Jan. 29, 1946. U. C. HEDIN 2,393,904

MERCURY RELAY

Filed Dec. 30, 1939 2 Sheets-Sheet 1

Fig. 1.

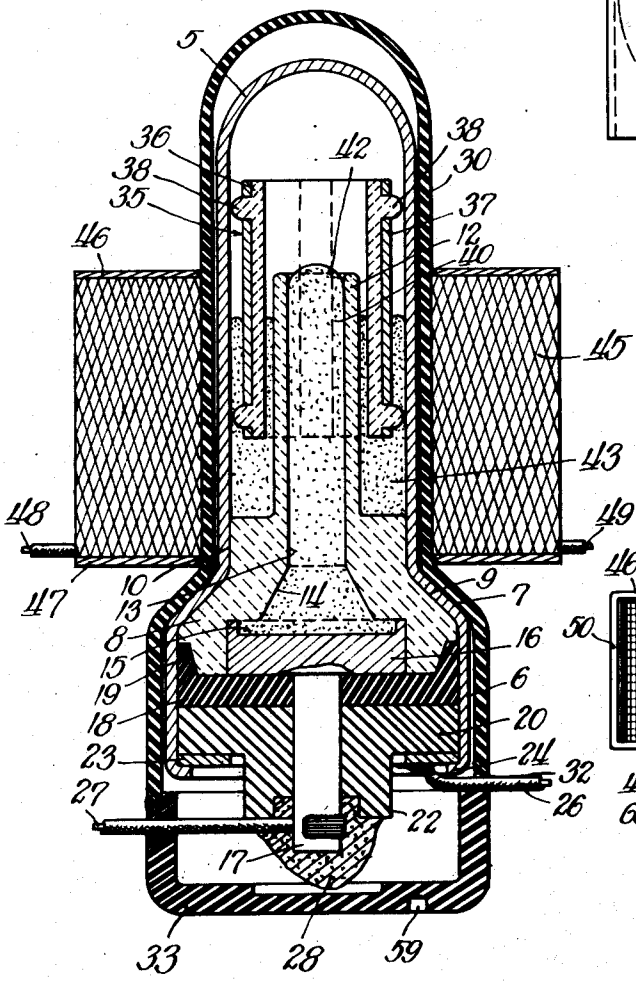


Fig. 3.

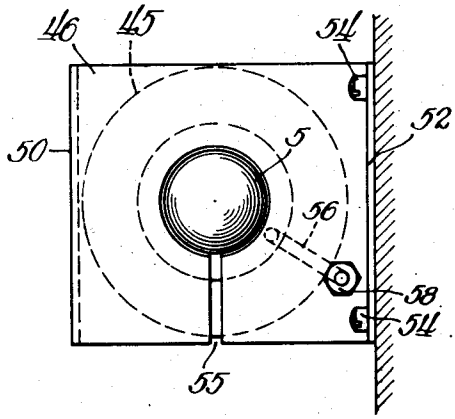
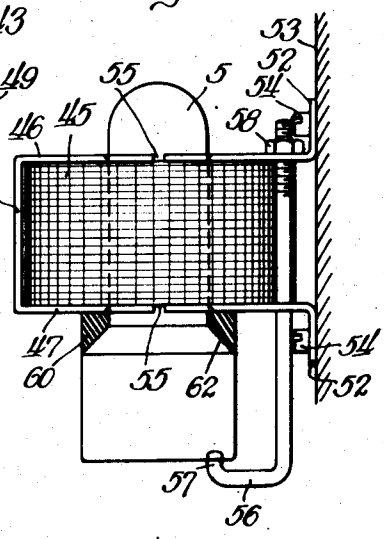


Fig. 2.



INVENTOR.
Uno C. Hedin.
BY Walter E. Schirmer
ATTORNEY.

Jan. 29, 1946. U. C. HEDIN 2,393,904

MERCURY RELAY

Filed Dec. 30, 1939 2 Sheets-Sheet 2

Fig. 4.

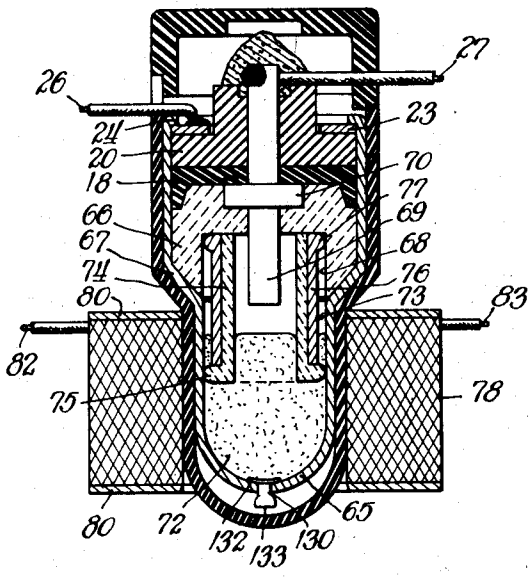


Fig. 5.

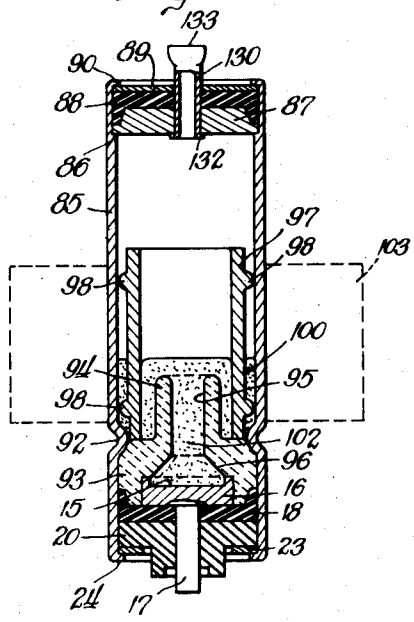


Fig. 6.

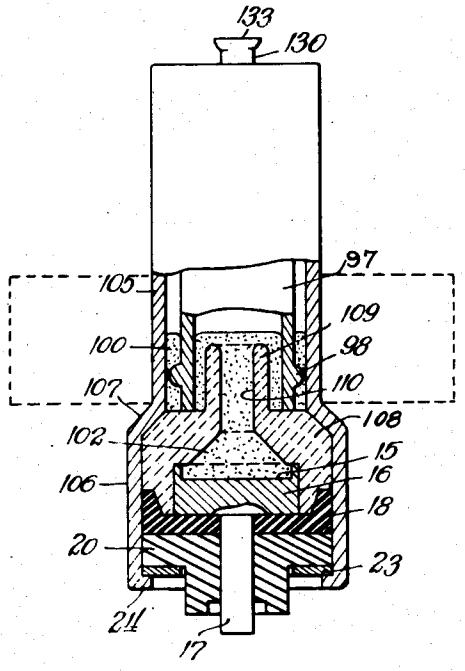
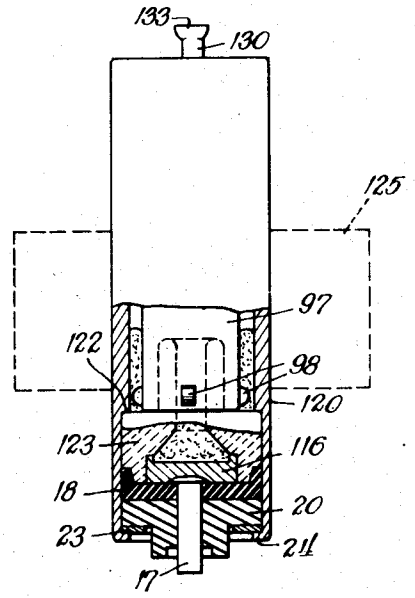


Fig. 7.



INVENTOR.
Uno C. Hedin.
BY Walter E. Achsmer
ATTORNEY.

Patented Jan. 29, 1946

2,393,904

UNITED STATES PATENT OFFICE

2,393,904

MERCURY RELAY

Uno C. Hedin, Elkhart, Ind., assignor, by mesne assignments, to Herbert E. Bucklen, Jr., Elkhart, Ind.

Application December 30, 1939, Serial No. 311,915

8 Claims. (Cl. 200—112)

This invention relates to mercury relays, and more particularly is directed to mercury relays of the displacer type comprising a metallic envelope having two electrodes spaced apart by means of a ceramic or refractory member with bodies of mercury retained in contact with one or both of the electrodes and adapted to provide bridging contact between the electrodes for completing a circuit upon displacement of a plunger or the like through magnetic action.

One of the primary objects of the present invention is to provide a metallic envelope mercury relay which will avoid the objections heretofore encountered in the use of glass relays in which the glass envelope was frequently cracked or broken during shipment or in use by reason of the action of the displacer, which must necessarily have a magnetic material associated therewith and which, when moved rapidly, might engage the glass envelope with sufficient force to break the same. In fact, in such previous constructions using glass envelopes it became necessary to employ cushioning means for the ends of the displacer to insure against too rapid movement thereof or shifting thereof during shipping, which means, however, was not wholly effective.

Another object of the present invention is to provide a construction in which the mercury relay can be readily mounted in a solenoid or the like, and is capable of assuming various axial positions therein by use of a novel type of spacing and clamping means so that relays of various capacities may be employed with the same solenoid mounting bracket.

Still another feature of the present invention is to provide a mercury relay construction in which the major portion of the component parts are similar to or identical with portions of the metal envelope mercury switches of the type now on the market, and as disclosed in the Paul S. Bear patents, Nos. 2,132,921 and 2,132,922, issued October 11, 1938, respectively. This allows mass production of certain of the parts, insuring economy of manufacture and facilitating conversion of the switches into mercury relay switches of the displacer type without a great deal of tooling expense.

Another feature of the present invention is to provide mercury relays which may be of either the normally open or the normally closed type without greatly changing the internal construction of the switch.

Still another feature of the present invention is to provide an improved mounting for holding the switch in fixed axial non-rotative position within the solenoid core.

Other objects and advantages of the present invention will be more apparent from the following detailed description which, taken in conjunction with the accompanying drawings, will disclose to those skilled in the art the particular construction and operation of a preferred form of the present invention.

In the drawings:

Figure 1 is a sectional view through one form of mercury displacer embodying the present invention;

Figure 2 is an elevational view, partly in section, of a switch such as shown in Figure 1 in conjunction with the mounting bracket for the solenoid;

Figure 3 is a plan view of the structure shown in Figure 2;

Figure 4 is a vertical sectional view through a mercury relay of the normally open type;

Figure 5 is a similar sectional view of a modified form of switch utilizing the tubular open ended envelope;

Figure 6 is a still further modified construction somewhat similar to that shown in Figure 1 but showing a switch of the normally closed type; and

Figure 7 is an elevational view, partly in section, showing a still further modified form of envelope structure.

Referring now in detail to the drawings, in Figure 1 I have shown a metallic envelope 5 having the enlarged end portion 6 joined to the main tubular body portion by the frusto-conical shoulder 7. This envelope must be of the austenitic type, and may comprise stainless steel or a non-magnetic material that does not amalgamate with mercury. A stainless steel of the 18–8 group is preferable, having not less than 24% chromium and nickel combined, but not less than 8% of each element. The shell has an enlarged open end in which is inserted the ceramic or refractory member 8 having a frusto-conical shoulder portion 9 seating on the shoulder 7 and axially locating the refractory 8 in position. The shoulder 9, together with the inwardly extending cylindrical portion 10 of reduced diameter, form means for radially centering the insert within the envelope.

The insert 8 is provided with the tubular extending portion 12, which is bored as indicated at 13, to form an axial passage therethrough, opening out at its lower end through the flared portion 14 into the face 15 of an electrode head 16 secured in the counterbored lower end of the in-

sert 8. The electrode head 16 is of an axial extent such as to fit fully within the end of the insert 8, and has the central projecting shank 17 projecting outwardly of the open end of the envelope 5. Seated against the rear face of the electrode head 16 and the lower end of the insert 8 is an elastic compressible sealing means 18, such as rubber or the like, forming a gasket having the projecting skirt or lip portion 19 extending about the frusto-conical shoulder formed on the insert 8. The gasket 18 is compressed in position by means of a refractory compression member 20 which extends into the open end of the envelope and has the reduced cylindrical portion 22 encircling the shank 17 of the electrode outwardly of the envelope end. The entire assembly is maintained under compression to force the gasket 18 into sealing engagement with the internal walls of the envelope by means of the metallic retaining ring 23 held in position by the spun-over edge 24 at the open end of the envelope. The retaining ring 23 is connected to one side of the circuit controlled by the relay through the conductor 26, electrically bonded thereto. The electrode shank 17 is connected to the opposite side of the circuit through the conductor 27 secured to the projecting end of the shank outwardly of the shouldered portion 22 of the compression member 20, and is preferably encased within a hard setting cementitious material, such as indicated at 28, which forms a water-proof bond over the terminal and the end of the compression member 20.

The envelope assembly is preferably enclosed within an insulated molded case formed of two pieces comprising the main body portion 30 which extends about the closed end of the envelope and is shouldered to enclose the enlarged end of the envelope, being notched as indicated at 32 for leading out the conductor 26. The end of the case member 30 is closed by a cup-shaped cap member 33 which is rabbeted into the end thereof and suitably cemented thereto.

Disposed within the tubular body of the envelope 5 and radially spaced from the extension 12 of the insert 8 is a circular plunger 35 comprising an inner member of refractory insulating material 36 and an outer tubular shell 37 of magnetic material such as soft iron or the like. Adjacent opposite ends the cylindrical sleeve 36 is provided with radially extending circumferentially spaced projections 38 which extend through suitable apertures formed in the iron sleeve 37 to locate the iron sleeve against axial movement relative thereto, and also to provide insulating bumpers for preventing contact between the iron sleeve 37 and the metallic shell 5. Disposed in the bore 13 of the extension 12 and lying in contact with the face 15 of the electrode is a body of mercury 40 which, at its upper end has the meniscus curve 42 lying within the circular edge of the sleeve 12. Disposed on the outside of the sleeve 12 and in the annular space between the external sleeve 12 of the tubular portion 5 is a second body of mercury 43 in which the lower end of the displacer 35 is immersed. Due to the relative differences in specific gravities of the displacer and the mercury, the displacer floats in the mercury, as shown in the normal inoperative position of the relay. At this time there is no contact between the two bodies of mercury 42 and 43, and consequently the circuit between the conductors 26 and 27 is open.

Surrounding the relay is a solenoid coil indicated diagrammatically at 45, and disposed between the metal plates 46 and 47, this coil having a bore through the center through which the tubular portion of the relay 5 extends. Upon energization of the coil 45 by closing a circuit through the conductors 48 and 49, the coil is energized and the magnetic action results in pulling the displacer 35 downwardly into the body of mercury 43. This displaces the mercury so that it rises in the annular space between the sleeve 12 and the shell until it breaks over the upper edge of the sleeve 12 and flows into contact with the body of mercury 40, completing a circuit between the conductors 26 and 27. So long as the coil is energized, the displacer remains in this position, but upon de-energization of the coil, the spacer moves upwardly due to its smaller specific gravity, consequently lowering the level of the mercury body 43 and breaking contact over the edge of the sleeve 12.

It will thus be seen that a mercury to mercury making and breaking of contact is effected over the refractory sleeve 12 and that any arc which might occur is located within the refractory sleeve 36, thereby preventing any possibility of arcing between the mercury and any adjacent metallic surface. As a result, the metallic surfaces are protected against possible pitting or burning caused by such arcs and a substantially uniform point of making and breaking contact is provided.

It will be noted that the body of mercury 40 has appreciable surface contact with the face of the electrode 15 so as to reduce the contact resistance between the electrode and this body of mercury. Similarly, the body of mercury 43 has considerable surface contact with the tubular shell 5 to insure low contact resistance therebetween, thereby reducing the resistance to flow of current through the switch when the coil 45 is energized.

Considering now the form of the invention shown in Figures 2 and 3, the switch 5 shown in these figures is similar to the switch disclosed in detail in Figure 1. The coil 45 in this embodiment of the invention is mounted in a substantially U-shaped bracket member 50 which has normally extending flanges 52 at the ends thereof which are adapted to be secured to a supporting surface 53 by means of the screws 54. The clamp 50 is normally made with the two parallel clamping surfaces 46 and 47 extending at a slight angle away from each other so that when placed in position they tend to clamp the coil 45 therebetween. The two legs 46 and 47 of the clamp are split, as indicated at 55, to prevent eddy currents therethrough and to reduce the magnetic reluctance of the circuit.

The plates 46 and 45 are apertured to receive the small diameter portion of the switch 5 which extends therethrough and through the bore of the coil 45. The switch is held in position by means of a J-bolt 56, preferably formed of spring material, having the vertically extending end 57 engaged in the recess 59 in the cap member 33 and having the shank portion extending through suitable openings in the legs 46 and 47 and secured by means of the nut 58 over the upper plate 46 in tensioned relation to hold the switch firmly in position.

To adapt the construction for use with various lengths of relays, a spacer member 60 is provided which may be formed of wood, porcelain, or any similar insulating material and which has a frusto-conical recess 63 therein seating about the frusto-conical surface formed by the enlarged

portion of the relay. This member seats against the under surface of the plate 47 and when the bolt 56 is tightened in position, the switch is securely held against movement axially with respect to the coil 45 or the clamp 50. Preferably, the recess 59 in the cap is arranged with respect to the bolt 56 so that the bolt extends radially with respect to the axis of the relay. Thus the bolt serves not only to hold the relay 5 against downward displacement relative to the coil 45, but also prevents rotation of the relay 5 within the clamp.

This provides a very simple mounting arrangement in which the switch can be accurately held in position both axially and rotatably, and insures a quick means of assembling the switch in position relative to the coil.

Considering now the embodiment of the invention shown in Figure 4, the relay 65 of this form of the invention is of shorter length than the shell 5 of Figure 1 and is provided with a different type of insert indicated generally at 66. The insert 66 in this form of the invention seats against the frusto-conical shoulder 67 of the shell 65, and is provided with the bore 68 which is of substantially the same diameter as the diameter of the tubular portion of the shell. Projecting through the insert 66 is an electrode 69 having the shouldered portion 70 limiting axial movement of this electrode inwardly of the insert. The gasket 18 corresponding to the gasket of Figure 1 seals the insert and electrode in position, being held in compressed position by the compression member 20 secured in place by the retaining ring 23 disposed beneath the spun-over edge 24 of the shell. It will be noted that the electrode 69 in this form of the invention projects an appreciable distance axially with respect to the bore 68 of the insert, and is normally disposed out of contact with respect to the body of mercury 72 carried in the lower end of the shell 65. A suitable two piece displacer 73 is provided comprising an inner sleeve of refractory material indicated at 74 having the annular flange 75 at one end thereof which bears against the internal surface of the tubular portion of the shell 65 and is surrounded by the metallic sleeve of magnetic material indicated at 76 having the annular flange 77 at the end opposite the flange 75, which engages in the bore 68, whereby the displacer 73 is held against radial movement and is guided by the flanges 75 and 77 for axial movement within the shell 65. Surrounding the lower end of the relay 65 is the coil 78 mounted between the plates 79 and 80, and adapted to be energized through the conductors 82 and 83. Upon energization of this coil, the displacer 73 is pulled downwardly into the body of mercury 72, thereby causing this mercury to rise until it contacts the electrode 69 completing a circuit between the shell 65 and conductor 26 and the electrode 29 and conductor 27. So long as the coil remains energized, the displacer is held in immersed position maintaining this circuit closed, but upon de-energization of the coil, the displacer 73 rises, breaking the circuit between the body of mercury 72 and electrode 69, and consequently opening the circuit. It will thus be apparent that this switch provides a metal to mercury contact, and is normally in open position, the circuit being closed therethrough upon energization of the solenoid coil.

In Figure 5 I have provided a further modification of the structure in connection with a normally closed type relay.

In this form of the invention, the shell of the relay is preferably made from straight tubular stock comprising the tubular blank 85, which at one end is provided with a counterbored portion defining the shoulder 86 receiving the ceramic refractory envelope 87. This member 87 is held on the shoulder 86 by means of the resilient gasket 88 corresponding to the gasket 18 compressed by means of the disc 89 held in position by the spun-over edge 90 of the tube.

Adjacent its lower end the blank 85 is provided with a grooved portion 92 which produces a shoulder preventing inward movement of the refractory insert 93. The insert 93 is somewhat similar to the insert 8 of Figure 1, but has a vertically extending sleeve portion 94 of less length than the sleeve 12 of Figure 1, being provided with the bore 95 opening through the flared portion 96 onto the electrode face 15 of the electrode 16, this electrode being provided with the axially extending shank 17 received within the ceramic compression member 20. Interposed between the compression member 20 and the insert 93 is a gasket 18 corresponding to the gasket described in Figures 1 and 4, which is compressed in position to seal this end of the switch and held in place by the spun-over edge 24 of the blank 85 engaging over the retaining ring 23.

In this form of the invention a metallic displacer 97 is provided having the bosses or lugs 98 for guiding the same for axial movement within the tube 85 and preventing any possible binding thereof in the tube. The displacer 97 is normally of sufficient mass so that it rests in the position shown in Figure 5, whereby sufficient mercury in the mercury body 100 is displaced to run over the end of the sleeve 94 and produce contact with the body of mercury 102 disposed in the bore 95 of the sleeve. Thus, this switch provides a construction in which the circuit is normally closed. Upon energization of the coil 103, the displacer 97 is lifted, thereby allowing the outer body of mercury 100 to drop in height until the circuit is broken between the bodies 100 and 102 over the peripheral edge of the sleeve 94.

It will therefore be seen that a mercury to mercury making and breaking of contact is effected in the relay shown in Figure 5, and that any possible arcing which occurs will occur over the refractory surface of the edge of the sleeve 94. Due to the fact that an annular contact is effected, there is an appreciable cross section of mercury whenever contact is made in the relay, thereby materially reducing the internal resistance of the relay.

In Figure 6 I have shown a form of the invention utilizing the same end closure as described in connection with the upper end of the shell 85, described in Figure 5, but in which the blank 105 has the enlarged lower end 106 defined by the frusto-conical surface 107. This takes the place of the annular groove 92 of the blank 85 of Figure 5, and forms a shoulder for receiving the refractory insert 108 to limit its axial inward movement. The refractory 108 is also provided with an axially extending cylindrical portion 109 defining a bore 110 which opens onto the electrode face 15 of the electrode head 16, this electrode corresponding to that described in connection with Figures 1 and 5. The relay of Figure 6 is provided with a displacer 97 corresponding to the displacer of Figure 5, which functions in the same manner for opening the circuit through the relay upon energization of a

coil surrounding the upper portion of the relay, and which normally maintains the circuit closed due to the displacement of the mercury over the edge of the sleeve portion 100. The coil is shown diagrammatically at 103.

Figure 7 is a still further modification of the structure shown in Figure 5 in which the lower end of the blank 120 is provided with a counterbored portion forming a shoulder 122 against which the insert 123 is disposed. This is the equivalent of the shoulder 107 of Figure 6 or the groove 92 of Figure 5, and serves the same function as these means in preventing axial inward movement of the insert 123 relative to the shell 120.

In other respects, the relay shown in Figure 7 is similar to that shown in Figures 5 and 6, and functions in the same manner for opening the circuit therethrough upon energization of coil 125 and closing the circuit therethrough upon de-energization of such coil.

It will be noted that in all forms of the invention shown in Figures 4 to 7, inclusive, one end of the switch is provided with the extending tubulation 130. This tubulation comprises a tubular member of relatively small cross section which, in the form shown in Figure 4, is welded to the inner surface of the rounded end of the shell 85 by means of the flange 132. The tubulation is employed for introducing the mercury into the relay and evacuating the interior of the relay after the parts have been assembled in position. After evacuation, the interior of the switch may be filled with hydrogen gas under pressure if so desired and the projecting end of the tubulation then pinched, as indicated at 133, and then welded to completely seal the interior thereof. The process for filling, evacuating, and sealing the relay is similar to that described in detail in the copending application of Paul S. Bear, Serial No. 293,690, filed September 7, 1939, and reference should be had thereto for a more complete description of this phase of the invention.

It is therefore believed apparent that I have provided a novel type of mercury relay construction which can be readily manufactured at low cost and which includes the provision of a metal enclosing envelope providing added strength and insuring against breakage of the relay, such as is common in connection with glass envelope types. Further, the construction is so designed as to facilitate the use of standard mercury switch parts. In addition, a novel type of clamping means for holding the relay in position relative to its energizing coil is provided and which is capable of adjustment to take care of various sizes of relays. It is to be understood that the switch shown in Figure 1 can also be provided with a tubulation shown in Figure 4 for filling, evacuating and refilling with hydrogen under pressure when such procedure is desired.

I am aware that various changes may be made in certain details of the construction herein shown and described, and therefore do not intend to be limited except as defined by the scope and spirit of the appended claims.

I claim:

1. A mercury relay comprising a cylindrical metallic sleeve, a counterbore in one end of said sleeve, a ceramic closure sealed in said counterbore closing said end, an annular shoulder adjacent the opposite end of said sleeve, a refractory insert in said latter end and abutting against said shoulder to limit inward movement thereof, means sealing said insert in position, said insert carrying an electrode insulated thereby from said sleeve, an integral tubular extension on said insert confining a body of mercury in contact with said electrode, a second body of mercury surrounding said last-named extension and in contact with said sleeve, and a displacer adapted to be magnetically operated for effecting making and breaking of contact between said mercury bodies over the upper edge of said tubular extension.

2. A mercury relay comprising a cylindrical metallic sleeve, means defining a counterbore in one end of said sleeve, a ceramic closure sealed in said counterbore closing said end, means defining a second counterbore in the opposite end of said sleeve, a refractory insert in said latter end seating in said counterbore to limit inward movement thereof, means sealing said insert in position, said insert carrying an electrode insulated thereby from said sleeve, means on said insert confining a columnar body of mercury in contact with and extending above said electrode, a second body of mercury surrounding said last-named means and in contact with said sleeve, and a displacer adapted to be magnetically operated for effecting making and breaking of contact between said mercury bodies over the upper edge of said confining means.

3. A mercury relay comprising a cylindrical metallic sleeve, means defining a counterbore in one end of said sleeve, a ceramic closure sealed in said counterbore closing said end, the opposite end of said sleeve being enlarged to form a radial shoulder, a refractory insert seated against said shoulder in said latter end of said sleeve, means sealing said insert in position, said insert carrying an electrode insulated thereby from said sleeve, means on said insert confining a body of mercury in contact with said electrode, a second body of mercury surrounding said last-named means and in contact with said sleeve, and a displacer adapted to be magnetically operated for effecting making and breaking of contact between said mercury bodies over the upper edge of said confining means.

4. A displacer for a metal envelope mercury relay comprising a refractory sleeve having circumferential series of projections adjacent opposite ends thereof, a sleeve of magnetic material encircling said refractory sleeve, and means in said second sleeve defining openings receiving said projections for locating said second sleeve axially and circumferentially on said refractory sleeve.

5. The displacer of claim 4 further characterized in that said projections are of greater radial extent than the wall thickness of said second sleeve.

6. A mercury relay comprising a tubular metallic envelope and having an enlarged open end, a ceramic insert seated in said end and having a reduced tubular extension projecting axially toward the closed end of said envelope, means forming an enlarged annular recess in the outer face of said insert opening into said extension, an electrode having a disc-like head portion seated in said recess closing the lower end of said extension, and having an axially outwardly projecting shank, means including resilient sealing means locking said insert and electrode in position, a body of mercury confined in said extension in contact with said head portion, a second body of mercury in said envelope around said extension, and a tubular displacer reciprocable in said

envelope for displacing said second body of mercury over the upper end of said extension into contact with said confined body of mercury.

7. A relay comprising a tubular metal envelope having an annular shoulder intermediate its ends, a ceramic insert of tubular form having an annular shoulder resting against said first shoulder, the insert having an upper end portion of reduced outside diameter between which and the side walls of the envelope a mercury retaining chamber is formed, a body of mercury in said chamber and a body of mercury in said reduced end portion, a closure for sealing the lower end of the envelope holding said ceramic in place against said shoulder, said closure supporting a central electrode having an external terminal at its outer end and an intermediate terminal in electrical contact with the mercury in the reduced upper end portion, and a tubular displacer surrounding the reduced upper end of the ceramic and being adapted to be operated magnetically.

8. The combination of claim 7 characterized by the internal terminal being of larger diameter than the bore of the upper end of the ceramic insert, and the insert having an enlargement of the bore adjacent said internal terminal to provide an extended area of contact of the mercury in the ceramic insert with said internal terminal.

UNO C. HEDIN.