June 8, 1948. I. E. McCABE 2,442,981

ELECTRICAL SWITCH STRUCTURE

Filed Jan. 11, 1947

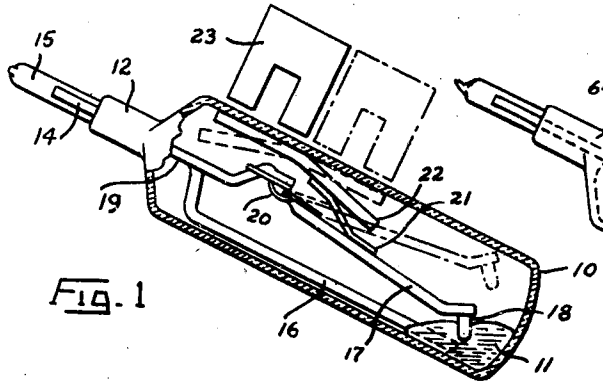


Fig. 1

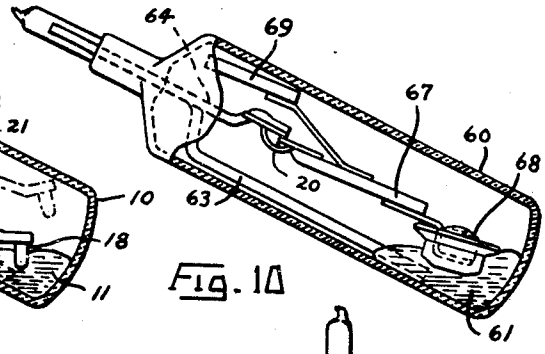


Fig. 10

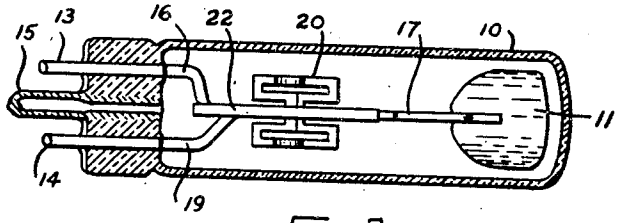


Fig. 2

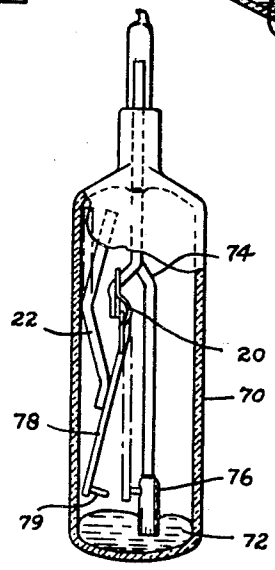


Fig. 11

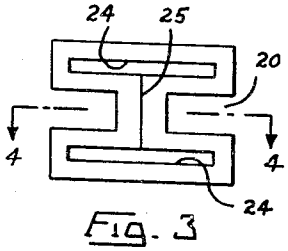


Fig. 3

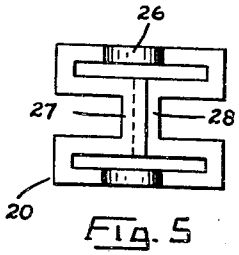


Fig. 5

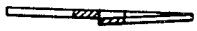


Fig. 4



Fig. 6

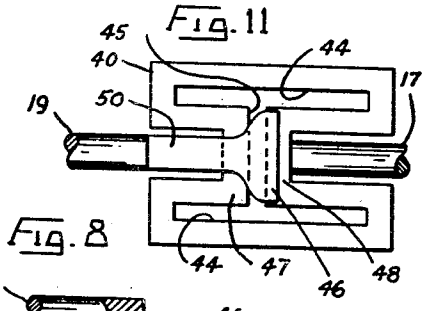


Fig. 8

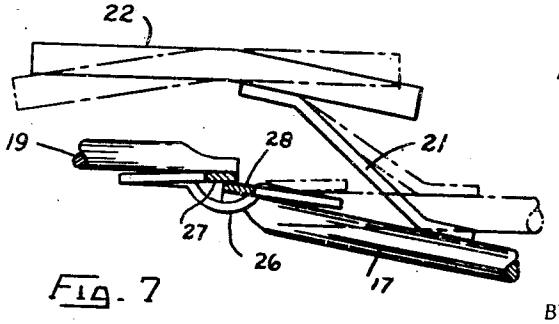


Fig. 7

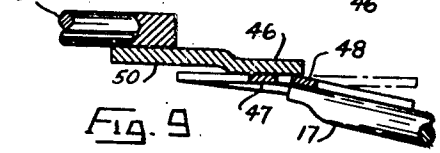


Fig. 9

INVENTOR.
IRA E. McCABE

BY

Williamson Hufley Byron & Hume

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ELECTRICAL SWITCH STRUCTURE

Ira E. McCabe, Chicago, Ill.

Application January 11, 1947, Serial No. 721,638

14 Claims. (Cl. 200—112)

1

The invention relates to electric switches of the kind having one or more flexible contact members responsive to mechanical or magnetic forces for their actuation, and has reference more particularly to improved hinge structure for the movable contact member and which may be incorporated in hermetically sealed mercury switches to afford a greater variety of multiple contact structures within small spaces than heretofore possible in switches of such character and which will also extend the use of said mercury switches to applications heretofore desired but difficult to obtain.

In electrical switch structures employing flexible or resiliently movable contact members a number of factors present problems involving special structure for various intended uses. In the simplest form, representative of the hermetically sealed magnetically operated type of mercury switch, the flexible contact members are of ribbon or wire, as disclosed in the Huncicker Patent No. 2,121,235, granted June 21, 1938. In these forms stability is afforded by fluting the ribbon or wire, or by selecting material of certain thickness. This, of course, tends to make the structure somewhat sluggish in operation and to create a need for magnetic forces of certain magnitude to operate them. Furthermore, the amplitude of movement of the movable member is somewhat limited, particularly where it is desired to keep the overall switch dimensions to a minimum.

Although switch structure as above described satisfactorily fulfill certain requirements, a switch having more amplitude of contact movement and operative in response to a less degree of magnetic attraction has been particularly desirable.

To meet the above requirements, relatively thin flexible members have been formed to provide spiral coils, as shown in the McCabe Patent 2,154,761, granted April 18, 1939, the said spiral coils having supporting means fixedly secured at one end, with the other end extended to support an armature and provide means to move a switch contact. However, where uniformity of operation is desired, as in the switch itself or between like switches, this form and others of similar construction provide a degree of flexibility in themselves, as, for example, between the convolutions of the aforementioned spiral spring, as to set up a degree of varying lost motion in the movement effected in response to the force which actuates the switch.

Whereas, magnetically actuated switches of the character referred to have wide application, their desired use in some instances has provided

2

a need for a switch which will operate in response to small magnetic forces, and which will have greater stability and uniformity of operation with adequate amplitude of contact movement and accuracy in that movement throughout repeated operations.

Therefore an object of the invention resides in the provision of an electric switch which will incorporate novel hinge structure for the movable member or members and which will have the desired characteristics as above mentioned. The improved flexible hinge structure of the invention is particularly desirable in mercury to mercury make and break switches of the magnetically actuated type because of the many advantages to be secured both as regards manufacture and operation. Also for example, the improved flexible hinge structure will render switches incorporating it capable of operations numbering hundreds a minute which heretofore has been difficult if not impossible to satisfactorily attain. Also switches incorporating the present flexible hinge structure are capable of substantial current carrying capacities even in their simplest forms.

Another object of the invention resides in the provision of a flexible hinge member formed of flat relatively thin metal substantially in the shape of the letter H, and wherein the hinging action will take place about the transverse center line in a manner to materially reduce twisting and similar torsional strains.

Another and more specific object resides in the provision of a flexible hinge member having particular application to electric switches of the hermetically sealed mercury type and which is formed of flat relatively thin metal, having the shape of the letter H and with the sides thereof slotted and the cross member separated throughout its length to provide two relatively movable sections with one section serving as the fulcrum member for the other section.

Another object is to provide a flexible hinge member for supporting the movable electrode or electrodes in mercury switches and the like which will render said switch structure accurate in operation, which will be capable of considerable amplitude of movement while maintaining space requirements to a minimum, which will render possible rapid operation to the extent of several hundred a minute, and which hinge member will have adequate stability for use in the mercury to mercury make and break type of magnetically actuated switch.

With these and other objects in view the in-

vention may consist of certain novel features of construction and operation as will be more fully described and particularly pointed out in the specification, drawings and claims appended hereto.

In the drawings which illustrate an embodiment of the invention and wherein like reference characters are used to designate like parts—

Figure 1 is a longitudinal sectional view through an enclosed mercury switch incorporating the improved hinge member of the invention and showing the switch elements in side elevation;

Figure 2 is a longitudinal sectional view through the mercury switch of Figure 1 showing the switch elements in plan elevation;

Figure 3 is a plan view of the flexible hinge member forming the subject matter of the invention shown in partially completed form;

Figure 4 is a sectional view of the member shown in Figure 3 taken substantially along line 4—4;

Figure 5 is a plan view showing the hinge member of the invention in completed form;

Figure 6 is a side elevational view of the same;

Figure 7 is a fragmentary detail sectional view on an enlarged scale illustrating the fulcruming action which one section of the present hinge member has on the other section;

Figure 8 is a plan view showing a modified form of flexible hinge member coming within the invention;

Figure 9 is a fragmentary detail section illustrating the fulcruming action of the modified form of member shown in Figure 8;

Figure 10 is a longitudinal sectional view showing a mercury to mercury make and break magnetically actuated type of switch equipped with the improved flexible hinge member of the invention; and

Figure 11 is a sectional view through another type of mercury switch employing the present flexible hinge member.

Referring to Figures 1 and 2, the enclosed mercury switch selected for illustrating the present invention essentially consists of a cylindrical glass tube or container 10 closed at its lower end for receiving and retaining a small body of mercury or other electrical conducting fluid 11. The upper end of the tube 10 is closed by a pinch seal identified by numeral 12, which seals in the body thereof one or more lead-in wires 13 and 14. A filling stem 15 is provided through which the mercury is inserted and after gas has been substituted for air in the tube the same is then sealed off. The lead-in wires may be extended to form one or more of the electrodes or contact members within the tube, which will be presently described in detail, or said electrodes may be welded or otherwise suitably secured to the inner end of the lead-in wires.

The fixed electrode identified by numeral 16, connecting with the lead-in wire 13, extends into and has electrical contact with the pool of mercury 11. The movable electrode 17 is provided with a contact point 18 for making and breaking the electrical circuit with the pool of mercury 11 and said movable electrode is supported by the flexible hinge member 20 of the invention mounted upon a wire support 19 connecting with the lead-in wire 14. The said hinge member consists of two relatively movable sections, one section being fixedly secured to the supporting wire 19, whereas, the other section has fixedly secured thereto the movable electrode 17. A

bracket 21 is fixed at one end to movable electrode 17 and said bracket carries at its other end an armature 22, which armature is actuated by magnet 23. With the magnet in position, as shown by full lines, Figure 1, the left end of armature 22 will be attracted to effect downward movement of electrode 17 with the result that the contact point 18 is caused to engage the mercury pool 11 to complete the electric circuit through the switch. With the magnet in the position as shown in dotted lines in said figure the right hand end of the armature 22 will be attracted thereby and the effect of this action is to lift the movable electrode 17, breaking electrical contact with the mercury pool 11 and thus opening the electric circuit.

Referring more particularly to Figures 3 to 6 inclusive, a preferred form of flexible hinge structure is disclosed as comprising a member 20 substantially in the shape of the letter H and which is formed of relatively thin, flat spring metal. The elongated spaced legs of the member are each slotted as at 24 and the connecting or transverse center section is cut from slot to slot, as, for example, at 25. As a result the member consists of two sections relatively movable and which sections are joined by the outer strip of metal of each elongated leg. The hinge member is further processed to provide said outer strip of metal of each leg with a semi-circular depression 26, Figures 5 and 6, the depression or deformation taking such depth and breadth as will draw the severed edges of the connecting center portion toward each other so that the separated parts 27 and 28 of the center portion have lapping relation, thus providing a fulcrum for the flexing of one section of the hinge member on the other. It is preferable to so arrange the location of the depressions in each leg so as to locate the edge of the underlapping part 28 substantially in alignment with the center of said depressions. As a result of this structure the fulcruming edge of the hinge member has action substantially centrally of the member and also centrally of the said depressions.

As best shown in Figure 7, one section, namely 27, of the hinge member has suitably secured thereto as by welding the supporting wire 19 connected to lead-in wire 14, which functions as a lead-in conductor for the movable electrode 17. The other section of the hinge member, namely, 28, serves to support the movable electrode 17 and which is suitably secured to said section. It will be observed that whereas section 27 is secured to the underside of the supporting wire 19, the other section 28 has securement to the top side of the electrode 17 and thus the wire is disposed above the member, whereas, the electrode is below the member. It will also be seen that as a result of the depressions 26 the underlapping part 28 is positioned with its cut edge in contact with the overlapping part 27 and thus a knife edge bearing is provided by the present hinge member, permitting flexing movement of the movable electrode with respect to the fixed supporting wire 19 and which flexing movement takes place in a manner to prevent transmission of torsional or twisting strains. The knife edge effect above described can be accentuated by increasing the angular relationship between the fulcruming parts of the hinge member.

It will be apparent from the foregoing that the knife edge bearing which section 28 has on section 27 provides a fulcrum capable of single flexing action which adds stability to the hinge

member, insuring long life, particularly so when the switch is subjected to rapid and continuous operation. By proper disposition of the magnet 23 considerable amplitude can be obtained. Furthermore, no lost motion is involved and the magnetic attraction of the armature is immediately effective as a result of the hinge member to move the electrode 17. It is also noted that by so positioning the armature with respect to the spring the magnetic attraction of the armature tends to maintain the fulcrum elements in contact with each other.

In Figures 8 and 9 the hinge member has been modified to eliminate the depressions 26 in the outer metal strips of the legs. In this modified form the hinge member 40 is substantially in the shape of the letter H and consists of a relatively thin, flat section of spring metal. The elongated legs are each slotted as at 44 and the connecting or transverse center section is also provided with a slot 45, the said slot 45 extending from the full length of the transverse center section and thus said slot 45 communicates with slots 44. Thus, the hinge consists of two relatively movable sections and which sections are joined by an outer strip of metal provided by each elongated leg. In order to provide for fulcruming action of one section on the other a fulcrum member 46 is fixedly secured to part 47. The supporting wire 19 is fixedly secured in turn to the extending end 50 of the fulcrum member 46 and accordingly section 47 of the hinge member is fixedly supported through the fulcrum member by the supporting wire 19. The fulcrum member 46 overhangs part 47 and in accordance with the invention part 48 of the hinge member contacts the same for the purpose of fulcruming thereon. Part 48, has fixed thereto the movable electrode 17 and the hinge member thus provides means permitting flexing movement of said movable electrode.

In the hinge member of both modifications a knife edge bearing is provided at the fulcrum point which adds to the stability of the switch structure, insuring uniformity of operation with adequate amplitude of movement of the movable electrode in response to small magnetic forces. The switch structure incorporating the present hinge member is well adapted to uses where rapidity of operation to the extent of several hundred a minute is desired. The fact that the flexure of the spring is positive and immediately responsive to the magnet without any lost motion together with the fact that a simple hinging action with good amplitude of movement results, renders this switch structure adaptable to such uses as those in connection with counting devices and high speed manufacturing equipment.

In the switch structure of Figure 1 it will be observed that magnetic means are employed to effect both make and break, since the slight lag involved when relying upon the spring hinge member to effect the break prevents the higher speeds of operation from being attained. In this form the spring hinge may position the movable electrode 17 midway between the extreme operating positions, thus relieving to a degree the stresses and fatigue in the hinge member since it plays no part in placing the movable electrode in either of its positions as contrasted with a spring return type. However, for infrequent or slowly repeated operations magnetic means effective in one direction only with spring return to the other direction is all that is needed.

Figure 10 discloses a switch having structure

providing a mercury to mercury make and break, thus affording means to handle larger currents than those handled by the type of switch shown in Figure 1. The glass tube or container 60 retains a small body of mercury or other electrical conducting fluid 61. A pair of lead-in wires are sealed at the other end of the tube and said lead-in wires support the electrodes or contact members within the tube. The fixed electrode, identified by numeral 63, and connected to one of the lead-in wires, extends into and has electrical contact with the pool of mercury 61. The movable electrode 67 supports a cup 68 of arc resisting, insulating material and which cup retains some mercury which thus makes electrical contact with the electrode 67 having a fixed relation to the base inside said cup. In accordance with the invention, the hinge member 20 supports the movable electrode 67 from a support in wire 64 connected to the other lead-in wire and said movable electrode is thus hingedly mounted and provided with an armature 69 for effecting actuation of the same magnetically. Magnetic attraction of said armature will submerge the cup 68 into the mercury pool 61 and the mercury thus overflows the edges of the cup to join the body of mercury within the cup whereby the electrical circuit is completed through the switch. Upon removal of the magnetic force the hinge member will become effective to lift the cup 68 which is caused to float upon the mercury pool in the tube and upon separation of the mercury contained in the cup from said pool the electrical circuit is opened.

In the switch such as shown in Figure 10 stability in the spring hinge member is needed to support the cup when afloat in the mercury and said spring hinge member must also have positive action in response to the operating force in submerging the cup into the mercury in order that said operating force may be a minimum commensurate with reliability in providing operation. The improved spring hinge structure of the invention has the desired characteristics and thus makes practical a magnetically actuated switch of this type. Furthermore, the hinge member is preferably spaced under tension by the buoyancy of the mercury in floating the cup so that the magnetic or operating force producing the submersion of the cup is aided by this spring tension so as to require only such power as is necessary to displace the amount of mercury necessary to submerge the cup. Thus smaller amounts of power are effective to operate the switch than is possible with other types of spring structures.

The switch structure shown in Figure 11 is similar to the enclosed mercury switch disclosed in the McCabe Patent No. 2,325,785, granted August 3, 1943. The glass tube or container 70 contains a body of mercury 72, and a pair of lead-in wires support electrodes in a manner as described with respect to the switches of Figures 1 and 10. In this form, however, the fixed electrode 74 carries at its lower end a capillary tube 76 of copper or other electrical conducting material and which is partly submerged in the mercury pool 71. The capillary tube has its upper end extending above the mercury pool to present a meniscus of mercury to be engaged or disengaged by the contact member 79 of the movable electrode 78. For proper operation of such mechanism it will be seen that it is absolutely essential for the contact 79 to always enter the opening provided therefor in the capillary tube 76 so

as to engage the meniscus of mercury provided thereby. The present hinge member with its many desirable features, as previously pointed out, lends itself to incorporation in switches of this capillary tube type by insuring accuracy in the movement of the movable electrode 78 throughout its operation.

It will be apparent that whereas the switches shown are of the normally open type the hinge member of the invention may be incorporated in switches of the normally closed type as well as switches employing a multiple of movable contact members or electrodes. The small space requirements for the hinge member makes possible the latter types without resorting to large enclosures for containing them.

The invention is not to be limited to or by details of construction of the particular embodiment thereof illustrated in the drawings, as various forms of the device will of course be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

What is claimed is:

1. In an electrical switching device including at least one movable contact member, flexible hinge structure supporting said member comprising a section of metal having a shape in plan to provide a pair of spaced elongated legs connected by a center transverse portion, said elongated legs each having a slot extending longitudinally thereof, and said center transverse portion being severed from slot to slot to thereby form two relatively movable parts.

2. In an electrical switching device including at least one movable contact member, flexible hinge structure supporting said member comprising a section of metal having a shape in plan to provide a pair of spaced elongated legs connected by a center transverse portion, said elongated legs each having a slot extending longitudinally thereof, said center transverse portion being severed from slot to slot to thereby form two relatively movable parts, and one of said parts providing means serving as a fulcrum for the other part.

3. In an electrical switching device including at least one movable contact member, flexible hinge structure supporting said member comprising a section of metal having a shape in plan to provide a pair of spaced elongated legs connected by a center transverse portion, said elongated legs each having a slot extending longitudinally thereof, said center transverse portion being severed from slot to slot to thereby form two relatively movable parts, and the outer edge of each leg having a formation substantially centrally thereof in transverse alignment with the center portion, whereby said relatively movable parts are caused to lap so that one part serves as a fulcrum for the other part.

4. In an electrical switching device including at least one movable contact member, flexible hinge structure supporting said member comprising a section of metal having a shape in plan to provide a pair of spaced elongated legs connected by a center transverse portion, said elongated legs each having a slot extending longitudinally thereof, said center transverse portion being severed from slot to slot to thereby form two relatively movable parts, and the outer edge of each leg having a depression formed therein substantially centrally thereof in transverse alignment with the center portion, whereby said relatively movable parts are caused to lap so that one part has knife edge contact with the other part for furcruming thereon.

5. In an electrical switching device including at least one movable contact member, a flexible hinge member supporting said contact member, said hinge member comprising a flat relatively thin portion of spring metal having substantially the shape of the letter H, said hinge member having a slot in each elongated side leg, and the transverse center part being severed from slot to slot to provide two relatively movable sections, one of said sections having fulcruming action with respect to the other section.

6. In an electrical switching device including at least one movable contact member, a flexible hinge member supporting said contact member, said hinge member comprising a flat, relatively thin portion of spring metal having substantially the shape of the letter H, said hinge member having a slot in each elongated side leg, and the transverse center part being severed from slot to slot to provide two relatively movable sections, one of said sections having an angular position with respect to the other section to provide a knife edge bearing therefor, whereby said angularly positioned member fulcrums on said knife edge bearing.

7. In an electrical switching device including at least one movable electrode, a flexible hinge member supporting said movable electrode, said hinge member comprising a flat, relatively thin spring in the shape of the letter H, said hinge member having a slot in each elongated side leg, the transverse center portion being severed from slot to slot to thereby form two relatively movable sections, and said sections overlapping so that one section has bearing contact on the other section to provide a fulcrum for the flexing of one section with respect to the other.

8. In an electrical switching device including at least one movable electrode, a flexible hinge member supporting said movable electrode, said hinge member comprising a flat, relatively thin spring in the shape of the letter H, said hinge member having a slot in each elongated side leg, the transverse center portion being severed from slot to slot to thereby form two relatively movable sections, and the outer edge of each leg having a depression formed therein substantially centrally thereof in transverse alignment with the center portion, whereby said relatively movable sections are caused to overlap so that one section has knife edge contact with the other section for fulcruming thereon.

9. In an electrical switching device including at least one movable electrode, a flexible hinge member supporting said movable electrode, said hinge member comprising a flat, relatively thin spring in the shape of the letter H, said hinge member having a slot in each elongated side leg, the transverse center portion being severed from slot to slot to thereby form two relatively movable sections, and a fulcrum member secured to one of said relatively movable sections and overlapping the other section to provide a fulcrum for said other section, whereby said other section has flexing movement about said fulcrum.

10. An electrical switching device as defined by claim 8 wherein the section having knife edge contact with the other section is angularly positioned with respect to said other section.

11. An electric switching device as defined by claim 9 wherein the other section is angularly positioned with respect to the fulcrum member so that said other section has knife edge contact

therewith for said fulcruming action on the member.

12. An electric switch including a sealed container, a pool of mercury therein, a fixed electrode extending into and submerged in the pool of mercury, a movable electrode, and a flexible hinge member supporting said movable electrode from a fixed lead-in wire, said flexible hinge member comprising a flat relatively thin spring having a shape in plan to provide a pair of spaced elongated legs connected by a center transverse portion, said elongated legs each having a slot extending longitudinally thereof, said center transverse portion being severed from slot to slot to thereby form two relatively movable sections, one of said sections of the hinge member being fixedly secured to said lead-in wire and the other section having the movable electrode secured thereto.

13. An electric switch including a sealed container, a pool of mercury therein, a fixed electrode extending into and submerged in the pool of mercury, a movable electrode, and a flexible hinge member supporting said movable electrode from a fixed lead-in wire, said flexible hinge member comprising a flat relatively thin spring having a shape substantially in the form of the letter H, said hinge member having a slot in each elongated side leg, and the transverse center part being severed from slot to slot to provide two relatively movable sections, one of said sections of the hinge member being fixedly secured to said lead-in wire and the other section having the movable electrode secured thereto.

14. An electric switching device as defined by claim 13, additionally including an armature fixed to the movable electrode for magnetically actuating said electrode to produce flexing movement thereof, and wherein as a result of said flexing movement one section has fulcruming action on the other section.

IRA E. McCABE.