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P. K. CRAMBLET

1,937,746

MERCURY SWITCH

Filed April 28, 1928

Fig. 1.

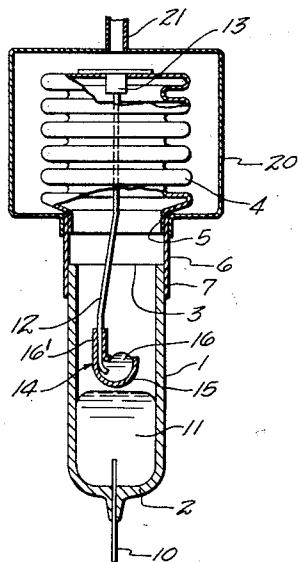


Fig. 3.

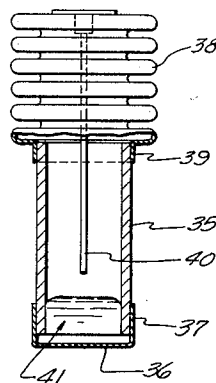
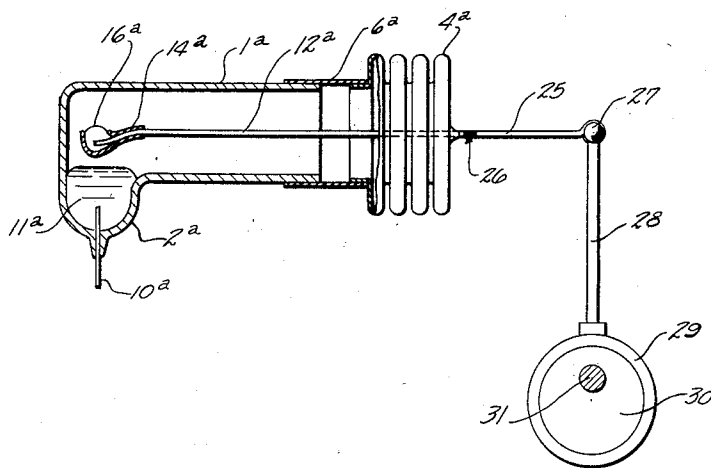


Fig. 2.



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MERCURY SWITCH

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mesne assignments, to Minneapolis-Honeywell
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Application April 28, 1928. Serial No. 273,519

1 Claim. (Cl. 200—152)

This invention relates generally to circuit makers and breakers and more particularly to a switch of the type having a hermetically sealed and evacuated or gas filled container which houses the operating elements of the switch.

One of the objects of the invention is to provide a switch of this type having a flexible or expansible and contractible element, such as a bellows, an elastic or flexible diaphragm or a flexible disk incorporated in the structure of the container and operable to cause the switch to make and break an electric circuit. Such a flexible element, being susceptible of convenient operation in a variety of ways, may be responsive to a fluid pressure control or to the operation and control of mechanical operating mechanism, and is utilized to actuate or control the operation of the contact making and breaking elements of the switch. In a mercury switch, these contact making and breaking elements may be so constructed and so organized with the flexible element as to provide a mercury to mercury make and break, or a make and break between a body of mercury and a movable electrode connected with and actuated by or through the flexible element. This organization has the advantage of permitting the container to remain stationary, if desired, and yet the switch may be operated at the desired speed and may be made extremely sensitive and accurate in its operation.

In one embodiment of the present invention a mercury switch is provided which comprises an outer container made up of a glass envelope having an opening and a flexible element, for example a bellows having a sleeve or flange fused and sealed to the glass envelope around the margin of its opening. Within the container circuit making and breaking means is provided and includes a body of mercury in constant electrical connection with one side of the circuit either through an electrode sealed in through the glass envelope or through a metal cap fused and sealed to the glass envelope and in constant contact with the body of mercury or otherwise. A movable electrode of the rod or solid type is carried by the bellows or other flexible element and is positively actuated or controlled thereby. This movable electrode is also in constant electrical connection with the opposite side of the circuit either through the bellows on which it is carried or otherwise. The movable electrode may be made to make and break contact with the body of mercury when actuated by the flexible element or may carry a trap or cup containing a body of mercury which makes and breaks with the stationary body of

mercury under the control of the bellows. The flexible element is susceptible of operation and control in any number of different ways. For instance, either fluid pressure or mechanical means may be utilized to control the expansion and contraction of the bellows, or the flexion of the flexible element and such movement or flexion of the bellows or other flexible element is utilized to actuate the contact making and breaking elements of the switch. The flexible element operates to cause the actuation of the contact making and breaking elements of the switch positively for both the making and the breaking operations as it is positively connected to the movable electrode.

Other objects and advantages reside in certain novel features of the construction, arrangement and combination of parts which will be hereinafter more fully described and particularly pointed out in the appended claim, reference being had to the accompanying drawing forming a part of this specification, and in which:

Figure 1 is a view partly in section and partly in elevation showing one form of mercury switch embodying the present invention;

Figure 2 is a similar view showing a somewhat different form of switch; and

Figure 3 is a similar view showing still another form of switch.

Referring to the drawing, and more particularly to Figure 1, it will be seen that in the embodiment of the invention shown the switch comprises an hermetically sealed container made up of a glass envelope 1 having one end closed as at 2 and having its other end provided with an opening 3. The envelope 1 may be of any suitable glass composition. A flexible element which may be a bellows 4 is provided and may be made of copper, nickel, Monel-metal, or of any other material having the properties making it suitable for this use. Preferably the metal of which the bellows is constituted is substantially unaffected by mercury or has a coating of metal unaffected by the action of mercury. In addition, the metal utilized or its coating should be non-porous as the container is evacuated to a commercial vacuum and filled with an inert arc suppressing gas. Nickel rolled in vacuum is one example of such a non-porous metal. The bellows 4 has an integral flange 5 fitted in and welded or otherwise secured to one end of a sleeve 6 constituted of the same metal as the bellows and having its opposite end fitted over the open end 3 of the glass envelope or tube 1, and fused and sealed thereto. This fusion and

sealing is accomplished by heating the sleeve and consequently also the interfitted portion of the envelope 1 until the glass making up the envelope is in a somewhat plastic state. During this heating action the sleeve 6 and the envelope 1 are rotated so that the plastic end of the envelope is displaced into intimate contact with the inner surface of the sleeve and becomes fused and sealed thereto to provide a permanent mechanical connection as well as a seal over a substantial area between these parts. This method of uniting the envelope 1 with the metal sleeve is fully set forth, described and claimed in the co-pending application of Clifford Hotchkiss, filed January 7, 1928, Serial No. 245,238, to which reference is made for a full disclosure of this method. It is obvious that the sleeve 6 instead of being a separate element may be formed integrally with the bellows.

An electrode 10 is sealed in through the closed end 2 of the glass envelope 1 and is immersed in a body of mercury designated at 11. A movable electrode 12 of the rod or solid type is soldered, welded, or otherwise appropriately secured as at 13 to the end plate of the bellows 4 and this movable electrode projects into the glass envelope 1 and is operatively related to the body of mercury 11. The movable electrode 12 is characterized as of the rod or solid type in the sense that it is constituted of a metal or other conductive substance existing in a solid state as distinguished from a liquid electrode, such as mercury. At its inner end the electrode 12 carries a cup or trap 14 which may be of hard glass or of any other suitable arc resisting material or other composition or substance, the trap 14 having a cupped shape body portion 15 open at its top and also having an integral attaching sleeve 16' embracing and securing to the electrode. A small body of mercury designated at 16 is contained in the trap 14.

It is to be understood that the trap 14 may be omitted and, in such event, the movable electrode has direct contact with the body of mercury 11 in the closed position of the switch.

In the form of the invention shown in Figure 1 the bellows 4 is housed in a pressure chamber 20 having a pipe 21 which leads to any source of variable fluid pressure or control means which of itself forms no part of the present invention. In the chamber 20 the pressure rises and falls to cause expansion and contraction of the bellows. When the bellows is compressed or contracted, electrode 12 is moved downwardly and the trap 14 is lowered down into the body of mercury 11 so that this body of mercury 11 unites with the body of mercury 16 over the lip of the trap 14. Upon lowering of the pressure in the chamber 20 the inherent resiliency of the bellows 4 and the gas pressure previously set up in the switch by the contraction of the bellows causes it to expand thereby raising the electrode 12 and its trap 14 to cause the body of mercury 16 to separate from the body of mercury 11 over the lip of the trap thereby breaking the electrical circuit in which the switch is incorporated. Thus, the electrode 12 is positively moved in both directions. It is to be understood that one side of the circuit is connected to the electrode 10 and the other side is connected to the electrode 12 through the sleeve 6 or through the bellows.

While this and the other forms of the invention illustrated contemplates especially metal to mercury or mercury to mercury contact, the invention is not restricted to these types of con-

tact making and breaking means but may utilize any types of contacts such as metal to metal contact or contacts of other conductive materials. Whatever may be the character of the contacts, the advantages of the hermetically sealed container and of the flexible operating member incorporated therein are always realized.

The switch shown in Figure 2 has an hermetically sealed container including a glass envelope 1^a similar in construction to the glass envelope 1 but horizontally disposed in its operative position and provided with a well 2^a containing a body of mercury 11^a into which an electrode 10^a projects. A flexible element which may be a bellows 4^a is provided and is of the same construction as the bellows 4 and has a gas tight connection with the glass envelope 1^a as by means of a sleeve 6^a welded to the flange of the bellows and fused and sealed to the glass envelope, as in the form of the invention shown in Figure 1. The switch of Figure 2 also has a movable electrode 12^a soldered or welded to the bellows and carrying a trap 14^a in which a body of mercury 16^a is contained. The trap 14^a may be omitted so that the electrode 12^a will make and break contact with the body of mercury 11^a, if thus desired. In this form of the invention the electrode 12^a is rocked to cause the bodies of mercury 11^a and 16^a to unite and separate to make and break the circuit in which the switch is incorporated. This rocking of the electrode 12^a may be accomplished in any suitable manner. One means for rocking the electrode 12^a is illustrated diagrammatically in Figure 2, and may consist of an arm 25 formed as an extension of the electrode but located exteriorly of the container and also appropriately insulated from the electrode as indicated at 26. The outer end of the arm 25 has a suitable connection 27 to a connecting rod 28 secured to an eccentric strap 29 embracing an eccentric 30 mounted on a drive shaft 31. As the drive shaft 31 is turned the connecting rod 28 arises and lowers to rock the arm 25 and consequently also to rock the electrode 12^a, the bellows 4^a permitting this operation.

The switch shown in Figure 3 is very similar to that shown in Figure 1 and includes a glass envelope 35 having its lower end closed by a metal cap 36 constructed of non-porous metal substantially unaffected by mercury or constructed of a metal having a non-porous coating substantially unaffected by mercury. The cap 36 has its flange 37 fused and sealed to the lower end of the glass envelope 35 over a substantial area by the method fully set out in the Hotchkiss application above referred to. A flexible element which may be a bellows 38 is provided and has a flange 39 fused and sealed to the upper end of the glass envelope 35. The end plate of the bellows carries a movable electrode 40 co-operable with a body of mercury designated at 41 and contained in the lower end of the envelope 35 and in direct contact with the cap 36. It will now be appreciated that the switch of Figure 3 is identical with that shown in Figure 1 except that the trap on the electrode is omitted and that a different method is utilized for closing the lower end of the glass envelope. Figure 3 also illustrates how the flange or sleeve between the bellows and glass envelope may be formed integral with the envelope. Any suitable operating mechanism may be provided for the bellows 38 to cause it to expand and contract and move the electrode 40 into and out of contact with the body of mercury 41. The cap 36 always contacts with the mercury and serves not only as a closure but also as an

electrode and makes it unnecessary to use lead in wires.

In all embodiments of the invention the switch is sensitive though positive in its operation. Even
5 where a mercury to mercury make and break is had the flexible element is not loaded with a heavy column of mercury but carries only the small amount of mercury in the trap. And due to the positive fastening of the rod type or solid
10 type of electrode to the flexible element the movable electrode is positively moved in both directions either when oscillated or reciprocated.

From the foregoing it will be appreciated that in all embodiments of the invention the flexible
15 element is utilized without impairing or rendering difficult the hermetic sealing of the container. In other words, by fusing and sealing the flexible element to the glass or plastic envelope the necessity of employing mechanical packing is avoided
20 and a permanent and true seal is had. This permits the container to be evacuated and if desired filled with an arc suppressing gas and yet the circuit making and breaking means may be operated from the exterior by a positive mechanical means and with the container in a fixed
25 position.

Another important advantage resides in the organization by which the movable electrode is positively moved to both of its positions. This
30 follows from the positive connection or fastening

of the electrode to the flexible element and from the use of one electrode of the rod or solid type as distinguished from a liquid or mercury electrode. And yet with a movable electrode of this character the switch may have a mercury to
80 mercury make and break without loading the flexible element with a heavy column of mercury as the movable electrode may be equipped with a trap as described.

I claim:

A mercury switch comprising a sealed envelope including a cup portion, a body of mercury in said cup portion, a sylphon bellows sealed to a wall of said envelope, a stationary electrode sealed to a wall of said envelope and immersed in the mercury
90 in said cup portion, and a second electrode movably sealed in another part of the envelope and normally out of contact with the mercury in the envelope, the movable electrode being connected to and movable by said bellows, said bellows being
95 flexible and capable of deformation to an extent sufficient to relatively move the movable electrode and the mercury in the cup to cause the movable electrode to dip into said mercury to make contact between said electrodes through the mercury,
100 and to move the electrodes with respect to each other to still further reduce the fluid path between the electrodes.

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