Dec. 11, 1956 A. W. HAYDON ET AL 2,773,955

SNAP ACTION SWITCH

Filed June 22, 1953

Fig. 1.

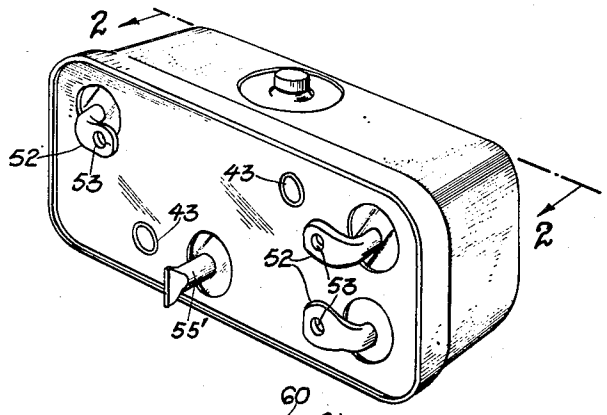


Fig. 2.

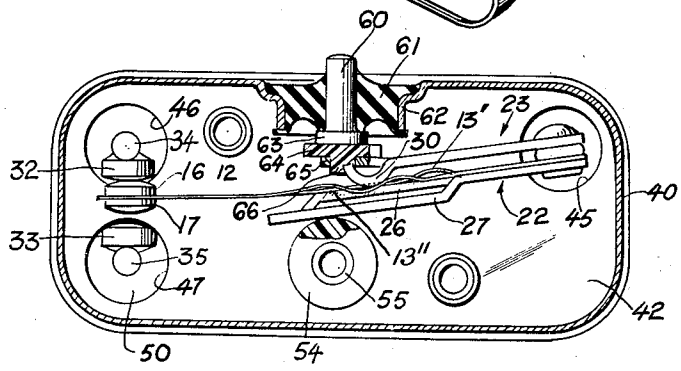


Fig. 3.

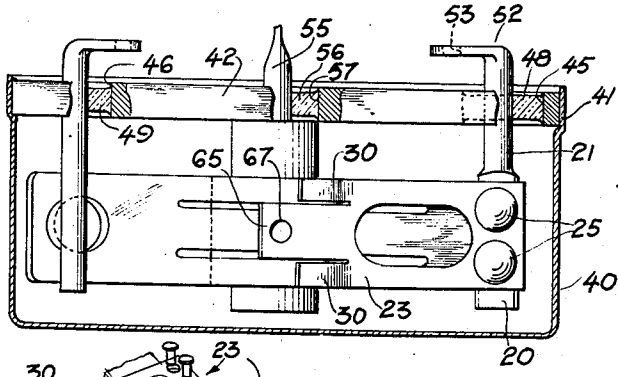
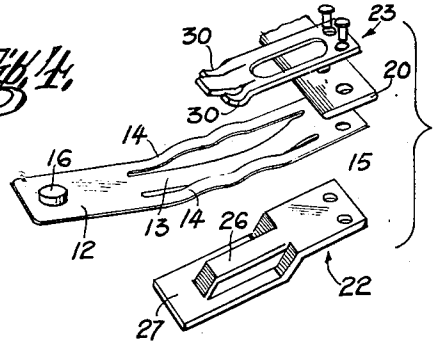


Fig. 4.



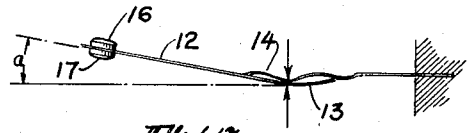


Fig. 5.

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SNAP ACTION SWITCH

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Application June 22, 1953, Serial No. 363,107

15 Claims. (Cl. 200—67)

This invention relates to snap action electric switches and more particularly to a hermetically sealed snap action switch. The invention is additionally concerned with a snap action switch similar in certain respects to that disclosed in the copending application of Arthur W. Haydon, Ser. No. 185,247, filed September 16, 1950, now Patent No. 2,700,079, issued January 18, 1955, but in which certain of the parts have been modified and rearranged to improve the operating characteristics of the switch.

In the aforementioned copending application there is disclosed a switch including a spring blade made up of a compression member and at least one tension member integrally interconnected at their opposite ends. The compression member is arched out of the plane of the blade as a whole while the tension member lies substantially in the plane of the blade and contains a number of transverse crimps which effectively shorten its length and increase its ability to elongate under tension. A normally fixed support may advantageously engage the tension member on the side of the blade opposite that from which the compression member extends. An actuating member is then provided on the opposite side of the blade from said support. A pair of contacts are provided adjacent the free end of the blade, one on either side thereof, the contact on the side of the blade opposite the actuating member being normally engaged by the end of the blade under positive pressure. When the actuating member which engages the compression member of the blade is moved toward the plane of the blade, contact pressure between the free end of the blade and the contact on the side of the blade opposite the actuating member is initially increased until the blade snaps and its free end is disengaged from the contact which it normally engages and is moved with a snap action to engage the other of said pair of contacts. As normally mounted, the spring blade is prestressed.

We have found, among other things, that the operating characteristics of the switch can be improved if the movable actuating member engages the tension member rather than the compression member, and the compression member is engaged by a fixed support. Hence in a switch with which this invention is concerned, the compression member of the spring blade (the spring blade being substantially similar to the spring blade of the aforementioned copending application) is engaged by a relatively fixed support, while the actuating member transmits operating force to the tension member. The blade, however, as normally mounted in the switch, is prestressed, as will be set forth hereinafter. As previously indicated, our invention is also concerned with a hermetically sealed snap action switch. Hence our invention also encompasses the provision of a switch housing which encloses the switch and the various contacts thereof so that they are not accessible to the elements, for example, air, corrosive gases, dust, humidity, water, ice, oil, grease, etc. Provision is of course made

for operation of the switch exteriorally of the housing.

Our invention also contemplates the provision of a hermetically sealed switch operable under extreme temperature conditions, the standard design thereof being satisfactorily operable within a temperature range of from −70° F. to +200° F.

In addition we contemplate a slight modification in the design of the spring blade to improve the actuating characteristics thereof as well as to increase the operative throw range.

For a more detailed understanding of our invention and the advantages thereof, reference may be had to the following specific description of one embodiment thereof taken in connection with the accompanying drawing in which said embodiment is illustrated and in which:

Fig. 1 is a perspective view of a hermetically sealed switch according to the invention;

Fig. 2 is a sectional view thereof in elevation taken along line 2—2 of Fig. 1;

Fig. 3 is a plan view, partly in section, of the switch with the wall of the housing that contains the actuating means removed;

Fig. 4 is an expanded view of the switch spring blade and support members therefor; and

Fig. 5 is a side elevation of an improved spring blade.

Referring to Figs. 4 and 5, the spring blade 12 of the switch comprises a rectangular piece of suitable conductive metal having suitable strength and fatigue characteristics such as beryllium-copper slotted intermediate its length tto provide a central compression member 13 and two outer tension members 14. This blade is substantially similar to that which is fully described in copending application Ser. No. 185,247 previously referred to. The compression member 13 is arched out of the general plane of the blade, a permanent bend 15 being imparted thereto for this purpose adjacent the end of the blade which is supported when the blade is mounted for use. The compression member 13 is further so formed that its peak is offset longitudinally of its midpoint toward the supported end of the blade. The tension members 14 are provided with a number of crimps to effectively shorten their length to accommodate the arching out of the compression member and further to provide them with greater longitudinal resiliency. At its outer end the spring blade 12 is provided with a pair of silver contacts 16 and 17 (Fig. 2) which are welded thereto to provide a connection of low electrical resistance and high heat conductivity. We have found that the operating characteristics of the blade may be improved, however, by so forming the blade that the outer contact supporting end thereof extends out of the general plane of the blade as defined by a line passing through the supported end of the blade and the major portion of the tension members, as illustrated most clearly in Fig. 5. The angle *a* which the outer end of the blade makes with the general plane of the blade is critical for obtaining the improved operating characteristics, the proper angle *a* having been found to be between 5° and 8°, preferably about 7°. If the angle *a* is greater than the above, the operating force required to operate the switch increases appreciably, while if the angle is smaller than specified, the throw range is smaller and special care must be taken in production of the switches.

Switch blade 12 is adapted to be secured to the flattened end 20 of a terminal rod 21 (Fig. 3) between a pair of support members 22 and 23, the switch blade and the support members being secured to the terminal rod by a pair of rivets 25. The support member 22 firmly engages the supported end portion of the blade 12 and has a central section 26 which engages the convex side of compression member 13, central section 26 being bounded

on either side by a depressed section 27 which accommodates movement of tension members 14 in operation of the switch. Support member 23, as clearly indicated in the drawing, is spaced at its supported end from spring blade 12 by the flattened end 20 of terminal rod 21. At its outer end, however, support member 23 is provided with depending portions 30 adapted to engage the tension members 14 of the blade as illustrated in Fig. 2.

When so mounted between support members 22 and 23, spring blade 12 is prestressed, the compression member being compressed by central section 26 of support member 22 and the tension members 14 being placed under a positive longitudinal tension. The spring blade 12 is further prestressed when mounted in the switch by reason of engagement of its supported contact 16 with one contact 32 of a pair of silver contacts 32 and 33 supported on opposite sides of its free end on terminal posts 34 and 35 respectively. The silver contacts 32 and 33 are welded to the terminal posts so that the connections therebetween have a high heat conductivity and a low electrical resistance. The prestressing of the spring blade as mounted in the switch is evidenced by a partial inversion of compression member 13 resulting in a portion of it lying above the general plane of the blade, as indicated at 13' in Fig. 2, and a portion thereof lying in or below the plane of the blade as indicated at 13'' in Fig. 2. The prestressing of course results in exceptionally good initial normal contact pressure between contact 16 on the blade and contact 32 on terminal post 34.

The switch casing enclosing spring blade 12 and the supporting structure therefor comprises a cup-like casing member 40 formed as by drawing from sheet steel, the open end thereof being bounded by a flange 41. Casing closure member 42 adapted to be received within flange 41 is provided to close the casing and support the major portion of the switch components within the casing. It is made of any suitable material of sufficient strength to firmly support such components and may, for instance, be made of sheet steel of substantially greater thickness than is the sheet metal of casing member 40. Closure member 42 is secured in place by a fluid tight seal. For example, it may be soldered in place with the solder being applied all around its peripheral edge to cover the seam between it and the flange. Closure member 42 is additionally secured in place by a pair of tubular members 43 which extend completely through the casing passing through openings in closure member 42 as well as through openings in the bottom of casing 40. The ends of tubular members 43 which extend through the openings in the bottom of the casing are brazed or otherwise secured to the walls of the openings so that a fluid tight seal exists therebetween. The opposite ends of tubular members 43 which pass through closure member 42 initially extend a very short distance beyond the outer face thereof but are then flared out and soldered in place to provide fluid tight seals between their outer walls and the inner walls of the openings in closure member 42. These tubular members 43 are adapted to receive bolts by which the completed switch may be mounted for use.

Terminal rods 21, 34 and 35 are supported in openings 45, 46 and 47, respectively, in closure member 42 by seal members 48, 49 and 50, respectively, made of a "compression" type of glass compound which is sealable both to the closure member 42 as well as to the terminal rods. The glass compound employed is one of exceptional ruggedness, seals made therefrom flaking off at the surface rather than cracking through when subjected to excessive stresses. This insures the maintenance of hermetic seals under adverse mechanical and thermal conditions. To reduce the likelihood of these glass compound seals being damaged by excessive stress due to extreme thermal conditions, the terminal rods themselves may be made of Kovar, a ferrous alloy, or some similar alloy having a coefficient of expansion substantially similar to the coefficient of expansion of the glass compound. To accommodate the attachment of electrical leads to the terminal rods, the outer end 52 of each is flattened and provided with an eye 53 through which lead wires may be run.

A cylindrical support member 54 made of a dielectric material such as nylon is located within the casing beneath and in engagement with the lower side of the recessed portion 27 of support member 22 to lend further rigid support to the otherwise unsupported outer end of support member 22. Cylindrical member 54 is freely supported on a tubular member 55 which is in turn mounted in a glass compound seal 56 in an opening 57 in closure member 42, the glass compound of seal 56 being the same as that of seals 45, 46 and 47. It will be realized, of course, that since the tubular member 55 is not an electrically conducting member in the switch, it may be mounted directly in the closure member 42, as by brazing, thereby eliminating the glass seal 56. The illustrated method of mounting, however, assures proper relative positioning of tubular member 55 with respect to terminal rods 21, 34 and 35 since all these members can be held in a fixture during insertion of the glass seals. It is through tubular member 55 that the switch casing may be evacuated and filled with a relatively inert gas such as nitrogen, after which the outer end of the tube may be pinched off and sealed, as indicated at 55'.

Under certain conditions it may be desirable to use a member 54 of other than cylindrical shape or to mount cylindrical member 54 eccentrically on tubular member 55. In either case the member 54 may then be used as a cam for adjustment of the switch (and even operation thereof, providing other modifications are made) by changing the position of the otherwise unsupported end of blade support member 27. In order that member 54 may be so employed as a cam, tubular member 55 would have to be rotatably supported in closure member 42. Additionally, in order to provide for a predetermined fixed number of adjustments, member 54 might have a hexagonal or similar cross section and be eccentrically mounted on the shaft 55.

The switch is adapted to be actuated by an actuating pin 60 movably supported by a flexible support member 61 in an opening in a side wall of casing member 40. The actuating member and its support means are fully disclosed in the copending application of John Haydon, Ser. No. 362,504, filed June 18, 1953. As pointed out in that application, flexible support member 61 is gas impervious and may be bonded in a fluid tight seal both to a depending stepped flange 62 integral with the side wall of the casing and to the pin. The flexible support 61 may be advantageously made from a silicone rubber compound which is resistant to most materials such as fresh or salt water, soda water, aircraft oil and greases, etc. and furthermore is not adversely affected by rather severe temperature changes, for instance, changes between —70° F. and +200° F., the range in which the switch is adapted to be employed.

The actuating pin 60 has an enlarged lower end 63 which engages a button 64 of a dielectric material such as nylon which is supported on an extension 65 of blade support member 23. The button 64 has a depending portion 66 of considerably smaller diameter extending through an opening 67 formed in the extension 65 of support member 23 to properly locate and maintain the button on such extension. Depending portion 66 of the button also performs a second function and that is to prevent excessive over-travel of support member 23 which might permanently deform the blade 12. It accomplishes this second function by engaging the central section 26 of lower support member 22 through the compression member 13 of the blade.

From the above it will be clear that in assembling the switch, the various terminal rods and their supported contacts, the spring blade and the supporting members

therefor may first be mounted on closure member 42. This assembly may then be inserted into the casing member 40 and the seam between the closure member and the casing member 40 and the seams between the closure member and tubular members 43 sealed by soldering. The casing may then be evacuated and filled through tubular member 55 and finally hermetically sealed by closing off the outer end of the tube.

In operation the normal position of the spring blade is that in which its contact 16 engages with a good positive contact pressure terminal contact 32. Upon depression of actuating pin 60, the aforesaid contact pressure is initially either increased or maintained at its normally high value. As actuating pin 60 is moved further toward the spring blade and the spring blade approaches the throw point, the contact pressure between contact 16 and 32 may decrease somewhat, but a zero contact pressure therebetween is not reached until the throw point of the spring blade has been reached, at which time the free end of the spring blade snaps sharply and abruptly downwardly, as seen in Fig. 2, to move contact 17 into contact with terminal contact 33. Upon release of actuating pin 60, the spring blade will snap back to its original position as illustrated.

The switch has been subjected to exhaustive and rigorous tests. It has been found to satisfactorily withstand a 100 pounds per square inch differential without rupture or leakage. The mechanical life of the switch in a temperature range of —70° F. to +200° F. is 1,000,000 operations, the life at rated load being 100,000 operations. The operating force required is relatively extremely light for a switch of such rugged construction and is about 20–32 ounces. The traverse rate of the free end of the spring blade is high, and negligible contact bounce is encountered.

Various changes and modifications may of course be made in the construction of the particular embodiment of the invention illustrated and specifically described above without departing from the scope of the invention which should be limited only to the extent set forth in the appended claims.

We claim:

1. In a snap action switch, a spring blade having a compression member which when the blade is unstressed extends out of the plane of the blade and a tension member lying substantially in the plane of the blade, said members being interconnected to each other at their opposite ends, a support member engaging said compression member on one side of said blade, a second support member engaging said tension member on the opposite side of the blade, and means securing said support members together and said spring blade therebetween under predetermined stress with a portion of the compression member being inverted.

2. In a snap action switch, a spring blade having a compression member which when the blade is unstressed extends out of the plane of the blade on one side thereof and a tension member lying substantially in the plane of the blade, said members being integrally interconnected to each other at their opposite ends, a support member engaging said compression member on said one side of the blade, a second support member engaging said tension member on the other side of the blade, and means securing said support members together and said spring blade therebetween under predetermined stress with a portion of the compression member being inverted and extending out of the plane of the blade on said other side of said plane.

3. A snap action switch according to claim 2 in which the portion of the compression member which is inverted and extended partially out of the plane of the blade on said other side of the plane is that portion of the compression member adjacent the supported end of the blade.

4. In a snap action switch, a spring blade having an arched compression member which when the blade is unstressed extends out of the plane of the blade and a tension member lying substantially in the plane of the blade, said members being interconnected to each other at their opposite ends, a pair of support members on opposite sides of the blade, means securing adjacent ends of said support members together and to one end of the blade to support said blade, one of said support members engaging said tension member intermediate its ends and the other of said support members engaging said compression member intermediate its ends and said securing means and said support members maintaining said spring blade under a predetermined stress, a fixed contact adjacent the free end of the spring blade and normally engaged thereby with a positive pressure, and actuating means engaging one of said support members to move at least a portion of it relative to the other support member to further stress the blade and move the free end thereof out of contact with said fixed contact with a snap action.

5. In a snap action switch, a spring blade having an arched compression member which when the blade is unstressed extends out of the plane of the blade and a tension member lying substantially in the plane of the blade, said members being interconnected to each other at their opposite ends, a pair of support members on opposite sides of the blade, means securing adjacent ends of said support members together and to one end of the blade to support said blade, one of said support members engaging said tension member intermediate its ends and the other of said supporting members engaging said compression member intermediate its ends and said securing means and said support members maintaining said spring blade under a predetermined stress, a fixed contact adjacent the free end of the spring blade and normally engaged thereby with a positive pressure, and actuating means engaging one of said support members to move at least a portion of it relative to the other support member to further stress the blade and move the free end thereof out of contact with said fixed contact with a snap action, the compression member of said spring blade when said blade is mounted between said support members and in engagement with said fixed contact having a portion thereof inverted and extending out of the plane of the blade on the side of the blade opposite the side thereof from which the compression member extends when the spring blade is unstressed.

6. A snap action switch according to claim 5 in which the actuating means engages the support member which engages the tension member of the blade.

7. A snap action switch according to claim 5 which includes a support member engaging the outer end of said compression member engaging supporting member on the side thereof remote from said spring blade.

8. A snap action switch according to claim 5 which includes a second fixed contact adjacent the free end of said spring blade and adapted to be engaged by said free end of the blade when said switch is actuated and said free end of the blade is moved out of contact with said first-mentioned fixed contact.

9. A snap action switch according to claim 6 in which the support member engaging said tension member engages said tension member at a point closer to the supported end of the blade than the point at which said other support member engages said compression member.

10. In a hermetically sealed snap action switch, a casing member having an open mouth, a rigid metal closure member therefor adapted to be secured in said casing member mouth by a fluid tight seal, a plurality of terminal rods supported in and extending through openings in said closure member, seals made of a compression type glass sealing compound secured in said openings in fluid tight relation with the walls thereof and with said terminal rods, and a spring blade mounted on and supported solely

by one terminal rod within the casing member with its free end adjacent and normally in positive contact with a contact mounted directly on a second terminal rod.

11. A snap action switch according to claim 10 which includes a pair of support members supported upon said spring blade supporting terminal member on opposite sides of and in engagement with said spring blade to maintain said blade in a prestressed condition.

12. A snap action switch according to claim 11 in which the spring blade has a compression member which when the blade is unstressed extends out of the plane of the blade and a tension member lying substantially in the plane of the blade and interconnected at its opposite ends to the opposite ends of said compression member, and in which one of said support members engages said tension member and the other of said support members engages the compression member and in which said spring blade is prestressed when mounted between said support members, a portion of the compression member lying on one side of the plane of the blade and a portion thereof being restricted by said other support member and lying substantially in the plane of the blade.

13. In a snap action switch, a spring blade adapted to be supported at one end and have its other end free to move into and out of contact with a switch contact, said spring blade having a tension member lying in the plane of the end of the blade adapted to be supported and a compression member arched out of said plane, the free end of the blade also extending out of said plane at an angle between 5° and 8°.

14. A spring blade according to claim 13 in which the free end of the blade extends out of said plane on the opposite side thereof from said compression member.

15. In a snap action switch, a spring blade adapted to be supported at one end and to have its other end free to move into and out of contact with a switch contact, said spring blade having a pair of substantially parallel longitudinally extending slots formed therein, the portion of the blade between the slots forming a substantially longitudinal arch extending out of the plane of the blade as defined by the end of the blade adapted to be supported and the portions of the blade outwardly of the slots and having its peak offset to one side of its longitudinal midpoint, and the free end of the blade extending out of said plane of the blade on the side thereof opposite said portion of the blade between the slots and at an angle of substantially 7° with respect to said plane.

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