Aug. 3, 1943. I. E. McCABE 2,325,785

ENCLOSED MERCURY SWITCH

Filed April 27, 1942

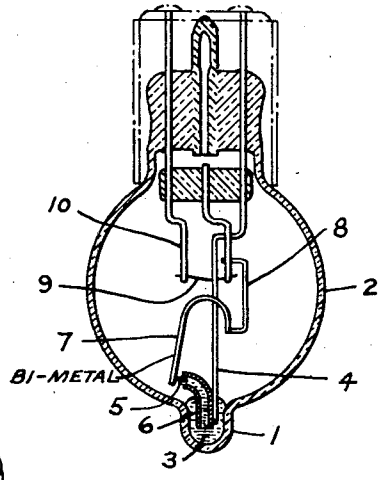



Fig. 1

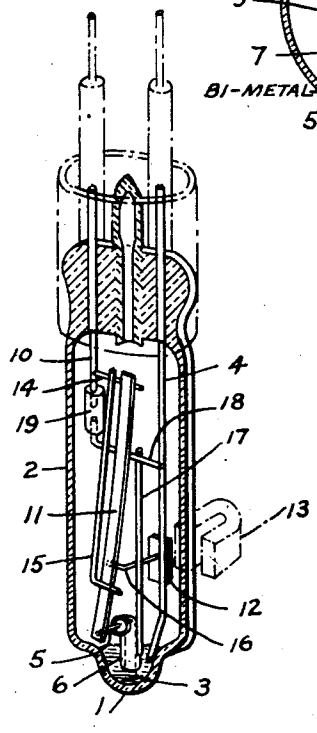



Fig. 2

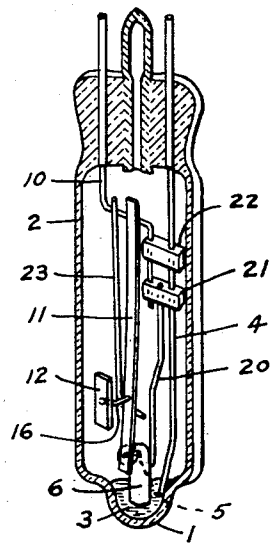



Fig. 3

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# UNITED STATES PATENT OFFICE

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## ENCLOSED MERCURY SWITCH

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Application April 27, 1942, Serial No. 440,685

4 Claims. (Cl. 200—112)

This invention relates to improvements in enclosed mercury switches and more particularly to this form of switch in which a pool of mercury is enclosed in a sealed tube with one electode of the switch arranged to be always immersed in the mercury and the other mounted in such a manner as to be moved into and out of the pool of mercury to close or open the circuit through the switch. In this type of mercury tube switches it has been found that when the switch has been continuously operated over a long period of time as the movable electrode in leaving the mercury causes an arc, a certain amount of the mercury will be vaporized. The vaporized mercury condenses upon the walls of the switch tube and when the condensation gathers in large enough globules, it will slide down the walls into the pool of mercury. Switches of this type are constructed to provide a certain degree of sensitiveness in operation. In most cases, normal operation of the switch will provide a long period of operation before sufficient vaporization may take place to reduce the supply of mercury in the pool to impair the sensitiveness of contact relationship with the movable electrode to cause faulty operation or failure entirely of the switch. There are times when switch operation occurs so rapidly or the switch subjected to overloads that failure of the switch may be brought about in much less time.

Whenever a vaporizaion of the mercury has occurred to impair the operation of the switch, it may be corrected by tapping the switch tube which will cause the condensed vapors of the mercury to become detached from the walls and return to the pool.

It is one of the objects of this invention to eliminate the need for this type of servicing and attention to the mercury tube switch. The majority of switches of this type are employed in automatic devices and it is obvious that the vaporization of the mercury in the pool may not be noticed for some time and the automatic operation impaired. Switches employed in automatic control devices are often located in places not readily accessible for observation or servicing.

Switches of the type referred to are such as disclosed in the Hunciker Patent No. 2,085,316, June 29, 1937. As shown, this type of switch is to be employed with the axis of the tube in a vertical or near vertical plane with a well formed in the lower end to contain the pool of mercury with the electrodes entering from the opposite sealed end, such as shown in this applicant's prior Patents No. 2,154,761, April 18, 1939, and No. 2,159,392, May 23, 1939, and No. 2,162,098, June 13, 1939.

It is an object of this invention to so construct this type of mercury tube switch so as to provide means to maintain a proper supply of mercury at all times so that a constant relationship between the movable contact and the mercury will be maintained.

It is a further object of this invention to accomplish this result by the employment of the principle of capillary attraction to provide a meniscus or globule of mercury above the surface of the well or pool of mercury to serve as a positive contact means for the movable electrode and to maintain a supply of mercury in the well of sufficient quantity to compensate for the possible vaporization of the mercury.

The advantages of such a construction are obvious, and furthermore, will allow of the proper functioning of the switching mechanism even though the mercury tube is tilted to dislodge the mercury pool from its normal position for short periods of time.

With these and other objects in view, reference is made to the accompanying sheet of drawings which illustrates preferred forms of this invention with the understanding that detailed changes may be made without departing from the scope thereof.

In the drawing:

Figure 1 is a view in central vertical section of a mercury tube switch of the flasher type containing the flasher mechanism within the bulb and including a thermostatically actuated movable contact member.

Figure 2 is a similar view partially in perspective, illustrating the application of this improved construction to a switch of the type disclosed in the above said Hunciker patent wherein the movable electrode is normally out of contact with the mercury pool and is actuated by a magnet to close the circuit.

Figure 3 is a similar view of a similar switch wherein the movable electrode is normally in contact with the mercury and is actuated by a magnet to open the circuit.

While each one of the three illustrations of the application of this invention disclose a well 1 formed in the bottom of the sealed mercury switch tube 2 to contain the pool of mercury 3 through which the circuit is closed and opened with the lower end of the fixed electrode 4 immersed in the pool of mercury and the movable

electrode provided with a contact member 5 adapted to be brought into and out of engagement with the mercury to close and open the switch, other forms of actuating means for the movable electrode and variations in switch structures such as disclosed in the aforementioned patents may be employed without departing from the scope of this invention.

In each one of the forms illustrated in Figures 1, 2 and 3, a capillary tube 6 of electrical conducting material, such as copper, is supported with its lower end submerged in the pool of mercury adjacent the bottom of the well and its upper end extending above the pool of mercury to present a meniscus of mercury to be engaged and disengaged by the movable contact member 5 of the movable electrode so that the contact 5 on the movable electrode will enter and depart from the upper open end of the capillary tube and engage and disengage the mercury extending from the pool through the capillary tube to the open end.

In Figures 1 and 2, the capillary tube 6 is supported in engagement with the lower end of the fixed electrode 4 which enters the pool of mercury. In Figure 1, the actuating mechanism includes a strip of bi-metallic metal 7 which is electrically connected through a support 8 and a lamp filament 9 to the other electrode 10 and is normally constructed so that when the switch containing bulb is not connected with the source of electricity, the contact 5 will be in engagement with the meniscus of mercury. When a circuit is established through the switch to the source of electricity, the passage of the current therethrough will cause the filament 9 to become incandescent and the heat therefrom will cause the thermal strip 7 to deform and withdraw the contact point 5 from engagement with the mercury and break the circuit through the switch. Upon cooling of the filament, the thermal strip 7 will return to its original position and renew the circuit through the filament and will continue to create a continuous flashing action as long as the tube is connected to a source of electricity, as fully disclosed in this applicant's co-pending application executed concurrently herewith, Serial No. 440,684, filed April 27, 1942.

In Figure 2, the capillary tube 6 is mounted upon a supporting rod 17 depending from a bracket extending from the fixed electrode 4. The other electrode 10 is connected to the upper end of a resilient conductor strip 11 normally mounting the contact point 5 on the lower end thereof out of engagement with the meniscus of mercury within the capillary tube 6. This strip 11 is provided with an armature 12 adapted to draw the contact point 5 into engagement with the mercury when the armature is brought within the field of a movable magnet 13, when the magnet is moved in proximity to the armature. When the magnet is moved to withdraw its field from the armature, the resilient strip 11 will withdraw the contact point 5 from engagement with the mercury in the capillary tube 6. In this form of construction, it is preferable to rigidly support the upper end of the resilient strip 11 upon a bracket 14 carried upon the electrode 10 upon which is also rigidly mounted a member 15, the lower end of which is bent at right angles thereto to extend into the path of the resilient strip 11 when the magnetic field is withdrawn from the armature 12 to act as a stop therefore to limit the distance the end of the contact 5 is moved away from the meniscus of mercury. The armature 12 is also preferably mounted upon a bracket 16 extending from the strip 11. In this form, the capillary tube 6 is preferably mounted upon the lower end of a supporting rod 17, the end of which is carried upon a bracket 18 extending from the fixed electrode 4 with its free end in engagement with a glass bead or other insulation 19, the opposite end of which is supported upon the other electrode 10. It is also to be noted in this form that the fixed electrode 4 may be in engagement with the capillary tube 6 or may be spaced apart therefrom within the pool of mercury if so desired, as the capillary tube is supported in circuit through the rod 17 and bracket 18 with the intermediate portion of the fixed electrode 4.

In the form shown in Figure 3, the submerged end of the fixed electrode 4 is spaced apart from the capillary tube 6 and the capillary tube 6 supported upon the lower end of a rod 20, the upper end of which is mounted in a glass bead 21 or support of insulating material carried on the fixed electrode 4. It is also preferable to extend the other electrode 10 through a glass bead or other insulation 22 carried upon the fixed electrode 4 above the bead 21 with its lower end engaged in the bead 21 but spaced apart from the capillary tube supporting rod 20. The upper end of the resilient strip of conducting material 11 is rigidly secured to the electrode 10 between the sealed end of the tube and the bead 22 and is so formed that the contact point 5 upon its lower end will normally be received within the open end of the capillary tube 6 and engaged with the meniscus of mercury contained therein. A stop is provided to limit the movement of the lower end of the strip 11 from engaging with or exerting pressure upon the open end of the capillary tube 6 by securing the upper end of a rod 23 to the electrode 10 between the sealed end of the tube and the upper end of the strip 11, the lower end of which rod is provided with a right angular extension to be engaged by the lower end of the strip 11 and act as a stop for the purpose above described. The armature 12 is carried upon a bracket 16 upon the lower end of the strip 11 in the same manner as described in connection with Figure 2. In this form, when a magnet 13 is brought in proximity to the wall 2 of the tube when the magnetic field embraces the armature 12, the armature will be moved in the direction of the wall of the tube to withdraw the contact 5 from the mercury contained in the open end of the capillary tube 6 and break the circuit through the switch. When the magnet 13 is moved away so as to withdraw the influence of its magnetic field upon the armature, the resilient strip 11 will return the contact 5 into engagement with the mercury contained in the capillary tube to again close the circuit through the switch.

A switch of this character employing a capillary tube for the purposes described will operate upon a very small differential of travel of the contact 5. In a switch of this character the contact breaking meniscus of mercury is held in a definite position located at the end of the capillary tube. The contact therewith is made and broken at more definite points than in the Hunciker patent disclosure since tilting, rocking or jarring of the mercury will not affect the making and breaking positions. The operating mechanism since it is hermetically sealed within the tube 2 is not affected by atmospheric pressure and for this reason, together with the aforementioned advantages of the capilliary tube arrangement, switches of this character are thus made available for use in airplanes where heretofore

enclosed mercury switches could not be used because of the dislodgment of mercury from its normal operating position. As shown in Figure 2, a switch of this type can be used in an airplane since movements of the plane in banking, or even if turned over, will not, for the duration of such conditions, affect the normal operation of the switch as there will be mercury contained in the capillary tube 6 connected with the movable electrode 4 through the support 17 and bracket 18, even if the motion of the plane causes the pool of mercury 3 to leave the well 1. With the pool of mercury dislodged from the well the switch will nevertheless continue its normal operation until the vaporization of the mercury within the capillary tube impairs its operation. Since this will take some time the righting of the switch will restore the mercury to the well and as long as it remains in the well 1 to submerge the lower end of the capillary tube, the meniscus of mercury will be maintained indefinitely in operating relationship with the contact point 5.

The switch structures illustrated in Figures 1 and 2 are particularly adaptable for use on airplanes where the switch may be tilted at various angles, and in fact, at times completely inverted. Under these conditions these structures will always remain operative on account of the mercury in the capillary tube which tube is connected in circuit with the fixed electrode. There may be conditions under which it is desirable to break the circuit in the event of undue tilting of the switch so the form in Figure 3 insulates the support of the capillary tube and in the event the pool of mercury is caused to leave the well 1, the circuit will be broken.

If desired, the fixed electrode may be provided with an insulating sheathing extending upon the interior of the switch tube from the sealed end thereof so that in the event the tube is inverted, the pool of mercury collecting at the sealed end will not close the circuit.

What I claim is:

1. An electric switch including a sealed container, a pool of mercury therein, a fixed electrode extending into and submerged in the pool of mercury, an independent capillary tube supported with its lower end submerged in the pool of mercury and presenting a meniscus of mercury above the pool, a movable electrode, means to actuate the movable electrode to engage and disengage the meniscus of mercury.

2. An electric switch including a sealed container having a well formed therein, a pool of mercury contained in the well, a fixed electrode extending through the sealed end of the container terminating adjacent the lower end of the well and submerged in the mercury, a second electrode extending through the sealed end, an independent capillary tube supported in an electrical engagement with the fixed electrode with its lower end submerged in the pool of mercury and presenting a meniscus of mercury above the surface of the pool, a movable contact member mounted in electrical connection with the second electrode and adapted to engage and disengage said meniscus of mercury whereby the switch will remain operative in the event the pool of mercury is caused to leave the well.

3. An electric switch including a sealed container having a well formed therein, a pool of mercury contained in the well, a fixed electrode extending through the sealed end and submerged in the mercury, a second electrode extending through the sealed end, a capillary tube supported with its lower end submerged in the pool of mercury and presenting a meniscus of mercury above the surface of the pool, a movable contact member mounted in electrical connection with the second electrode adapted to engage and disengage said meniscus of mercury, said capillary tube being insulated from the fixed electrode, whereby in the event the pool of mercury is caused to leave the well when the switch is closed the circuit will be immediately opened.

4. A tiltable magnetically actuated electric switch including a sealed container, a well formed of the walls of the container, a pool of mercury contained in the well, a fixed electrode extending into the well, a magnetically attractable movable electrode, means for maintaining a portion of the mercury in positive fixed contact relation with the movable electrode throughout various tilted positions of the switch comprising a capillary tube supported from the fixed electrode having its lower end submerged in the well and presenting a meniscus of mercury drawn from the pool at contact level with the movable electrode and magnetic means to actuate the movable electrode to engage and disengage the meniscus of mercury.

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