Jan. 16, 1968 W. E. RHODES 3,364,320

HERMETICALLY SEALED SWITCH

Filed April 20, 1964 2 Sheets-Sheet 1

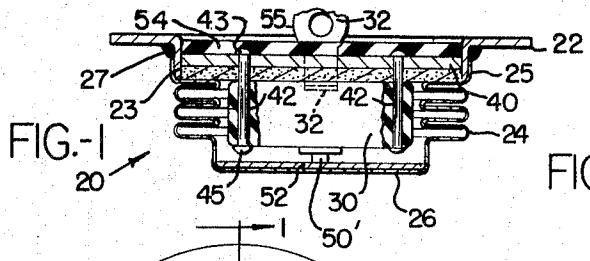

FIG.-1

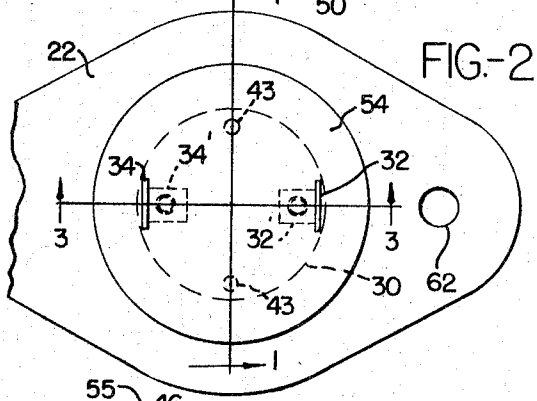

FIG.-2

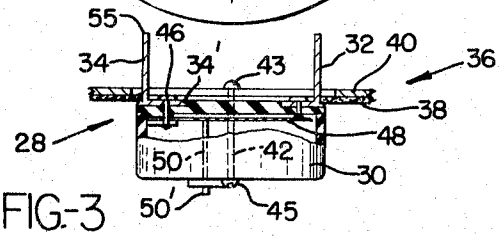

FIG.-3

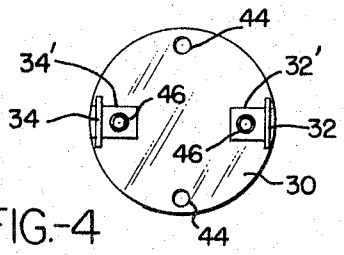

FIG.-4

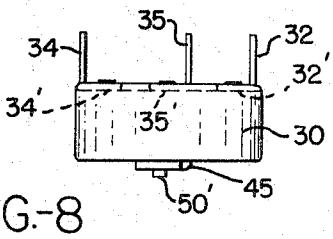

FIG.-8

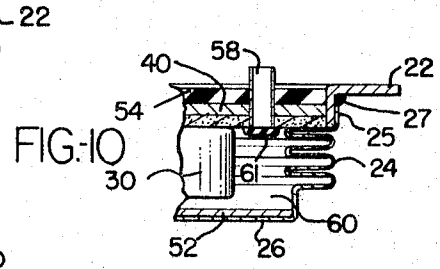

FIG.-10

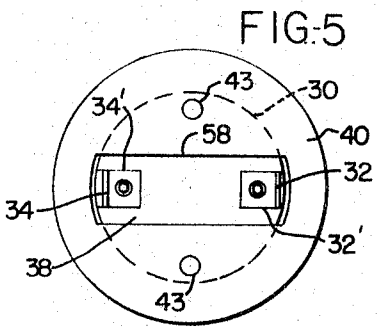

FIG.-5

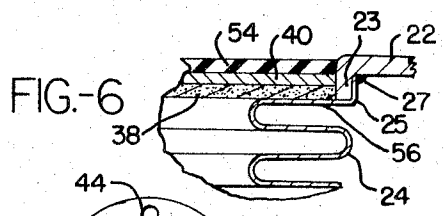

FIG.-6

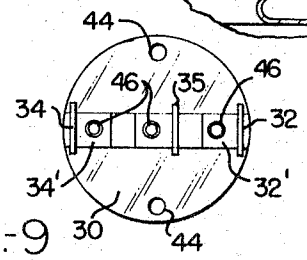

FIG.-9

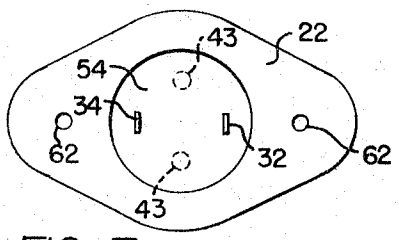

FIG.-7

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HERMETICALLY SEALED SWITCH

Filed April 20, 1964 2 Sheets-Sheet 2

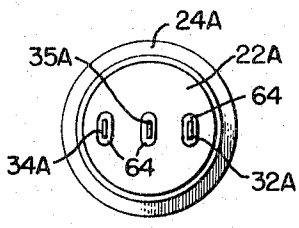

FIG.-12

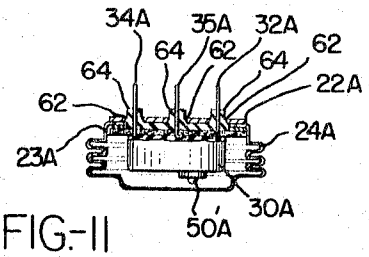

FIG.-11

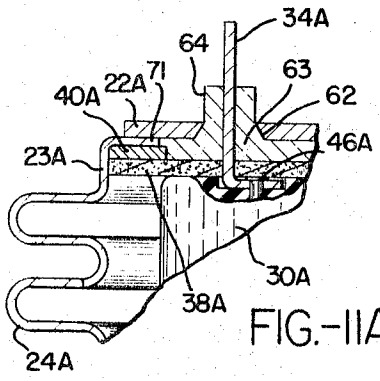

FIG.-11A

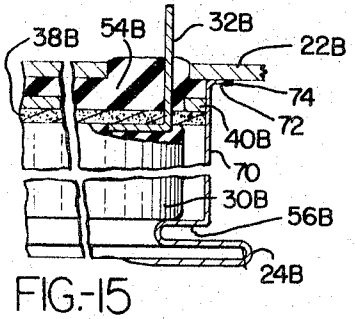

FIG.-15

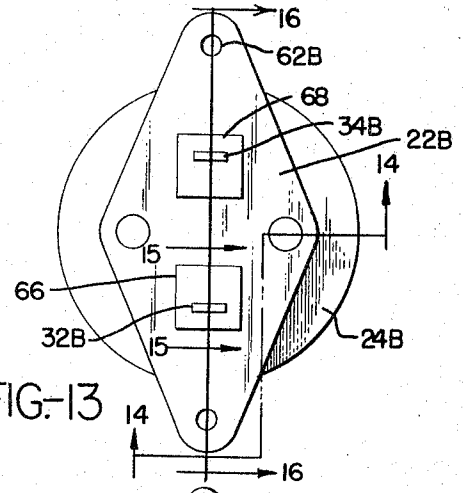

FIG.-13

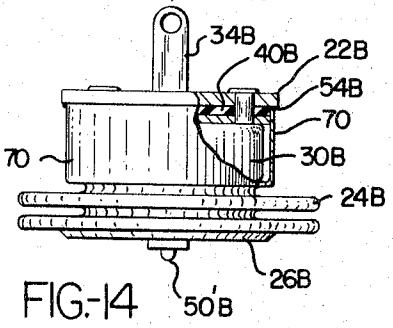

FIG.-14

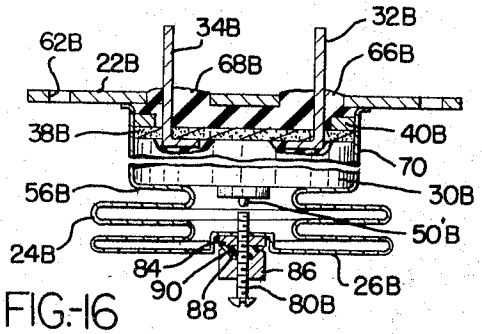

FIG.-16

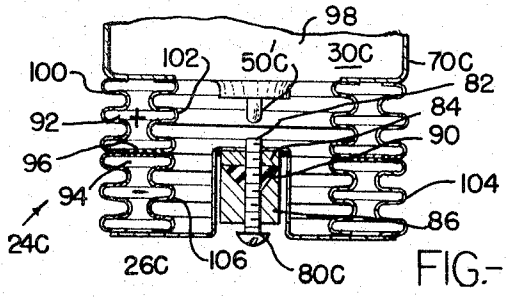

FIG.-17

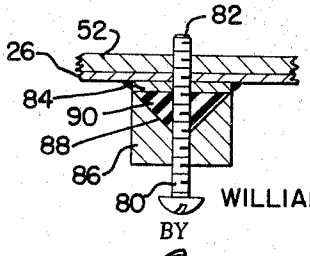

FIG.-18

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3,364,320

HERMETICALLY SEALED SWITCH

William E. Rhodes, Columbus, Ohio, assignor to Robertshaw Controls Company, Richmond, Va., a corporation of Delaware

Filed Apr. 20, 1964, Ser. No. 361,016
15 Claims. (Cl. 200—83)

This invention relates to a hermetically sealed switch and method.

More specifically, this invention relates to a switch combination and method, which includes a unitary sub-assembly support construction that may have a plate for support and the like, and a cylindraceous bellows member bonded to such plate. The bellows member may have a bellows bottom which may actuate a switch actuator to be described. This permits the use of a separately constructed flexible metallic bellows that may thereafter be bonded to the plate as a unitary sub-assembly.

The combination may also include a unitary switch sub-assembly which may have a unitary main insulating switch body containing a switch, having a plurality of electrical conductors extending from the top of said switch body, and having switch body supporting and insulating means that may be adjacent the plate. The switch body may have a downwardly biased and downwardly extending switch actuator adjacent to and actuated upwardly and downwardly by upward and downward movement of said bellows bottom.

After the foregoing members have been sub-assembled as described above, the sub-assemblies may be assembled together. Then a sealing material or compound construction or layer may be sealed to the sub-assembly support construction and to the unitary switch sub-assembly to produce a seal adjacent the switch body completely to seal the entire combination hermetically with the plurality of conductors extending from the switch through the top portion of the entire combination and through the sealing material or compound construction or layer.

This invention relates also to the method of making a switch combination of the character herein disclosed.

Other features of this invention are apparent from this description, the appended claimed subject matter, and from the accompanying drawings, in which:

FIGURE 1 is a vertical cross-section of one embodiment of this invention, such cross-section being taken along the line 1—1 of FIGURE 2.

FIGURE 2 is an enlarged top view of FIGURE 1.

FIGURE 3 is a cross-section taken along the line 3—3 of FIGURE 2, but omitting the top plate and sealing layer.

FIGURE 4 is a top view of FIGURE 3, but omitting the metal plate, and the insulating plate.

FIGURE 5 is a top view of FIGURE 3.

FIGURE 6 is an enlarged portion of FIGURE 1.

FIGURE 7 is a complete top view of the switch construction shown in FIGURES 1–6, in reduced scale.

FIGURE 8 is a side view of a unitary main insulating switch body having three electrical conductors for use with a double pole switch instead of the two electrical conductors shown in FIGURES 1–7, which ordinarily are used with a single pole switch.

FIGURE 9 is a top view of FIGURE 8.

FIGURE 10 is a view similar to a portion of FIGURE 1, and showing the addition of a pressure or breathing tube.

FIGURE 11 is a diagrammatic vertical cross-section of another embodiment of this invention.

FIGURE 11A is an enlarged portion of FIGURE 11.

FIGURE 12 is a top view of FIGURE 11.

FIGURE 13 is a top view of another embodiment of this invention.

FIGURE 14 is a view partly in elevation, and partly in cross-section of the embodiment of FIGURE 13, taken along the irregular lines 14—14.

FIGURE 15 is an enlarged cross-section taken along the line 15—15 of FIGURE 13.

FIGURE 16 is a diagrammatic cross-section along the line 16—16 of FIGURE 13.

FIGURE 17 shows a further embodiment with modification of the bellows construction of FIGURES 13–16.

FIGURE 18 is a cross-section showing a calibrating feature which may be added to FIGURE 1, for example.

Certain words are used in this specification and in the claims that describe relative position, direction, and the like. These words are used in this application solely for the sake of clearness and brevity in describing the parts as shown in the drawings. However, it is to be understood that the direction and relative position of the parts of this invention as used in an actual working embodiment may be entirely different from the relative position, direction and the like in the drawings. That is, certain parts, such as a bottom, as described in the specification and claims of this application may be really at the top of the embodiment and vice versa. Also, such bottom might be on the side, when the embodiment is held or operated in a horizontal position instead of a vertical position as illustrated in the drawings. However, it is intended that the claims be applied to the actual embodiment when it is held or viewed in the position shown in the drawings. Examples of words of the character herein referred to are top, bottom, vertical, horizontal, etc.

Reference is first made to the embodiment of FIGURES 1–7. In this embodiment, the entire switch combination is shown in FIGURE 1, with the exception that the calibrating feature of FIGURE 18 may be added. A unitary sub-assembly support construction **20** may include a metal plate **22**, which may be a support plate and may have an opening formed by a downward cylindraceous flange **23**, FIGURE 6. A cylindraceous bellows **24** may be bonded to the plate **22**, for example, at the flange **23**, where an upward telescoping cylindraceous extension **25** of the bellows may be bonded or soldered to the downward flange **23** at **27**.

The bellows member **24** may have a transverse or horizontal bellows bottom **26**.

The entire switch combination of FIGURE 1 may also have a unitary switch sub-assembly **28**, FIGURES 3 and 5, which may be preassembled before inserting such sub-assembly into the unitary sub-assembly support construction **20**, as shown in FIGURE 1.

The unitary switch sub-assembly **28** may include a unitary main insulating switch body **30**, which may contain a switch **48**, FIGURE 3, and may have a plurality of electrical conductors **32** and **34** extending from the top of the body **30**, which may be connected electrically to the switch **48**, as diagrammatically indicated in FIGURE 3.

The unitary switch sub-assembly, of FIGURES 3 and 5, may have switch body and supporting insulating means **36**. This may include an outward flange forming means at the top of the switch body **30** comprising or including a generally circular lower insulator plate and a generally circular upper metal plate **40**. The plates **38** and **40** may be secured to the unitary body **30** by means of the bolts or rivets **42**, which may be passed through holes in the plates **38** and **40**, and through holes **44**, FIGURE 4, in the switch body **30**. Holes similar to **44** are provided in the plates **38** and **40**.

The bolts or rivets **42** may have the heads **43** and **45** to hold the plates **38**, **40** and body **30** securely together. The holes **44** are made in the body **30** in the insulating portion of such body **30**, so that nothing can enter into

the inside of the body 30 to injure the working parts of the switch 48 inside the body 30.

The electrical conductors 32 and 34 may have horizontal flanges 32' and 34' countersunk in the body 30 and held on the body 30 by means of rivets 46, which are electrically connected with the snap switch 48, as diagrammatically indicated in FIGURE 3.

The snap switch 48 may be actuated back and forth from open and closed position by the downwardly biased actuator 50, which extends out of the bottom of the switch body 30 at 50'. The switch actuator 50, and its extension 50', are actuated upwardly and downwardly respectively by the upward and downward movement of the bellows bottom 26. The bellows bottom 26 may be covered with a relatively rigid metal plate 52, more efficiently to transmit the upward and downward movement of the bottom 26 to the downwardly biased extension 50' of the actuator 50. If desired, the plate 52 may be bonded to the bottom 26 by soldering or the like.

A sealing material or compound construction or layer 54, made of epoxy resin, or the like for example of an adhesive may be provided. It may be sealed to the sub-assembly support construction 20 and to the unitary switch sub-assembly. For example, such layer 54 may be sealed to the flange 23, FIGURE 6, and to the metal plate 40 and insulating plate 38. This seals the combination of FIGURE 1 hermetically. In FIGURE 1, the sealing construction or layer 54 may be applied in plastic or pliable or liquid form, to produce the layer 54 within the flange 23 of the plate 22, and to rest on the upper metal plate 40. In the embodiment of FIGURES 1 to 7, the assembly 36 may be held downwardly, so that the insulating disc 38 rests on the top corrugation horizontal wall 56, FIGURE 6, of the bellows member 24. The plates 38 and 40 may be held downwardly by pushing down on the tops 55 of the conductors 32 and 36 while the adhesive 54 is being applied. These conductors 32 and 34 are rigid enough to receive a downward pushing action to hold the sub-assembly in position against the corrugation horizontal wall 56.

The connections or rivets 46 of the electrical conductors 32 and 34 and any additional electrical conductors of similar character may extend from the switch 48 through the switch body 30. The main parts of the conductors 32 and 34 may extend through the switch body supporting and insulating means 36, such as the plates 38 and 40, and through the sealing compound 54. The insulating plate 38 has a tight fitting slit through which the insulators 32 and 34 pass, so that substantially no adhesive can flow past the insulator plate 38 into the lower portion of the switch combination shown in FIGURE 1. The insulator plate 38 also rests realtively tightly against the upper corrugation horizontal wall 56 of the bellows, so that the adhesive cannot flow past this point as well as along the tight slits through which the conductors 32 and 34 pass. The metal plate 40, which is shown in FIGURES 3, 5 and 6 has a central opening with its outside edges 58, shown in FIGURE 5, spaced away from the conductors 32 and 34. This prevents the metal plate 40 from shorting the conductors 32 and 34, after such metal plate 40 has been riveted tightly in place by the rivets 42. Hence, the flange construction 36 indicated in FIGURE 3 firmly positions the switch body 30 at the correct vertical height within the switch combination. Also, the flange construction 36 produces a bottom support for the sealing compound construction or layer 54. This limits the downward movement of the adhesive so that the pliable or fluid adhesive cannot pass through the insulating layer 38 into the lower part of the construction 20 which is shown in FIGURE 1.

The switch combination may be provided with a gas transmitting tube. This tube 58 transmits gas into or out of the chamber 60 in the interior of the bellows 24, as shown in FIGURE 10. A filtering means 61 may be adhesively secured to the insulation plate 38, or may be inserted in the tube 58. This filtering means 61 may be any sponge-like material, such as made from sponge rubber or the like, such as other sponge plastic materials, which set in an expanded and sponge-like condition. Any suitable substance may be used which permits the transmission of gas, but prevents the passage of solid liquid particles and the like. The tube 58 may be connected to a thermostatically responsive bulb, or to a bellows within a chamber or with its end open in such chamber which chamber is being provided with compressed fluid by a pumping means or the like which may be controlled by the switch 48. Similar applications are obvious.

The support plate 22 may extend horizontally beyond the bellows member 24, as shown in the drawings, so that the plate 22 can be attached where desired. For example, the support plate 22 may be provided with attaching perforated means or apertures 62 for attachment by screws or the like at the place of use.

FIGURES 8 and 9 show an additional electrical conductor 35, in addition to the previously described conductors 32 and 34. Otherwise, the switch body 30 of FIGURES 8 and 9 may have substantially the same construction and function and use as heretofore described in connection with FIGURES 1–7. It is obvious that the various members can be easily adjusted to receive the additional conductor 35, and that the conductors 32, 34 and 35 may be connected to the switch 48, by suitable rivets 46 so that its movable blade is connected to one of the conductors, and that a double pole construction at the top and bottom of the upward and downward movement of the switch blade of the switch may be connected to the two other conductors, as desired, so that a double electrical control may be performed, as is well known in connection with double throw switches.

In the embodiment of FIGURES 11, 11A, and 12, the bellows member 24A may be substantially the same as previously described in connection with FIGURES 1–10. The switch body 30A and its contents and the actuator and its switch actuator extension 50'A and the conductor or conductors 32A, 34A and 35A, if used, may be substantially the same as previously described in connection with FIGURES 1–10. However, in this embodiment the metal plate 22A need not extend horizontally beyond the bellows 24A and may be connected to the bellows 24A by an upward cylindraceous extension 23A. This extension 23A may be soldered or otherwise bonded to the plate 22A by the inward flange 71.

In assembling the embodiment of FIGURES 11, 11A and 12, the body 30A may be pulled upwardly against the plate 22A, and then a glass seal or epoxy resin seal may be poured into the openings 62 in plate A which may be surrounded by suitable molds, so that the glass seals may extend upwardly above the plate 22A, as shown at 64, in FIGURES 11 and 11A.

Other members are identified with reference numerals similar to those used in FIGURES 1–10. However, a suffix A has been added to distinguish from the previous reference characters. Such members with the suffix A may be substantially the same in construction and function as in FIGURES 1–10, except for the obvious modification shown.

In FIGURES 13–16, an embodiment is shown in which the plate 22B is provided with a pair of openings 66 and 68, through which the electrical conductors 32B and 34B extend, and which may be substantially the same in construction and function as previously described in connection with FIGURES 1–10.

FIGURE 11A shows a detailed enlarged cross-section of the connection between the plate 22A and the main body 30A of the switch. In this embodiment, substantially the same type of metal plate 40A and insulating disc 38A may be placed between the plate 22A and the main body 30A of the switch. A cylindrical extension 23A at the upper end of the bellows 24A may be provided with an inward flange 71 which may be soldered or otherwise

bonded to the plate 22A, as shown in FIGURE 11A. Glass or adhesive 63 may be inserted in the openings 62 in the plate 22A. The glass or other adhesive may be poured through such openings 62, and may be mounted at 64 around the electrical conductors 34A etc., if desired. The mounded construction 64 may be produced by a temporary mold or funnel through which the glass may be poured, and be allowed to solidify after which the molds may be moved upwardly. For this purpose, the mounds 64 may be contracted inwardly slightly into conical formation, so that the molds may be lifted from the switch combination without adhering to the glass construction.

In FIGURES 13–16, the bellows member 24B may be provided with a horizontal upper corrugation 56B, and a cylindrical upward extension 70, and if desired a short outward flange 72. The flange 72 may be soldered to the plate 22B at 74. The switch body 30B, the lower insulator plate 38B, the upper metal plate 40 may be substantially the same as previously described in connection with FIGURES 1–7, including the opening with edges 58 in the metal plate 40 and the riveting action to hold the body 30B against the plates 38B and 40B. The adhesive layer or sealing compound construction or layer 54B may be inserted, poured or otherwise introduced into the construction through the openings 66 and 68. The construction and action of the combination shown in FIGURES 13–16 is substantially the same as previously described, in connection with FIGURES 1–7, as is obvious.

Wherever numerals are used in the FIGURES 13–16, which correspond to the reference numerals in FIGURES 1–10, but with the suffix B added, it is understood that such member so designated with the suffix B is substantially the same in construction and function as in FIGURES 1–10, modified if necessary, as is obvious. Therefore, numerals are placed on FIGURES 13–16 and 18 which are not specifically described in connection with these figures. However, it is to be understood that they correspond in function and structure to corresponding numbers in FIGURES 1–10 without the suffix B.

A calibrating feature is shown in FIGURES 13–18 which has been applied to the structure of these FIGURES 13–16 with suffix B and to FIGURE 17 with suffix C. This feature is for the purpose of providing a calibration at the bottom of the bellows structure. The feature of FIGURE 18 is substantially the same as in FIGURES 13–17, but is shown as applied to the bottom of FIGURE 1, for example. It is to be understood that this feature may be applied to all the structures of this invention in an obvious manner, and has therefore not been illustrated in all of the figures.

The calibration feature is shown in FIGURES 16, 17 and 18 and may include an adjustable screw 80, 80B and 80C, which can be sealed and locked to the bellows bottom 26, 26B and 26C by any suitable construction for this purpose. In this manner, the distance between the end 82 of the screw 80, 80B and 80C and the extension 50, 50'B and 50C of the switch actuator 50 may be calibrated by axially adjusting the screw 80, 80B and 80C and thereafter sealing it so that no fluid can enter or leave at this point.

For example, a metal disc 84 may be hermetically bonded to the bellows bottom 26, 26B and 26C by soldering or other method. The screw 80, 80B and 80C is threaded in this disc 84, so that turning of the screw will cause the end 82 to be axially calibrated upward and downwardly in the bellows of the various embodiments. A combined sealing and locking nut 86 may be provided wth a cone-shaped end 88. This end 88 compacts and seals the seal packing material 90 around the screw 80, and between the end surfaces of the nut 86, and the disc 84. Any other well known axial movement and sealing and locking construction may be used in lieu of the constructions specifically disclosed in FIGURES 16, 17 and 18.

FIGURE 17 shows an embodiment somewhat similar to the embodiment of FIGURES 13–16 and 18, and shows the lower part of FIGURE 16 modified in accordance with the features of FIGURE 17. Reference characters with the letter C are used in FIGURE 17 to indicate the parts which correspond in structure and function with the reference characters used in FIGURES 13–16 and 18, but in which the suffix C is used in FIGURE 17 merely to indicate that a similar element is being used which was described or shown in FIGURES 13–16 and 18, as well as in previous FIGURES 1–12.

In FIGURE 17, a bellows structure 24C is used which, however, has a pair of annular bellows 92 and 94 which are hermetically separated at 96. These annular bellows are so constructed at their upper ends, that they have an upward cylindrical extension 70C, which may surround the switch body 30C in the same manner that the extension 70 in FIGURES 13–16 surrounds the switch body 30B. The upper part of the structure shown in FIGURE 17, above the break line 98, may be substantially the same as shown in FIGURES 13–16 and the adjustable screw 80C and its sealing and locking construction may be substantially the same as shown in FIGURES 16 and 18 without further description.

In FIGURE 17, the annular bellows chamber 92 may be made with an outer corrugated bellows wall 100, and with an inner bellows corrugated wall 102. These corrugated walls 100 and 102 enclose the bellows chamber 92, which, if desired, may have a pressure higher than atmosphere or an average pressure desired, as will become apparent.

It is therefore provided with the plus sign (+). The lower bellows construction 94 may have an outer annular corrugated wall 104, and an inner annular corrugated wall 106. These corrugated annular walls 104 and 106 are similar to the walls 100 and 102 and close the bellows chamber 94, which may be at subatmospheric pressure, or at a minus pressure compared to average pressure desired to be established between or by the bellows structures 92 and 94. Therefore, the chamber 94 has been provided with a minus sign (−). In this manner, the bellows structures 92 and 94 compensate each other, and compensate for atmospheric pressure changes and the like, which may surround the bellows structure 24C.

While FIGURE 18 has been illustrated and described specifically in connection with the structure of FIGURE 1, it is to be understood that such structure can be applied to any of the other embodiments. For example, the bellows bottom 26 of FIGURE 18 may be considered to be the bellows bottom 26 of FIGURE 1, and it can be applied thereto without any substantial change in FIGURE 1, except to add the structure of FIGURE 18 at the bottom of FIGURE 1. If desired the metal disc or plate 52 of FIGURES 1 and 18 may be soldered or otherwise bonded to the bellows bottom 26. A similar inner disc construction like 52 may be provided for all of the embodiments.

While the screw structure 80B of FIGURE 16 has been shown as located in the central axis of FIGURE 16, it is obvious that it can be located sidewise of the central axis, if the switch structure in the body 30B or any other body 30 in any of the figures, requires the extension 50', 50'B, etc. to be axially sidewise displaced, for example, as shown in FIGURE 3 or FIGURE 8.

Additionally, it is to be seen that the metal plate 52 of FIGURE 1, etc. which is inside the bellows may be used to produce the function of the outer disc 84, merely by bonding the disc 52 to the bottom 26, to produce a hermetic connection between the bottom 26 and the disc 52. This bonding action may be by soldering or the like, and the disc 52 in such a case will be provided with a threaded hole to receive the screw 80, and the bottom 26 may have an opening which may be substantially of the same diameter as the screw 80, or it may be a larger

opening, so that the packing 90 may be placed adjacent the bonded disc 52 of FIGURE 1, as is obvious.

The switch structures or combinations of this invention may be used as thermostatic switches, which may be responsive to the temperatures of the medium surrounding the switches, which imparts its temperature to the gaseous medium within the bellows structure. The increase or decrease of temperature of the gaseous medium within the bellows construction causes the bottoms 26, 26B, and 26C to have a downward and upward movement in accordance with such rise and fall in surrounding temperatures, and this in turn causes the bottom of the bellows structure to actuate the switch within the body 30, 30B or 30C or 30A in response to the temperatures outside of the switch structure. Also, if desired, the switch combination of any of the embodiments herein disclosed may be made responsive to the temperature or pressure within the tube 58, as shown in FIGURE 10, and which can be applied to all of the embodiments. The tube 58 may be connected by a tubular extension to an enclosure which is desired to be maintained at a desired pressure. In this case, the end of the tube 58 may be extended into such chamber and the switch 48 within any of the embodiments herein disclosed may control a pressure producing member for such enclosure. Such member may be a pressure or vacuum pump which varies the pressure in the chamber. The switch 48 can start and stop the motor which actuates such pump. Also, if desired, the tube 58 may be used to be responsive to the temperature within an enclosure distant from the switch combination. In this case a bulb or the like may be connected to the end of the extension to the tube 58, and the temperature of the enclosure within which said bulb is located may cause the bulb to contract and expand and to increase and decrease the pressure in the tube 58. This in turn may cause the switch 48 to control a heating or cooling unit which varies the temperature of the enclosure to which the tube 58 is connected. Other applications of the switch combination may be used.

It is therefore to be seen that a new, useful and unobvious and improved construction and method of operation and method of manufacture of a hermetically sealed switch combination have been provided.

While the form of the invention now preferred has been disclosed as required by the statutes, other forms may be used, all coming within the scope of the claims which follow.

What is claimed is:

1. In combination: a unitary sub-assembly support construction including a support plate with an opening in the form of a downward cylindraceous flange, such flange having a bottom circumferential edge and an outer cylindraceous surface; a cylindraceous bellows member with a transverse bellows bottom and with a top corrugated horizontal wall connected to an outer vertical wall, said horizontal wall engaging said circumferential edge and the inner surface of said outer vertical wall being bonded to said outer cylindraceous surface; a unitary switch sub-assembly with a main switch body containing a switch and extending downwardly into said bellows member, said last named sub-assembly having an outward switch body supporting and insulating flange construction over and engaging said corrugated horizontal wall, said main switch body having a downwardly biased and downwardly extending switch actuator adjacent to and actuated upwardly and downwardly by upward and downward movement of said bellows bottom; and a sealing material layer over and bonded to said insulating flange construction and sealed and bonded to a portion of said support plate.

2. A combination according to claim 1 in which said sealing layer is sealed and bonded to said downward cylindraceous flange of said support plate.

3. A combination according to claim 1 in which said supporting and insulating flange includes a lower insulator plate and an upper metal plate with edges adjacent said downward cylindraceous flange.

4. A combination according to claim 3 in which said main switch body is riveted to said lower insulator plate and said upper metal plate.

5. A combination according to claim 1 in which a plurality of electrical conductors extend from said switch and through said sealing material layer.

6. A combination according to claim 1 in which a gaseous transmitting tube extends from the exterior of said combination into the interior of said bellows member.

7. A combination according to claim 6 in which filtering means is provided for said tube to prevent entrance of contaminating substances into the interior of said bellows member.

8. A combination according to claim 1 in which said support plate extends horizontally beyond said bellows member.

9. A combination according to claim 8 in which said support plate is provided with perforated means for attachment of said combination at the plate of use.

10. In combination: a unitary sub-assembly support construction including a plate, and a cylindraceous bellows member having an upper horizontal flange construction bonded to said plate and extending downwardly from said plate, said bellows having a transverse bellows bottom; a unitary switch sub-assembly sub-assembled independently of said sub-assembly support construction, said switch sub-assembly including a unitary main insulating switch body containing a switch actuatable back and forth between open and closed positions in said insulating switch body and having a plurality of electrical conductors electrically connected to each other and disconnected from each other in said insulating switch body by said switch, said conductors extending upwardly from the top of said body, said switch body having switch body supporting and insulating means adjacent said plate and having a downwardly biased and downwardly extending switch actuator extending downwardly from the lower part of said switch body adjacent to and actuated by upward and downward movement of said bellows bottom to actuate said switch back and forth between open and closed positions; and a sealing material construction sealed to said sub-assembly support construction and to said supporting and insulating means to seal said combination hermetically, said plurality of electrical conductors extendnig from said switch through said switch body supporting and insulating means, and through said sealing material construction.

11. A combination according to claim 10 in which calibrating means are provided on said combination to calibrate the actuation responsiveness of said switch to the upward and downward movement of said bellows bottom.

12. A combination according to claim 10 in which said bellows member includes a pair of centrally axially aligned bellows construction having respective bellows chambers at different internal pressures.

13. In combination: a unitary sub-assembly supporting construction including a support plate with a cylindraceous downward flange, and a cylindraceous bellows member with a transverse bellows bottom, said bellows being bonded to said downward flange; and a unitary switch sub-assembly sub-assembled independently of said sub-assembly support construction, said switch sub-assembly including a main switch body containing a switch actuatable back and forth between open and closed positions in said insulating switch body and extending downwardly into said bellows member, said switch sub-assembly having an outward switch body supporting and insulating flange construction engaging said sub-assembly supporting construction, said main switch body having a downwardly baised and downwardly extending switch actuator adjacent to and actuated by upward and downward movement of said bellows bottom, and a sealing

material layer engaging said insulating flange construction and sealed and bonded to a portion of said support plate.

14. A combination according to claim 13 in which a plurality of electrical conductors extend from said switch and through said sealing material layer.

15. In combination: a unitary sub-assembly support construction including a support plate with an opening, and a cylindraceous bellows member bonded to said plate and extending downwardly from said opening, said bellows having a transverse bellows bottom; and a unitary switch sub-assembly sub-assembled independently of said sub-assembly support construction, said switch sub-assembly including a main switch body containing a switch actuatable back and forth between open and closed positions in said insulating switch body and extending downwardly into said bellows member, a switch body supporting and insulating means engaging said sub-assembly support construction adjacent said opening, said main switch body having a downwardly biased and downwardly extending switch actuator adjacent to and actuated by upward and downward movement of said bellows bottom, a sealing material layer engaging said supporting and insulating means and sealed and bonded to a portion of said sub-assembly support construction; and a plurality

of electrical conductors extending from said switch through said switch body, through said switch body supporting and insulating means, and through said sealing material layer, said electrical conductors being electrically connected to each other and disconnected from each other in said insulating switch body by said switch.

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