April 17, 1962 J. O. ROESER 3,030,465

SWITCH

Filed Aug. 30, 1960

Fig. 1

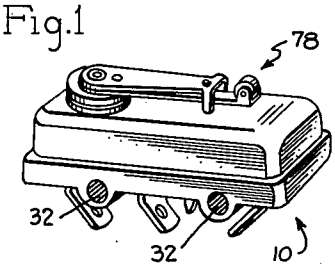


Fig. 2

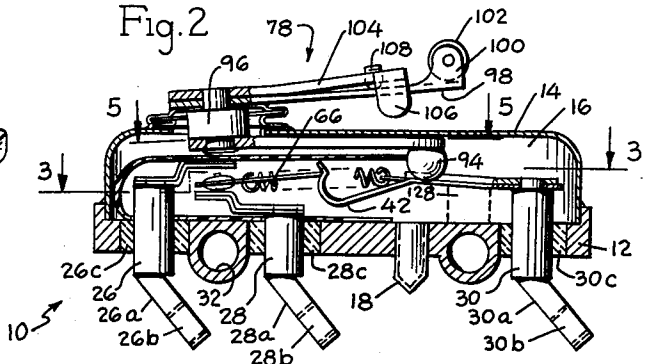


Fig. 4

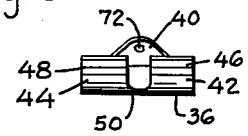


Fig. 3

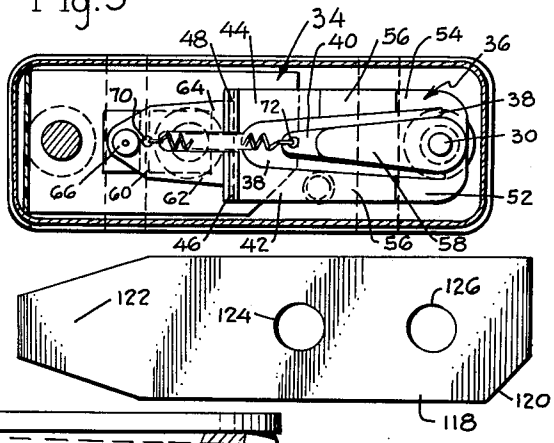


Fig. 5

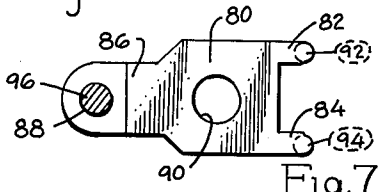


Fig. 7

Fig. 6

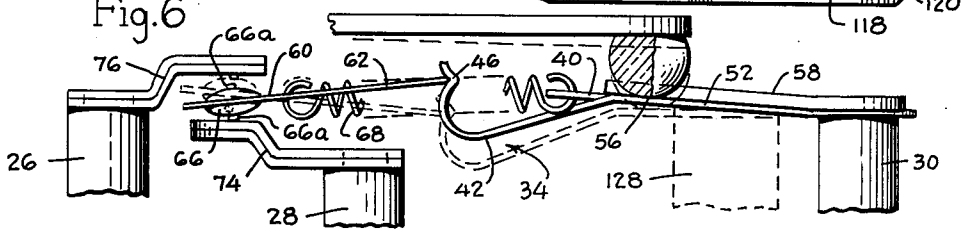
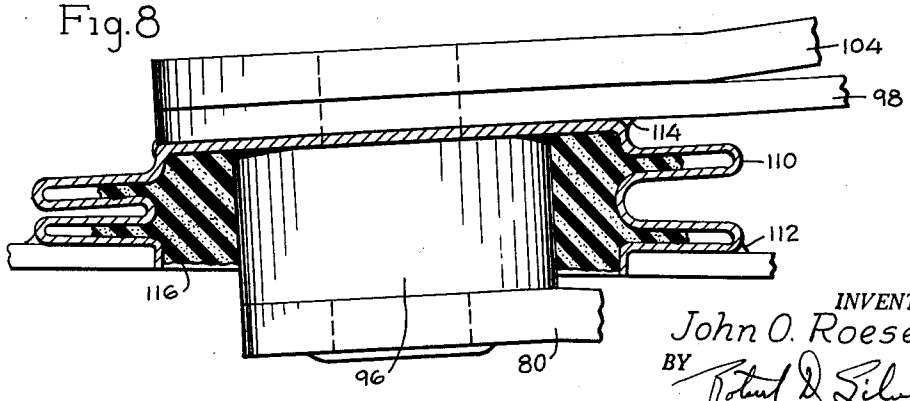


Fig. 8



INVENTOR.
John O. Roeser
BY Robert D. Silver
ATTY.

United States Patent Office 3,030,465 Patented Apr. 17, 1962

3,030,465

SWITCH

John O. Roeser, Park Ridge, Ill.

Filed Aug. 30, 1960, Ser. No. 52,947
16 Claims. (Cl. 200—67)

This invention relates in general to switches, and more particularly relates to a rugged, low travel, electrical switch, wherein the contacts are encapsulated in a hermetically sealed enclosure.

The exigencies of modern-day aircraft and spacecraft have demanded the development of extremely rugged and compact electrical switching devices. These switching devices must withstand extremes in vibration and shock resistance, must be operable over a wide range of ambient temperatures, and must provide the utmost in reliability under these extreme conditions. Therefore, it is a general object of this invention to provide a small compact electrical switch of the hermetic type which is exceedingly rugged and has extremely high shock and vibration resistance.

Another object of this invention is to provide a reliable electrical switch device of the above type wherein the contact mechanism is encapsulated in a chamber which is evacuated, there being a true hermetic type seal which has a leak-rate of under 10^{-6} cc. per second.

It is another object of this invention to provide an electrical switch having the above characteristics which requires only a very low travel of the actuator member to actuate the switch blade while still maintaining the desired characteristics of high vibration and shock resistance.

It is another object of this invention to provide a switch of the snap action type, which has a large over-centering movement of the contact actuator assembly to get positive controlled vibration resistance switching action.

It is another object of this invention to provide a switch of the aforestated type which has no dead-centering characteristics, is positive in operation, is easy to assemble, and is otherwise well adapted for the purposes for which it was designed.

The novel features that are characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, may best be understood by the following description of a specific embodiment when read in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of the switch device;

FIG. 2 is a longitudinal sectional view through the device depicted in FIG. 1;

FIG. 3 is a sectional view along line 3—3 of FIG. 2;

FIG. 4 is an end view of the common terminal arm, detached from the rest of the components;

FIG. 5 is a partial sectional view taken along line 5—5 of FIG. 2;

FIG. 6 is an enlarged view of a portion of the switch structure shown in FIG. 2, the dotted lines showing the actuated position of the switch;

FIG. 7 is a view of the flexible insulator means prior to its assembly to the apparatus; and

FIG. 8 is an enlarged partial sectional view of the upper portion of the actuator assembly shown in FIG. 2.

As shown in the drawings, the switch device **10** essentially comprises a very rugged cast base **12** and a cover **14** which defines an internal sealed chamber **16**. The base is preferably made of steel and it has been found convenient to cast the base by the so-called investment casting method so as to get an extremely strong and rugged component. The cover **14** is preferably formed

of steel and fits into a suitable groove in the base **12** and is braised or soldered to the base to provide a rugged leak-proof seal for chamber **16**. An evacuation outlet tube **18** is fixed in a suitable bore in the base **12** to provide a means of evacuating the chamber after assembly and then pinching off the tube in the usual manner to completely seal the chamber.

The base **12** is formed with a plurality of spaced aligned transverse apertures which are adapted to receive terminal pins **26**, **28** and **30**. Each pin is preferably made of an electrically conducting metal, and has an angularly offset depending portion **26A**, **28A** and **30A** respectively each of which is drilled and tapped to receive suitable terminal screws in the bores **26B**, **28B**, **30B**. The terminal pin bores in the base **12** are sealed by a compression glass seal **26C**, **28C**, **30C** respectively, said seal being exceedingly rugged in structure and serves to electrically insulate the respective terminal pins from the steel base. It will be noted that the base **12** is also formed with a pair of spaced cross bores **32** which serve as mounting holes to mount the switch unit in position for its desired application.

The terminal pins **26**, **28** and **30** may be respectively designated as the normally open and normally closed and common terminal pins. A movable contact assembly **34** is mounted on the common terminal **30** for coaction with the fixed terminals. More particularly, an elongated perforate member **36** is fixedly attached to the terminal **30** at one end and is preferably made of a thin springy metal. As best shown in FIG. 3, a portion of the member **36** is blanked out at **38** to define a central tongue portion **30** having a wide base portion and a relatively narrow free end portion. The blanked out portions **38** of member **36** is formed in a somewhat U-shaped configuration, the amount removed at the base being considerably thicker than the arms, and in addition to the tongue portion provides a pair of narrow curved arm portions **42** and **44** which terminate in a pair of fingers **46** and **48** at the free end of member **36** (the curve is only in side elevational view—see FIGS. 2 and 6). It is to be noted that the blanked out U-shaped aperture **38** does not extend completely to the free end of member **36**. The fingers **46—48** are further formed in a manner to provide V-shaped notches as best shown in FIGS. 4 and 6, for pivotal receipt of the contact carrying member later to be described. A shallow U-shaped aperture **50** formed in the free end of member **36** defines the upright finger portions **46—48** of the curved arm portions **42** and **44**, but it should be noted that a small portion of the metal intermediate, the base of the U-shaped aperture **50** and the furthest extent of the blanked out portion **38** remains after the blanking out procedure, so that the two arms **42—44** and fingers **46—48** will always operate simultaneously. While there are two arms and fingers, they are actually integrally connected at both ends. The interconnection of the two arms and fingers provides vibrational stability, a very important feature in the instant switch.

As shown in FIG. 6, the member **36** has arm portions **52** and **54** which are relatively straight adjacent to the common terminal pin **30**, but are canted or offset slightly upwardly from the horizontal from the point of attachment of the member to pin **30**. At the outer extent of straight portions of **52** and **54**, the arms are respectively engaged at points **56** by the operating means which will be later described. See the point marked X in FIG. 3.) The arms then are reversely offset downwardly and near the end thereof are sharply reversely curved upwardly so that the V-shaped notches in the fingers **46—48** are substantially transverse to the major plane of member **36**.

The tongue portion **40** of member **36** is overlaid by a

substantially thicker stiffening or rigidifying member 58, which is integrally joined thereto. As shown, member 58 extends substantially along the entire length of the tongue portion, terminating just short of the free end thereof, and the function of member 58 is to stabilize the tongue to afford vibration resistance.

A U-shaped contact carrying movable blade member 60 is mounted for pivotal coaction with member 36, the free arms 62 and 64 of said member 60 being inserted in the V-shaped notches in the fingers 46–48. The movable contact 66 mounted on member 60 has a very slightly raised central portion or nib 66a on each face thereof and is biased into engagement with the lower fixed contact 74 by spring member 68. The spring member 68 is mounted at one end thereof in an aperture 70 formed near the base of the U in member 60 with its other end being firmly fixed in aperture 72 on the free end of tongue member 40. The arms 62—64 and the fingers 46—48 are separated just sufficiently to receive the spring member 68 which passes therebetween, the spring in addition to providing the biasing force for the movable contact assembly serves to locate the contact carrying member 60 relative to member 36. As will be apparent, the contact 66 is biased toward engagement with the lower fixed contact 74 and is movable to engagement with the upper fixed contact 76. Each of the fixed contacts 72—74 is preferably made of a silver brass laminate, the silver portions being adapted to come in contact with the movable contact.

It should be noted that the movable contact has a sliding or wiping action on each actuation thereof by the operator means, and which is later described. When the pivot point of the arms 62—64, in the notches on the fingers 46—48, passes through center, the movable contact 66 slides to the left as viewed in FIG. 6, to provide the very desirable wiping contact action. Also the characteristics of the arrangement shown is such that the pivotal connection point of the fingers 46—48 and arms 62—64 are forced, by reaction force, to a considerable over-center position, which provides a very stable vibration resistance assembly. Stated another way, the arrangement of the pivot point in the midpoint of the spring causes the fingers 46—48 to pass considerably over the dead-center point after the switch has actuated in either direction. This over travel of the pivot point is caused by the reaction force of the movable contact engaging the fixed contacts. It will also be apparent that there is no dead centering of the movable contact 66 since the movable contact is always biased by the spring 68.

Low travel operator means 78, in the form of an actuator assembly is best shown in FIGS. 1 and 2. The actuator assembly essentially comprises an internal elongated lever means 80, a cross pin member 96 and an outside lever 98. These three components present a generally U-shaped force transmitting configuration, with the U being turned on its side, members 80 and 98 forming the two arms of the U, the free ends of the two arms of the U essentially being the points of application of force and transmission of force to the contact assembly. The internal lever 80 is formed with a notch at one end to form short stubby leg portions 82—84. The other end of the lever 80 is necked down at 86 and has a slight cant or offset in horizontal view (see FIG. 2) from the major plane of member 80. A bore 88 is formed in the end surface to mount the cross link cylindrical pin member 96 which is firmly fixed therein.

A pair of glass bead members 92—94 are fused to the metal and thereby attached to the short stubbing arms 82—84 of the inner lever means 80 in depending relation. The glass beads serve the dual function of being a force transmitting member and the providing of electrical insulation between the lever 80 and the member 36. The beads 92—94 impinge upon the respective arm portions at points 56 as aforestated. As shown in FIG. 5, the operator lever 80 is formed with a central aperture 90 which serves as a weight reducing means for the lever.

Central cross pin member 96 is firmly fixed to members 80 and 98, a bellows means 110 being interposed between the upper lever 98 and the housing to provide a flexible seal. The lever 98 is mounted on the outside of the bellows 110 and terminates in a pair of upstanding tabs 100 which mount a miniature ball-bearing roller mechanism 102. An over-travel preventing means for the actuating mechanism in the form of an elongated member 104, having depending tabs 106 and an adjustable screw 108 prevents damage to the internal structure of the switch. The tabs 106 bottom on the top of the casing prevent more than the selectively adjustable amount of travel desired for actuation. It will be appreciated that the outside lever member 98 is made of thinner gage material than member 104 and hence is somewhat flexible such that a severe force applied to member 102 at the end of the lever will cause member 98 to flex but will not cause further actuation of the interior lever 80.

The bellows 110 as aforementioned provides a flexible seal for the operator means and further tends to dampen any vibrations that the somewhat elongated lever means might normally be subject to when the entire switch 10 is in turn subjected to shock or to severe vibrations. More particularly, the bellows 110 is sealed to the upper portion of the housing at 112 and is fixed to the lever member 98 at 114. The interior of the bellows is preferably potted with a silicone rubber compound 116. More particularly, the silicone rubber compound is compounded by using a silicone rubber polymer which has a rather pasty, dry consistency, much like window putty. Into this material, by the use of rotating cylinders, is inserted a so-called blowing agent which is a dry powdery chemical which sublimes on the application of slight heat to produce a gas. Just a few percent of blowing agent is used, and the dry pasty material is packed into the bellows cavity with a small spatula and then the whole assembly is put into the oven at a temperature of about 250° F. The heating causes the blowing agent to sublime and thereby provide small gas pockets within the silicone rubber compound. The net effect is to force the silicone into the crevices of the bellows, for intimate contact therewith except for the areas wherein the compressed air is greater than the force of the gas generated by the subliming material. The silicone rubber occupies most all of the crevices and provides a good vibrational dampening effect. When the utmost in vibrational resistance is desired for the switch, an additional pad of this silicone rubber compound is foamed in place (at 128) beneath the flexible arm portions of member 36 to provide additional vibrational dampening characteristics. However, the additional pad of material 128 is not found to be necessary for vibration resistance when the switch is subjected to forces under 50 gravities with 0 to 2,000 cycles per second vibration, the actuator being within .005 inch of the trip point, since the described switch structure without such additional material 128 serves to provide that function.

As can be best seen in FIG. 2, a flexible supplementary insulator means 118 (shown in its preassembled form in FIG. 7) is bent into a U-shaped form and is interposed, at the upper portion thereof, between the lever 80, and the fixed contact and the movable contact assembly. The member 118 at one end is provided with a truncated corner 120 so as not to cover up the evacuation tube 18. Bores 124 and 126 in member 118 respectively receive the terminal pins 26 and 28 during the assembly operation and the end of member 118 is reduced at its other end at 122 so as to not interfere with the depending glass bead members 92 and 94 when finally assembled.

From the foregoing description it will be apparent that a low travel, rugged, hermetically sealed switch is provided which is extremely vibration resistant and adapted for applications requiring a high degree of shock. The

switch has been found to operate very well over wide range of ambient temperatures and tests have indicated that it will have a long, trouble-free field life.

Having thus described a single embodiment of the low travel, rugged, hermetically sealed switch, it is to be understood that the illustrated form was selected to facilitate the disclosure of the invention rather than to limit the number of forms the invention may assume. Various modifications, adaptations and alterations may be applied to the specific form shown to meet the requirements of practice, without in any manner departing from the spirit or scope of the present invention, and all such modifications, adaptations and alterations are contemplated and may come within the scope of the appended claims.

What is claimed as the invention is:

1. A hermetic switch comprising housing means defining a sealed chamber having first, second, and third electrical terminal means sealingly extending therethrough, first and second fixed contact means mounted on said first and second terminal means within said chamber, movable contact means having a first position and movable to a second position relative to said first and second fixed contact means and comprising a U-shaped relatively rigid contact carrying member, an elongated perforate member having relatively flexible portions and a relatively rigid portion fixed at one end to said third terminal means and having a free end spaced therefrom, said free end being configured for pivotal engagement of said U-shaped member, spring means fixed to said U-shaped member at one end and to said relatively rigid portion of said elongated member at the other end to maintain the pivotal connection between said U-shaped member and said elongated member and to bias the movable contact against said first fixed contact means, and operator means sealingly extending through said housing means and engageable with said flexible portions of said elongated member and operable to move said free end to cause movement of said movable contact from said first to said second fixed terminal means.

2. A hermetic switch comprising housing means defining a sealed chamber having first, second and third electrical terminal means sealingly extending therethrough, first and second fixed contact means mounted on said first and second terminal means within said chamber, movable contact means having a first position and movable to a second position relative to said first and second fixed contact means and comprising a relatively rigid member carrying the movable contact, a second member having a relatively flexible portion and a relatively rigid portion, fixed at one end to said third terminal means and having a free end spaced therefrom, said free end being configured for pivotal engagement of said contact carrying member, spring means engageable with said contact carrying member at one end and with said relatively rigid portion of said second member at the other end to maintain the pivotal connection therebetween and to bias the movable contact against one of said first and second fixed contact means, and operator means sealingly extending through said housing means and engageable with said flexible portion of said second member and operable to move said free end thereof to cause movement of said movable contact from its said first to its said second position.

3. A switch comprising metalic housing means defining a chamber having first, second, and third electrical terminal means electrically insulatingly extending therethrough, first and second terminal means within said chamber, movable contact means having a first position and movable to a second position relative to said first and second fixed contact means and comprising a movable relatively rigid member carrying a movable contact, a second member having a relatively flexible portion and a relatively rigid portion, fixed at one end to said third terminal means and having a free end spaced therefrom, said free end being configured for pivotal engagement with said contact carrying member, spring means engageable with said contact carrying member at one end and with said relatively rigid portion of said second member at the other end to maintain the pivotal connection therebetween and to bias the movable contact against said first fixed contact means, operator means including a metallic actuator means extending through said housing means and engageable with said flexible portion of said second member and operable to move said free end thereof to cause movement of said movable contact from said first to said second fixed terminal means, said operator means including first insulation means operably interposed between said actuator means and said flexible portion of said second member and flexible second insulation means interposed between said actuator means and said second fixed contact means, said contact carrying member and said spring means.

4. The switch set forth in claim 1 wherein the operator means comprises a generally U-shaped member and flexible bellows on said housing means, one arm of the U-shaped member being disposed outside of the housing means for engagement on the free end thereof and the other arm being disposed within the sealed chamber for engagement with the movable contact means adjacent the free end thereof, the flexible bellows engaging the bail portion of the U-shaped member which extends therethrough to thereby mount the operator means on said housing means so that the free ends inside and outside the housing means are in substantial alignment with each other.

5. The switch set forth in claim 4 wherein the bellows is substantially filled with flexible plastic foamed material to increase the vibrational resistance thereof.

6. The switch set forth in claim 1 wherein first, second and third terminal means extend through a single wall of said housing means to respectively mount said first and second fixed contacts means and said movable contact means.

7. The switch set forth in claim 1 wherein the elongated perforate member is of relatively thin spring material having a short tongue portion blanked out of the central portion thereof to define a pair of spaced flexible arm portions, said flexible arm portions each having a first portion extending below the major plane of said perforate member and a second portion extending above said major plane.

8. The switch set forth in claim 7 wherein said second portion of each of said arms are formed into a finger having a V-shaped configuration generally normal to the major plane of said perforate member at the free end thereof to provide coacting pivotal surfaces for said contact carrying member.

9. The switch set forth in claim 8 wherein said tongue portion is rigidified to provide a support for a portion of said biasing means not subject to vibration.

10. The switch set forth in claim 9 wherein said contact carrying member is bifurcated to form spaced legs having end portions coacting with said V-shaped configurations of said fingers, the biasing means being in the form of a coiled spring confined between the leg portions of said contact carrying member and extending between the fingers at the free ends of said perforate member for attachment to the end of said rigidified tongue member.

11. A hermetic switch comprising housing means defining a sealed chamber having first, second, and third electrical terminal means sealingly extending therethrough, first and second fixed contact means mounted on said first and second terminal means within said chamber, movable contact means having a first position and movable to a second position relative to said first and second fixed contact means and comprising a U-shaped relatively rigid contact carrying member, an elongated perforate member having relatively flexible portions and a relatively rigid portion fixed at one end to said third terminal means and having a free end spaced therefrom,

said free end being configured for pivotal action with said contact carrying member, biasing means engaging said contact carrying member at one end and said relatively rigid portion of said elongated member at the other end to maintain the pivotal connection between said U-shaped member and said elongated member, to provide positive snap action over centering and to bias the movable contact against said first fixed contact means, and operator means sealingly extending through said housing means and engageable with said flexible portions of said elongated member and operable to move said free end to cause movement of said movable contact from said first to said second fixed terminal means, said biasing means and said U-sahped member upon engagement of said movable contact with said first and second fixed terminal means causing said free end to move by reaction force to a stable vibration resistant over center position.

12. A hermetic switch comprising housing means defining a sealed chamber having first, second and third electrical terminal means sealingly extending therethrough, first and second fixed contact means mounted on said first and second terminal means within said chamber, movable contaet means having a first position and movable to a second position relative to said first and second fixed contact means and comprising a U-shaped relatively rigid contact carrying member, an elongated perforate member having relatively flexible portions and a relatively rigid portion fixed at one end to said third terminal means and having a free end spaced therefrom, said free end being configured for pivotal engagement of said U-shaped member, spring means fixed to said U-shaped member at one end and to said relatively rigid portion of said elongated member at the other end to maintain the pivotal connection between said U-shaped member and said elongated member and to bias the movable contact against said first fixed contact means, and operator means sealingly extending through said housing means and engageable with said flexible portions of said elongated member and operable to move said free end to cause movement of said movable contact from said first to said second fixed terminal means, said operator means comprising an elongated lever means mounted for movement within said chamber and having an at-rest position in engagement with said housing means to provide strong vibration resistance thereto.

13. The switch set forth in claim 12 wherein said operator means further includes flexible bellows means sealingly mounting said elongated lever means, said spring means through said U-shaped member and flexible portion of said elongated perforate member biasing said lever means toward engagement with said housing means.

14. The switch set forth in claim 13 wherein said operator means further includes second lever means exterior of said housing means associated with the lever means interiorly of said housing means said second lever means including adjustable over travel permitting means.

15. A switch comprising a generally rectilinear housing means having a relatively greater length than depth or height defining a chamber having first, second, and third electrical terminal means extending therethrough, said third terminal being spaced by mounted adjacent one end of said chamber, first and second fixed contact means mounted on said first and second terminal means within said chamber and adjacent the other end thereof, movable contact means having a first position and movable to a second position relative to said first and second fixed contact means and comprising a U-shaped relatively rigid contact carrying member, an elongated perforate member having relatively flexible arm portions and a relatively rigid central tongue portion fixed at one end to said third terminal means, said arms being connected at a free end spaced from said fixed end for movement in the area intermediate the ends of said chamber, said free end being configured for pivtol engagement of said U-shaped member, spring means fixed to said U-shaped member at one end and to said relatively rigid central tongue portion of said elongated member at the other end to maintain the pivotal connection between said U-shaped member and said elongated member and to bias the movable contact against said first fixed contact means, and operator means extending through said housing means and engageable with said flexible arm portions of said elongated member and operable to move said free end to cause movement of said movable contact from said first to said second fixed terminal means.

16. A hermetic switch comprising housing means defining a sealed chamber having first, second, and third electrical terminal means sealingly extending therethrough, first and second fixed contact means mounted on said first and second terminal means within said chamber, movable contact means having a first position and movable to a second position relative to said first and second fixed contact means and comprising a relatively rigid member carrying the movable contact, a second member having relatively flexible spaced arm portions and a relatively rigid tongue portion fixed at one end to said third terminal means, said second member having a free end spaced from said fixed end, said free end being characterized as presenting substantially short spaced fingers disposed at substantially right angles to said arm portions said fingers being connected together at the base thereof to define a U-shaped notch, said fingers being configured for pivotal engagement of said contact carrying member, spring means engageable with said contact carrying member at one end and with said relatively rigid tongue portion of said second member at the other end, said spring means extending through said U-shaped notch to maintain the pivotal connection between said rigid member and second member and to bias the movable contact against one of said first and second fixed contact means, and operator means sealingly extending through said housing means and engageable with said flexible arm portions of said second member and operable to move said free end thereof to cause movement of said movable contact from its said first to its said second position.

References Cited in the file of this patent

UNITED STATES PATENTS

2,415,546	Willman	Feb. 11, 1947
2,483,685	Willman	Oct. 4, 1949
2,505,605	Coake	Apr. 25, 1950
2,794,889	Bachman	June 4, 1957

FOREIGN PATENTS

514,386	Italy	Feb. 9, 1955
540,179	Canada	Apr. 30, 1957