W. J. CRUMPTON.

ELECTRIC SWITCH.

APPLICATION FILED APR. 3, 1905.

1,010,620.

Patented Dec. 5, 1911.

3 SHEETS—SHEET 1.

Fig. 3.

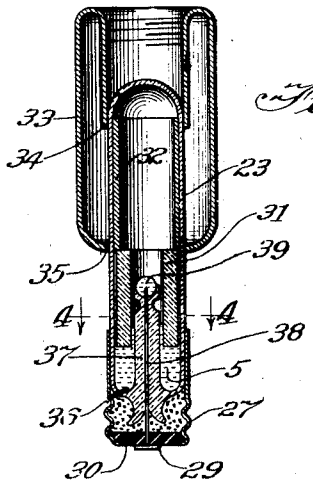


Fig. 1.

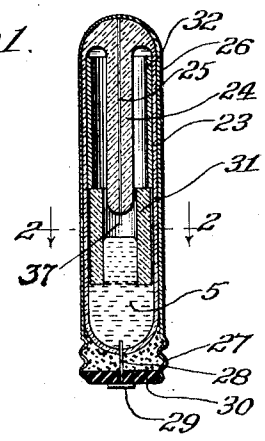
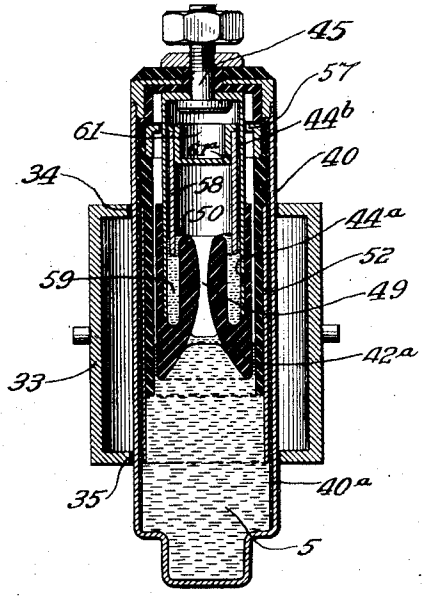


Fig. 4.

Fig. 9.



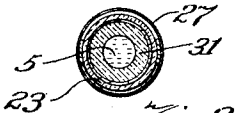


Fig. 2.

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3 SHEETS—SHEET 2.

Fig. 7.

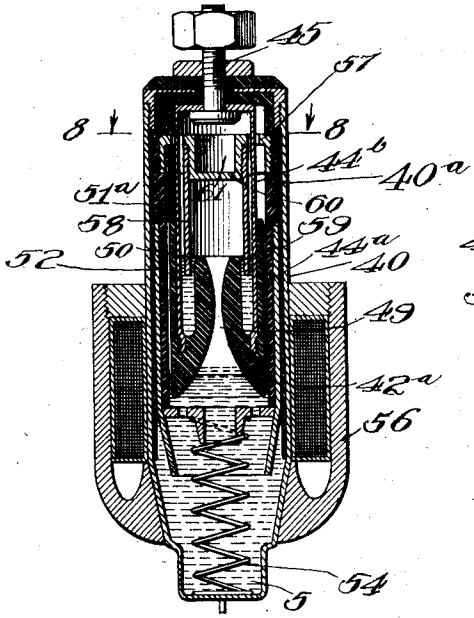


Fig. 8.

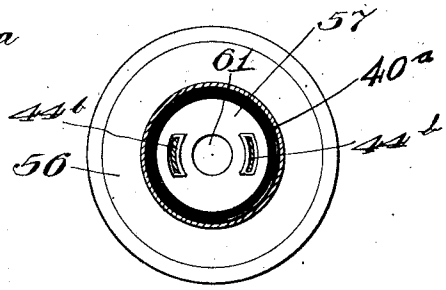


Fig. 5.

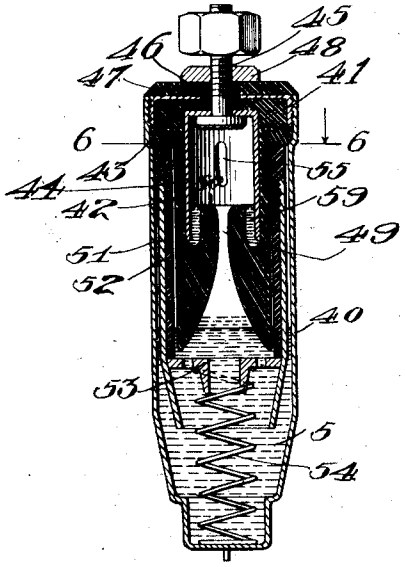
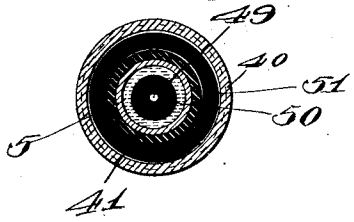


Fig. 6.



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1,010,620.

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3 SHEETS—SHEET 3.

Fig. 11.

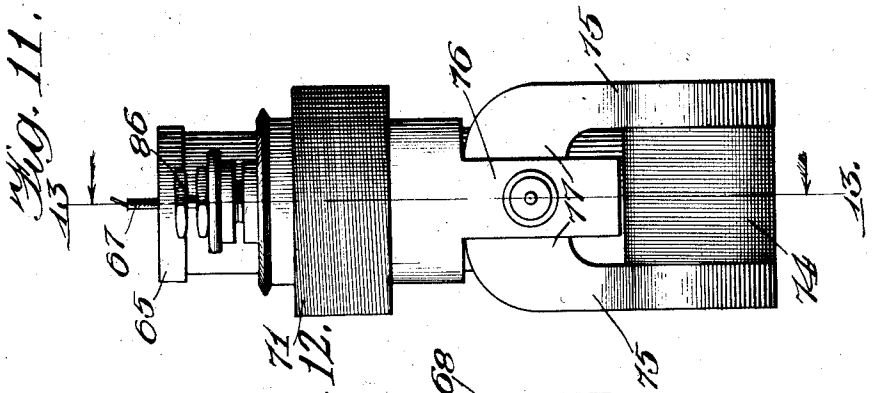


Fig. 12.

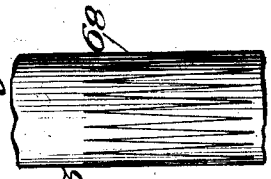
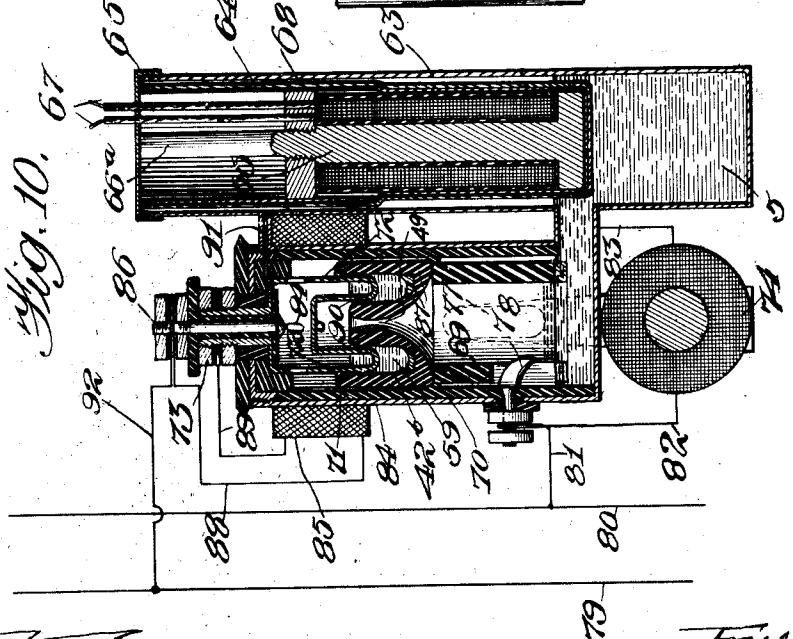


Fig. 10.



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ELECTRIC SWITCH.

1,010,620. Specification of Letters Patent. Patented Dec. 5, 1911.

Application filed April 3, 1905. Serial No. 253,420.

To all whom it may concern:

Be it known that I, WILLIAM J. CRUMPTON, a citizen of the United States, residing at Superior, in the county of Douglas and State of Wisconsin, have invented new and useful Improvements in Electric Switches, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to electric switches or contacts, my object being to provide a switch in which there is absolute certainty of contact, non-destructive terminals at the point where the circuit is made and broken, and in general to produce a device that shall be of reasonable first cost, of long life, and of minimum expense to maintain.

The ordinary electric switches or contacts of solid metal exposed terminals are subject to deterioration from ordinary surrounding conditions and still more from mechanical abrasion and the heat developed by the arc upon closing and opening the circuit, especially the latter. The demand for a circuit closing and opening device whose terminals and contact points do not materially deteriorate with time and use, consequently insuring absolute certainty of contact, has led to the development of this device.

In carrying out the invention, I provide a circuit closing and breaking medium in the form of a liquid, preferably mercury, which is contained in a closed chamber so as to prevent loss by vaporization and to keep away all foreign matter, thereby preventing oxidation, clogging, etc., and reducing the arcing to a minimum both in the making and in the breaking of the circuit. The arrangement of the apparatus is such that this liquid conductor is displaced relatively to the points of opposite polarity, the switch terminals, to make or break the circuit; which displacement may be brought about in various ways, as for instance by mechanically moving the chamber or a suitable displacer within the chamber or within a communicating chamber, by mechanically moving a magnetic body which reacts magnetically upon the movable displacer or by setting up a magnetic field of fixed location which reacts magnetically upon the movable displacer within the chamber or within a communicating chamber. In some forms of the invention, the make and break occurs between a solid and a liquid terminal, and in others between two liquid terminals. When small currents are employed, solid and liquid terminals may be used without objection, but for heavy currents the liquid terminals are preferable.

In some forms of the invention, means are provided for restricting the cross-section of the liquid terminals where the make or break occurs, and in still other forms a magnetic device is provided which shatters the liquid conductor completing the circuit through the switch and in addition blows out any arc that may be formed. In addition, provision may be made to coat the surfaces surrounding the point at which the break occurs with some insulating medium, such as oil, in order to protect such surfaces, and this operation is repeated at each making and breaking of the circuit in order to maintain such surfaces in good condition.

Other advantages and objects will appear from the detailed description and claims in connection with the accompanying drawings in which the same reference characters are used throughout the several views to indicate the same parts, and in which:

Figure 1 is a longitudinal sectional view of one form of the switch embodying the invention; Fig. 2 is a cross sectional view of the same on the line 2—2 of Fig. 1; Fig. 3 is a vertical section of another form of the invention; Fig. 4 is a transverse section taken on the line 4—4 of Fig. 3; Fig. 5 is a vertical sectional view of still another form of a switch embodying the improvements; Fig. 6 is a transverse sectional view of the same on line 6—6 of Fig. 5; Fig. 7 is a vertical section taken through the center of another form of a switch embodying the principles of the invention; Fig. 8 is a transverse section taken on the lines 8—8 of Fig. 7; Fig. 9 is a view similar to Fig. 7, showing an arrangement wherein the electromagnet of Fig. 7 is replaced by a movable permanent magnet similar to that of the form shown in Fig. 3; Fig. 10 is a vertical section of still a different arrangement of the parts of a switch constructed and operating according to the invention; Fig. 11 is a side elevation of the device shown in Fig. 10 and looking toward the left side of the same; and, Fig. 12 is a detail side view of the displacer of Figs. 10 and 11.

Referring to Figs. 1 and 2, 23 indicates a

tubular chamber preferably of glass, containing the conducting liquid 5, and having at its upper end a downwardly extending integral projection 24, through the center of which one of the conductors 25 is sealed, the inner end of which forms one of the terminals of the switch. This conductor is soldered at its upper end to a metallic strip 26 passing over the upper end and down both sides of the chamber 23 and terminating at its lower end in a suitable threaded shell 27 by means of which the switch may be secured into a corresponding socket similar to the Edison lamp socket in which the threaded receiving shell is connected with one side of the electric circuit. The other conducting wire 28 is sealed through the lower end of the chamber 23, and is therefore in contact with the conducting liquid within the chamber. This wire 28 is connected with the contact plate 29, forming the central terminal for the base, which plate is suitably supported and insulated from the shell 27 by the insulating block 30. It will be understood that this center contact is engaged by the corresponding center contact of the socket in which the device may be inserted. A cement filling is placed within the shell 27 and below the chamber 23. Within the tube 23 is placed a tubular displacer 31, preferably of some insulating material which is adapted to float in the liquid 5, and above the same is located a tube 32 formed of some magnetic or conducting material. When the displacer 31 is in the position shown in the drawings, the surface of the liquid 5 is beneath the terminal 37 and the circuit through the device is opened, but when the displacer 31 is depressed, the mercury is caused to rise within the chamber and to come into contact with the terminal 37, thereby completing the circuit between the wires 25 and 28. The function of the tube 32 is to suitably depress the displacer 31, this movement being caused by a magnetically inductive member upon the outside of the tube which is arranged to attract said tube 32 through the walls of the glass chamber. The said tube 32 thus constitutes an armature of the magnet. As indicated in Figs. 3 and 9, this magnetically inductive member 33 may be in the form of a permanent magnet, adapted to be moved longitudinally along the chamber 23, the air gap between the poles 34 and 35 being always substantially closed by the tube 32. It is obvious that an ordinary electromagnet may be used in place of the permanent magnet, and that an electromagnetic coil may be wound within the magnetic-circuit member 33, or other methods may be employed for operating the armature tube 32. If alternating currents be employed to energize an electromagnet or inductive member of such design that the magnetic lines of force cut the armature tube 32, the latter may be of any conducting material, since the secondary or eddy currents set up therein would produce reactions which would give the desired movement. It will thus be seen that the member 33 is in effect an inductor member or shell movably associated with the chamber for inductively acting upon the member 32 within the chamber for closing and opening the switch.

In the form of the invention shown in Figs. 3 and 4, the threaded shell 27 of the base is connected through the walls of the chamber 23, by means of the terminal wire 36, which is thus constantly in contact with the conducting liquid 5. The lower end of the chamber 23 in this instance, is formed with an integral part 37, through which the wire 38 from the center contact 29 extends to its upper end. The upper end of this extension is hollowed out to form a depression in which a drop or globule of mercury 39 is adapted to remain after the displacer 31 has been raised and the surface of the mercury has fallen below the upper end of said projection. Thus both of the conductors 36 and 38 are constantly in contact with the conducting liquid, which as stated before is preferably mercury, and both the make and break of the circuit in the device takes place in and by means of the said liquid. This arrangement is of advantage in that the liquid terminals are not burned away, and in that no difficulty is caused by the slight vaporization of the mercury that may occur. In the preceding form of the invention the terminals have been a solid and a liquid while in the present and subsequent forms the terminals are liquid, this latter feature being a most important feature of the invention since there is no permanent destruction of the terminals as is the case when solid terminals are employed.

In the remaining figures, forms of the invention are shown which are particularly adapted for heavy current work, and in which the mercury or other connecting liquid is also contained within a closed chamber. For example, in Figs. 5 and 6, the device includes an outer, preferably non-magnetic metallic chamber 40, having its lower end designed to fit within a suitable socket, clip or other device suitably connecting it with one side of the electric circuit, and within which chamber the conducting liquid 5 is contained. The upper end of this chamber 40 is closed by a metallic cap 41, threading into the same. An insulating member 42, preferably of lava, fiber, porcelain, or the like, is secured within the chamber 40, by means of a flange 43 at its upper end, and is clamped in place by the cap 41. The upper end of this insulating member 42 is provided with a cylindrical bore within which is located the inverted

metal cup 44, which is clamped to the upper end of the device by the bolt 45 passing through the insulating sleeve 46 and insulating washer 47 and upon which a check nut 48 is threaded to clamp the same in position. A nut placed upon the upper end of the bolt 45 together with the bolt serves as a binding post to which the other side of the electric circuit may be connected. The lower end of the insulating member 42 is provided with a flaring opening leading downwardly from the cylindrical bore of its upper end; the upper end of this opening forms a restricted passage 49. The lower end of the terminal cup 44 extends into the annular depression surrounding the inner wall 50 of the upper end of said passage 49 in said member 42, and is thus in contact with the mercury in said depression as hereinafter explained. The displacer in this instance, by means of which the conducting liquid is caused to rise and fall within the chamber comprises a tubular member 51 of insulating material surrounded by a metallic or magnetic tube 52, which tubes are threaded together at their upper ends; across the said tube 52 beneath the tube 51 is placed a disk or cross bar 53, against the lower side of which bears a coiled spring 54, resting at its lower end upon the inner side of the lower end of the chamber 40. This tube 52 also forms the armature of the operating magnet upon the exterior, having a form similar or equivalent to that shown in Fig. 7. When the displacer is depressed, the liquid 5 is caused to flow up through the throat or passage 49 in the insulating member 42 and to fill the space within the cup 44, and thereby to connect the chamber 40 with the binding post or bolt 45, thus completing the circuit between the two conductors. Suitable openings 55 are formed in the terminal cup 44 as well as through the insulating member 42 to enable the liquid to flood the whole upper portion of the chamber 40, thereby increasing the cross section of the conductor establishing the circuit between the two conductors ending within the chamber. When the displacer is raised the mercury falls within the chamber 40, a portion of the same remaining in the annular depression into which the lower end of the cup 44 dips, the circuit being ruptured in the mercury itself as it separates over the annular shoulder 50. Thus the making and breaking of the circuit occurs between liquid terminals, that is to say between bodies of conducting liquid rather than between solid and liquid terminals, or between two solid terminals, consequently the arcing has no destructive effect upon the terminals. In order that the insulating material surrounding the place at which the circuit is made and broken may be preserved as much as possible, and also to better insulate the two terminals from each other when the circuit is opened, it is desirable to fill the chamber more or less with oil or some insulating liquid, which in rising and falling with the mercury serves both to coat the surface of the member 42 and to suppress the arc at the place where the arc is established by the making and breaking of the circuit, and thus to protect and to re-coat the said surface at each operation of the switch.

In Fig. 7 there is shown a suitable magnet for operating the displacer both of Figs. 5 and 7. This magnet has a shell 56, the lower end of which surrounds and closely fits the lower tapering part of the chamber 40, and the upper end of which surrounds the straight portion of the chamber 40 some distance below the upper end of the magnetic tube 52 when in its normal position. The lower end of said tube 52, it will be noted, in both Figs. 5 and 7, is tapered to fit the lower tapered end of the outer non-magnetic chamber 40. When a sufficient current is directed through the said magnet, magnetic poles are formed at the lower and upper ends of its shell, thereby attracting the magnetic tube 52 which is drawn downwardly to shorten the air gap between said poles. When the current is turned off from the magnet, the said displacer is caused to rise by means of the coiled spring 54 and by its tendency to float in the liquid within the chamber.

In Figs. 7 and 8, the interior arrangement of the device is similar to that of Fig. 5, but differs in that the break of the circuit is confined to the smallest cross section of the throat 49, thereby limiting to a greater extent the area exposed to the destructive effects of the arc formed in breaking the circuit. In this instance, the insulating member 51^a of the displacer carries at its upper end a transverse member 57 having a central depending annular part or cup to which a second tubular displacer 58 is threaded at its upper end, the lower end of which displacer projects into the annular mercury chamber 59 to cause the liquid therein to overflow to meet the liquid that is rising up through said throat when the displacer is first being depressed. In this device the tube 44^a is threaded at its lower end and supports the insulating member 42^a. The upper portion of said tube 44^a is cut away upon each side and the remaining portions 44^b pass through suitable apertures in said transverse member 57 as shown in Fig. 8, thence engaging over the lower end of the binding post bolt 45, as in the case of Fig. 5, to which one conductor of the electric circuit may be connected. An insulating lining 40^a may be provided for the chamber 40. Thus, when the operating magnet is energized the displacer, as in the case of Fig. 5, is drawn downwardly against the action of

the spring 54 and its tendency to float in the liquid, and at the same time the tube 58 is depressed in the annular chamber 59 surrounding the shoulder 50 of the insulating member 42^a. The liquid is thus caused to rise in the throat 49 and likewise to overflow from said chamber 59 and flow downwardly in said throat, the two streams meeting in the passage 49, thereby completing the circuit. When the mercury rises to its full extent it flows in and around the terminal 44^a and through a small port 60 into the chamber or cup 61, formed in the upper side of said transverse member 57. When the current is cut off from said operating magnet, the displacer rises and the cup 61 (owing to the small size of the port 60,) together with the tubular displacer, serves to draw up a quantity of the liquid; at the same time the liquid falls in the lower part of the chamber, the effect being to rupture the connecting stream of the liquid in the throat 49 at about its restricted portion, thereby confining the arc to said portion. The liquid in the cup 61 then slowly discharges through the port 60 and down into the annular chamber 59 to completely fill the same. Thus the making and breaking of the circuit are confined to the throat 49. As above stated, a suitable insulating fluid, such as oil, may be employed to coat the surface of the throat 49 at each operation, and to aid in the insulation when the circuit is open.

In Fig. 9 I have shown a form of the device in which the arrangement of the internal parts and their operation are the same as those of the form shown in Fig. 7, the electromagnet of the latter form being, however, replaced by the movable permanent magnet of the form shown in Fig. 3.

In Figs. 10 and 11, I have shown in addition a means for magnetically shattering the connecting stream of the conducting liquid to break the circuit and to blow out the arc that may be formed, when the device is operated to open the circuit. In this form of the invention, as well as in other forms, the displacer may be located in a portion of the chamber at one side of or at a distance from the switching parts. This portion in Figs. 10 and 11 is indicated at 63. Within the part 63 is secured at its upper end a non-magnetic metal tube 64 held in position therein by the threaded cap 65. Within this non-magnetic tube 64 is located a magnet 66 which is fixed in position within the tube in any desired manner, with its winding connected by the leads 67 with any suitable source of current for energizing the same. The core of the magnet may be prolonged as at 66^c to form a means for holding the magnet rigidly in place and for readily pulling the magnet out when the cap 65 is removed. The displacer consists of the metal cup or cylinder 68 which is vertically movable between the tubes 63 and 64 and the lower end of which is closed. This tube is constructed as is indicated in the side view on Fig. 12, with its upper portion of magnetic metal and its lower portion of non-magnetic metal, the two parts being serrated where they join together so that the when the magnet is energized the magnetic portion of the displacer tends to move downwardly in order to shorten the air gap between the ends or poles of the magnet spool, thereby displacing the conducting liquid in the said portion of the chamber and causing it to rise in the connecting portion at the left. This portion at the left is flattened or elliptical as shown in Fig. 11, and within the same is arranged a tubular float 69 of similar form and of some insulating material, which when the liquid rises is lifted and raises the insulating member 42^b corresponding to the similar parts in Figs. 5, 7 and 9, and provided with the throat or passage 49. When this part 42^b is lifted the liquid in the annular chamber 59 is displaced and flows downwardly through the said passage 49. Normally the member 42^b rests upon the annular rib 70 formed upon the interior of the insulating lining 71 of this portion of the inclosed chamber. The upper conductor 72 of the switch is hollow and of the form indicated and is electrically connected with the binding nuts 73 with which the circuit conductors may be suitably connected. The magnetic blow-out and shattering device consists of the magnet 74 having extended pole pieces 75 terminating at the two flattened sides of the lower portion 76 of the left hand side of the conducting liquid chamber, and upon opposite sides of the point where it is desired to shatter the mercury stream. These pole pieces are indicated at 77. A shunting contact 78 projecting into this elliptical or flattened portion of the chamber extends through the side walls of the same and is provided with suitable binding nuts upon the exterior in order to enable the same to be connected with the circuit connectors. It will be understood that the metallic chamber forms the lower conductor of the device. In order that the current for operating the blow-out magnet may not pass through the same except at the time desired, said magnet is suitably connected in circuit with the shunting contact 78 so that as the liquid rises in the chamber it automatically cuts out or short circuits said magnet and as it falls automatically cuts in the magnet at the proper time to establish the magnetic circuit and shatter the stream of mercury as well as blow out the arc. Various circuit arrangements may, of course, be employed, but for the sake of illustration I have indicated one method of connection for accomplishing the purpose. In this method 79 and 80 indicate

the circuit leads, the shunt contact 78 being connected by a wire 81 with the conductor 80, a second conductor 82 leading therefrom to one terminal of the magnet 74 and a third conductor 83 reaching from the other terminal of the magnet 74 to the exterior of the chamber containing the conducting liquid. Thus, it will be understood, that as the liquid rises it is electrically connected with the contact 78 and wire 81 directly with one side of the circuit 80, but as it falls beneath the contact 78, the path for the current is then continued through the conductor 82, the magnet 74 and conductor 83 to the liquid, and therefore said magnet is in circuit and is energized. When the displacer magnet 66 is energized, the displacer 68 is drawn down and the liquid is caused to rise in the portion 76 of the chamber. As the liquid rises the float 69 also rises and lifts the member 42^b which causes the liquid in the annular chamber 59 to overflow and to pass down through the passage 49 to meet the rising liquid in the lower part of the chamber and thereby to establish the circuit. As the liquid continues to rise it completely fills the hollow terminal 72 through the flooding apertures 84 and establishes a complete circuit. When the current is turned off from the displacer magnet, the displacer rises and the liquid in the lower portion of the adjoining chamber rapidly falls and passes beneath the shunting contact 78, thereby establishing the circuit through the blow-out magnet 74. At the same time, the liquid in the upper part of the chamber escapes through the throat 49 in a stream to which the circuit is now confined, this stream being between the poles 77 of the magnet 74. As soon therefore as the magnet is thrown into circuit it magnetically shatters the stream and blows out any arc that forms, thereby completely opening the circuit. In order to prevent the member 42^b from falling immediately when the liquid lowers, thereby preventing any prolonged streaming of the liquid through the passage 49 and the possible reëstablishment of the circuit, I provide additional apparatus to maintain for a moment or short time, the member 42^b in its raised position. This means consists of a magnet 85 surrounding the upper end of the chamber and a second shunting contact 86. A magnetic ring 87 is located in the bottom of the annular chamber 59. Now when the liquid rises to its fullest extent in the chamber it comes into contact with the lower end of the contact 86 thereby completing the circuit directly through said contact 86 and the wire 92 to the other side 79 of the power circuit. Whenever the liquid falls beneath the lower end of the contact 86, the circuit is extended from the wire 92 through the conductor 88, the magnet 85, conductor 89, to the terminal 72. This magnet serves to magnetize the magnetic metal conductor 72 which in turn attracts the magnetic metal ring 87 carried by the member 42^b and maintains the same in its raised position. This continues until the conducting stream is shattered and the arc is blown out as stated above, when the current is thus cut off from the magnet 85 and the member 42^b drops to its initial position. The apertures or ports 90 are small enough to prevent the liquid contained in the hollow chamber 72 from escaping so rapidly as to prevent the desired action of the liquid, and at the same time sufficient liquid is withheld to completely fill the annular chamber 59. In this device also there may be placed an insulating liquid such as oil to coat the various parts at each operation and to prevent disintegration due to the arcs that may be formed and to aid in insulating the terminals on open circuit. In order to permit such fluid to readily flow into the right hand part of the chamber when the conducting liquid rises a passage 91 is formed therebetween.

All space within these several devices not taken up by solid insulation or solid or liquid conductor is of course occupied by a fluid insulator, such as air robbed of its oxygen, as inert gas, or oil, or both, and the pressure within the chamber may be great or small.

The circuit arrangement of the magnets 74 and 85 or either of them may be varied as desired to suit the conditions of the work to be performed or the particular apparatus with which the device is to be associated, or to meet the views of the designer. Thus they may be arranged in series as shown, or in shunt, and only the blow out device without the upper retaining magnet may be employed.

So far as some features of the invention are concerned, other forms of displacers may obviously be employed, and operated in different manners, and the blow-out device of the last figures may also be applied to the other devices.

While I have thus described several forms of the invention and the specific manner of applying the same to practice, I do not wish to be limited in all respects to the specific details thus shown and described, since it is obvious that various changes and alterations may be made therein without departing from the scope or principles of the invention.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In an electric switch the combination with a hermetically sealed chamber having an upper terminal and a lower liquid terminal container, said terminals being connected by a restricted passage, of means for displacing the liquid in said container to

cause it to fill said passage and connect the two terminals.

2. In an electric switch the combination with a hermetically sealed chamber having an upper liquid terminal container, and a lower liquid terminal container, said containers being connected by a restricted passage, of means for displacing the liquid in at least one container to cause it to rise through and fill said passage to connect the two terminals.

3. In an electric switch the combination with a hermetically sealed chamber having an upper liquid terminal container and a lower liquid terminal container, said containers being connected by a restricted passage, of means for displacing the liquid in at least one of said containers to cause it to fill said passage and connect the two terminals.

4. In an electric switch the combination with a hermetically sealed chamber having an upper liquid terminal container and a lower liquid terminal container, said containers being connected by a restricted passage, of means for displacing the liquid in at least one of said containers to cause it to fill said passage and connect the two terminals and means exterior of the chamber for operating said displacing means.

5. In an electric switch the combination with a hermetically sealed chamber having an upper liquid terminal container and a lower liquid terminal container, said containers being connected by a restricted passage, of means for displacing the liquid in both containers and causing it to fill said passage and connect the two terminals.

6. In an electric switch the combination with a hermetically sealed chamber having an upper liquid terminal container and a lower liquid terminal container, said containers being connected by a restricted passage, of means for displacing the liquid in at least one of said containers to cause it to fill said passage and connect the two terminals, and magnetically inductive means exterior to the chamber for operating said displacing means.

7. In an electric switch the combination with a hermetically sealed chamber having an upper liquid terminal container and a lower liquid terminal container, said containers being connected by a restricted passage, of means for displacing the liquid in both of said containers to cause it to fill said passage and connect the two terminals, and magnetically inductive means exterior to the chamber for operating said displacing means.

8. In an electric switch the combination with a hermetically sealed chamber having an upper liquid terminal container and a lower liquid terminal container, said containers being connected by a restricted passage, of a movable displacer for displacing the liquid in at least one of said containers to cause it to fill said passage and connect the two terminals and an inductor movably associated with said chamber exteriorly thereof and in inductive relation to the movable displacer within said chamber, whereby the movement of the exteriorly arranged inductor will be accompanied by a corresponding movement of the displacer.

9. In an electric switch the combination with a hermetically sealed chamber having an upper liquid terminal container and a lower liquid terminal container, said containers being connected by a restricted passage, of a tubular displacer within said chamber for displacing the liquid in at least one of said containers to cause it to fill said restricted passage and connect the two terminals, an inductor shell slidable on said container and in inductive relation to said displacer whereby the movement of said shell will be accompanied by a corresponding movement of the displacer.

10. In an electric switch, the combination with a closed chamber having a receptacle therein, of a liquid conductor in said receptacle, means for displacing the liquid conductor from said receptacle to cause it to overflow for closing the circuit of the switch, and means for automatically flooding the receptacle when the switch is again opened to be placed in condition for another closure.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

WILLIAM J. CRUMPTON.

Witnesses:
M. R. ROCHFORD,
ROBERT LEWIS AMES.