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A. W. HAYDON ET AL

2,878,348

SEALED SWITCH AND ACTUATOR ASSEMBLY

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FIG. 1

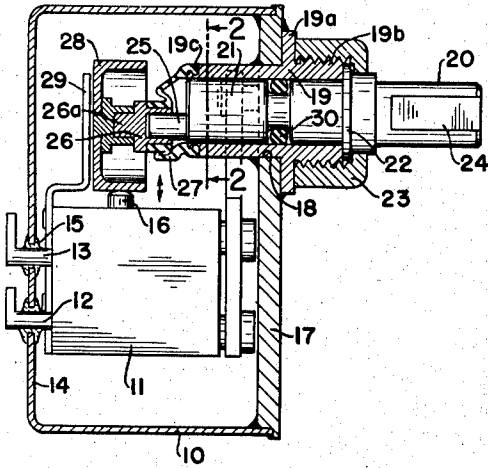


FIG. 2

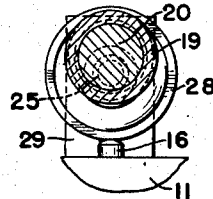


FIG. 3

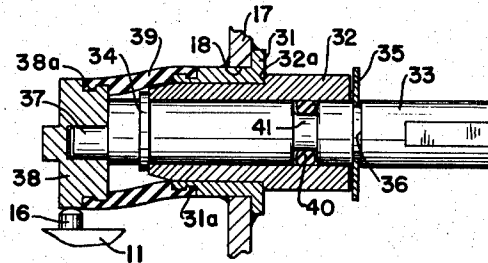


FIG. 4

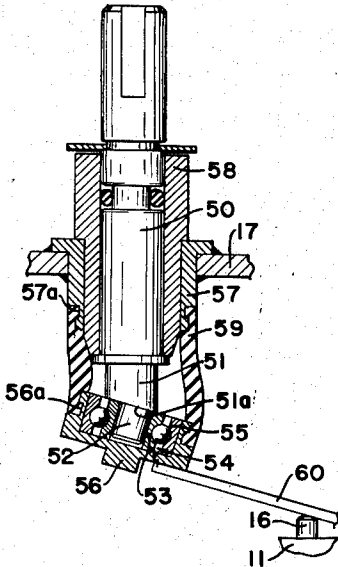


FIG. 5

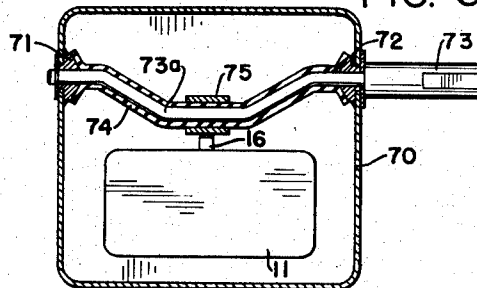
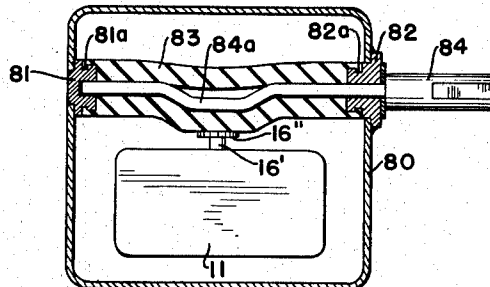


FIG. 6



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SEALED SWITCH AND ACTUATOR ASSEMBLY

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14 Claims. (Cl. 200—168)

The present invention relates to electrical switching devices, and more particularly to improved arrangements for effecting the actuation of hermetically sealed switch assemblies.

Where switch assemblies are employed in aircraft, for example, it is generally desirable and often necessary to hermetically seal the switch to avoid the effects of moisture condensation, freezing and the like. The present invention is directed to an improved assembly wherein critical parts of the switch apparatus are more effectively sealed.

One of the improved features of the invention resides in the provision of a switch assembly comprising a switch mechanism mounted within a casing which is generally sealed but which has an opening therein for receiving a rotatable control member used in actuating the switch. The improved apparatus includes a novel arrangement for providing a seal about the rotary control element in such manner that the critical parts of the switch actuating mechanism are located within the sealed casing. With this arrangement it is possible to eliminate icing of the more delicate components of the actuating mechanism as might otherwise occur when the switch assembly is employed in aircraft, for example.

As one of its more specific improved features, the new apparatus includes a rotary control member having an eccentric portion which is generally surrounded by a tubular sealing element secured at one end about the opening in the casing through which the control member extends. A switch is actuated by means of the eccentric portion of the control member acting in some cases directly through the sealing element and in other cases through additional elements which are secured to the sealing element.

For a better understanding of the invention, reference may be made to the accompanying drawings, in which:

Fig. 1 is a cross-sectional view of a switch assembly constructed in accordance with the invention;

Fig. 2 is a fragmentary cross-sectional view taken along line 2—2 of Fig. 1;

Figs. 3 and 4 are fragmentary cross-sectional views of modified forms of the new assembly; and

Figs. 5 and 6 are cross-sectional views of further modifications of the new assembly.

Referring initially to Figs. 1 and 2, the numeral 10 designates a casing, which may be a steel stamping for example. Mounted within the casing is a switch 11, which may have a mechanism similar to that disclosed in the copending application of Arthur W. Haydon, Serial No. 362,505, filed June 18, 1953, for "Snap Action Switch", now U. S. Patent No. 2,773,954, issued December 11, 1956. The switch 11, in itself, need not be hermetically sealed, and has terminal posts 12, 13 extending through the back wall 14 of the casing, through seals 15 of glass or other suitable material. At the top of the switch 11 is an actuating plunger 16 which is adapted with a limited vertical movement to effect the opening and closing of the switch contacts.

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At the front of the casing 10 is a cover plate 17, and, in the completed assembly, the cover 17 is brazed or soldered to the side walls of the casing to form an air-tight seal therewith. Above the switch 11, the cover plate 17 has an opening 18 in which is received and secured a bearing sleeve 19. The sleeve 19 has a flange 19a intermediate its ends engaging the front face of the cover 17 and having a threaded portion 19b extending outwardly from the cover. The inner end of the sleeve 19 extends partly over the top of the switch 11 and has an annular groove 19c at its outer surface.

A control member 20, having a cylindrical portion 21, is received and journaled by the sleeve 19. The control member 20 has a flange 22 at the outer end of the cylindrical portion 21 which engages the outer end surface of the sleeve 19, so that the member 20 is positioned in proper axial relation to the sleeve. A threaded cap 23 engages the threaded outer portion 19b of the sleeve 19 to retain control member 20 in the desired axial position while permitting rotation of the member. The outer end of the control member 20 may be knurled or otherwise machined, as at 24, to receive a suitable control knob, not shown.

At the inner end of the control member 20 is an eccentric spindle 25 disposed in parallel relation to the axis of rotation of the control member 20 and preferably forming an integral part thereof. The forward end portion of the eccentric spindle 25 rotatably supports a bearing 26 having an axially projecting tip portion 26a.

In accordance with the invention, the side walls of the bearing 26 are connected to the side walls of the sleeve 19 by means of a flexible tubular sealing element 27 formed of silicone rubber or equivalent material. The tubular sealing element 27 is received at one end in the annular groove 19c and at its other end about the open end portion of the bearing 26, the sealing element 27 being suitably bonded to both members 19 and 26 so as to form air-tight seals therewith.

The axially projecting tip portion 26a of the bearing 26 receives and supports a cap 28 which, in the illustrated apparatus, is generally in the form of a cup. The cap 28 is slidably received on the bearing 26 and is normally held thereon by means of a bracket 29 secured to the body of the switch 11. As will be observed in Fig. 1, the cap 28 overlies the actuating plunger 16 of the switch 11 so that vertical movements of the cap 28 will open and close the contacts of the switch 11 by moving the plunger 16.

It will be observed that the cap 17, sleeve 19, flexible tube 27, and bearing 26 form an air-tight seal about the opening 18 in the cover plate 17, so that the entire mechanism of the switch 11 is hermetically sealed within the casing 10. Actuation of the switch 11 may be effected by rotating the control member 20 to cause the eccentric spindle portion 25 thereof to move through a circular path about the axis of rotation of the control member. The bearing member 26, which is secured to the flexible sealing element 27, does not rotate but is carried in a circular path by the spindle 25. In a similar manner, the center of the cap 28 moves in the circular path generated by the bearing member 26. The resultant vertical movements of the cap 28 cause the plunger 16 to be moved in a vertical direction to effect opening and closing of the switch contacts.

Since one of the contemplated uses of the new switch assembly is in the control systems of aircraft, it is essential to provide for the wide variation in atmospheric pressures which occurs when an aircraft changes altitude. As will be observed in Fig. 1, the flexible sealing element 27 fits loosely (provides more "working" material and for axial adjustment) about the end of the control member 20, forming a void space between the control mem-

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ber 20 and the bearing 26. Thus, under normal circumstances, a substantial reduction in atmospheric pressure outside of the casing 10 would tend to draw the sealing element 27 tightly against the end surface of the control member 20. This is avoided in the improved apparatus by filling the void space with a silicone oil or other suitable fluid which displaces any air in the space in addition to acting as a lubricant for the free rotation of the control member 20. An O-ring 30 seals the passage between the control member 20 and the inner walls of the bearing sleeve 19 so that oil is retained at the inner ends of the control member 20 in the manner desired.

In the form of the invention shown in Fig. 3, a flanged guide sleeve 31 is received in the opening 18 in the cover plate 17 and is secured thereto by solder or brazing, for example, so as to form an air-tight seal. A bearing sleeve 32 and control member 33 are supported in the guide sleeve 31 in such manner that the control member 33 projects over the top of the switch 11 and actuating plunger 16. The control member 33 is positioned within the bearing sleeve 32, by means of a flange 34 near the forward end of the control member 33, and by means of a collar 35 received in a groove 36 near the opposite end of the control member. As will be observed in Fig. 3 the control member 33 and bearing sleeve 32 are inserted as a unit within the guide sleeve 31 until the flange of the sleeve 31 is engaged by a shoulder 32a of the bearing sleeve. The bearing sleeve 32 is retained in its assembled position by a cap or other suitable means, not shown.

At the inner end of the control member 33 is an eccentric spindle 37 which supports a combined bearing and end cap member 38. The cap 38 is substantially the same diameter as the guide sleeve 31 and has an annular groove 38a therein corresponding generally to a similar annular groove 31a in the sleeve 31. A flexible tubular sealing element 39 is received at one end over the inner end of guide sleeve 31 and is retained in the annular groove 31a in such manner as to provide an air-tight seal between the sleeve 31 and sealing member 39. The outer end of the sealing member 39 is received in a similar manner in the annular groove 38a of the end cap. The void space surrounding the inner end of the control member 33 and bounded by the sealing element 39 is filled with a suitable lubricating fluid such as silicone oil. An O-ring 40 received in a groove 41 in the control member 33 seals the passage between the control member and the bearing sleeve 32 and retains the lubricating fluid about the inner end of the control member.

The switch assembly of Fig. 3 is actuated by rotating a control member 33, which causes the end cap 38 to be carried in a circular path by the eccentric spindle 37. The cap 38, being connected to the guide sleeve 31 through the flexible sealing element 39, does not rotate but is merely carried through a circular path of movement. The actuating plunger 16 of switch 11 follows the vertical movements of the cap 38 and effects the actuation of switch 11 in the manner desired.

In the modification of Fig. 4, the actuator mechanism includes a control member 50 having an end portion 51 with an end surface 51a disposed at an angle of less than 90 degrees with respect to the axis of rotation of the control member 50. At the extreme inner end of the control member 50 is a spindle 52 disposed at right angles to the angular end surface 51a and mounting the inner race 53 of a ball bearing 54. The outer race 55 of the bearing 54 carries an end cap 56 having an annular groove 56a in its outer surface. The control member 50 is supported on the cover 17 by means of a guide sleeve 57 and bearing sleeve 58 and is sealed off from the interior of the switch casing by a flexible tubular sealing element 59 engaged at one end in the annular groove 56a and at its other end in an annular groove 57a in the guide sleeve.

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Rotation of the cap 56 is prevented by the sealing element 59, so that upon rotation of the control member 50 the cap 56 merely wobbles or tilts from side to side.

In most cases the amplitude of movement of the cap 56 will be quite small, and accordingly, it may be desirable to magnify this movement somewhat. In the illustrated apparatus this is accomplished by providing a lever 60 which is secured to the cap 56 and extends radially outward therefrom. The end of the lever 60 overlies the actuating plunger 16 of the switch 11, and as the cap 56 is tilted from side to side the lever 60 will be raised and lowered to move the plunger 16 and effect the opening and closing of the contacts of the switch 11. If desired the rotation of the cap 56 may also be restricted by restricting the motion of the amplifying member 60 to one useful plane, with any suitable means, thereby taking some of the burden off of the flexible seal in the matter of resisting rotation of the cap.

In the modification shown in Fig. 5, the switch 11 is mounted within a casing 70 having bearings 71, 72 mounted in opposite side walls. The bearings 71, 72 journal a control member 73 which has an eccentric portion 73a located between the bearings. In accordance with the invention, the bearings 71, 72 are mounted on the casing 70 in such manner as to form air-tight seals therewith. The inner end surfaces of the bearings 71, 72 are of conical form to fit with the outwardly flaring end portions of a flexible tubular sealing element 74. The sealing element 74 is relatively thin-walled and extends between the bearings 71, 72, in surrounding relation to the control member 73, and is bonded to the bearings 71, 72 in such manner as to form air-tight seals at each end.

Received over the outer surface of the flexible sealing element 74, along the eccentric portion 73a of the control member 73 is a ring 75 of metal, plastic or other hard material. The ring 75 is generally aligned with the actuating plunger 16, so that upon rotation of the control member 73 the ring 75 will be carried by the eccentric portion 73a in a circular path above the plunger 16. When the eccentric portion 73 moves the ring 75 through the lower portion of its circular path the ring 75 will engage and depress the plunger 16 to actuate switch 11.

In the modification of Fig. 6, the switch 11 is mounted within a casing 80 having bearing members 81, 82 in opposite side walls thereof secured in such manner as to form seals with the casing 80. The inner end portions of the bearings 81, 82 have annular grooves 81a, 82a which engage the opposite end portions of a flexible tubular sealing element 83. The sealing element 83 of the instant embodiment is relatively thick-walled and surrounds and forms a seal about the inner end portion of a control member 84. The control member 84 has an eccentric portion 84a positioned between the bearings 81, 82 and as will be observed in Fig. 6 the eccentric portion 84a causes the adjacent side wall areas of the flexible element 83 to be deformed outwardly. The switch 11 of the instant embodiment has an actuating plunger 16' having an enlarged pad 16'' at its upper end. The pad 16'' is positioned below and normally in spaced relation to the flexible sealing element 83. However, as the control member 84 is rotated to move the eccentric portion 84a thereof through the lower portion of its circular path the side wall of the sealing element 83 will be deformed downwardly to engage and depress the actuating plunger 16''.

Thus in all forms of the invention, a rotatable member having an eccentric portion extends into the interior of an hermetically sealed casing but is sealed off from the interior of the casing by means of a flexible tubular sealing element formed of silicone rubber or equivalent material. When the control member is rotated the eccentric portion thereof acts either directly or through intermediate members to effect the actuation of a switch within the casing, and the sealing element flexes as necessary to accommodate the movements of the eccentric portion. The new

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switch assembly is ideally suited for use in aircraft, for example, where unsealed portions of the assembly are apt to become frozen, since all parts of the assembly other than the control member are effectively sealed; and it is contemplated that the control member will be of sufficiently rugged and durable construction to permit it to be broken free when icing occurs. In addition, in the embodiments of Figs. 1-4, the inner end portion of the control member is surrounded with a lubricating fluid, such as silicone oil, which excludes moisture from the inner portion of the control member. With this arrangement only the outer portion of the control member is likely to freeze, and this may be readily broken free with manual force.

As is readily apparent, the new switch assembly has several basic forms. Thus, in the embodiments of Figs. 1-4 the eccentric portion of the control member effects the actuation of the switch through a cap member carried by the eccentric portion and caused to move in such manner as to depress switch actuating plunger 16. In the embodiments of Figs. 5 and 6 the force is transmitted directly through the sealing element to the switch actuating plunger. In the latter case the actuating force is distributed over a relatively large area of the flexible sealing element. In the embodiment of Fig. 5 this is accomplished by providing a ring 75 of metal or hard plastic material about the outer wall of the flexible element 74. In the embodiment of Fig. 6 the actuating plunger 16' is provided with an enlarged pad 16'' at its upper end so that a large area of the sealing element 83 engages the pad to depress the plunger 16'.

It should be understood that the specific embodiments herein shown and described are intended to be illustrative only. Reference should therefore be made to the following appended claims in determining the full scope of the invention.

We claim:

1. An hermetically sealed switch and actuator assembly comprising a generally sealed casing having an opening therein, a switch mounted within said casing and having terminals extending through the casing, means to actuate said switch comprising a control member mounted in said casing for rotation and extending through said opening, said control member having an eccentric portion for effecting the actuation of the switch upon rotation of the member, a non-rotatable member formed of non-resilient material and located adjacent an end of said control member, and means including a flexible tubular sealing element formed of resilient material and open at both ends, said sealing element being contained within said casing and having at least one end secured in fixed relation to the casing, the other end of said tubular sealing element being sealingly and fixedly secured to said non-rotatable member, said sealing element surrounding and forming a seal about said opening and about said eccentric portion.

2. An hermetically sealed switch and actuator assembly comprising a generally sealed casing having an opening therein, a switch mounted within said casing and having terminals extending through the casing, means to actuate said switch comprising a control member mounted in said casing for rotation and extending through said opening, said control member having an eccentric portion for effecting the actuation of the switch upon rotation of the member, a non-rotatable member formed of non-resilient material and located adjacent an end of said control member, and means including a flexible tubular sealing element formed of resilient material and open at both ends, said sealing element being contained within said casing and having at least one end secured in fixed relation to the casing, the other end of said tubular sealing element being secured to said non-rotatable member, said sealing element surrounding and forming a seal about said opening and about said eccentric portion, said non-rotatable member com-

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prising an end piece received on the eccentric portion of said control member, said sealing element being secured to said end piece and forming a seal therewith enclosing said eccentric portion, said eccentric portion acting through said end piece to actuate said switch upon rotation of said control member.

3. The switch assembly of claim 2, characterized by said end piece including a bearing member and an end cap supported by said bearing member, said end cap engaging said switch to actuate the same upon rotation of said control member.

4. The switch assembly of claim 1, characterized by said casing having means at opposite sides thereof for journaling said control member, said control member extending between the journal means and having an eccentric portion intermediate its ends, said sealing element extending between said journal means and forming a seal therewith, said control member being received internally of said tube, said non-rotatable member comprising the journal means at one side of said casing.

5. The switch assembly of claim 4, characterized by said sealing element comprising a thin-walled tube and conforming intimately with said eccentric portion, and including a sleeve of non-resilient material positioned about a portion of said tube surrounding said eccentric portion, said sleeve being adapted to engage and actuate said switch upon rotation of said control member.

6. The switch assembly of claim 4, characterized by said sealing element comprising a relatively thick-walled tube, said tube being adapted to be deformed by said eccentric portion, and said switch including an actuable member having an enlarged head portion adapted to be engaged and moved by deformed portions of said tube upon rotation of said control member.

7. An hermetically sealed switch assembly comprising a generally sealed casing having an opening therein, a switch mounted within said casing and having terminals extending through the casing, a control member extending through said opening and journaled by said casing, eccentric means actuated by rotation of said control member to effect the actuation of said switch, a non-rotatable member formed of non-resilient material and located adjacent an end of said control member, and a flexible tubular sealing element formed of resilient material and secured at one end about said opening and at its other end to said non-rotatable member, said sealing element sealing off said control member from the interior of the casing and being movable with said eccentric means when said control member is rotated.

8. An hermetically sealed switch assembly comprising a generally sealed casing having an opening therein, a switch mounted within said casing and having terminals extending through the casing, a control member movably mounted on said casing and adapted upon movement to actuate said switch, a non-resilient member located adjacent an end of said control member, said control member being movable relative to the non-resilient member, and a flexible tubular sealing element formed of resilient material surrounding the opening and said control member and secured at one end about said opening and at its other end to said non-resilient member, said sealing element sealing said control member off from the interior of said casing.

9. An hermetically sealed switch and actuator assembly comprising a generally sealed casing having an opening therein, a switch mounted within said casing and having terminals extending through the casing, means to actuate said switch comprising a control member mounted in said casing for rotation and extending through said opening, said control member having an eccentric portion for effecting the actuation of the switch upon rotation of the member, a sleeve received in the opening in said casing and extending into the casing, the control member being received in said sleeve and having its eccentric portion projecting beyond the end of the sleeve within said

casing, an end piece received on the eccentric portion of said control member, and means including a flexible sealing element secured in fixed relation to the casing and forming a seal about said opening and about said eccentric portion, said sealing element comprising a sleeve of resilient material surrounding said control member and connected at one end to the inner end of said sleeve and at the other end to said end piece, said sealing element forming with said end piece a seal enclosing said eccentric portion, said eccentric portion acting through said end piece to actuate said switch upon rotation of said control member.

10. The switch assembly of claim 9, including an O-ring member forming a seal between the control member and sleeve, and characterized by the space between the O-ring and bearing being filled with a lubricant.

11. An hermetically sealed switch and actuator assembly comprising a generally sealed casing having an opening therein, a switch mounted within said casing and having terminals extending through the casing, means to actuate said switch comprising a control member mounted in said casing for rotation and extending through said opening, said control member having an eccentric portion for effecting the actuation of the switch upon rotation of the member, and means including a flexible sealing element secured in fixed relation to the casing and forming a seal about said opening and about said eccentric portion, the eccentric portion of said control member comprising a surface at the inner end thereof disposed at an angle to the rotational axis of the control member, said end piece including bearing means mounted on said control member and positioned in contact with said surface, said flexible sealing element comprising a tube secured at one end about the opening in said casing and at its

other end to said end piece whereby to form a seal about said eccentric portion, said eccentric portion acting through said bearing means to actuate said switch upon rotation of said control member.

12. The switch assembly of claim 11, characterized by said eccentric portion including a spindle disposed at right angles to said surface, and said bearing means including an anti-friction bearing having its inner race mounted on said spindle, and said end piece including an end cap carried by the outer race of said bearing and having sealing engagement with the said other end of said sealing element.

13. The switch assembly of claim 12, including an arm carried by said end cap and having actuating engagement with said switch.

14. An hermetically sealed switch assembly comprising a generally sealed casing having an opening therein, a switch mounted within said casing and having terminals extending through the casing, a control member movably mounted on said casing and adapted upon movement to actuate said switch, a flexible sealing element surrounding the opening and said control member and sealing said control member off from the interior of said casing, and means forming a second seal between said control member and casing, said last-mentioned means and said sealing element forming a sealed cavity for the reception of lubricating fluid about portions of said control member.

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