** has the hollow boss **16'** projected downwardly or outwardly therefrom so that it may be directly exposed to the flame of a torch or other heating instrument more readily than is the case in Fig. 1. The contact member **17'** is urged toward the diaphragm by a coil spring **21'**. Also, the contact member **17'** is hollow or has a central bore extending therethrough which the solder **22'** may enter when it melts and provide a solder lock. The insulating ring **12'** is of ceramic composition capable of being fused to ring **11'** and the back plate **10'**. The method of assembly may be generally similar to that heretofore described in connection with Figs. 1 to 5, inclusive.

It will at once be apparent that a switch of the type herein disclosed may be fabricated at a relatively low cost while at the same time it incorporates a minimum number of parts and is dependable in operation. Once the switch is set, it will stand relatively rough handling, shock and acceleration forces without disturbing its preset condition, an important factor in certain installations.

In practice, a number of different arrangements for connecting the contact member **17** to the base **10** other than those shown have been utilized. For example, the lower end of the member **17** has been projected through an opening formed in the base so that the solder **22** is accessible for direct contact by the flame of a torch. In such instances, however, there is a chance that a leak may develop in the soldered area at the base of the contact member. Also, to expedite breaking and making of the solder bond at **22**, the wall of the plate **10** in this area may be thinned to facilitate heating of the solder. These and other minor changes in structure and method of fabrication may be adopted within the scope of the invention as defined by the appended claims.

What is claimed is:

1. The method of fabricating a pressure-responsive switch of the type in which coacting electrical contacts are located in a chamber defined at least in part by a diaphragm carrying a contact on one side of said chamber and a backing plate carrying a coacting contact on the opposite side thereof, which consists in locating a spring-pressed contact member in a guide bore carried by said plate along with bonding material effective when in a solid state to retain the contact member fixed in said bore but capable of being fused by the application of a medium exterior of the plate, assembling the diaphragm to the plate, while said contact member is unbonded subjecting the diaphragm to a pressure such as will cause it along with its contact to assume a positon corresponding to the position it will assume when subjected to the pressure at which the switch is to operate, and causing said bonding material to solidify and hold the contact member in a fixed permanent position in its guide bore.

2. The method of fabricating a pressure-responsive switch of the type in which coacting electrical contacts are located in a chamber defined at least in part by a diaphragm carrying a contact on one side of said chamber and a backing plate carrying a coacting contact on the opposite side thereof, which consists in locating a spring-pressed contact member in a guide bore carried by said plate along with bonding material such as solder capable of being fused by the application of a heating medium exterior of the plate, assembling the plate and diaphragm to provide a closed chamber, while the bonding material is in an unsolidified state subjecting the diaphragm to a pressure such as will cause its contact to assume a position with respect to said spring-pressed contact corresponding to the position assumed when the diaphragm is subjected to the pressure at which the switch is to operate, and then causing the bonding material to solidify and permanently fix the contact member to said plate.

3. The method of fabricating a pressure-responsive switch of the type in which coacting electrical contacts are located in a chamber defined at least in part by a diaphragm carrying a contact on one side of said chamber and a backing plate carrying a coacting contact on the opposite side thereof, which consists in fabricating the plate and diaphragm separately and prior to assembly locating a spring-pressed contact member in a guide bore carried by said plate, temporarily bonding said contact member in fixed position by setting the contact member in bonding material which is fusible when heated to a given temperature, assembling the diaphragm to the plate, subjecting the diaphragm to a pressure such as will move it to a position corresponding to the position it will assume when subjected to the pressure at which the switch is to operate to make or break an electric circuit, applying heat to the backing plate in the area of said contact to fuse the said bonding material and permit the spring to move the contact member to a predetermined operating position with respect to the contact carried by the diaphragm, and thereafter removing the heat to permit the bonding material to solidify and fix the contact member in its operative position.

4. In a diaphragm-type pressure-responsive switch, a backing plate and a diaphragm coacting therewith to provide a closed gas-tight chamber said plate having a guide bore formed therein, a contact member located in said bore, fusible material in said bore bonding said contact member in a predetermined contact position, and a spring engaging said contact member for the sole purpose of moving it to said predetermined contact position when said material is fused by the application of a fusing medium exterior of said plate.

5. In a diaphragm-type pressure-responsive switch, a backing plate, means providing a guide bore located sub-

stantially centrally of said plate, a contact member mounted in said bore, fusible matrial such as solder disposed in said bore for locking said contact member in a fixed contact position, a diaphragm coacting with said plate to provide a closed gas-tight chamber, an annular member connected to the peripheral edge of said diaphragm, an insulation ring interposed between the peripheral edge of said plate and said annular member, said insulation ring being made of material capable of being bonded to said plate and annular member, and a spring engaging said contact member for the sole purpose of moving it to said fixed contact position when the solder is fused by the application of a heating medium exterior of said plate.

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