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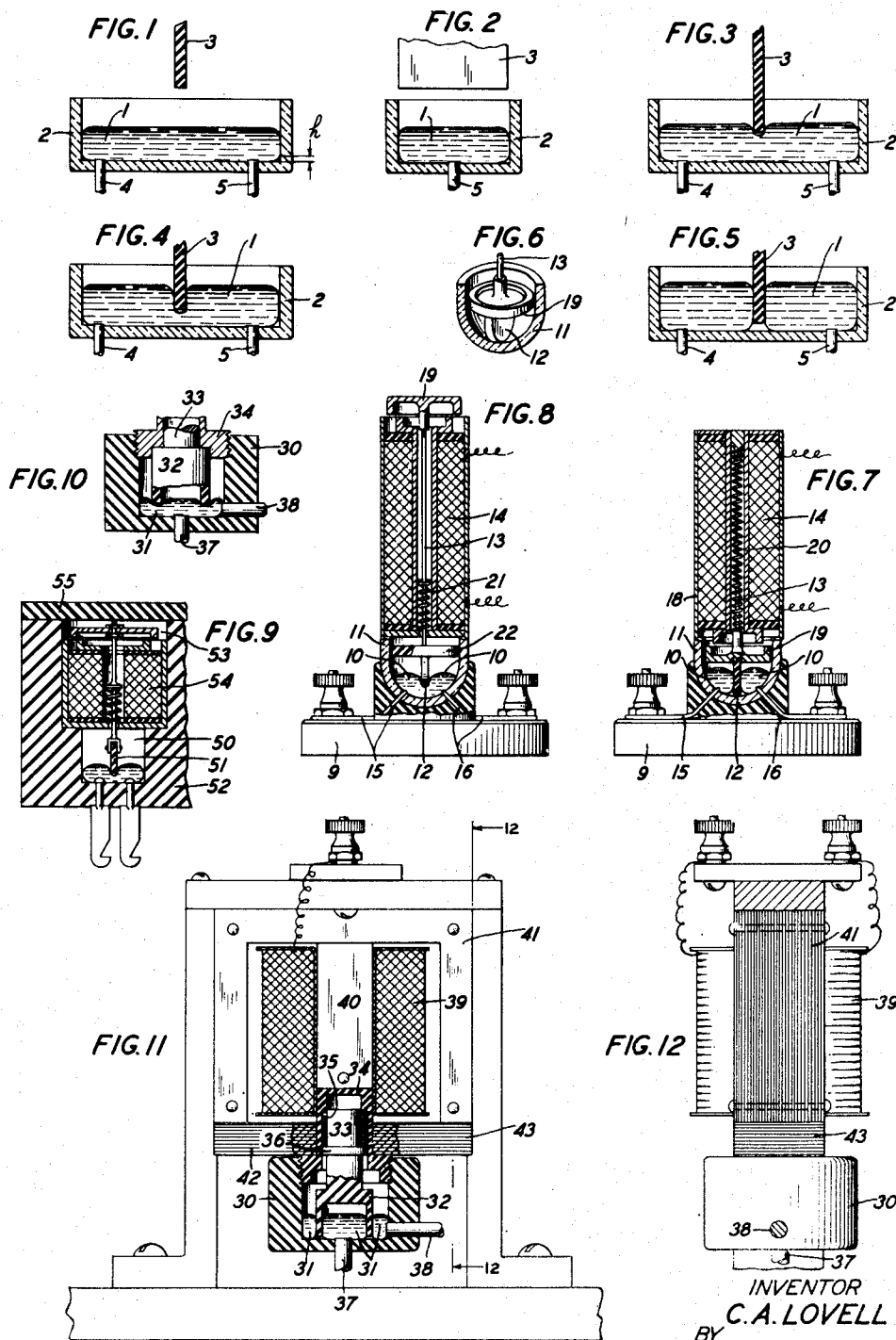
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2,153,633

RELAY

Filed April 23, 1937

2 Sheets-Sheet 1



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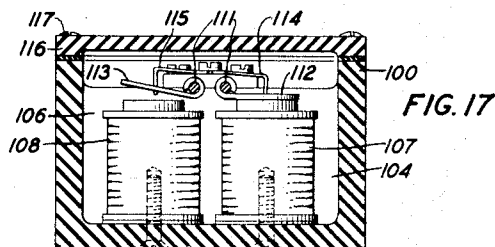
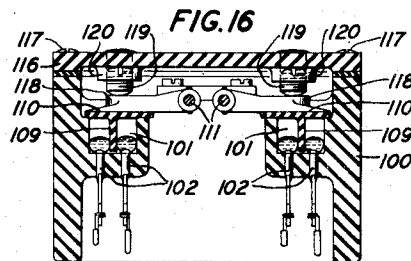
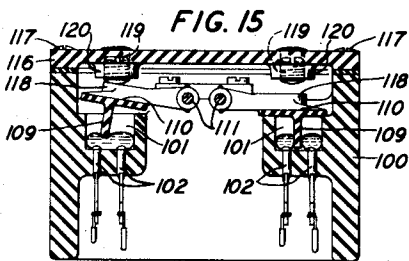
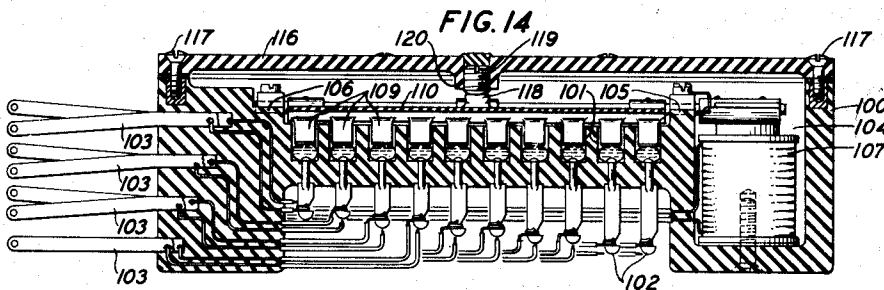
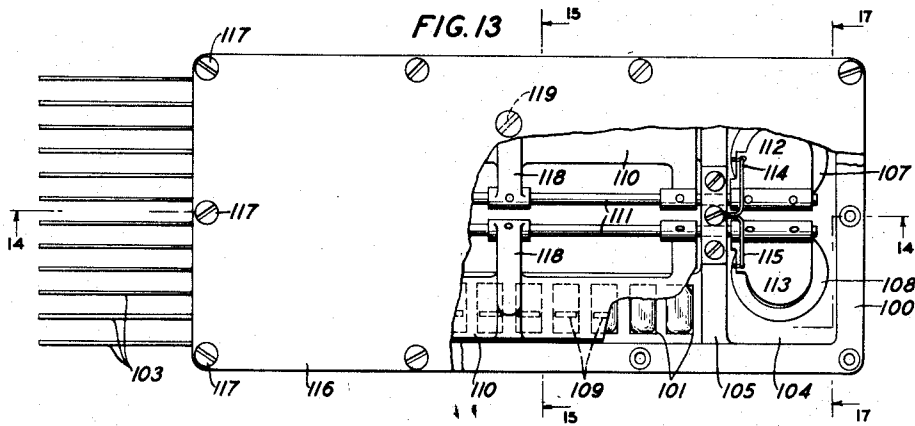
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UNITED STATES PATENT OFFICE

2,153,633

RELAY

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Application April 23, 1937, Serial No. 138,590

6 Claims. (Cl. 200—112)

This invention relates to switching devices and has for its object to provide a more reliable response in such devices.

More specifically, the invention contemplates an improvement in electrical switching devices employing liquid mercury for one or more contacts.

Many forms of electric switches employing liquid mercury for making or breaking electric contacts are in common use. The operation of these switches in all cases involves a motion of the mercury container and in most cases involves the motion of an appreciable volume of mercury. For this reason they are not well adapted for high speed operation, especially in cases where the timing is important.

In accordance with the present invention, a liquid mercury contact is provided, the operation of which does not involve motion of any large masses and which may be operated at speeds considerably higher than that of the conventional mercury switch. An important feature of the device lies in the fact that even at these high operating speeds the duration of the periods in which the circuit is open or closed can be controlled with accuracy. This result is attained by using a mass of mercury through which an output circuit is completed and an insulating separator which may be operated at high speed to open the circuit.

The invention will be more clearly understood from a consideration of the following description in connection with the drawings, in which:

Figs. 1 to 5 disclose a simple, more or less theoretical, embodiment of the invention, Fig. 2 being a side view of the switch shown in Fig. 1 and Figs. 3, 4 and 5 showing the switch in different operated positions;

Figs. 6 and 7 disclose one practical embodiment of the invention, Fig. 6 showing the separator and bowl of Fig. 7 in partial perspective;

Fig. 8 discloses a modified form of the embodiment of Fig. 7;

Fig. 9 discloses an adaptation of Fig. 8 for use in controlling multiple contacts;

Figs. 10, 11 and 12 disclose a second practical embodiment of the invention, Fig. 11 being a front elevational view partly in cross-section, Fig. 12 being a partial sectional view taken along section line 12—12 of Fig. 11, and Fig. 10 being a detail showing the separator in its retracted position; and

Figs. 13 to 17, inclusive, show a further embodiment of the invention for controlling a plurality of circuits, Fig. 13 being a top plan view, Fig. 14

being a vertical sectional view taken along the section line 14—14 of Fig. 13, Figs. 15 and 16 being sectional views taken along section line 15—15 of Fig. 13, Fig. 15 showing the mechanism in operable condition and Fig. 16 showing the mechanism as prepared for shipment, and Fig. 17 being a sectional view taken along section line 17—17 of Fig. 13.

The phenomenon of surface tension which, to a greater or lesser degree, is common to all liquids is very pronounced in mercury. This phenomenon causes a volume of mercury free in space to act as if it were contained in an elastic skin under tension. A small drop of mercury on a plate of glass or other non-metallic substance assumes a form nearly spherical and the free surfaces of drops of larger size are convex. In all cases such a drop assumes a form in which the gravitational energy plus the energy of the surface tension is a minimum. This characteristic of a mercury drop can be utilized in electric switching.

Referring to Figs. 1 to 5, consider a volume of mercury 1 in a rectangular container 2 of non-conductive material. The mercury does not occupy all of the space in the container but, due to the surface tension, retains an oval form in the container. Under such conditions the pressure due to surface tension of the free surfaces of the mercury is balanced against the pressure in the mercury due to gravity. Suppose a rectangular insulating wedge 3, which will be referred to hereinafter as the separator, to be inserted as shown in Figs. 3 to 5, inclusive. When the separator is lowered from the position shown in Fig. 1 into the mercury until it approximately reaches the position shown in Fig. 4, the mercury 1 recedes from the sides of the container in the neighborhood of the lower corners and, the surface energy, seeking its minimum value, will cause the mercury 1 to separate as shown in Fig. 5. When the separator is withdrawn to the position shown in Fig. 4 the mercury drops come together again. The difference between the make and break positions of the separator is a function of its thickness and shape, and the depth of the mercury. Iron or tungsten electrodes 4 and 5 placed in the mercury as shown in the figures complete the essential elements of a practical mercury contact switch. The switch could if desired be arranged to have its separator move in a horizontal direction instead of a vertical direction, the electrodes in that case being in a side wall of the container, and the mercury pool being divided in a horizontal plane by the movement of the separator.

This type of relay contact forms a new and perfect surface at each break, and deterioration such as pitting, which is common to solid metal contacts, is entirely absent. When used with alternating current there is no tendency to chatter as does the usual form of relay, due to the alternating current component or "ripple", even at low frequencies, since movement of the separator within the mass of mercury is ineffective if the separator is not allowed to move to the break point.

Referring now to Figs. 6 and 7, a relay is disclosed having a base 9 upon which is positioned a hemispherical bowl 11 of insulating material containing mercury 10 normally separated into two globules by the semicircular separator 12 of insulating material. Attached to the separator is a soft iron disc 19 which acts as the armature of an iron-clad magnet which covers the opening in the bowl 11. Terminals 15 and 16 lead to the output circuit which is closed when the separator 12 is raised and opened when the separator descends as shown in Fig. 7. The magnet coil 14 is enclosed in a shell 18 of magnetic material and has a tubular core 20 of the same material in which the guide rod 13 to which the armature 19 is connected moves under the control of spring 21. The tubular core 20 and shell 18 are magnetically joined at their upper ends and are provided with flanges on their lower ends which form an air-gap within which the soft iron armature 19 moves when the coil 14 is energized. This relay provides a normally open circuit between terminals 15 and 16 which is closed when the magnet is energized, and the upward movement of the separator 12 permits the two mercury globules to unite.

Fig. 8 shows a modification of the structure of Fig. 7 in which the output circuit is normally closed. In this case the soft iron armature is mounted at the top of the coil, the guide rod 13 passing completely through the hollow core of the magnet. The spring 21 holds the armature in its upper position from which it is drawn downward by the energization of coil 14. The disc 22, which in this case is of the same insulating material as the separator 12, may be omitted entirely.

The embodiment shown in Figs. 10 to 12 provides an arrangement whereby the mercury contact unit can be sealed in a container filled with an inert gas, the container including all the essential moving parts so that the contact unit may be inserted as a whole in the magnetic circuit. The mercury contact member consists of a cup 30 containing a quantity of mercury 31. The insulating separator 32 is in the form of an inverted cup and is mounted on a magnetic plunger type armature 33. The cup 30 is closed by a cylindrical envelope 34 which also acts as an armature guide, a spring 35 controlling the restoration of the armature by pressing on a shoulder of the envelope 34 and a flange 36 on the armature itself. One terminal 37 of the output circuit is located in the center of the cup 30 and the other terminal 38 is at the side of the cup, whereby the separator when in its depressed position as shown in Fig. 11 opens the output circuit and when raised as shown in Fig. 10, permits the circuit to close. It is obvious that an enclosed contact unit could be made employing separators similar to those previously discussed instead of the inverted cup separator as shown.

While the precise form of the magnetic circuit is not essential to the invention it has been

shown as comprising a coil 39 having a laminated core 40 extending part of the way through the coil. Linked to the upper end of the core is a U-shaped yoke 41 having its arms extending along the sides of the coil in parallel with the core and terminating in laminated pole-pieces 42 and 43. These pole-pieces 42 and 43 are cut to closely embrace the envelope 34 containing the armature 33 of the contact member.

Fig. 12 is a sectional view taken along the line 12-12 of Fig. 11 showing the arrangement of the laminated yoke 41, the pole-piece 43 and the cup 30. The laminated form of yoke and pole-piece is especially advantageous when using alternating current.

Fig. 9 shows an arrangement by which a plurality of relays may be grouped for convenience in mounting while still under individual magnetic control. The drawing shows a broken-away section to disclose the internal structure of an individual relay which resembles the structure of Fig. 6 except that a rectangular well 50 and separator 51 is employed. In this case the base 52 is molded to include a plurality of mercury wells 50 each one integral with a recess 53 to receive the electromagnetic structure 54. A cover 55 completes the protection of the moving parts.

In this arrangement the energizing circuits may be multiplied together to create a multi-contact relay or both the energizing circuits and the outgoing circuits may be multiplied as is common with the conventional type of relay to provide greater reliability of operation or greater current carrying capacity.

Figs. 13 to 17 show an embodiment wherein a plurality of mercury contacts have been grouped under common control to constitute a multi-contact relay. A block of insulating material 100 is molded to provide a plurality of wells 101 with a pair of terminals 102 entering each well, to embrace the soldering terminals 103 and the associated wiring, and to provide a mounting recess 104 for the operating magnets 107 and 108 and bridges 105 and 106 for mounting the separators and operating equipment thereupon. This structure may be formed by a single molding operation.

The separators 109 are formed in the shape of a T, the flat portion of the T acting as a cover to the corresponding well. These separators are mounted on levers 110 which are fixed to rods 111 rotatable in bearings mounted on bridges 105 and 106. At one end of the rods 111 are fastened the armatures 112 and 113 of magnets 107 and 108, respectively, whereby the energization of one of the magnets rotates the corresponding rod, and depresses the set of separators to open all of the circuits on that side of the relay. The armatures 112 and 113 are normally held in retracted position by springs 114 and 115 which are also mounted on bridge 105.

After the proper quantity of mercury has been placed in each well 101, to preserve the mercury surfaces, a cover 116 is clamped in place by screws 117 and an atmosphere of an inert gas is supplied by any convenient method.

In order to provide means for assuring that the proper amount of mercury will remain in each well during shipment, the flat portions of the separators are arranged to be pressed down into engagement with the tops of the wells by screws 119 which are threaded into the embossments 120 of the cover 116 for engagement with ribs 118 of the levers 111. When the relay is ready for shipment, the screws 119 are screwed down until the

separators close the wells as shown in Fig. 16 and the holes over the heads of screws 119 are then sealed with wax. To make ready for use, a hot screw-driver inserted in the holes melts the wax permitting the screws to be withdrawn sufficiently to free the levers and separators without allowing the gaseous atmosphere to escape.

It is apparent from the foregoing description that the present invention provides a novel and practical relay, free from the faults of contact deterioration and chatter.

What is claimed is:

1. A multicontact relay comprising a base, a plurality of wells in said base, a pool of mercury in each of said wells, a pair of electrodes and an insulating separator for each well, a magnet controlled member carrying said separators, a cover for each well, and means for clamping said covers over said wells.

2. A multicontact relay comprising a base, a cover for said base, a plurality of wells in said base, a pool of mercury in each of said wells, a pair of electrodes and an insulating separator for each well, a magnet controlled member carrying said separators, a cover for each well also carried by said member and means for clamping said covers over said wells, said clamping means comprising a reinforced rib on said member and a screw extending through said cover to engage said rib.

3. A multicontact relay comprising a base, a cover sealed to said base for enclosing an inert gas therein, a plurality of wells in said base, a pool of mercury in each of said wells, a pair of electrodes and an insulating separator for each well, a magnet controlled member carrying said separators, a cover for each well also carried by said member and means for clamping said covers over said wells, said clamping means comprising a reinforced rib on said member, and a wax sealed screw extending through said cover to engage said rib.

4. In a relay, a pool of mercury, a container

therefor, a pair of electrodes connectable by means of said pool of mercury, a separator comprising a sheet of insulating material conforming in shape to the cross-section of said container but of smaller area than said cross-sectional area, and electromagnetic means to move said separator transverse of said pool of mercury into and out of approximate registration with the inner walls of said container, the surface tension of said mercury permitting the division of said pool into two portions when said separator approaches the inner walls of said container.

5. In a relay, a pool of mercury, a gas-filled sealed container therefor, a pair of electrodes connectable by means of said pool of mercury, a separator comprising a sheet of insulating material conforming in shape to the cross-section of said container but of smaller area than said cross-sectional area, and electromagnetic means to move said separator transverse of said pool of mercury into and out of approximate registration with the inner walls of said container, the surface tension of said mercury permitting the division of said pool into two portions when said separator approaches the inner walls of said container.

6. In a multicontact relay, a plurality of containers, pools of mercury therein, pairs of electrodes connectable by means of said pools of mercury, a separator for each container comprising a sheet of insulating material conforming in shape to the cross-section of said container but of smaller area than said cross-sectional area, and electromagnetic means to simultaneously move said separators transverse of said pools of mercury into and out of approximate registration with the inner walls of said containers, the surface tension of said pools of mercury permitting the division of each of said pools into two portions when said separators approach the inner walls of said containers.

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