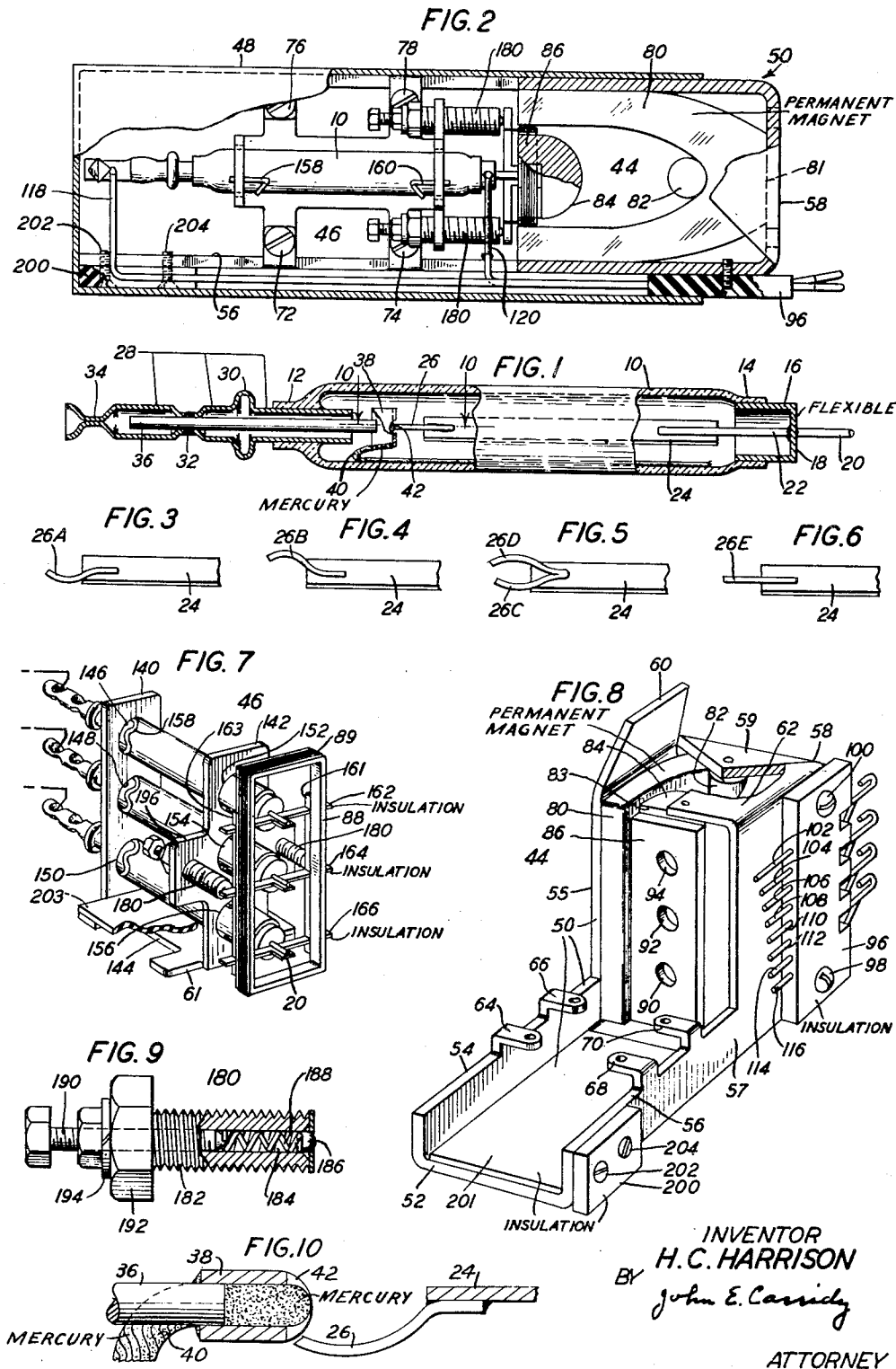


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MERCURY TYPE RELAY

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MERCURY TYPE RELAY

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This invention relates to electromagnetic relays and more particularly to improvements in electromagnetic relays wherein contact is established through liquids, particularly mercury or through mercury combined with other materials.

An object of this invention is the improvement of relays in which contact is established through liquids, particularly mercury or mercury combined with other materials.

A further object of this invention is the provision of an electromagnetic polar relay having a movable coil and a mercury contact.

A further object of this invention is the provision of an electromagnetic relay having a mercury contact sealed in an impervious container in which the contact is externally adjustable.

A feature of this invention is a mercury contact so disposed in an impervious container that the position of the contact is adjustable.

A further feature of this invention is a mercury contact so arranged that the mercury is maintained by a wick through capillarity.

A further feature of this invention is a relay having contacts which are substantially free from chatter.

A further feature of this invention is a movable current conducting coil of very low inductance supported in a magnetic field, which coil controls the motion of a fine platinum wire contact in an impervious container through a movable system of small mass so that the contact dips into and is withdrawn from a globule of mercury to establish an electrical circuit through the contact and the globule in response to an operating force of a few dynes.

These and other objects and features will become apparent from the following description when read with reference to the associated drawing which discloses arrangements exemplifying the invention in a particular preferred embodiment thereof. It is to be understood however, that the invention is not limited to the particular embodiment described but may be incorporated in other embodiments which will readily suggest themselves to those skilled in the art.

In the drawing,

Fig. 1 is a vertical elevation partly in section, of the improved electric switch comprising an impervious container, a mercury contact, a movable contact, the contact adjusting details and the plat-

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inum wick for maintaining the mercury contact;

Fig. 2 is a plan view of the relay assembly partly in section in which portions are shown broken away to more fully disclose the details of the relay;

Figs. 3 to 6 show various arrangements of the metallic contacts which cooperate with the mercury contact;

Fig. 7 is a perspective view of a subassembly of the relay comprising the movable conducting coil and the fixed mounting frame for the impervious containers together with three containers, in which view a portion of an insulation element is broken away to disclose details of the container mounting frame;

Fig. 8 is a perspective view of a subassembly of the relay showing the permanent magnet 80 and supporting frame assembly for the magnet together with the terminal strip assembly and having details of the top portion partially opened and broken away to disclose details of the assembly; and

Fig. 9 shows partly in section one of two frame vibration dampers employed in the relay.

Fig. 10 is an enlarged view of a horizontal section taken through line 10—10 of Fig. 1.

Refer now to Fig. 1, which shows an elongated tube 10, preferably of transparent material such as glass or plastic, having reduced sections 12 and 14, at its left-hand and right-hand ends respectively. Sealed in its right-hand end 14 is a cylindrical cup 16, preferably of a current conducting alloy, and having a diaphragm end 18 which is relatively thin and flexible. Butt welded to the outer and inner surfaces of the flexible end 18 are short rods 20 and 22 preferably of stainless steel and welded to the left-hand end of rod 22 is a relatively narrow and thin strip preferably of stainless steel 24, to the left-hand end of which is welded a bent contact or contacts such as 26 preferably of platinum. The contact may be arranged in any of a number of manners, as shown in Figs. 3 to 6, depending upon conditions to be more fully described below. Sealed into the left-hand reduced section 12 is a formed tube 28 preferably of current conducting alloy which extends beyond the right-hand end of reduced section 12 and projects into the interior of the tube 10.

The tube 28 is shaped so as to form a raised

circular contact adjusting ring 30, of increased diameter, to the left of the end tube section 12, and a contact rod supporting portion of reduced diameter 32, to the left of the contact adjusting ring 30 and the tube is closed at a flattened section 34 preferably by welding. Welded within the tube 28, at reduced section 32, and at a point intermediate the ends of the wire is wire 36 which may be of stainless steel. Wire 36 extends toward the right beyond the right-hand end of tube 28 and into the interior of tube 10. Welded to the right-hand end of wire 36 is a rectangular folded detail of platinum plated stainless steel 38 having a U-shaped section. The fold is at the right and disposed vertically and the opposed interior side surfaces of detail 38 are slightly spaced each from the other. The rod 36 may project partially into the space between the opposed inner surfaces of detail 38 and the rod 36 is preferably welded to each of the opposing interior surfaces of detail 38. A platinum wick 40 is introduced through the bottom opening between the interior opposed surfaces of detail 38 and is welded to each opposed interior surface. The wick is looped toward the left-hand end of tube 10 and lies along the bottom of tube 10 substantially throughout the entire length of the tube. A notch 42 is cut in the right-hand or folded edge of detail 38 equidistant the top and bottom of the detail. An enlarged horizontal section through the line 10-10 in Fig. 1 is shown in Fig. 10, disclosing more clearly the mercury contact and cooperating solid metal contact.

The tube 10 is filled with any desired inert gas, and a globule of conducting liquid, such as mercury, mercury combined with other materials to prolong its useful life, or other suitable conducting liquid contacting material, is introduced into the tube 10 and tube 28 is then welded closed at 34. A large part of the conducting liquid is gathered by platinum wick 40 and drawn up by capillarity into the opening between the opposed surfaces of the U-shaped detail 38 filling the notched opening 42. As the platinum contact 26 is moved, in a manner to be described, its left-hand end projects into and is withdrawn from the conducting liquid which is disposed in the notch 42.

Attention is particularly called to the fact that the position of the detail 38 and of the conducting liquid in notch 42, relative to contact 26, may be adjusted by bending tube 28 slightly as may be required, by applying pressure manually through adjusting ring 30 which controls the movement of rod 36 through the welded connection at reduced section 32. To permit the movement of rod 36 and of the contact detail 38, rod 36 is of substantially smaller section than the interior section of tube 28, throughout the length of tube 28, except at the reduced section 32 which is relatively short and rod 36 is therefore free to be displaced as necessary within the tube to effect the required contact spacing adjustment.

The wire contacting element 26 may be subjected to motion in any desired manner, such as by the movement of a coil connected to rod 20, to actuate contact 26 to engage with or disengage from the conducting liquid in the notch 42. An electrical contact may be established through any conducting element connected externally to cup end 18, conducting rod 22, conducting strip 24, contact 26, conducting liquid in notch 42, contact detail 38, conducting rod 36 and conducting tube 28 to which an external conductor may be attached. The contacts may be arranged so that the circuit is normally open or normally

closed and when motion is imparted through the thin flexible diaphragm 18 contact may be established or broken in a variety of ways depending upon the arrangement of the movable contacting wire or wires.

Attention is particularly called to the fact that the switch per Fig. 1 is capable of a wide variety of applications and may be actuated in many different manners, electrically, mechanically or even manually. The force required for operation may be very small. The mercury contact is self-renewing and if not overloaded has an extremely long maintenance free life.

Contacts may be shaped and attached to the conducting strip 24 in any of a number of ways, for instance as shown in Figs. 3 to 6. The edge shown in perspective is the top edge of strip 24 in Fig. 1. When frame 88 is in the normal or rest position, strip 24 is in mid-position in tube 10. In the arrangements per Figs. 3, 4 and 5, the contacting left-hand tips of contacts 26A, 26B, 26C and 26D will be displaced from the mercury in notch 42 for this condition. Or the contacts may be adjusted by bending slightly so as to make contact for this condition. Straight contact 26E in Fig. 6 would engage with the mercury for this condition. Fig. 3 for instance shows a contact 26A which may be normally disengaged from the liquid in the notch 42 and which engages when the strip 24 is moved toward the rear as seen in Fig. 1 in response for instance to an impulse of a positive polarity applied through a movable coil to rod 20. Or the contact may be in engagement with the liquid and be moved toward the front to break engagement in response to an impulse of a negative polarity. Fig. 4 shows a contact 26B which may be moved forward to make engagement in response to an impulse of a negative polarity or the contact may be in engagement with the liquid and be moved backward to disengage in response to opposite magnetism. Fig. 5 shows two contacts 26C and 26D which may both be normally disengaged from the liquid, while strip 24 is in its normal mid-position, which contacts may engage alternately with the liquid as the strip is alternately moved forward and backward in response to alternately applied magnetic forces of opposed polarity. Fig. 6 shows a contact 26E which may normally engage the conducting liquid and which may disengage therefrom in response to forward or backward motion of strip 24 due to an impulse of either positive or negative polarity.

Attention is also called to the fact that with minor modifications obvious to one skilled in the art it is possible to provide a plurality of movable wire contacts and adjustable mercury contacts within a single impervious container.

In a particular embodiment the mercury contact switch assembly per Fig. 1 may be incorporated in a polar relay per Fig. 2. In this particular arrangement three switches per Fig. 1 are employed, but it is to be understood that one, two, four or more switch assemblies per Fig. 1 may be employed depending upon the switching which is to be effected. The modifications in the polar relay structure to be described, necessary to accommodate such switching units as may be desired, will be obvious to one skilled in the art.

Refer now to Figs. 2, 7 and 8. Fig. 2 is a plan view of the polar relay of the present invention, partly in section, with portions broken away to disclose the details and Figs. 7 and 8 are perspective views of subassemblies of major units of Fig. 2 to more clearly illustrate the invention.

The polar relay per Fig. 2 comprises two main subassemblies, the frame and magnet assembly 44, shown separately in the perspective per Fig. 3, and the coil and switch assembly 46, shown separately in the perspective per Fig. 7. The relay is provided with a cover 48.

As shown in Fig. 2 and Fig. 8, the frame 50 may be formed of a single sheet of non-magnetic material such as aluminum. The frame comprises a horizontal base 52, a rear vertical wall 58, two irregularly shaped side walls having relatively low front portions 54 and 56 and higher rear side walls portions 55 and 57 and a top portion formed by bending forward a wedge-shaped portion 59 appended to the rear vertical wall 58 and by bending inwardly projections 60 and 62 of the left and right-hand higher rear wall portions 55 and 57. The rear edges of the top folds 60 and 62 may be cut at an angle to conform to the edges of the wedge-shaped fold 59. Projections 64, 66 and 68, 70 of walls 54 and 56, respectively, are bent inwardly and the projections are drilled and tapped to accommodate set screws 72, 74, 76 and 78 which engage with the top surfaces of the insulating mat 203 covering the four projections, such as 61, of the switch assembly and clamp the switch assembly in position on top of the insulating mat 201.

A U-shaped magnet 80 is housed in the space in the rear portion of the main frame 44 with the outer surfaces of the opposed arms of the magnet secured between the inner surfaces of the opposed walls 55 and 57. A cylindrical non-magnetic clamping element 82 is welded between the top and bottom inner surfaces of the magnet compartment so as to secure magnet 80 in position with its flattened rear end surface 81 abutting the inner surface of end wall 58. A non-magnetic element 84 of semi-circular section, is also welded between the top and bottom inner surfaces of the magnet compartment and welded to its flat front surface 83 is a rectangular plate of magnetic material 86, the front surface of which magnetic plate is in the vertical plane of the two front ends of the magnet. The rectangular plate is shorter and narrower than the internal length and width of the non-magnetic coil frame 88 in Fig. 7 so that the coil frame 88 may be pushed into position about the edges of the magnetic plate and separated therefrom to permit rotation of frame 88 together with its coil 89, wound on the frame, in a limited arc in a vertical plane about a vertical axis through the center of the coil frame. Three clearance apertures 90, 92 and 94 are drilled horizontally in vertical alignment in the magnetic plate 86, through which the right-hand ends of connecting rods such as 20 may protrude and in which they may move freely when motion is imparted to the frame due to the interaction of the field of the magnet and the current in current conducting coil 89 when the coil is energized.

A rectangular terminal strip 96, preferably moulded of insulating material, is secured to the outer surface of side wall 57, by means of screws 98 and 100. The terminal strip is apertured in alignment with tapped holes in wall 57 to accommodate the screws. Moulded in the terminal strip are eight terminals 102, 104, 106, 108, 110, 112, 114 and 116 arranged in four pairs and having the rear end of the lower terminal of each pair bent inwardly for clearance. The upper terminal of each of the three upper pairs may be connected individually by means of a soldered conductor such as 118 to the forward end of a

particular tube 28. The corresponding lower terminal of each of the three upper terminals may be connected individually by means of a soldered conductor such as 120 to the outer cylindrical surface of a particular cup such as 16. The bottom pair of terminals may be connected by means of soldered flexible conductors to the two terminals of coil 89. The conductors may be covered individually with an insulating sleeve.

The switches per Fig. 1 are mounted in a switch frame 46 as shown in perspective in Fig. 7. The switch frame 46 is formed of a single bent plate of non-magnetic material. The plate is substantially U-shaped having opposed vertical arms 140 and 142 and a horizontal base 144. The base has four horizontal corner clamping projections such as 61 by means of which the switch frame is clamped in position as heretofore described.

Each of the vertical arms 140 and 142 is provided with three vertical apertures, 146, 148 and 150 in vertical arm 140 and 152, 154 and 156 in vertical arm 142. The three apertures in each arm are in vertical alignment and corresponding apertures in opposed arms are in horizontal alignment. Three switch assemblies per Fig. 1 are supported as shown in opposed apertures. Each aperture is equipped with a bent wire spring such as 158 and 160 which springs serve to retain the switch assemblies securely in position. A strip of insulating material 161 and 163 is cemented to the rear of each of the vertical elements of coil frame 88 as seen in Fig. 7. Three horizontal bars of non-magnetic material 162, 164 and 166 are welded individually to the three rods 20 of the switch assemblies per Fig. 1. Each of the insulating strips 161 and 163 has three notches aligned horizontally in pairs in which the horizontal bars 162, 164 and 166 are cemented.

When the component parts of this relay are assembled, as the coil frame and coil are rotated in a limited arc when the coil is energized by an electrical current, the motion of the coil frame is imparted through the horizontal bars 162, 164 and 166 and the corresponding rods 20, through the flexible ends 18 of cups 16 to rods 22, the movement of which controls the switching elements as described in the foregoing. It is particularly pointed out that the coil frame 88, the insulating strips 161 and 163, the horizontal bars 162, 164 and 166 and the three rods such as 20 constitute a rigid assembly. The small alternate clockwise and counter-clockwise movements of the frame 88, as viewed from the top, in response to the energizations of the coil 89 by currents of opposite polarity, are imparted through rods 20 and through the flexible diaphragms 18 to rods 22, strips 24 and contacts 26. The relatively small rotary movement of frame 88 results in an amplified movement of the contacts 26 in proportion to their respective radial distances from the vertical axis of the frame. The coil 89 and non-magnetic frame 88 should have a minimum of inductance.

The relay is equipped with two coil frame travel controls and vibration dampers 180 as shown separately in Fig. 9, and as assembled in Figs. 2 and 7. Each assembly 180 as shown in Fig. 9 comprises a set screw 182 having an axial tapped channel 184 throughout its length and having an opening of reduced diameter at its right-hand end as seen in Fig. 9. A ball 186 of larger diameter than the opening protrudes partially through the opening. The ball 186 is pressed into position by spring 188 which is acted upon in turn by set screw 190. The assembly includes also

lock nut 192 and lock washer 194. Vertical arm 142 as seen in Fig. 7 has two cross arm projections such as 196. Each of these projections is tapped to receive an assembly 180 which projects horizontally through the tapping so that its ball bearing 186 is opposed to the rear edge of horizontal bar 164 near the extremities of the bar. In the normal idle position the bar 164 will engage the two balls 186 lightly and the motion of the coil frame when actuated will be limited to a few mil inches.

With the parts all in adjustment the switch contacts are maintained in mid-position to operate at a given current in either direction. The main set screws 182 control the position of the switch contacts and the secondary set screws 190 adjust the coil springs 188 and hence the current required to operate. In response to current of one polarity in coil 89, the coil will be rotated clockwise, as seen from above. In response to current of the opposite polarity the coil 89 will be rotated counter-clockwise. If operation in only one direction is desired one main set screw need have no secondary set screw spring and ball. A dust cover 48 fits over the relay frame, sliding over the frame from left to right, as seen in Fig. 1, and fitting tightly about the terminal strip 98 and the magnet housing. A cover guide or spacer 200, preferably of insulating material, is secured to the forward end of side wall 56 by two screws 202 and 204 which protrude through apertures in the spacer 200 to engage in tappings in the side wall 57.

After all of the parts other than the cover are mounted in place the mercury contacts may be adjusted by bending the metal tube 28 by means of the adjusting ring 30. This provision for final adjustment of the mercury contact substantially eliminates the need for any narrow tolerances in the manufacture of the switch.

What is claimed is:

1. An electrical switch comprising an impervious container, a movable contact therein, a globule of mercury in a supporting detail within said container, a capillary feed for supplying said mercury to said detail, conductors connected to said container for establishing an electrical circuit through said contact and said globule and a manually operable spacing adjuster for said detail connected with said container, said adjuster actuable through the exterior of said container after the manufacture of said switch, said adjuster comprising an elongated bar secured within and coaxial with a tubular extension of said container, said bar connected to said detail, for adjusting the normal spacing between said globule and said contact.

2. An electrical switch comprising a transparent impervious container having a manually adjustable movable switching element and a globular mercury switching element having a capillary feed all within said container, said feed a flexible metallic wick, and a relatively flexible mechanical spacing adjuster interconnecting said mercury switching element and said container for establishing the normal position of said mercury element.

3. As elements of an electrical switch, an impervious container, a displaceable element connected internally to said container, a mercury supporting detail connected to said displaceable element, a globule of mercury in said detail, and a flexible metallic wick connected to said detail for replenishing said mercury in said detail by capillarity, an elongated cylindrical tube, said dis-

placeable element a bar secured intermediate its ends in said tube, said tube forming part of said container for adjusting the position of said supporting detail and of said globule by manually actuating said displaceable element.

4. In an electrical switch, an impervious container comprising a vessel having a flexible diaphragm sealed therein, a displaceable cylindrical extension also sealed in said vessel, a movable metallic contact in said vessel connected to said diaphragm, a globular fluid contact in said vessel, said fluid contact supported through a relatively long bar of relatively small section projecting into said extension, said bar spaced from said extension throughout a substantial portion of its length, said extension having a reduced section intermediate its ends for gripping said bar, so as to manually adjust the relative spacing of said metallic and fluid contacts through cooperative displacement of said diaphragm and said extension.

5. A polar relay comprising a permanent magnet, a movable current conducting coil in the field of said magnet, an impervious container having a flexible diaphragm, a displaceable metallic contact within said container, connected to said diaphragm, a normally stationary manually adjustable globular mercury contact within said container, a support for said globule, said support and said globule arranged so that said globule may be engaged by lateral movement of said displaceable contact, and a mechanical connection between said movable coil and said diaphragm for making and breaking an electrical circuit through said displaceable contact and said mercury contact in response to the energization of said coil.

6. A relay in accordance with claim 5 including a displaceable bar in an elongated flexible tube, said tube substantially cylindrical and normally coaxial with said bar, for adjusting the normal position of said mercury contact relative to said displaceable metallic contact.

7. A relay in accordance with claim 5 including a flexible capillary feed for maintaining said mercury globule.

8. A relay in accordance with claim 5 including a flexible wick depending into a mercury supply to maintain said mercury contact by capillarity.

9. A polar relay comprising a current conducting coil suspended in the field of a permanent magnet, a plurality of impervious vessels each having a flexible surface element, a movable contact within each vessel connected individually to said element, a mechanical connection responsive to the movement of said coil for imparting motion through each of said surface elements to said movable contacts, and a manually displaceable globule of mercury in each of said vessels engageable by said movable contacts to complete an electric circuit.

10. A polar relay comprising a permanent magnet, a current conducting coil suspended in the field of said magnet, an impervious vessel having a flexible surface element, a mechanical connection between said coil and said element for flexing said element, a manually adjustable movable metallic contact in said vessel attached to said element, a normally stationary electrically conducting liquid globule contact in said vessel, a manually operable flexible mechanical connection between said globule and a surface section of said vessel for displacing said globule through movement of said section to adjust the spacing

relationship between said globule and said movable contact, and electrical conductors connected to said contacts for making and breaking an electrical circuit through said contact and said globule in response to the movement of said flexible surface element.

11. A switch in accordance with claim 10 including a flexible capillary feed for maintaining said globule.

12. A switch in accordance with claim 10 including a support for said globule and a flexible metallic wick depending from said support into a supply of said liquid to maintain said globule.

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