

Sept. 26, 1950

H. C. HARRISON

2,523,366

MERCURY TYPE RELAY

Filed Sept. 28, 1946

2 Sheets-Sheet 1

FIG. 1

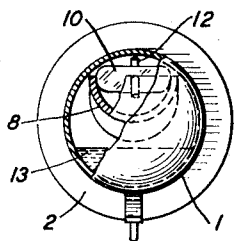


FIG. 2

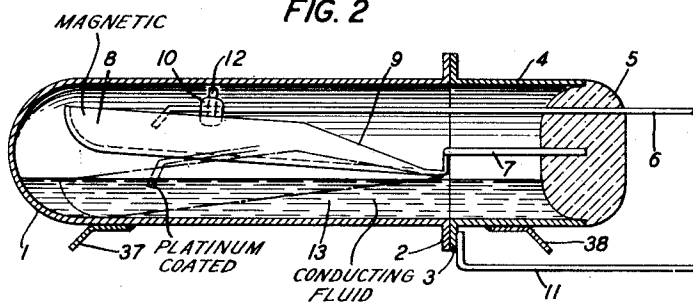


FIG. 3

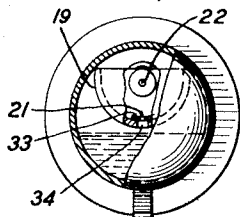


FIG. 4

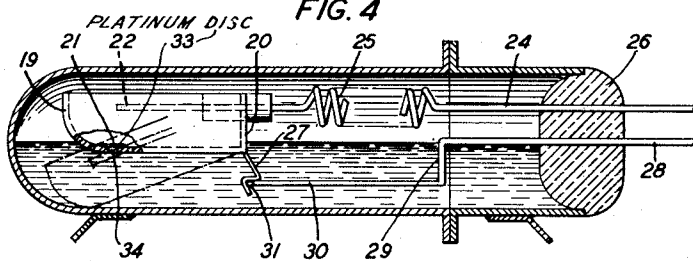


FIG. 5

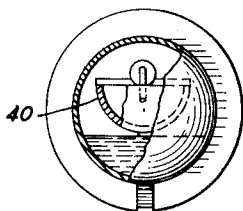


FIG. 6

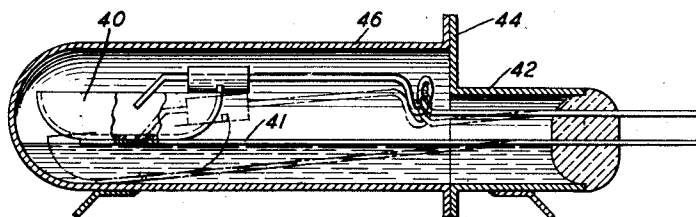


FIG. 7

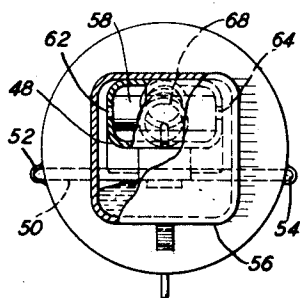
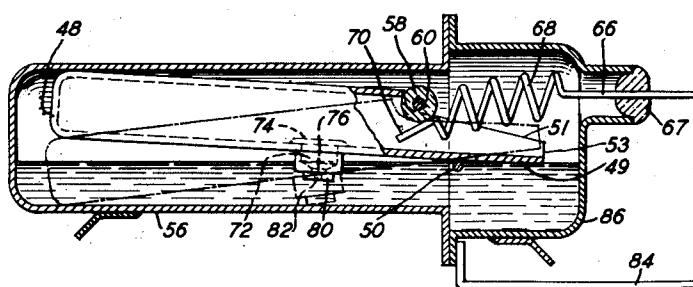


FIG. 8



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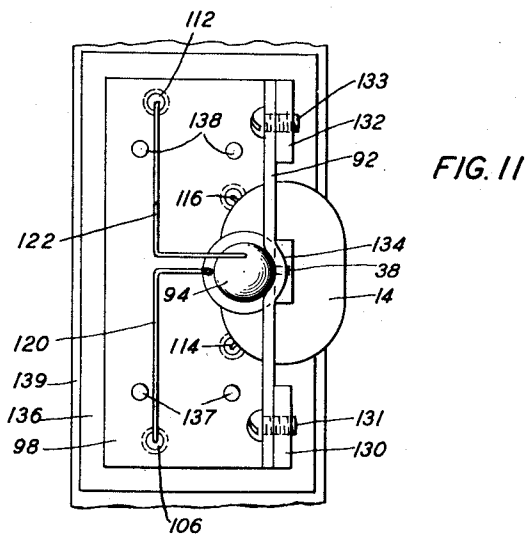
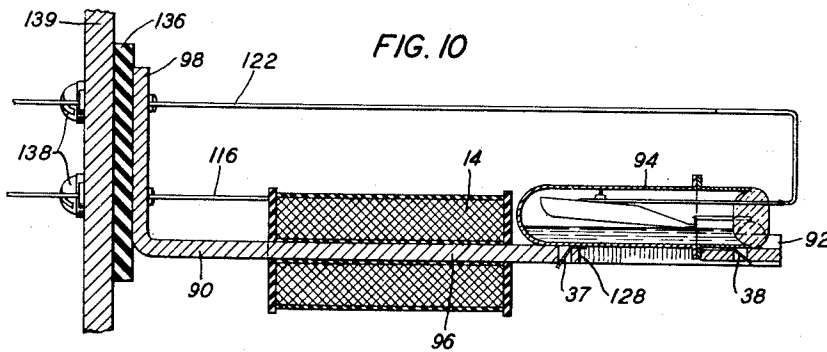
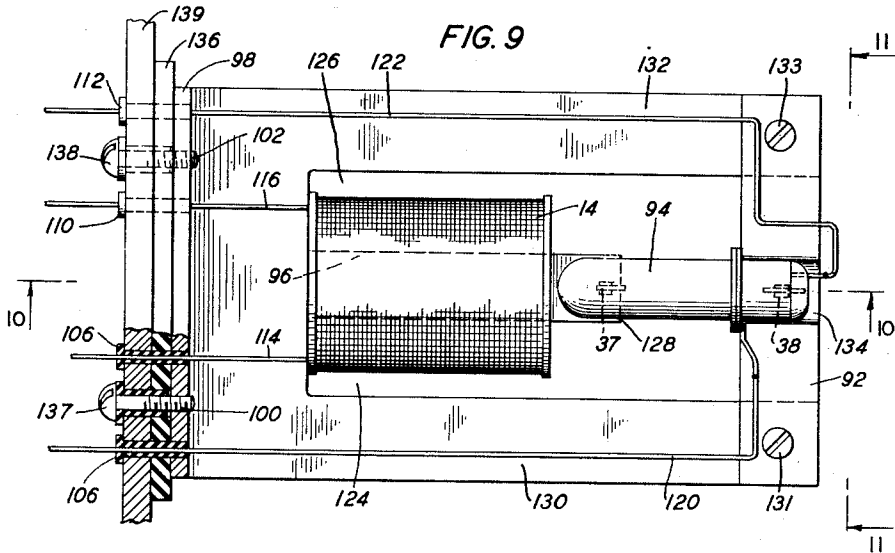
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2,523,366

MERCURY TYPE RELAY

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Application September 28, 1946, Serial No. 700,138

6 Claims. (Cl. 200-112)

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This invention pertains to electromagnetic relays and more particularly to such relays in which a conducting fluid and cooperating electromagnetically-controlled elements are arranged to provide contacts which may be made slow to operate, slow to release, fast to operate or fast to release as well as to provide various combinations of contact operate and release times, to meet the requirements of switches and relays employed in electrical circuits, particularly in communication switching circuits. There are known in the present art a number of devices which delay the operation and/or release of a relay or to provide various combinations of contact operate and release times. However, when a considerable delay interval in operating or releasing a relay is required, it is frequently necessary either to supplement the relay with a timing circuit, such as a condenser timing circuit, or to employ a relatively elaborate and expensive switch including a mechanical relay. There is no basic relay available today which will provide a wide variation of make and break delay intervals without the use of such auxiliary devices as mentioned hereinbefore.

An object of the present invention is the provision of relay structures which will fulfill the needs set forth in the foregoing discussion.

A more particular object of this invention is the improvement of relays which include a delay feature.

Another object of this invention is the provision of a compact inexpensive relay or switch having a basic structure which can be arranged to provide various combinations of contact operate and release intervals and which structure can be readily adapted to change the contact operate and/or release delay intervals over a very wide range.

Another object of the invention is to provide a relay having fluid contact elements and including a delay feature which relay can be mounted on vertical mounting plates with the longitudinal axis of the relay in a horizontal plane.

The invention may be understood from the following description when read with reference to the associated drawings which disclose a preferred embodiment of the basic relay structure of the invention and a number of preferred embodiments of interchangeable fluid contact assembly units arranged to provide various combinations of contact operate and contact release intervals. The invention is not however limited to the described and illustrated embodiments but

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may be practiced when incorporated in many other forms suggested by the following description and drawings. In the drawings:

Fig. 1 is a left elevation, and Fig. 2 is a front elevation, both partly in section, of the fluid contact assembly unit of the relay in which the contacts are arranged to provide a relatively long delay on closure and a relatively fast break;

Fig. 3 is a left elevation and Fig. 4 is a front elevation, both partly in section, of a second embodiment of the fluid contact assembly unit of the relay, showing a unit having contacts arranged for a relatively short delay on closure and a relatively long delay on break;

Fig. 5 is a left elevation and Fig. 6 is a front elevation, both partly in section, of a third embodiment of the fluid contact assembly unit of the relay, showing a contact unit having a relatively long delay on both contact closure and contact break;

Fig. 7 is a left elevation and Fig. 8 is a front elevation, both partly in section, of a fourth embodiment of the fluid contact assembly unit of the relay, showing a contact unit having a relatively long delay on contact closure and a relatively short delay on contact break;

Fig. 9 is a plan view partly in section, Fig. 10 is a vertical section on the line 10-10 in Fig. 9, and Fig. 11 is a right-hand end view taken in the direction of the arrows 11-11 in Fig. 9, of a preferred relay assembly of which any of the relay contact units of Figs. 1 to 8 form a part and in which relay the contact units may be interchangeably mounted.

Before proceeding with the detailed description of the relay assembly the various contact unit assemblies will be described.

Refer to Figs. 1 and 2 which show a fluid contact assembly unit having a relatively long delay on contact closure and a relatively fast break.

In Figs. 1 and 2, an impervious generally cylindrical container 1, which may for instance be of non-magnetic material such as glass or plastic but preferably is of stainless steel, has a left-hand end which may be hemispherical and a right-hand end terminated in an outwardly projecting annular flange 2. Sealed to the flange 2 is the flange 3 of a stainless steel tubular eyelet 4, well known in the art, sealed in the right-hand end of which is a glass bead. Welded to the flange 3 at any part thereof is a conductor 11. Projecting through the glass bead 5 into the interior of the container is a conductor 6. A flat spring steel strip support 7 projects at its right-hand end into the glass bead 5 and is secured therein.

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The left-hand end of support 7 is bent first downwardly and then to the left slightly, at right angles, where it is welded to the right-hand end of armature scoop 8 which is preferably formed of a unitary piece of magnetic alloy material. The left-hand end of armature scoop 8 and its front and rear side walls, as seen in Fig. 2, are formed upwardly. There is no wall at the right-hand end of the armature scoop. The right-hand portions of the side walls 9 may be tapered downwardly toward the bottom of the scoop. Sealed between the front and rear side walls of the scoop 8, near the top of each wall, is a glass bead 10 through an aperture in which the left-hand end of conductor 6 extends and in which the conductor 6 is sealed. A short distance to the left of glass bead 10, conductor 6 is bent downwardly at an angle. The left-hand end of conductor 6 may be plated with platinum which wets with mercury. Sealed in the upper portion of glass bead 10 and projecting upwardly therefrom is a short hard-rubber insulator 12 which abuts against the inner top surface of the container 1 and serves as a stop for the armature. The lower portion of the chamber formed by the container 1 and the eyelet 4 is filled to about $\frac{1}{2}$ its depth with a conducting fluid 13, such as mercury or mercury combined with other materials, well known in the art, to improve its characteristics as a contacting material.

The lower level of the armature scoop 8 is normally above the upper surface of the conducting fluid, so that the circuit, one side of which extends from the conductor 11 through the flange 3 and the eyelet 4 to the fluid 13, and the other side of which extends through conductor 6, is open. When the relay coil, such as the coil 14 in Fig. 9 is energized, as will be described in detail hereinafter, the left-hand end of armature scoop 8 and the left-hand end of conductor 6 are drawn downwardly as a unit against the tension of supporting spring 7 into the fluid 13 to such a depth that the fluid overflows the side walls at the left-hand end of the scoop. After the fluid has risen sufficiently in the interior of the scoop, the left-hand end of conductor 6 makes contact with the fluid and the circuit is closed. When the magnetic coil such as coil 14 is no longer energized the scoop armature 8 is snapped upwardly by spring 7 into its normal position in which its bottom slopes downwardly toward the right and the mercury is spilled rapidly out of the open right-hand end of the scoop.

The arrangement per Figs. 1 and 2 provides a delay in contact closure but a delay which can be made relatively short, if desired, by controlling the dimensions of the scoop, the height of the fluid and the position of the contacting end of conductor 6 with relation to the bottom of the scoop.

Refer now to Figs. 3 and 4.

The arrangement per Figs. 3 and 4 differs from the arrangement per Figs. 1 and 2 in that instead of a scoop armature having an open rear end the rear end of the armature 19 is closed with a vertical wall 20 and a small circular aperture 21 in a thin platinum disc 33, welded to the inner surface of the bottom of the armature, is in axial alignment with a slightly larger aperture 34 in the bottom of the armature, through which apertures 34 and 21 the fluid, such as mercury, flows to enter the interior of the armature. Platinum wets with mercury but dissolves thereby to only a negligible amount. The thickness of the plati-

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num disc 33 is less than and preferably much smaller than the radius of the circular aperture 21 so as to prevent variations in the flow of fluid through aperture 21 due to temperature changes. Investigation by applicant has disclosed that with the aperture 21 so proportioned, the rate of flow is less dependent on changes in viscosity which varies with temperature. The left-hand end of the conductor 24 may be bent downwardly or may be horizontal as shown depending upon the delay interval to be obtained.

A coiled spring 25 is formed in the conductor 24 intermediate the armature and the glass bead 26. Welded to the lower right-hand end of the armature is a Z-shaped element 27 formed of a flat spring steel strip. The conductor 28 projects through the glass bead 26 into the chamber. It is bent downwardly as at 29 and then horizontally to the left as at 30 and then forwardly at right angles as at 31 where it abuts the lower angle of the Z-shaped element 27 and forms a pivot contact about which the Z-shaped element and the armature 19 may rotate.

As the armature 19 is drawn downwardly a small amount of conducting fluid flows through the aperture 21 into the interior of the armature, however the downward movement of the armature under the influence of the magnetizing coil is made quite fast so that the conducting fluid quickly overflows the armature walls and rises in the armature to make contact and close a circuit through contact 22. When the magnetizing coil is deenergized the armature 19 is snapped upwardly and the conducting fluid drains slowly through bushing 21. It is particularly pointed out that since the circuit is to remain closed for an interval after the magnetizing coil is deenergized, the level of the fluid must be such that it makes contact with the bottom surface of the armature when the armature is raised with its load of conducting fluid.

Both the operate and release times may be varied by varying the position of the contact 22 with respect to the interior bottom surface of the armature as well as by varying the capacity of the armature, the size of aperture 21, the magnetizing force, the tension of the spring 25, the quantity of fluid in the container and the capacity of the container. When all other factors are fixed a considerable variation in release time may be obtained by varying the position of contact 22 with respect to the bottom of the armature.

The arrangement per Figs. 5 and 6 resembles the arrangement per Figs. 3 and 4.

The armature is supported on a thin flat strip 41 of conducting material to which the armature is welded. The conductor 41 may be apertured in axial alignment with the aperture in the bottom of the armature. The armature 40 is arranged with relatively high walls so that the fluid does not overflow the walls when the armature is drawn downwardly. The conducting fluid flows into the interior of the armature and out of the armature through an aperture in the bottom of the armature arranged as described for Figs. 3 and 4. Such an arrangement provides a relatively long delay both on contact closure and contact break. The eyelet is arranged in a slightly different manner than in Figs. 1 and 2 or Figs. 3 and 4, being equipped with a flange 44 of much larger diameter. The periphery of the flange is trimmed to conform to the periphery of the flange of the container 46. By providing eyelets having flanges of wide diameter and trimming the flanges to

conform as required an eyelet of a single standard size may serve containers of varying sizes.

In the arrangement per Figs. 7 and 8 the armature 48 is a rectangular box-like structure having an extended bottom member 49, side walls which are tapered near their right-hand ends such as at 51, and an open right-hand end 53. The armature 48 is supported by and is rotatable about a transverse steel rod 50 welded to the bottom of the armature. As seen in Fig. 7, the opposed ends of rod 50 project into opposed cavities in hollow ears 52 and 54 forming protuberances on the surface of container 56. A cylindrical ceramic insulating bushing 58 extends between the side walls of the armature. The bushing is reinforced by an axial steel rod 60 the opposed ends of which project into opposed apertures 62 and 64 in the front and rear side walls of the armature. The bushing is fixed in position just to the right of the shortened top member of the armature and to the left of the rod 50. A conductor 66 projects from the exterior through the glass bead 67 in the eyelet into the interior of the chamber. A coiled spring portion 68 is formed in the conductor 66. The conductor terminates in a contact element 70, the right-hand end of which abuts against and is depressed downwardly by the lower surface of the ceramic bushing 58. The spring thus tends to rotate the armature 48 counterclockwise about rod 50 as a center. Sealed in the bottom 49 shortly to the left of rod 50 is a combination entrance and exit port 72, which may for instance be a hollow cylindrical cup opening into the bottom 49 and secured thereto by a flange 74 sealed to the bottom 49. A circular aperture 76 is formed in the bottom of the port 72, and a thin circular disc of platinum 80 having an orifice 82 in axial alignment with aperture 76 is secured to the bottom of the port.

When the left-hand end of the armature 48 and the contact 70 are drawn downwardly under the influence of the magnetizing coil, the conducting fluid flows slowly through the orifice 82 and the aperture 76 into the interior of the port 72 and rises into the interior of the armature, engaging contact 70 and closing a circuit between conductor 84, welded to the exterior surface of the eyelet jacket 86, and conductor 66. When the magnetizing coil is deenergized, the armature 48 is snapped upwardly by the spring 68 and the conducting fluid is emptied almost instantly out of the armature. This arrangement provides a relatively long delay interval on contact closure and a quick contact break.

Refer now to Figs. 9, 10 and 11 which disclose a preferred relay structure in which the various fluid contacting units of Figs. 1 to 8 may be interchangeably mounted. It is particularly pointed out, however, that the contacting units are not limited to incorporation in such a relay structure as is shown in Figs. 9, 10 and 11 but may be employed with many other relay structures which will readily suggest themselves to those skilled in the art.

The relay structure per Figs. 9, 10 and 11 comprises a number of major component elements namely, an energizing coil assembly 14, a combination magnet element and mounting bracket 90, a magnetic path closure element and support 92 for the contact unit assembly and the contact unit assembly 94 which may be any of the contact unit assemblies per Figs. 1 to 8 or adaptations of those per Figs. 1 to 8 to provide required combinations of delay on contact closure or break.

The energizing coil 14 may be wound on an

independent spool of insulating material separable from the magnetic core 96. The spool has an axial opening generally conforming in section to the section of core 96 so that it fits snugly about the core. The magnetic element 90 is a flat, generally rectangular, plate of magnetic material bent upwardly at its left-hand end to form a mounting bracket which is perforated and tapped 100 and 102 to accommodate mounting screws and perforated and bushed with insulating material 106, 108, 110, and 112, to accommodate the conductors 114 and 116, which connect to the terminals of the coil 14 and to the conductors 120 and 122 which connect to the contact unit. The horizontal portion of the magnetic element 90 is separated by longitudinal notches 124 and 126 into three legs. The middle leg 98 which forms the magnet core is shorter than the two outer legs 130 and 132 being cut off at right angles at 128. The outer legs are interconnected by a transverse plate 92 of magnetic material which forms a closure for the magnetic paths. The under surface of plate 92 may abut the upper surfaces of legs 130 and 132 near the right-hand extremities of the legs and the element 92 may be secured to the legs 130 and 132 by means of screws 131 and 133. The middle portion 134 of element 92 may be concave slightly as seen from above to conform to the outer surface of the eyelet of the contact unit assembly to provide a bearing surface for the eyelet portion of the contact assembly. The contact unit assembly is supported at its left end by the right-hand end of the pole-piece. Both the right-hand end of the pole-piece and the concave portion 134 of element 92 may be apertured to receive spring wire projections 37 and 38 which may be flexed each toward the other momentarily while the projections are being inserted in the apertures and then released to secure the contact unit in position.

It is particularly pointed out that the space between the right-hand end of the pole-piece 96 and the left-hand end of the concave portion 134 of element 92, constitutes a magnetic gap which is bridged by the armature in the contact assembly unit. When the coil 14 is deenergized the armature is in its upper position. When the coil is energized the left-hand end of the armature is drawn downwardly to narrow the magnetic gap. The magnetic flux may be considered to flow from the core 96 toward the rear where it divides. One-half flows toward each outer leg, then forwardly through outer legs 130 and 132, then from each leg inwardly through element 92 toward the center of element 92, then across the right-hand gap to the right-hand end of the armature, such as armature 8 in Fig. 1, then through the armature and across the left-hand gap between the armature and the pole-piece 96 to the pole-piece.

It is pointed out that the magnetizing coil and the contact unit assembly are arranged as separable units to facilitate the assembling of relays having various coils and contact units to meet specific requirements. The element 92 is made separable to facilitate the mounting of the coil on the core 96. It is also pointed out that the contact unit may be mounted in any other convenient manner such as by means of spring-type clamps or clips secured to the pole-piece 96 and to cross element 92. Although the legs 130 and 132 are shown in the Figs. 9, 10 and 11 as being arranged with their broad opposed surfaces horizontal, the legs may be formed upwardly so that the broad surfaces are in a vertical plane and the cross element 92 modified to conform, to provide

a more compact relay when a saving in mounting space is desirable.

The relay is mounted by screws 137 and 138 which pass through apertures in the vertical mounting plate 139 and in the insulator 136 to engage in tapped holes in the vertical bracket element 98, to support the relay so that the longitudinal axis of the coil and of the contact assembly unit is horizontal. As thus arranged the relay may be mounted in the same manner as relays are mounted generally in the communication switching plant without the necessity for making special provision therefor.

What is claimed is:

1. An electromagnetic relay, comprising a scoop shaped armature, said armature having a walled portion and an unwalled portion, a pool of conducting fluid, means comprising a magnetizing coil for actuating said armature so that said fluid overflows said walled portion to enter the interior of said scoop and establish an electrical contact at a first time, and means for tipping said scoop to permit said fluid to flow out through said unwalled portion to break said contact at a second time.

2. An electromagnetic relay arranged for providing a relatively fast contact make and a relatively slow contact break, comprising a hollow armature having a large opening at the top and an orifice in the bottom, a pool of conducting fluid, means comprising a magnetizing coil for drawing said armature down into said pool so that said fluid flows through said large opening into the interior of said hollow armature to establish an electrical contact, and means for withdrawing said armature from said pool to permit said fluid in said armature to drain through said orifice to open said contact.

3. An electric relay arranged for a slow contact closure and a slow contact opening, a hollow armature in said relay, an orifice in said armature, a pool of conducting fluid, means comprising a magnetizing coil for displacing said armature with respect to said pool so as to permit said fluid to flow through said orifice into the interior of said hollow armature, means responsive to the flow of said fluid into the interior of said armature for establishing an electrical contact, and means for releasing said armature to permit said fluid to drain through said orifice to open said contact.

4. An electrical relay arranged for a slow contact closure and a fast contact opening, a hollow armature in said relay, an orifice in said armature, a large opening in said armature, a pool of conducting fluid, means comprising a magnetizing coil for displacing said armature with respect to said pool, so as to permit said fluid to flow

through said orifice into the interior of said hollow armature to close an electrical circuit and means including a spring for restoring said armature to its original position and permitting said fluid to empty through said large opening to open said circuit.

5. An electromagnetic relay assembly, arranged to provide various contact delay intervals on closure and break, comprising a mounting bracket, a magnetizable core, two magnetizable legs spaced from said core, communicating with said core, said bracket core and legs formed out of a single element, a magnetizing coil mounted on said core, said coil readily separable from said core, a magnetizable strip interconnecting said legs, and a liquid contact assembly unit, arranged for a particular contact operate and contact release delay combination, said unit including a magnetizable armature, and a conducting liquid both in an impervious container, mountable in a gap between said strip and said core, said unit interchangeable with other units to provide other delay combinations.

6. An electric relay comprising a container, a contact in said container connected to a conductor extending through the walls thereof insulated with respect to a fluid hereinafter mentioned, a vessel in said container empty of said fluid in the non-conductive position of said contact, said vessel being generally concave on its upper side, conductive fluid in said container, said vessel being generally magnetic, means operable magnetically to lower said contact and vessel sufficiently with respect to the surface of said fluid to cause it to become sufficiently filled with said fluid to conductively contact said fluid and thus temporarily establish a circuit between said conductor and another conductor through said fluid, and means to restore said vessel to its unlowered position and open said circuit.

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