March 10, 1936. P. S. BEAR ET AL 2,033,372

SWITCH

Filed April 12, 1933 2 Sheets-Sheet 1

Fig. 1.

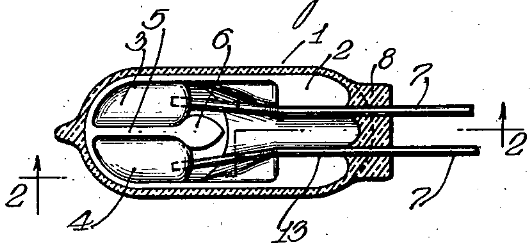


Fig. 2.

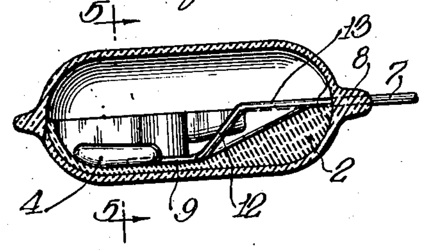


Fig. 3.

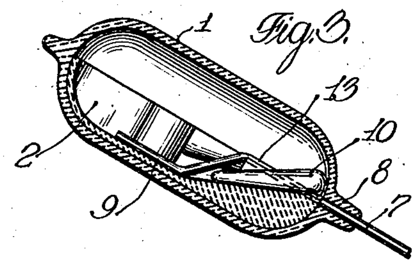


Fig. 4.

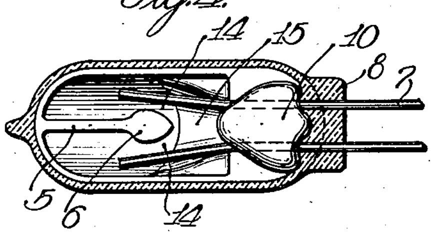


Fig. 5.

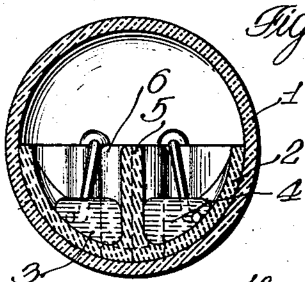


Fig. 6.

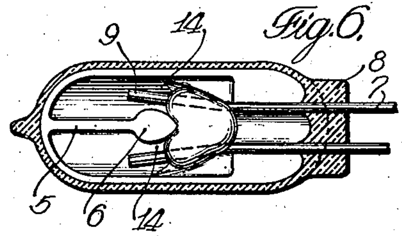


Fig. 7.

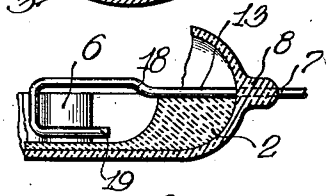


Fig. 8.

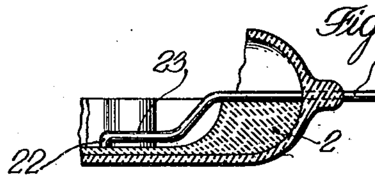
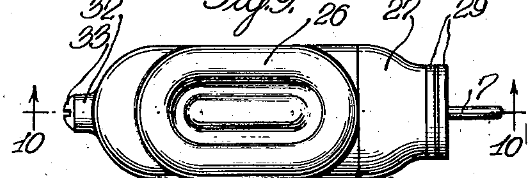


Fig. 9.



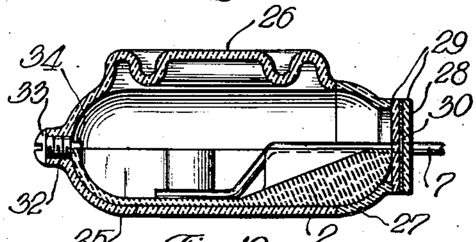


Fig. 10.

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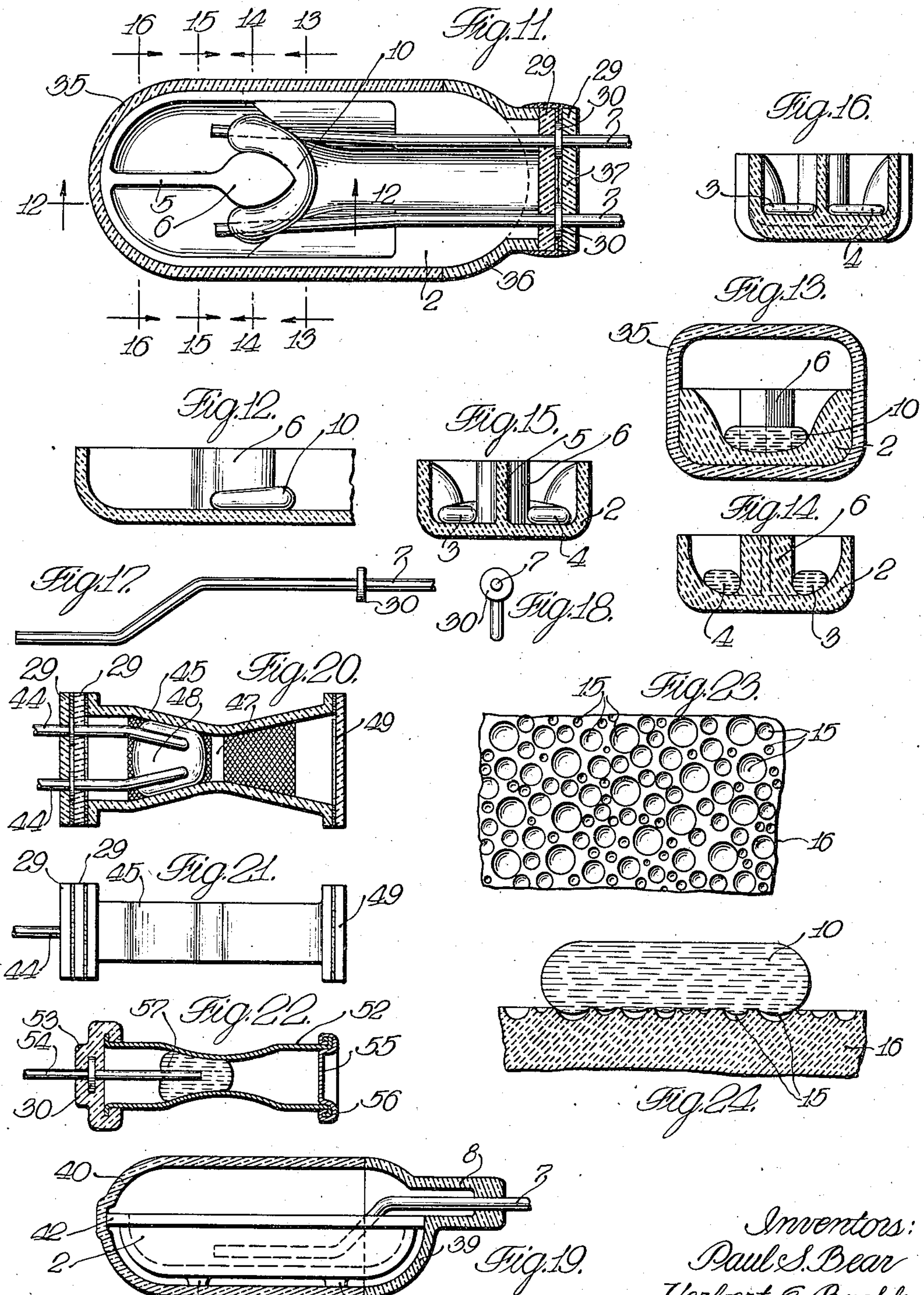
March 10, 1936. P. S. BEAR ET AL 2,033,372

SWITCH

Filed April 12, 1933 2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,033,372

SWITCH

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Application April 12, 1933, Serial No. 665,654

11 Claims. (Cl. 200—152)

Our invention relates to switches and the like. The particular embodiment disclosed herein is a gravity operated mercury switch. The invention is particularly advantageous to switches of that class but it is not our intention to confine the invention to that class of devices, as certain phases of the invention have utility in other classes of devices.

Enclosed mercury switches of the gravity operated type have come into wide use for circuit control under conditions where exposed contacts are subject to deterioration by atmospheric and other influences. Being enclosed they are less able to dissipate the heat generated by the flow of current therethrough and particularly the heat evolved as the switch approaches interruption of the circuit, or as it closes the circuit, and also during actual interruption. The resistance of mercury is relatively high and it is a known fact that as the mercury begins to attenuate on approaching interruption, a very considerable amount of heat may be evolved.

In devices of this class as heretofore constructed the conduction of such heat to the seal where the terminals enter the envelope has resulted in opening of the seal or cracking of the envelope. Hence it has been difficult to construct practical switches of this class for anything but small current flow and low wattage.

It is the chief object of our invention to improve the construction and mode of operation of switches of this class to secure greater freedom from injury, particularly by heating.

A further object of the invention is to increase the capacity of switches of this class.

According to one phase of our invention, we provide a novel form of envelope in place of the glass or rigid insulation heretofore employed. With this construction, construction is facilitated and permanent tightness of the envelope, particularly at the seal, is more readily maintained, even under adverse conditions.

According to another phase of our invention, we provide a separate mercury container of heat resistant material, particularly designed for sustaining the localized heat of the arc formed upon interrupting the circuit.

Another feature of our invention consists in providing a liquid filling of insulating material, which has the important dual function of assisting in extinguishing the arc of interruption and of transferring heat engendered by the current flow more freely to the container and equalizing the temperature of the device, thereby reducing the concentration of heat upon the seal.

Further, we provide as an optional form of the invention a metallic envelope which is provided with increased heat radiating surface, and, preferably, at the same time, is expansible and contractible with variations of internal pressure such as may be caused by heat.

A further improvement resides in the provision of inleads of a novel construction designed, among other purposes, to conduct heat more freely and dissipate the same from the interior of the switch.

Another important feature of our invention resides in the construction of the channels for the mercury, to provide a latching in and latching out effect, for more positive action in opening and closing the circuit.

Another feature of improvement is the provision of a novel character of surface of either the walls of the mercury container, the envelope, the electric terminals, or all such parts as may be in contact with the mercury. We have discovered that the friction of the flow of mercury with the surface on which it rests, or against which it bears, may be greatly reduced by honeycombing or pitting these surfaces.

It is another important object of our invention to improve the structure of switches of this class, both for greater ease and lower cost of construction and for greater uniformity in manufacture. According to known processes of manufacture there is an unavoidably large percentage of rejects. Our invention aims to reduce this.

Among the novel features contributing to this object is the construction of the envelope of a material separate and distinct from the mercury container. By constructing these parts separately, each may be designed and constructed best to perform its individual purpose or purposes. For example, the envelope may be made, in whole or in part, of cellulose acetate, which is easily worked, molded and joined. The mercury container may be made, in whole or in part, of unglazed porcelain, constructed by the wet process or the dry process, or it may be made of any similar material.

The switch may be made up of a metal container, sealed with a molded insert, and a single electrode or inleads employed. The surfaces of the metal parts in contact with the mercury may be treated to give them a honeycombed or scratch finish, as by sand blasting, brushing, or

the like, to control the friction of flow of the mercury in contact therewith.

Numerous improvements in detail will be apparent from the following detailed description, drawings and claims.

Now in order to acquaint those skilled in the art with the manner of constructing and operating the device embodying our invention, we shall describe, in conjunction with the accompanying drawings, a specific embodiment of the invention.

In the drawings:

Figure 1 is a horizontal sectional view of a switch embodying our invention;

Figure 2 is a vertical longitudinal section of the same taken on the line 2—2 of Figure 1;

Figure 3 is a view similar to Figure 2, except that the switch has been tilted through a large angle and is in circuit closing position.

Figure 4 is a horizontal sectional view similar to the view of Figure 1, showing the mercury in the position indicated in Figure 3;

Figure 5 is a transverse cross-sectional view taken on the line 5—5 of Figure 2;

Figure 6 is a longitudinal horizontal section of the unit like Figure 1, but showing the mercury in position to close the circuit;

Figure 7 is a fragmentary longitudinal sectional view showing a modified construction of the electrode or inlead;

Figure 8 is a similar view showing another form of electrode or inlead;

Figure 9 is a top plan view of a modified form of switch;

Figure 10 is a vertical longitudinal section taken on the line 10—10 of Figure 9;

Figure 11 is a horizontal longitudinal section of a modified form of switch employing a transparent molded envelope and a ceramic mercury container;

Figure 12 is a fragmentary sectional view on the line 12—12 of Figure 11, showing the position of the mercury with respect to the dividing vane;

Figure 13 is a cross-sectional view on the line 13—13 of Figure 11;

Figure 14 is a cross-sectional view on the line 14—14 of Figure 11;

Figure 15 is a cross-sectional view on the line 15—15 of Figure 11;

Figure 16 is a cross-sectional view on the line 16—16 of Figure 11;

Figure 17 is a side elevational view of the inlead employed in the structure of Figure 11;

Figure 18 is an end view of the inlead shown in Fig. 17;

Figure 19 is a longitudinal vertical section through a modified form of switch, showing the ceramic mercury container spaced from the walls of the envelope;

Figure 20 is a horizontal longitudinal section of a modified form of switch;

Figure 21 is a side elevational view of the same;

Figure 22 is a horizontal longitudinal section of another form of switch embodying our invention;

Figure 23 is an enlarged fragmentary elevational view of a honeycombed surface such as we employ in certain parts of our switch; and

Figure 24 is a sectional view through a globule of mercury resting upon a surface such as shown in Figure 23.

Referring first to the switch shown in Figures 1 to 6, this structure includes a tubular glass envelope 1, within which is contained a mercury container, in this case a ceramic such as unglazed porcelain, which serves to hold the mercury which, in Figure 1, is shown in two globules, namely, 3 and 4, on opposite sides of a partition 5, the forward portion of which partition constitutes a separator 6. A pair of electrical conductors 7, 7 generally termed "inleads", extend through the wall of the envelope 1, a seal being formed at 8 about the inleads. The inner ends of the inleads 7, 7 are adapted to contact with the globules of mercury 3, 4 in any of the normal operating positions of the switch. The inner ends of these inleads rest on the floor of the mercury container on opposite sides of the separator 6. The mercury container 2, which is preferably formed of unglazed porcelain, is manufactured separately and is employed as an insert within the envelope. The inleads 7 constitute, in this form of switch, a horizontal portion 9 resting upon the bottom of the mercury container, a diagonal portion 12 extending from the bottom of the container upwardly, and a horizontal portion 13. Both the portions 9 and 13 may engage the adjacent surface of the ceramic insert to hold the same in place, or engagement of either portion with the ceramic may be employed for this purpose. The shape of the passageways 14, 14 on either side of the separator 6 is such as to produce a gradual constriction to a central portion of maximum constriction and then an expansion thereafter in the direction of flow. This is for the purpose of giving the mercury a latching in and latching out effect. That is to say, the tendency of the mercury to remain in circuit closing position until a definite gravity action overcomes the tendency to remain stationary, and the tendency to remain in circuit opening position until, likewise, a gravity action becomes great enough to cause motion, is secured by this construction.

Consider the switch as shown in the position of Fig. 1 with the mercury globules 3, 4 back of the separator 6. The partition 5 separates the two bodies of mercury and the enlargement at 6 tends to hold them in place. If, now, the switch as shown in Figs. 1 and 2 be tilted in a clockwise direction, as the motion proceeds the right-hand end of the switch shown in Figure 2 will begin to tilt downwardly, that is, lie below the left-hand end and the tendency will be for the mercury bodies 3, 4 to pass the separator and join in the space 15 in front of the nose of the separator 6. However, the necessity for laterally deforming the mercury to enable it to pass through the constricted portions 14, 14 requires a definite, though small, force. The tendency, therefore, is for the mercury to increase in vertical thickness, that is, to assume a higher gravity head by reason of the force required to deform the same laterally. Then, as soon as the component of gravity, acting upon the bodies 3, 4, has become great enough to force one or the other of these bodies through its corresponding channel 14, there is a tendency for the flow, after it is once initiated, to continue and, in effect, to overthrow the position which would represent an approach to stable equilibrium gradually. The necessity for piling up the mercury in front of the most constricted portion gives an excess of operating force which causes this overthrow.

When the switch is to be moved to the opposite position, that is, from circuit closing position to circuit opening position, the reverse action occurs. The breaking of the circuit is illustrated in Figure 11.

It is, of course, well recognized that mercury

always tends to assume a globular form, as does any liquid when removed from other influences, due to the surface tension. The surface tension of mercury is quite strong and where the mercury does not wet the contacting surface the surface tension is important in controlling the shape of the body of mercury.

As the switch is tipped in counter clockwise direction, see for example Figure 6, where the body of mercury begins to be forced through the channels 14, 14, it will resist deformation but will gradually be forced into the channels 14, 14 until, with the building up in vertical height of the mercury and sufficient component of gravity being present, it will suddenly proceed through the channels 14, 14 and run into the pockets on each side of the partition 5. After the mercury has once receded from the position shown in Figure 6 to the position shown in Figure 11, it will proceed to a break. The tendency of the mercury to assume a globular form assists in this break for the reason that as a considerable body of mercury forms beyond the most constricted portion of the channels 14, 14 on each side of the separator 6, the mercury there tending to assume its globular form pulls upon the mercury remaining in front of the separator 6 and thereby assists in the separation of the two portions.

A minor variation in lateral leveling of the switch is relatively unimportant. However, it is desirable that the switch be leveled up transversely, so that approximately equal parts of the mercury form the bodies 3, 4 throughout the operation of the switch. Tilting of the switch to an extreme closed position or an extreme open position does not alter the circuit controlling relation of such position. That is to say, in moving the switch from open to closed position the angular motion may be extreme but it does not change the circuit conditions. Likewise, when the switch is tilted toward the open circuit position and the mercury is once broken, continued tilting in that direction will not again close the circuit.

The mercury container 2, which is formed as a separate body, is preferably made of porcelain, either by the wet process or the dry process. The wet process gives much greater strength and density and, particularly for the purpose of breaking the arc across the nose of the separator 6, such formation of the insert is desirable. However, it may be made by the dry process, which is considerably cheaper and, under certain circumstances, equally suitable with the wet process porcelain.

We have discovered that by the use of unglazed porcelain, sand blasted glass, or, in fact, any such material the surface of which is full of cellular pockets, herein termed a "honeycombed" surface, the freedom of flow of the mercury on the surface may be greatly increased. We refer to Figures 23 and 24 in explanation of the same. It is well known that the surface of unglazed porcelain is irregular and characterized by fine cellular depressions or pores, particularly in the case of dry process porcelain. Sand blasted glass similarly has fine pits or craters formed in the surface. We have found that a globule of mercury resting on such a surface can move far more freely than if the surface were smooth and uninterrupted. It appears that the mercury has this freedom on such a honeycomb surface for two reasons. First, the mercury being non-capillary and having such a high surface tension, and failing to wet the surface on which it rests, tends to rest only upon the high point of the surface, the surface tension tending to bridge the low spots. Second, these cells tend to trap air, assuming the surface to be dry, and the mercury rests then partly upon the high spots and partly upon the entrapped air. The air thus serves as a lubricant.

In the case of a liquid filling such as we employ in certain forms of our invention, the liquid arc extinguishing material tends to wet the surface of the porcelain or sand blasted glass, and instead of a gas being trapped in the pockets such as 15, 15, liquid is trapped therein and serves as a lubricating medium between the mercury and the surface of the body 16 with which it engages. The arc extinguishing liquid fills these small pockets, or pits, and is particularly useful in providing liquid directly in contact with both the mercury and the insulation, protecting the insulation directly from the heat of the arc and, by vaporization under the mercury, tending to drive the mercury away and thereby increase the length of and extinguish the arc.

This principle of forming a self-lubricating surface for use in connection with mercury may be employed where a ceramic insert, such as porcelain, may be employed, or if the mercury rests in direct contact with a glass envelope the surface of the glass with which the mercury is to contact may be treated, as by sand blasting, to incorporate the large number of surface depressions to give the desired honeycomb effect. Any other material with which the mercury comes in contact in the course of its operation may be similarly treated, either in whole or in part, in order to govern the relative freedom of movement of the mercury at its different positions.

The liquid filling which may be employed in the switch shown in Figures 1 to 6 and, in fact, in the various forms of our invention, is preferably a halogen derivative of a hydrocarbon. For example, the arc extinguishing liquid may be carbon tetrachloride, trichloroethylene, tetrachloroethylene, tetrachloroethane, or the like. In fact, various compounds or derivatives of halides and hydrocarbons may be employed in this connection. Likewise, hydrocarbons alone may be employed as arc extinguishing mediums. One example of a suitable compound for use in this connection is trichloro-fluoro-methane.

By making the mercury container and the envelope of separate parts it is possible to design each properly to perform its own function, without compromise with respect to the other. Also, the tendency for heat to be concentrated upon the seal 8 is reduced. The separator 6, across the nose of which the chief heating effect occurs, may be made a separate piece but preferably is integral with the remainder of the container. By employing a filling of a light insulating and arc extinguishing liquid such as the hydrocarbon derivatives above mentioned, there is a tendency, first, to keep the surface of the porcelain wet with the arc extinguishing liquid and to preserve it, therefore, against injury by the arc. Second, the presence of the arc extinguishing liquid in the pores of the porcelain tends to give an improved arc extinguishing effect; and, third, the presence of the arc extinguishing liquid within the envelope tends to equalize the heat and carry the same from the hotter portions of the switch to the colder portions, and to provide a much greater radiating surface by conveying heat to all parts of the envelope.

The electrodes or inleads may be constructed

to assist in this equalization of the heat, and may be so formed as to subject them more freely to the cooling effect of the liquid filler. For example, in Figure 7 we have shown the inleads or electrodes **18** as extending through the seal **8** and then forming a loop to approach the position of the channels on each side of the separator **6**. In this way a greater length of the inlead is exposed to the cooling or heat distributing effect of the filling liquid between the portion where heat is received and the sealed portion **8**.

In Figure 8 the inlead is shown as comprising an end portion which engages the bottom of the ceramic insert **2**, and then a horizontally extending portion **23** lying above the floor of the insert. In each case the length of conductor exposed to the cooling effect is thereby increased. Also, greater freedom for the flow of the mercury is thereby provided.

The conductors which form the inleads or electrodes may be made of copper with a chromium plating thereupon, or they may be made of the well known materials such as iron, or alloys of iron, stainless steel, etc. Preferably, but not necessarily, we make these inleads of a larger diameter than has been customary heretofore and, by providing the cooling effect of both the ceramic across which the inleads extend and the filling where it is used, less danger of injury to the seal is caused.

It will be observed that the upper horizontal portion **13** (see particularly Figs. 1 and 2) extends in quite intimate contact with the thickened portion at the right of the mercury container **2**, hence, if the inlead is subjected to heating, it tends to equalize with the porcelain insert **2** before the heat is conducted to the seal **8**.

In Figures 9 and 10 we have shown a modification in which the envelope is formed of cellulose acetate. This material is substantially transparent and is of a fairly clear color. It is flexible in thin section, although of sufficient rigidity to serve the purpose desired. It may be easily shaped, pressed and molded, particularly when heated to approximately the temperature of boiling water, and it is readily dissolved in certain solvents such, for example, as acetic anhydride. The envelope may be constructed of sections, which are then joined by wetting the adjacent edges with solvent and pressing them together, or by a suitable cement which contains a solvent, to join adjacent parts.

In the form shown in Figures 9 and 10 the ceramic insert **2** is substantially like that disclosed in connection with Figures 1 to 6. The envelope **1** is formed in sections. The main body section **25** may be a straight tubular piece with a closed end. In the form shown in Figures 9 and 10 we have provided this section with an expansible portion **26** to take care of pressure arising due to heating of the filling liquid or gas. It also serves the important function of increasing the cooling area, particularly where there is a filling of liquid or gas. The neck portion **27** joins the body portion **25** and the seal portion **28**. This seal portion may be made integral with the neck **27** or it may be made, as shown in Figure 10, of two separate plates **29, 29** having suitable openings or holes therethrough for receiving the shanks of the inleads **7, 7** and for engaging upon opposite sides of the integral flange **30** formed on the shank of the inlead as shown in Figures 17 and 18. The two plates **29, 29** are assembled on opposite sides of the flange **30** and then cemented together or heated and pressed together to coalesce and form a tight seal. The inner plate **29** may be made integral with the neck portion **27** if desired. The body of mercury may be inserted prior to the joining of the neck and body portion or it may be introduced afterward, as desired. For this purpose a small filling opening is provided in the boss **32** and this opening may then be closed by the screw **33** which, before being threaded into the opening, is smeared with a cement or solvent to join it to the body of the boss **32**. The inner end of the screw **33** may have a projecting portion **34** extending over the edge of the ceramic **2** to hold it in place.

The operation of this form of the device is like that previously described in connection with Figures 1 to 8. It is to be understood that while glass cannot be satisfactorily formed into a flexible portion such as **26**, nevertheless the glass envelope may be corrugated to increase the heat radiating capacity, particularly where a liquid filler is employed.

Where the envelope is of a material which might be dissolved by a liquid filling of a chlorinated hydrocarbon or the like, or affected thereby, we use as the liquid filling pure water with sufficient admixture of a non-freezing component, such as alcohol, glycol, or the like, to maintain the same in fluid condition at all temperatures. Water is an excellent arc extinguishing medium and it also has a high thermal capacity.

In Figures 11 to 16 we have shown a modified form of switch employing the cellulose acetate envelope. In this case the envelope is substantially rectangular in cross-section, the corners being suitably rounded. The body portion of the envelope **35** has a completely closed end at the left, as viewed in Figure 11. The porcelain or ceramic insert **2** is slipped into the same telescopically and then the neck portion **36** and seal portion **37** are joined to the main body portion **35** with the inleads **7, 7** in place. The ceramic insert **2** is preferably shaped to fill out completely the bottom part of the envelope so that the mercury cannot escape into any crevices between the envelope and the ceramic insert during shipment or during use. Since the cellulose acetate envelope may be easily softened, either by heat or by solvents, it is comparatively easy to telescope these parts together sufficiently to make a close fit of the envelope with the ceramic. A suitable cement may be be inserted between the side and bottom walls of the ceramic and the envelope to fill up any space which might appear.

In Figure 11 the operation of opening the circuit between the inleads **7, 7** is shown. That is to say, the body of mercury **10** is just moving towards the open position. It will be seen from Figure 12 that the height of the body of mercury **10** in advance of the nose of the separator **6** is higher than that of the portions which have passed through the most constricted part of the passageway. While the mercury has very little rigidity, it nevertheless resists distortion, and may be considered as a concrete, definite body of very little strength.

In the sections of Figures 12 to 16, inclusive, the inleads or electrodes have been omitted for the sake of clearness. In Figure 16 it is assumed that the mercury has been completely divided into its portions **3, 4** and these have spread out to minimum thickness to fill the space between the partition **5** and the side walls. The other views, **12, 13, 14** and **15**, show the mercury in the transitional position illustrated by Figure 11.

Instead of dividing the envelope transversely, as we have shown, it may be divided longitudinally on the line of the conductors 7, 7 or in any other desired manner.

The flanges 30 on the conductors or inleads 7, 7 are preferably secured by welding, brazing, soldering, or the like, to secure a tight connection to prevent gas leakage along the surface of the conductor. A sufficiently tight joint may be made by mechanically shrinking the flange 30, it being in the shape of a washer, but it is better to weld, braze or solder the parts into intimate gas-tight union.

While we have described the ceramic insert 2 as fitting closely within the lower part of the envelope, it is to be understood that it is not essential that the parts be in extensive contact. It is desirable to provide no crevice into which the body of mercury could, in whole or in part, be lodged. In Figure 19 we have shown the ceramic insert as provided with a flange 42 which fits against the inner walls of the envelope 40 to provide a substantially mercury-tight joint, the other portions of the ceramic insert 2 being spaced away by projections such as 43, 43. In this event the space is preferably filled with an insulating liquid of the type heretofore discussed, to assist in transferring heat from the ceramic material 2 to the walls of the envelope. The seal of the envelope upon the inlead 7 may be made much as in the case of glass, by fusion and by compressing the material of the envelope or neck portion 39 upon the inlead 7.

While in the above forms of our invention we have disclosed the separator 6 as disposed in such a position as to divide the body of mercury into two parts for the purpose of breaking the connection between the inleads, our invention contemplates other means of performing this interruption of the circuit, as shown, for example, in Figures 20 and 21. In this construction the inleads 44 extend into one end of the constricted envelope 45. Preferably this envelope is made of cellulose acetate, although it may be made of bakelite, or any other molded material, if desired. The interior surface of the envelope 45 is honeycombed along the side and bottom walls, as indicated at 46, on either side of a central portion 47 which is of smooth or flat surface. A body of mercury 48 is adapted to connect the inner ends of the inleads 44 and is adapted to extend through the central restricted portion in breaking the circuit between said inleads. The inleads are sealed into the envelope as by means of the plates 29, 29 lying on opposite sides of the flanges 30 on the inleads 44, and being cemented together. These plates may then in turn be cemented to the end of the envelope 45 which has a suitable flange for this purpose. At its opposite end the envelope 45 has a similar flange for cementing the closing plate 49 thereto. Obviously, instead of a separate closure plate, one end of the envelope may be provided with an integral closure.

If the switch shown in Figure 21 is subjected to tilting so that the right-hand end tilts down, the body of mercury 48 tends to crowd into the narrower portion, where it meets the two restraining forces, namely, the smooth part of the walls 47 and the constricting effect of these walls upon the body which body tends to remain as nearly as possible in globular form. However, as soon as a substantial part of the mercury has begun to move beyond the constricted portion, the motion will continue to the point of breaking the connection between the electrodes 44, 44.

Upon reverse tilting the action is repeated, that is, there is first a holding back effect and then, when the mercury does begin to move, it proceeds to an overthrow, thereby accomplishing the latching in and latching out effect heretofore mentioned.

In Figure 22 we have illustrated a modified form of our invention in which the envelope is formed of sheet metal such as iron, stainless steel, or the like. The main body of the envelope is indicated at 52. The seal 53, through which the single inlead or electrode 54 extends, may be a molding of bakelite or the like. The opposite end of the sheet metal body 52 may be closed by a cap 55 which is secured as by beading, shown at 56, or soldering or the like, to form a closure. In this case, the conductive character of the envelope 52 eliminates the necessity for one of the inleads and the body of mercury 57, which connects the inlead 54 with the envelope 52, forms the switching element. The central part of the envelope 52 is constricted sufficiently to give the effect heretofore described, that is, it gives the definite, full-stroke tendency of the mercury to proceed to the complete making or breaking of the circuit after it once starts into motion.

In the forms shown in Figures 20 and 22 the mercury preferably does not fill the cross-section of the narrowest part, although it may do so. If the mercury fills the narrowest portion of the cross-section, then the gas pressure which is created on one side or the other tends to introduce a variable, which is generally not desirable. For this reason the depth of the envelope in a vertical direction is made great enough and the size of the globule of mercury is controlled so as to prevent the filling of the narrowest section by the globule of mercury under normal operation.

Obviously, a suitable liquid filling for arc extinguishing and heat dissipating purposes may be employed, optionally, in any of the forms to which we have referred.

Where a metal envelope is employed, two inleads and an ungrounded circuit may be utilized by inserting the porcelain mercury container heretofore described. That is to say, the main body of the envelope, excepting the seal, may be made of metal or other conductive material where the porcelain mercury container is used. In such case the envelope, as well as the leads, should be made of a metal or alloy which is not subject to amalgamation with the mercury. We contemplate the employment of other conductive liquids besides mercury.

The separator 6 may extend to the top of the envelope, particularly for the purpose of conducting away heat from the point of current interruption. It may be made a part of the envelope, if desired.

The extension of the partition 5 throughout the entire distance from the separator 6 to the end wall of the mercury container is not essential where the globules of mercury 3, 4 leave the ends of the inleads. If, however, the mercury remains at all times in contact with the inleads, as shown in the form of device of Figures 1 to 6, then the partition 5 is necessary to keep the two bodies from merging.

We do not intend to be limited to the details shown and described except as they are specifically recited in the appended claims.

We claim:—

1. In combination, an enclosing envelope, a pair of inleads extending into the interior of the

envelope and providing a pair of substantially parallel contacts, a vertically disposed separator within said envelope extending between said contacts, said separator having a relatively thick forward portion and a relatively thin rear portion to define Venturi-like channels on each side of the separator and a body of conducting liquid in continuous engagement with said contacts, said liquid being divided by said separator upon angular movement of the envelope.

2. In combination, an envelope, a mercury container within the envelope, said container comprising an elongated open topped receptacle having a vertical partition extending along a part of the length of the container, inleads extending through the envelope and into the container upon opposite sides of the partition, a body of mercury in the container, said partition dividing the body of mercury upon tilting of the envelope, the portion of the partition adjacent the dividing edge being thickened, said container having channels for the mercury, which channels are constricted by the thickened portion of said partition.

3. In a device of the class described, an elongated cup shaped mercury container having a vertical interrupter partition along a part of the length of the container, said partition having a relatively thick forward portion and a relatively thin rear portion to provide restricted Venturi-like spaces between said thick part of the partition and each of the side walls.

4. In a gravity operated mercury switch, an envelope, a body of mercury in said envelope, said envelope containing a pair of Venturi-like channels for the movement of said mercury therein by gravity, and a pair of electrodes each extending into one of said channels.

5. In a gravity operated mercury switch, an envelope, a body of mercury in said envelope, said envelope containing a pair of Venturi-like channels for the movement of said mercury therein by gravity, said channels at one end leading into a common pocket and at the other end into separate pockets, and a pair of electrodes each extending into one of said channels and remaining in contact with a part of the mercury until after the circuit between them is broken by separation of the body of mercury into two bodies as it flows into the two separate pockets.

6. A mercury switch comprising a casing having a pair of inleads, a body of mercury within the casing for establishing and disestablishing circuit connections between the inleads, and a partition of insulation adjacent one end of the casing providing two constricted passageways leading from a junction chamber and dividing the body of mercury into two separate bodies as the mercury moves from one end of the casing to the other, the mercury passageways being constricted adjacent the free end of the partition and widened beyond the constricted portion to increase the minimum force required to overcome surface tension in separating of the body of mercury into two bodies and to accelerate the mercury by surface tension when the body of mercury first separates into two bodies, the inleads extending into the two constricted passageways and in engagement with the mercury at the time of division thereof, whereby the circuit between the inleads is first opened at the point of division of the body of mercury, and the gap in the circuit is increased by the acceleration of the mercury.

7. A mercury switch, comprising a tubular outer container composed of cellulose acetate material, said container having a fluid opening at one end and a sealing portion at the other end, an open mercury dish in said container, a closure member extending through said fluid opening and engaging said dish, a contact member extending through said sealing portion and having a flange in sealed relation therewith.

8. A mercury switch, comprising an envelope of metal having insulated inleads and composing a mercury container, said container having a restricted throat portion, and said inleads extending into said throat portion, a body of mercury for connecting and disconnecting said inleads disposed in said container, and a body of an insulating fluid for transferring the heat due to current flow from the mercury and said inleads to said metal envelope.

9. A mercury switch of the type described, comprising a container having an enlarged portion and a restricted portion, at least a part of said enlarged portion being composed of a metal and forming an electrical connection with a body of mercury contained in said switch, and a second electrical connection extending into said switch and terminating within the restricted portion, said second connection being insulated from said metal and adapted to form an electrical circuit with said metal and a body of mercury in said switch when the switch is in proper position.

10. In a gravity-operated switch, a container having a Venturi-like channel of substantially circular cross section and forming a path of travel for mercury, a body of mercury in said container, and an electrode within said container and centrally positioned within said Venturi-like channel.

11. In a gravity-operated switch, a container having an electrically conductive body member and a restricted portion forming a Venturi-like channel for the path of travel of mercury, a body of mercury within said container, and an electrode extending into said container in regulated relation with respect to said body member, said electrode being substantially centrally positioned adjacent said channel.

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