April 13, 1965 B. A. GAY ETAL 3,178,540

ELECTRICAL SWITCH HAVING DEFORMABLE CONTACT MEMBERS

Filed April 17, 1961 2 Sheets-Sheet 1

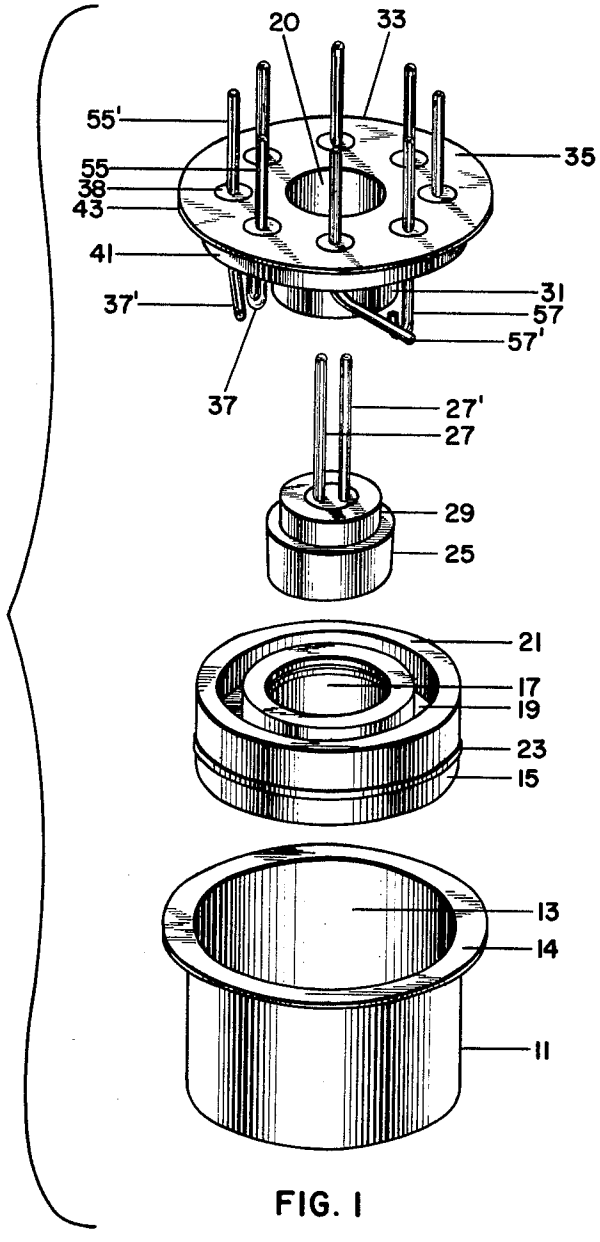


FIG. 1

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Filed April 17, 1961 2 Sheets-Sheet 2

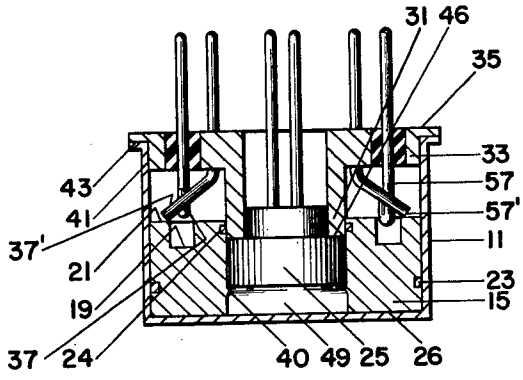


FIG. 2

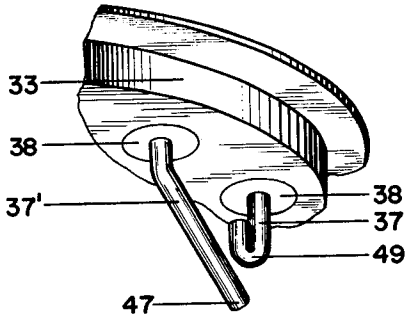


FIG. 3a

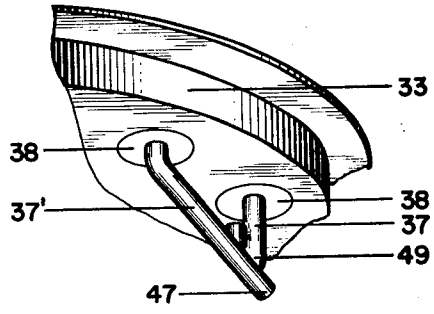


FIG. 3b

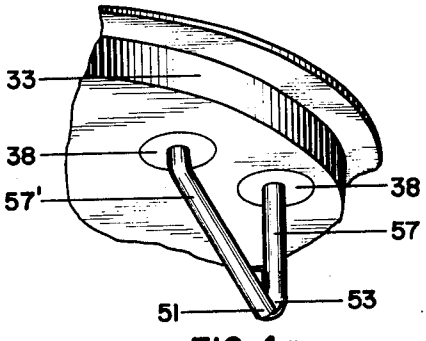


FIG. 4a

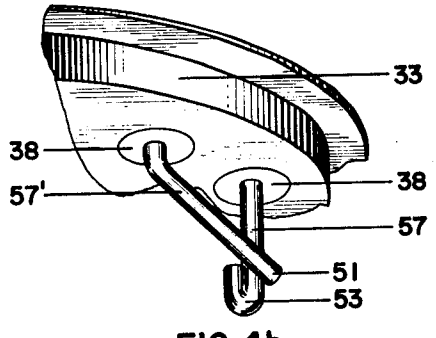


FIG. 4b

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ELECTRICAL SWITCH HAVING DEFORMABLE CONTACT MEMBERS

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11 Claims. (Cl. 200—142)

The present invention relates to an electrical switch, and in particular relates to an irreversible electrical switch particularly adapted to be squib activated.

Certain types of vehicles which travel at high speeds require electrical switches that are highly reliable and stable under conditions of vibration, violent tumbling and sudden changes of direction. It is therefore an object of the present invention to provide a switch of extremely rugged construction which will remain stable in a desired connect or disconnect position.

It is also an object of the present invention to provide a switch that is highly reliable and capable of carrying high amperage and voltage without jump or breakdown.

It is a further object of the present invention to provide a switch of very small size and of low contact resistance.

It is a further object of the present invention to provide a switch which is easily adapted to be squib actuated.

A still further object of the present invention is to provide a switch which may easily be adapted to be high temperature safe, i.e., the switch will be inoperative if exposed to high ambient temperature conditions.

These and further objects will become apparent from the following specification and claims, particularly when considered in conjunction with the accompanying drawings.

The switch of the present invention comprises in combination a switch housing, a movable piston member adpted to be received in the housing, and a contact assembly member having at least one pair of spaced electrical contact members positioned therein. Each pair of electrical contact members has a closed position wherein the members are in contact and an open position wherein the members are out of contact. The electrical contact members of each pair are so arranged in relation to each other that a deformation of one member of the pair into a permanent set effects a change of the pair from one position to the other. The movable piston member is positioned within the switch housing and a means of driving the piston member is provided. Upon actuation of the piston driving means, the piston member is moved toward the electrical contact pairs to contact and deform into a permanent set a member of each pair and thereby effect a change of the pair from one position to the other. A switch of the present invention is made temperature-safe by fabricating the piston member of a material which so softens as to be incapable of actuating the contact members at an ambient temperature below the temperature which is sufficient to thermally actuate the piston driving means.

In a preferred arrangement, one electrical contact member of each pair has movable or deformable portion and is bent in a direction toward the second or stationary member of the pair. The stationary member preferably has a broadened portion located along its length closest to the movable member to facilitate a reliable physical contact between the pair. The movable or bent electrical contact member is preferably fabricated of a malleable metal and is of sufficient length to reach and physically contact the second or stationary member of the pair.

In case the electrical contact pair is to be connected, or closed, the contact members of the pair are initially positioned out of physical contact and so arranged in relation to each other that a further bending of the movable or deformable contact member toward the contact assembly member, sufficient to cause physical contact between the contact pair members, causes the movable contact member to be deformed into a permanent set. In case the electrical contact pair is to be disconnected, or opened, the contact members of the pair are initially positioned in physical contact and so arranged in relation to each other that a further bending of the movable contact member toward the contact assembly member, sufficient to cause the contact pair members to be separated, causes the movable contact member to be deformed into a permanent set.

The term "deformed into a permanent set" is used herein to describe the amount that a movable or deformable electrical contact member is bent or deformed, and should be interpreted as a bending or deforming to a point that the contact member will no longer regain its original form upon the removal of the deforming force.

The electrical contact assembly member is adapted to be received in the switch housing and in a preferred embodiment of the invention the contact assembly member encloses one end of the switch housing. The electrical contact pair members are mounted in the contact assembly member in such a manner that their connecting and disconnecting portions are within the confines of the assembled switch. The movable piston member is adapted to be received and encased in the switch housing and is positioned between one end of the switch housing and the contact assembly member. The piston member is preferably recessed to receive the stationary contact members and is equipped with a non-conducting striker portion to contact the ends of the movable or bent electrical contact members. In operation the piston member is caused to move toward the electrical contacts mounted in the contact assembly member, the stationary contact members are received in the recessed portion of the piston and the movable or deformable contact members are physically contacted by the striker portion of the piston and bent toward the contact assembly member into a permanent set. The action of the piston causes the electrical contact members originally positioned in an open position to move to a closed position and simultaneously causes the electrical contact members originally positioned in a closed position to move to an open position. In a preferred embodiment of the invention the piston member is motivated by gas pressure directed on the face of the piston member farthest from the contact assembly member. Preferably the gas pressure is obtained from an electrical squib means positioned within the switch housing.

Electrical connection of the switch in a circuit may easily be accomplished by merely extending a portion of the electrical contact members through the contact assembly member to form external pole terminals.

The invention will be more clearly understood by reference to the accompanying drawings in which similar reference numbers are used to denote similar elements throughout the several views.

FIGURE 1 is an exploded view of a switch in accord with this invention.

FIGURE 2 is a partial sectional view of the assembled switch shown in FIGURE 1.

FIGURES 3*a* and 3*b* are fragmentary perspective views and show in detail a pair of electrical contact members, similar to those of a switch as shown in FIGURES 1 and 2, mounted in a portion of contact assembly member 33. FIGURE 3*a* shows a pair of contact members in a normally open position. FIGURE 3*b* shows the pair of contact members of FIGURE 3*a* in a closed position.

FIGURES 4*a* and 4*b* are fragmentary perspective views and show in detail a pair of electrical contact members, similar to those of a switch as shown in FIGURES 1 and 2, mounted in a portion of contact assembly mem-

ber 33. FIGURE 4*a* shows a pair of contact members in a normally closed position. FIGURE 4*b* shows the pair of contact members of FIGURE 4*a* in an open position.

Referring to FIGURE 1, numeral 11 refers to the switch housing generally cylindrical in shape and preferably fabricated of a metal. Suitable metals, for example, are stainless steel or brass. Switch housing 11 has an open end 13 and preferably has an extended lip portion 14. A piston member 15 is adapted to fit snugly within housing 11. Piston 15 is equipped with a center opening 17 therethrough, and has a recessed portion 19 and a non-conducting striker portion 21 along one face. Piston 15 is preferably fabricated entirely of a suitable non-conducting material, nylon has been found to be eminently satisfactory. If piston 15 is fabricated of a conductive material, a layer of insulating material such as nylon is placed on the surface of striker portion 21. If the piston member is fabricated of metal or a ceramic material, an O-ring 23 may be positioned around the circumference of the piston member to insure a gas-tight fit between the piston and the switch housing. An electrical squib member 25 having leg wires 27 and 27′ is adapted to be snugly received by center opening 17 of piston 15. Squib 25 is equipped with a neck portion 29 adapted to be received by an annular collar 31 extending from electrical contact assembly member 33. Annular collar 31, is in turn, adapted to be snugly received in center opening 17 of piston 15. Electrical contact assembly member 33 has a plurality of electrical contacts such as 37, 37′, 57 and 57′ positioned therethrough. The ends of contact members extend through face 35 of contact assembly member 33 and form pole terminals such as 55 and 55′. Preferably the contact assembly member 33 is fabricated of metal and in such case the electrical contacts such as 37, 37′, 57 and 57′ are desirably insulated from electrical contact with the contact assembly member by means of glass or plastic insulating beads 38 placed around the electrical contacts at the points at which they pass through the contact assembly member. Contact assembly member 33 is preferably equipped with a center opening 20 adapted to receive the lead wires 27 and 27′ of squib 25. An annular flange portion 41 of the contact assembly member is adapted to be received in the open end 13 of switch housing 11 and annular surface 43 is adapted to seat on annular lip 14 of switch housing 11.

FIGURE 2 shows a partial sectional view of the switch of FIGURE 1 as it would appear if it were assembled. Switch housing 11 contains a snugly fitting piston member 15 having a central opening therethrough to receive a portion of squib 25. Squib 25, not shown in section, is an item of commerce readily available from explosives suppliers. Piston 15 is shown as equipped with an O-ring 23 to insure a snug fit with the internal surface of housing 11. FIGURE 2 shows an additional O-ring 24, not seen in FIGURE 1, which may be utilized to insure a snug fit between piston member 15 and annular collar 31.

Piston 15 has an annular recessed portion 19 to receive the stationary contact members, such as 37 and 57. Surface 21 of piston 15 is positioned in relation to the ends of the bent contact members such as 37′ and 57′ in such a manner that movement of the piston toward the electrical contact members results in physical contact between striker portion 21 of the piston member, and the ends of the movable contact members. Further movement of the piston toward the movable contact members then causes a bending of the movable contact members toward contact assembly 33. A detailed description of the electrical connection and disconnection of the pairs of electrical contact members follows in the discussion of FIGURES 3*a*, 3*b*, and 4*a* and 4*b*. Annular collar 31 is adapted to seat on shoulder 46 of squib 25 and contact assembly member 33 is adapted

to be tightly secured to the switch housing 11 along surface 43 and flange portion 41.

It is to be noted from FIGURE 2 that the expanding gases from a firing of squib 25 would be directed to area 49 underlying squib 25 and toward surface 26 underlying piston 15. In a preferred embodiment of the invention piston member 15 is fabricated of a plastic material and the sudden pressure directed on surface 26 will cause distortion of the piston and result in a substantially gas-tight seal along the surfaces between the piston member and the switch housing and between the piston member and the contact assembly member. Piston member 15 is secured against movement along the vertical axis of the switch against external forces such as shock and vibration by a securing flange 40. Upon the release of gases from a squib source into area 49, securing flange 40 is ruptured or deformed and piston member 15 is then allowed free movement along the vertical axis of the switch toward contact assembly member 33 and is rapidly and forcefully moved in that direction by expanding squib gases. Striker portion 21 of piston member 15 is forced against the movable contact members such as 37′ and 57′ causing them to be permanently deformed in the direction of contact assembly member 33.

FIGURES 3*a* and 3*b* are fragmentary perspective views showing in detail a pair of electrical contact members such as 37 and 37′ and a portion of contact assembly member 33. The contact members are depicted in an open position in 3*a* and in a closed position in 3*b*. The electrical contact members are insulated from contact assembly member 33 by a non-conducting bead or sleeve 38. A bending of end portion 47 of movable contact member 37′ in a direction toward contact assembly member 33 until physical contact between contact member 37′ and broadened portion 49 of stationary contact member 37 is obtained causes contact member 37′ to be formed into a permanent set.

FIGURES 4*a* and 4*b* are fragmentary perspective views showing in detail a pair of electrical contacts such as 57 and 57′ and a portion of contact assembly member 33. The contact members are depicted in a closed position in 4*a* and in an opened position in 4*b*. The electrical contact members are insulated from contact assembly member 33 by a non-conducting bead or sleeve 38. A bending of end portion 51 of movable contact member 57′ in a direction toward contact assembly member 33 until physical contact between contact member 57′ and broadened portion 53 of stationary contact member 57 is broken causes contact member 57′ to be deformed into a permanent set.

The electrical contact members, such as 37, 37′ 57 and 57′, are preferably fabricated of a malleable metal having little or no spring-back ability. Contact members of malleable brass or nickel-iron alloy have been found to be eminently satisfactory. It is to be noted that the positive and stable positions of the electrical contact members in the switch of the present invention eliminates chatter, i.e., undesired making and breaking of electrical contact when the switch is exposed to rigorous agitation or violent vibration.

The switch of the present invention is designed to be easily adapted to a temperature-safe switch wherein the device will not perform a switching function if the switch is exposed to a high temperature such as might be encountered in flareups during vehicle launching or in case of a conflagration in a vehicle storage area. In an embodiment of a temperature-safe switch of the present invention, the piston member is fabricated of a thermoplastic material which so softens at a temperature lower than the thermal ignition temperature of the squib that is incapable of moving the electrical contact members to activate the switch. Nylon or a plastic material marketed by the General Electric Company under the trademark of Lexan-100 melt at about 400° F. and have been found to be eminently satisfactory for fabrication of the piston

member when used in conjunction with a squib containing an ignition drop comprised of a mixture of lead mononitroresorcinol and potassium chlorate in a weight ratio of about 90/10 held together by a small amount of inert binder material, and a base charge comprised of a mixture of lead mononitroresorcinol and potassium chlorate in a weight ratio of about 95/5. Such a squib has a thermal ignition temperature of about 500° F. If the squib is ignited after the piston has melted the expanding gases from the squib source will force their way through and around the softened or melted piston member to fill the internal volume of the switch. Under such circumstances, no directed force will be applied to the movable contact members and the pairs of contact members will remain stable in their original present positions.

What is claimed is:

1. An electrical switch comprising a switch housing containing a movable piston member and a plurality of pairs of electrical contact members, each pair of electrical contact members having a closed position wherein they are in contact and an open position wherein they are out of contact, said electrical contact members of each pair positioned in relation to each other so that deformation of one member of the said contact pair into a permanent set effects a change of said pair from one of said positions to the other of said positions, means within said switch housing to drive said movable piston toward said contact members, said contact members positioned so that upon movement of said piston member said piston member contacts and deforms into a permanent set one member of each contact pair and thereby causes the pairs of contact members to change from one of said positions to the other of said positions.

2. An electrical switch comprising a switch housing having side walls and first and second end walls, one end wall comprising a contact assembly member, said contact assembly member having at least one pair of electrical contact members extending therethrough and insulated therefrom, said electrical contact members having a closed position in which they are in contact and an open position in which they are out of contact, said electrical contact members of each pair positioned in relation to each other so that deformation of one member of the said contact pair into a permanent set effects a change of said pair from one of said positions to the other of said positions, a non-conducting movable piston member positioned within said switch housing, means for driving said movable piston toward said contact assembly member to contact and deform into a permanent set one member of each pair of said electrical contact members and thereby cause said pairs of electrical contact members to change from one of said positions to the other of said positions.

3. The electrical switch of claim 2 wherein the movable piston member is constructed of a rigid, non-conducting plastic.

4. An electrical switch comprising a switch housing having side walls and first and second end walls, said housing containing a movable piston member, one end wall comprising a contact assembly member, said contact assembly member having a plurality of pairs of deformable electrical contact members extending therethrough, each of said pairs of electrical contact members capable of being positioned in one of two positions, a closed position wherein the members of each pair are in contact with each other and an open position wherein the members of each pair are out of contact, said positions located in relation to each other that a change from one to the other requires sufficient bending of contacts as to cause them to be permanently set, said movable piston member positioned within the switch housing between said end walls, means for driving said piston member toward said contact assembly member, said piston member having a non-conducting striker portion adapted to contact and deform into a permanent set a contact member of each pair and thereby cause the electrical contact members originally positioned in an open position to move to a closed position and simultaneously the electrical contact members originally positioned in a closed position to move to an open position.

5. An electrical switch comprising a switch housing containing a movable piston member, said piston member having a non-conducting striker portion, and a plurality of pairs of electrical contact members, one member of each pair being of a malleable metal and in a position to be bent into a permanent set by the striker portion of said piston member, the other member of each pair being in a position not to be bent by the striker portion of said piston member, each pair of electrical contact members having a position in which the members are in contact and a position in which the members are out of contact, said electrical contact members of each pair are positioned in relation to each other so that deformation of one member of the said contact pair into a permanent set effects a change of said pair from one of said positions to the other of said positions, means for driving said movable piston member toward said contact pairs to contact and bend said malleable metal contact member of each of said pairs into a permanent set and thereby cause each pair of electrical contact members to change from one of said positions to the other.

6. A switch comprising a plurality of pairs of electrical contact members and a movable piston member, each of said pairs of electrical contact members comprising a stationary and a deformable member, said deformable contact member of each pair comprised of a malleable metal, each of said pairs of contact members having a position wherein the pair members are in contact and a position wherein the pair members are out of contact, said electrical contact members of each pair are positioned in relation to each other so that deformation of one member of the said contact pair into a permanent set effects a change of said pair from one of said positions to the other of said positions, said movable piston member having a non-conducting striker portion adapted to contact and bend said deformable member into a permanent set and thereby cause said pairs of contact members to permanently change from one of said positions to the other of said positions.

7. An electrical switch comprising a switch housing having side walls, first and second end walls, one end wall comprising a contact assembly member, said housing containing a piston member, said contact assembly member having at least one pair of electrical contact members therein, and extending toward said piston member, each pair of electrical contact members comprising one stationary contact member and one deformable contact member adapted to be bent into a permanent set position, said contact members having two positions, a closed position in which the members of each contact pair are in contact with each other and an open position in which each member of the contact pair is out of contact with the other, one of said members of each pair being bent into a permanent set when said contact members change from one position to the other, said piston member having a first position wherein said piston member is between the base portion of said switch housing and said contact assembly and is out of contact with said contact members, and being movable to a second position wherein the piston is in contact with said electrical contact members, deformable securing means holding said piston member in said first position, said piston member having a non-conducting striker portion adapted to contact and deform into a permanent set said deformable electrical contact members and thereby cause said contact members to move from one position to the other if said piston member moves from its first position to its second position, and means for deforming said deformable securing means and driving said piston member from one position to the other.

8. The switch of claim 6 wherein the means for driving said piston member is an explosive squib.

9. An explosively operated switch comprising an explosive squib, a piston member adapted to be moved by gas pressure from the firing of said squib, and a switch means actuated by movement of said piston, said piston member being constructed of a material which so softens as to be incapable of actuating said switch means, at an ambient temperature below that sufficient to thermally ignite said squib.

10. An explosively operated switch adapted to be non-operative at high temperatures containing a normally rigid piston member, a squib member and electrical contact members having an open and a closed position, said piston member positioned intermediate the discharge end of said squib and the electrical contact members, said piston member adapted to be moved by gas pressure from the firing of said squib means, said electrical contact members adapted to be moved from one of said positions to the other by movement of said piston member, said piston member adapted to soften and become incapable of moving said electrical contact members at a temperature level of about 400° F., and said squib member adapted to thermally ignite at a temperature above the said softening point of said piston member.

11. The switch of claim 10 wherein the piston member is fabricated of nylon.

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