July 1, 1941. H. C. HARRISON ET AL 2,247,493

MERCURY CONTACT RELAY

Filed Nov. 2, 1939

FIG. 1

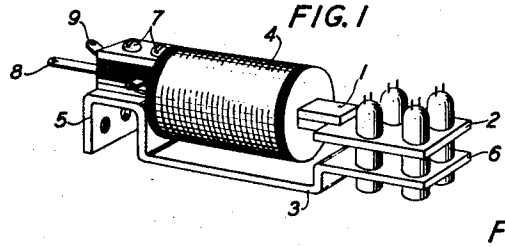


FIG. 3

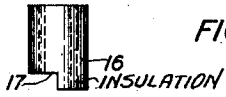
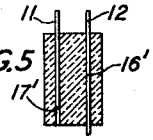


FIG. 5



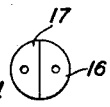


FIG. 4

FIG. 15

FIG. 2

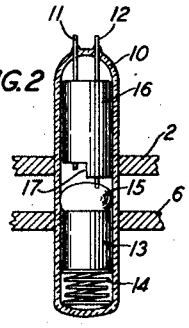


FIG. 6

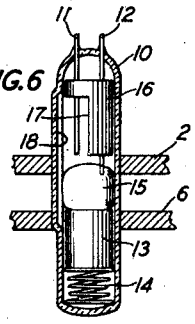


FIG. 7

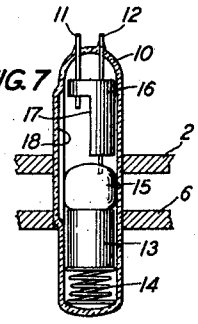


FIG. 8

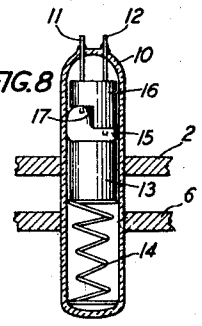


FIG. 9

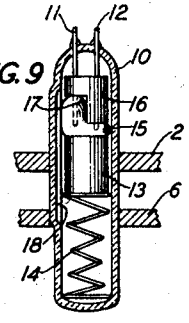


FIG. 10

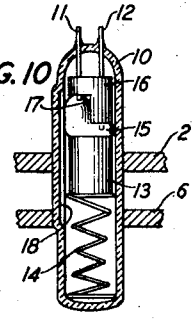


FIG. 11

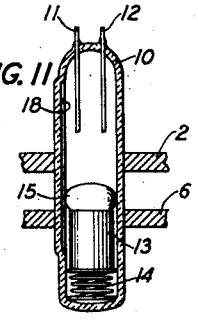


FIG. 12

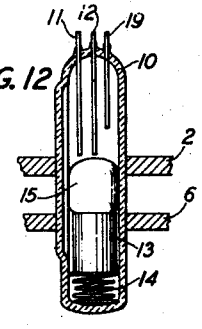


FIG. 13

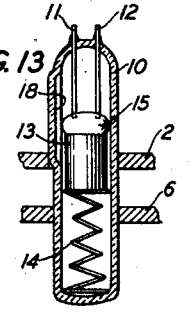


FIG. 14

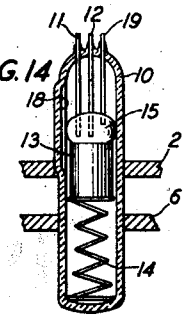


FIG. 16

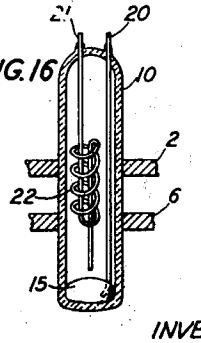
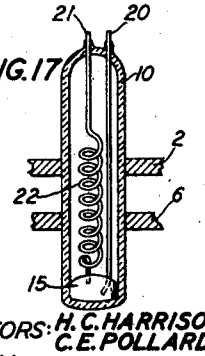


FIG. 17



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ATTORNEY

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UNITED STATES PATENT OFFICE

2,247,493

MERCURY CONTACT RELAY

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Application November 2, 1939, Serial No. 302,526

11 Claims. (Cl. 200—112)

This invention relates to electromagnetic devices and more particularly to relays in which circuits between the contact terminals thereof are established by means of mercury.

Switches in which circuits are established between contact terminals through the medium of mercury possess many advantages over switches of the contact spring type in that the tendency of arcing of the contacts and the consequent contact deterioration is reduced; the tendency of contact chatter is much reduced or practically eliminated; the current carrying capacity is materially increased without requiring a great increase in the size of the switch; a smaller operating current is required; the switch is readily adaptable for delayed circuit closing or opening or for providing many contact combinations required for circuit control such as transfer contacts, continuity contacts, etc., and a plurality of such switches having different time constants may be easily assembled for operation by the same electromagnetic means.

It is therefore the object of the present invention to provide electromagnetically operated switches of the mercury contact type in which the above specified and other advantages are readily and economically attained.

For attaining this object and in accordance with one embodiment of the present invention a small envelope of glass or other suitable material is provided in which a light plunger armature of magnetic material is slidably positioned and which supports a globule of mercury. Sealed into one end of the envelope are two or more inwardly extending contact terminals or electrodes which may be bridged by the globule of mercury. Preferably to reduce the deterioration of the contacts and the contamination of the mercury, the envelope is evacuated and refilled with an inert gas, such as hydrogen, neon, argon, etc. at a suitable pressure. For securing different types of contact closures, such as for example, quick make-quick break, quick make-slow break, and slow make-quick break and different types of contact openings, such as quick break-quick make, slow break-quick make and quick break-slow make, ceramic insulators of different configurations may be supported by the electrodes in one end of the envelopes or the depending ends of the electrodes may be differently spaced from the surface of the mercury globule. To actuate the plunger armature, the envelope may be inserted in the aligned openings of two parallelly disposed pole-pieces of an electromagnetic circuit, although it will be apparent that other types of magnetic circuits, such as a solenoid coil surrounding the envelope might be employed. It will also be apparent that a plurality of switches having different operating characteristics could have their plunger armatures actuable by a common magnetic circuit by providing a plurality of aligned openings in the pole-pieces of the magnetic circuit in which such switches are positioned.

As an alternative construction the envelope may contain a pool of mercury in the bottom thereof in which one of the depending electrodes is immersed and the other electrode may be terminated in a coil of magnetic material which when subjected to a magnetic field either contracts or expands to break or make contact with the pool of mercury.

For a more complete understanding of the invention, reference may be had to the following detailed description taken in connection with the accompanying drawing in which:

Fig. 1 shows a relay having a plurality of mercury type switch elements;

Fig. 2 is a partial cross-sectional view of one of the switch elements arranged for a quick make-quick break of its normally open contacts;

Fig. 3 is a side elevational view and Fig. 4 is a bottom end view of the ceramic insulator of the switch disclosed in Fig. 2;

Fig. 5 is a cross-sectional view of a modified type of ceramic insulator;

Fig. 6 is a partial cross-sectional view of a switch element arranged for a quick make-slow break of its normally open contacts;

Fig. 7 is a partial cross-sectional view of a switch element arranged for a slow make-quick break of its normally open contacts;

Fig. 8 is a partial cross-sectional view of a switch element arranged for a quick break-quick make of its normally closed contacts;

Fig. 9 is a partial cross-sectional view of a switch element arranged for a slow break-quick make of its normally closed contacts;

Fig. 10 is a partial cross-sectional view of a switch element arranged for a quick break-slow make of its normally closed contacts;

Figs. 11 to 14, inclusive, show modified forms of switch elements arranged for quick recycling of which the element of Fig. 11 is arranged to close its contacts slowly and to open them quickly; the element of Fig. 12 is arranged to close certain of its contacts quickly, to close other contacts slowly and to open all of its contacts quickly; the element of Fig. 13 is arranged to open its normally closed contacts quickly and to

close them slowly; and the element of Fig. 14 is arranged to open all of its normally closed contacts quickly and to close certain of them quickly and others of them slowly;

Fig. 15 is a cross-sectional view of the envelope used in switch elements of the types disclosed in Figs. 6, 7 and 9 to 14, inclusive;

Fig. 16 shows a modified type of switch element in which a conductive path through a pool of mercury is established by the elongation of a coil of magnetic spring material under the influence of a magnetic circuit; and

Fig. 17 shows the switch element of the same type as disclosed in Fig. 16 in which a normally established path through a pool of mercury is disrupted by the construction of a coil of magnetic spring material.

A relay employing switch elements of the mercury contact type is disclosed in Fig. 1. This relay comprises a core 1 to the forward end of which is suitably secured a pole-piece plate 2 and to the rear end of which is secured a forwardly extending return pole-piece 3. The return pole-piece is offset in its middle portion to provide clearance for the relay winding 4 surrounding the core 1, is bent at right angles at its rear end to form a mounting bracket portion 5 by which the relay may be secured to a relay rack mounting plate and has its forward end 6 positioned parallel to and suitably spaced from the pole-piece plate 2. Secured by screws 7 and insulatedly supported upon the rear end of core 1 are terminal lugs 8 and 9 to which the terminals of the coil 4 are connected. Other terminal lugs may be provided, if desired, for connection with the electrodes of the switch elements supported by the pole-pieces as hereinafter described. As illustrated the pole-pieces 2 and 6 are provided with aligned openings in which four mercury contact switch elements are positioned. It will, of course, be obvious that provision may be made for a single switch element or any desired number of such elements.

The switch elements may be of any of the types disclosed in Figs. 2, 6 to 14, inclusive, 16 and 17. The switch elements disclosed in Figs. 2 and 6 to 10 each comprises an envelope 10 made of glass or any other suitable material which will not amalgamate with the mercury enclosed therein, two electrodes 11 and 12 sealed through one end thereof and extending into the inside of the envelope, a plunger armature 13 of magnetic material supported upon a spring 14 positioned in the bottom of the envelope, the plunger being of slightly smaller diameter than the inside diameter of the envelope whereby it is free to slide within the envelope, a globule of mercury 15 positioned adjacent to one face of the plunger and an insulating cylinder 16 preferably of porous unglazed ceramic material not easily contaminated by the mercury supported upon electrodes 11 and 12 in one end of the envelope.

The insulating cylinder 16 for the switch element of Fig. 2, disclosed in detail in Figs. 3 and 4, is provided with two holes extending longitudinally thereof through which the switch electrodes may extend, the electrodes fitting tightly enough in such holes to support the cylinder securely in the desired position in the upper end of the envelope. The lower end of the cylinder is cut away as indicated to provide a half cylindrical recess 17 for a purpose to be later described.

As disclosed in Fig. 2, the plunger 13 is normally so positioned within the envelope that when the switch element is mounted in the aligned openings of the pole-pieces 2 and 6 of the electromagnet, its upper surface will be substantially in the plane of the upper face of the pole-piece 6 in which position the globule of mercury 15 is engaged with the end of the electrode 12. When, however, a magnetic potential is established between the pole-pieces 2 and 6, a flux path will be established through the plunger 13 and the plunger will be drawn upwardly in the envelope in an attempt to center itself between the pole-pieces 2 and 6. This movement of the plunger moves the globule of mercury upwardly, a tongue of the mercury being forced into the recess 17 of the insulating cylinder 16 until it engages the end of electrode 11 which extends downwardly into the recess. Since the recess is shallow and the electrode 11 extends nearly to the lower end thereof, the movement of the mercury globule effects quick closure between the electrodes 11 and 12. Reversely when the pole-pieces 2 and 6 become demagnetized, the plunger 13 is freed to drop upon the upper end of spring 14 which in this case serves as a shock absorber and the tongue of mercury will be withdrawn quickly from the recess 17 due to the spring action of the surface tension of the mercury, thus forcing the plunger downwardly and effecting a quick opening between the electrodes 11 and 12. This switch element thus affords a quick make-quick break of normally open contacts.

The switch element disclosed in Fig. 8 is substantially similar to that disclosed in Fig. 2 except that the insulator 16 is shorter and spring 14 is expanded to normally hold the plunger 13 in the position disclosed, whereby the globule of mercury 15 is normally in contact with the ends of both electrodes 11 and 12 thus effecting a normal circuit closure. When, however, a magnetic potential is created between the pole-pieces 2 and 6, the plunger 13 will be drawn downwardly in the envelope to compress the spring 14 and due to its surface tension the tongue of mercury will withdraw quickly from the recess 17 thus quickly opening the contact between the mercury and the electrode 11. Reversely when the pole-pieces become demagnetized, the plunger is quickly forced upwardly by the spring 14 to force a tongue of mercury into the recess 17 to again effect a circuit closure. This switch element thus affords a quick break-quick make of normally closed contacts.

The switch element of Fig. 6 is substantially the same as that disclosed in Fig. 2 with the exception of the arrangement of electrodes 11 and 12 with respect to the recess in the insulator 16. In this case the recessed portion 17 of the insulator is made much deeper and the depending end of electrode 11 extends substantially to the lower end of the recessed portion 17. When the plunger 13 is electromagnetically actuated toward the upper pole-piece 2, a tongue of mercury from the globule 15 is forced into the recess 17 and quickly engages the end of electrode 11, thus effecting a quick contact closure. As the plunger moves upwardly the tongue of mercury becomes extended until it completely fills the recess. Reversely when the pole-pieces are demagnetized and the plunger 13 drops down upon the buffer spring 14 the surface tension of the mercury globule will tend to withdraw the tongue of mercury from the recess 17. To delay this action the envelope is provided with a capillary groove 18, shown most clearly in Fig. 15, in the wall of the envelope opposite the recessed portion 17 of insulator 16 through which the gas flows slowly

past the mercury globule. Since, during the delayed withdrawal of the tongue of mercury from the recess 17, the mercury continues in contact with the end of electrode 11 until the tongue is completely withdrawn, a slow break between the electrodes 11 and 12 results. This switch element thus affords a quick make-slow break of normally open contacts.

The switch element of Fig. 7 is substantially the same as that disclosed in Fig. 6 except that the depending portion of electrode 11 protrudes for only a short distance below the top of the recessed portion 17 of the insulator 16. When the plunger 13 is electromagnetically actuated towards the pole-piece 2, the tongue of mercury from the globule 15 is forced into recess 17 but due to the slow flow of gas through the capillary groove 18, past the mercury globule, the time required for the tongue to completely fill the recess and engage the end of electrode 11 is extended, thus effecting a slow closure between the electrodes 11 and 12. Reversely, when the pole-pieces are demagnetized and the plunger 13 is freed to drop down upon the buffer spring 14, the end of the tongue of mercury will, due to the surface tension of the mercury withdrawn from the end of electrode 11, quickly thus forcing the plunger downwardly and effecting a quick break between the electrodes. This switch element thus affords a slow make-quick break of normally open contacts.

The switch element of Fig. 9 is substantially the same as that disclosed in Fig. 8 except that the capillary groove 18 is provided, the recess 17 in the insulator 16 is made deep and the depending end of electrode 11 extends throughout the entire length of the recess. Normally the plunger 13 is held in the position shown by the spring 14 so that a tongue of the mercury globule 15 is forced up into and completely fills the recess, thus electrically connecting the electrodes 11 and 12. When the plunger 13 is electromagnetically drawn against the tension of spring 14 toward the pole-piece 6, the tongue of mercury will tend to withdraw from the recess but will be retarded in its withdrawal by the slow flow of gas through the groove 18 and since the tongue of mercury will engage the end of electrode 11 until it is entirely withdrawn from the recess, a slow break between the electrodes 11 and 12 is effected. When the pole-pieces become demagnetized, however, the plunger 13 will first be restored rapidly by the spring 14 thereby quickly engaging the mercury globule 15 with the ends of electrodes 11 and 12 and will thereafter move more slowly until a tongue of mercury again fills the recess 17. This switch element thus affords a slow break-quick make of normally closed contacts.

The switch element of Fig. 10 is also substantially similar to that of Fig. 9 with the exception that the depending end of electrode 11 extends but a short distance into the recess 17 of the insulator 16. In the normal position of the plunger 13 as disclosed, a tongue of the mercury globule is forced into and completely fills the recess, thus connecting the ends of the electrodes. When the plunger 13 is electromagnetically drawn downwardly toward the pole-piece 6, the tongue of mercury will tend to withdraw from the recess but will be retarded in its withdrawal by the slow flow of gas through the groove 18 but since the exposed end of electrode 11 is short, the mercury will, however, be disengaged quickly from it. After an interval, the tongue of mercury will entirely withdraw from the recess. When the pole-pieces are thereafter demagnetized, the plunger 13 will at first be restored quickly by the spring 14 and will tend to force a tongue of mercury into the recess 17. The further restoring movement of the plunger will then be delayed by the slow extension of the tongue of mercury into the recess as determined by the flow of gas through the groove 18, until finally the end of the tongue engages the end of electrode 11 to re-establish the contact between the electrodes 11 and 12 through the mercury. This switch element thus affords a quick break-slow make of normally closed contacts.

As an alternative the semicylindrical recess 17 of the insulator may be omitted as disclosed in Fig. 5 and the electrode 11 may be extended different distances through the hole in the insulator 16' dependent upon the circuit closing or opening characteristic desired, the remaining portion of the hole 17' below the lower end of electrode 11 serving as a recess into or from which the tongue of mercury is forced or withdrawn.

While the switch elements shown in Figs. 2 to 10, inclusive, have been illustrated as positioned vertically with their plungers in the lower portions thereof, these elements will function if inverted or positioned horizontally.

Figs. 11 to 14, inclusive, disclose switch elements which are not provided with insulating cylinders in the upper portion of the envelopes whereby more space is provided in the upper portion of the envelopes to enable a quicker recycling through the more rapid collapse of the globules of mercury. Figs. 11 and 12 disclose switch elements having normally open contacts and Figs. 13 and 14 disclose switch elements having normally closed contacts.

In accordance with Fig. 11 upon the magnetization of the pole-pieces 2 and 6, the plunger 13 is drawn upwardly toward the pole-piece 2, thus raising the globule of mercury 15 into engagement with the ends of electrodes 11 and 12. The movement of the globule is, however, delayed due to the slow passage of gas through the capillary groove 18 past the globule whereby a slow closure is effected between the electrodes. When the pole-pieces are demagnetized, the plunger drops down upon the buffer spring 14 and the globule collapses quickly to disengage from the electrodes. This switch element therefore affords a slow make-quick break of normally open contacts.

In accordance with Fig. 12, three electrodes 11, 12 and 19 are provided, electrodes 11 and 12 terminating just above the upper surface of the mercury globule 15 and the electrode 19 terminating at a greater distance above the surface of the globule. When the pole-pieces 2 and 6 become magnetized, the plunger 13 is drawn upwardly toward the pole-piece 2 thus raising the globule of mercury into engagement with the ends of electrodes 11 and 12 to effect a quick closure between them. The further movement of the globule is, however, delayed due to the slow passage of gas through the capillary groove 18 past the globule whereby a slow closure between the electrodes 11 or 12 and electrode 19 is effected. When the pole-pieces are demagnetized, the plunger drops down upon the buffer spring 14 and the globule collapses quickly to disengage all of the electrodes. This switch element therefore affords both a quick and slow make and a quick break of its normally open contacts.

The switch element of Fig. 13 is so constructed that plunger 13 is normally held in the position disclosed by the spring 14 in which position the

globule of mercury 15 makes contact with the ends of electrodes 11 and 12. When the pole-pieces 2 and 6 become magnetized, the plunger is drawn downwardly toward the pole-piece 6 thereby compressing the spring 14 and quickly withdrawing the mercury from engagement with the electrodes. Upon the later demagnetization of the pole-pieces the spring 14 tends to restore the plunger to its normal position, but is delayed in doing so by the slow leak of gas past the globule through the capillary groove 18. A delay interval is thus introduced before the plunger rises sufficiently to move the globule of mercury into engagement with the electrodes. This switch element therefore affords a quick break and a slow make of its normally closed contacts.

The switch element of Fig. 14 is similar to that of Fig. 13 except that three electrodes 11, 12 and 19 are provided, the ends of electrodes 11 and 12 being normally deeply immersed in the mercury globule 15 and the end of electrode 19 being less deeply immersed. In the operation of this switch element when the pole-pieces 2 and 6 become magnetized and the plunger 13 is drawn toward the pole-piece 6, against the tension of spring 14, the mercury globule 15 follows it to quickly disengage all of the electrodes. When thereafter the pole-pieces become demagnetized, the spring 14 tends to restore the plunger to its normal position but is delayed in doing so by the slow leak of gas past the globule through the capillary groove 18. Due, however, to the fact that electrodes 11 and 12 are long and in the operated position of the plunger their ends are close to the upper surface of the globule, the first part of the restoring movement of the plunger will quickly bring the globule into engagement with the ends of such electrodes, but electrode 19 being much shorter will not be engaged by the globule until near the end of the restoring movement of the plunger. This switch element thus provides a quick break of all of its normally closed contacts, a quick make between certain of its contacts and a slow make between other of its contacts.

In Figs. 16 and 17 a further embodiment of the invention has been disclosed in each of which the globule of mercury 15 is deposited in the bottom of envelope 10 and one of the electrodes 20 has its end immersed in the globule. The other electrode 21 is made of magnetic spring material or has that portion thereof depending within the envelope made of such material and provided with a helix 22.

The switch element disclosed in Fig. 16 is of the normally open circuit type. The electrode 21 thereof extends downwardly to a point above the lower pole-piece 6 and is then coiled upwardly about the downwardly extending portion to form the closely coiled helix portion 22, with the end of the electrode extending from the top coil of the helix downwardly through the helix and terminating just above the upper surface of the mercury globule. When the pole-pieces 2 and 6 become magnetized, the lower portion of the helix is drawn toward the lower pole-piece 6 thereby moving the lower end of the electrode 21 into engagement with the mercury to quickly establish a circuit through the mercury between the electrodes 20 and 21. When the pole-pieces become demagnetized, the helix contracts quickly and withdraws the end of electrode 21 from the mercury thus opening the connection between the electrodes.

The switch element of Fig. 17 is of the normally closed circuit type and therefore the end of the electrode 21 is normally immersed in the mercury globule 15. The helix 22 there of has its coils loosely wound. When therefore the pole-pieces 2 and 6 become magnetized, the adjacent coils of the helix 22 become attracted toward each other thereby contracting the helix to such an extent as to disengage the end of electrode 21 from the mercury to effect a circuit opening. Thereafter, upon the demagnetization of the pole-pieces the helix expands to again engage the end of electrode 21 with the mercury.

While the invention has been illustrated by certain specific embodiments thereof, other arrangements of electrodes and magnetically actuated members and the association of the globules of mercury therewith for securing other types of circuit control will be apparent to those skilled in the art. It is therefore to be understood that the scope of the invention is limited only by the bounds set forth in the appended claims.

What is claimed is:

1. In an electromagnetic structure having an electromagnetic field, a contact element comprising a sealed envelope, terminals extending into said envelope, a plunger of magnetic material responsive to said electromagnetic field and freely movable in said envelope and a globule of mercury supported on the end of said plunger in engagement with the inner wall of said envelope and movable thereby to control the bridging of said terminals.

2. In an electromagnetic structure having an electromagnetic field, a contact element comprising a sealed envelope, terminals extending into said envelope, a plunger of magnetic material responsive to said electromagnetic field and freely movable in said envelope and a globule of mercury supported on the end of said plunger in engagement with the inner wall of said envelope and movable thereby into bridging engagement with said terminals.

3. In an electromagnetic structure having an electromagnetic field, a contact element comprising a sealed envelope, terminals extending into said envelope, a plunger of magnetic material responsive to said electromagnetic field and freely movable in said envelope and a globule of mercury supported on the end of plunger in engagement with the inner wall of said envelope and movable thereby out of normal bridging engagement with said terminals.

4. In an electromagnetic structure having an electromagnetic field, a contact element comprising a sealed envelope, an insulator supported in one end of said envelope, the inner end of which is provided with a recessed portion, a pair of terminals of different lengths extending through the end wall of said envelope and through said insulator, the inner end of the longer terminal being exposed beyond the inner end of said insulator and the inner end of the shorter terminal being exposed in the recessed portion of said insulator, a plunger of magnetic material responsive to said magnetic field and freely movable in said envelope and a globule of mercury adjacent to said plunger and movable thereby to control the bridging of said terminals.

5. In an electromagnetic structure having an electromagnetic field, a contact element comprising a sealed envelope, an insulator supported in one end of said envelope, the inner end of which is provided with a recessed portion, a pair of terminals of different lengths extending through the end wall of said envelope and through said

insulator, the inner end of the longer terminal being exposed beyond the inner end of said insulator and the inner end of the shorter terminal being exposed in said recessed portion of said insulator, a plunger of magnetic material responsive to said magnetic field and freely movable in said envelope and a globule of mercury associated with said plunger normally in engagement with said longer terminal and movable by said plunger into the recessed portion of said insulator into engagement with said shorter terminal.

6. In an electromagnetic structure having an electromagnetic field, a contact element comprising a sealed envelope, an insulator supported in one end of said envelope, the inner end of which is provided with a recessed portion, a pair of terminals of different lengths extending through the end wall of said envelope and through said insulator, the inner end of the longer terminal being exposed beyond the inner end of said insulator and the inner end of the shorter terminal being exposed in said recessed portion of said insulator, a plunger of magnetic material responsive to said magnetic field and freely movable in said envelope and a globule of mercury associated with said plunger normally in engagement with the inner end of said insulator and filling the recessed portion thereof to bridge said terminals, said globule being movable by the attracted movement of said plunger out of engagement with said terminals.

7. In an electromagnetic structure having an electromagnetic field, a contact element comprising a sealed envelope, an insulator supported in one end of said envelope the inner end of which is provided with a deeply recessed portion, a pair of terminals of different lengths extending through the end wall of said envelope and through said insulator, the inner end of the longer terminal being exposed beyond the inner end of said insulator and the inner end of the shorter terminal extending substantially throughout the length of said recessed portion of said insulator, a plunger of magnetic material responsive to said magnetic field and freely movable in said envelope, a globule of mercury associated with said plunger and movable thereby to control the bridging of said terminals, and a capilliary groove in the inside wall of said envelope for controlling the rate of movement of said globule of mercury.

8. In an electromagnetic structure having an electromagnetic field, a contact element comprising a sealed envelope, an insulator supported in one end of said envelope, the inner end of which is provided with a deeply recessed portion, a pair of terminals of different lengths extending through the end wall of said envelope and through said insulator, the inner end of the longer terminal being exposed beyond the inner end of said insulator and the inner end of the shorter terminal being exposed only just beyond the bottom of the recessed portion of said insulator, a plunger of magnetic material responsive to said magnetic field and freely movable in said envelope, a globule of mercury associated with said plunger and movable thereby to control the bridging of said terminals and a capillary groove in the inside wall of said envelope for controlling the rate of movement of said globule of mercury.

9. In an electromagnetic structure having an electromagnetic field, a contact element comprising a sealed envelope, an insulator supported in one end of said envelope, the inner end of which is provided with a deeply recessed portion, a pair of terminals of different lengths extending through the end wall of said envelope and through said insulator, the inner end of the longer terminal being exposed beyond the inner end of said insulator and the inner end of the shorter terminal extending substantially the length of said recessed portion of said insulator, a plunger of magnetic material responsive to said magnetic field and freely movable in said envelope, a globule of mercury associated with said plunger and normally in engagement with said longer terminal and movable by the attracted movement of said plunger into the recessed portion of said insulator into engagement with said shorter terminal, and a capillary groove in the inside wall of said envelope for delaying the flow of said mercury glouble from the recessed portion of said insulator upon the retractive movement of said plunger.

10. In an electromagnetic structure having an electromagnetic field, a contact element comprising a sealed envelope, an insulator supported in one end of said envelope, the inner end of which is provided with a deeply recessed portion, a pair of terminals of different lengths extending through the end wall of said envelope and through said insulator, the inner end of the longer terminal being exposed beyond the inner end of said insulator and the inner end of the shorter terminal extending substantially the length of said recessed portion of said insulator, a plunger of magnetic material responsive to said magnetic field and freely movable in said envelope, a globule of mercury associated with said plunger normally in engagement with the inner end of said insulator and filling the recessed portion thereof to bridge said terminals, said globule of mercury being movable by the attracted movement of said plunger out of engagement with said terminals and a capillary groove in the inside wall of said envelope for delaying the flow of said mercury globule from said recessed portion upon the attracted movement of said plunger.

11. In an electromagnetic structure having an electromagnetic field, a contact element comprising a sealed envelope, an insulator supported in one end of said envelope, the inner end of which is provided with a deeply recessed portion, a pair of terminals of different lengths extending through the end wall of said envelope and through said insulator, the inner end of the longer terminal being exposed beyond the inner end of said insulator and the inner end of the shorter terminal being exposed only just beyond the bottom of the recessed portion of said insulator, a plunger of magnetic material responsive to said magnetic field and freely movable in said envelope, a globule of mercury associated with said plunger normally in engagement with said longer terminal and movable by the attracted movement of said plunger into the recessed portion of said insulator into engagement with said shorter terminal and a capillary groove in the inside wall of said envelope for delaying the flow of said mercury globule into said recessed portion of said insulator.

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