

June 30, 1942.

H. C. HARRISON

2,288,451

ELECTRIC SWITCH

Filed June 15, 1940

3 Sheets-Sheet 1

FIG. 1

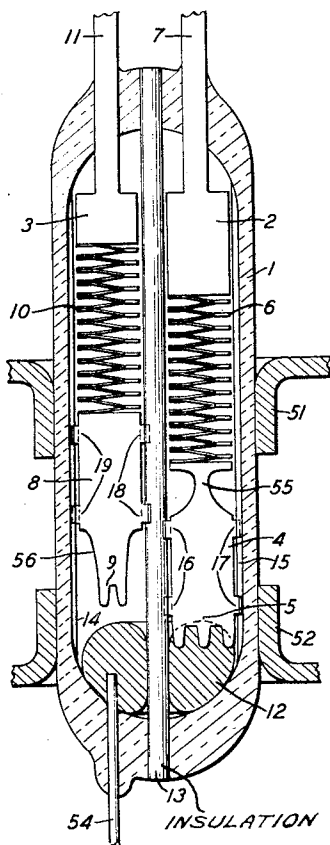


FIG. 4

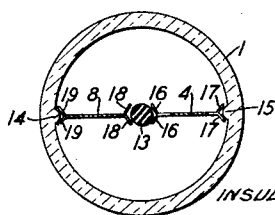


FIG. 2

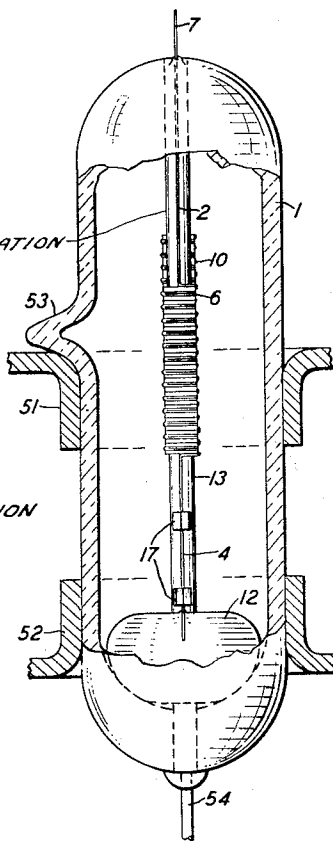
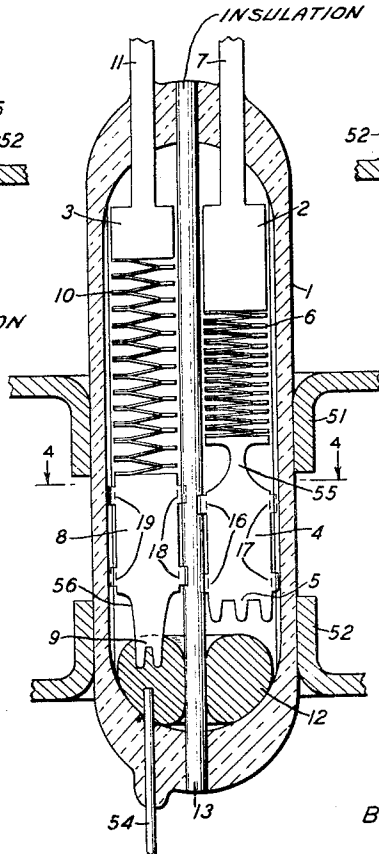


FIG. 3



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FIG. 5

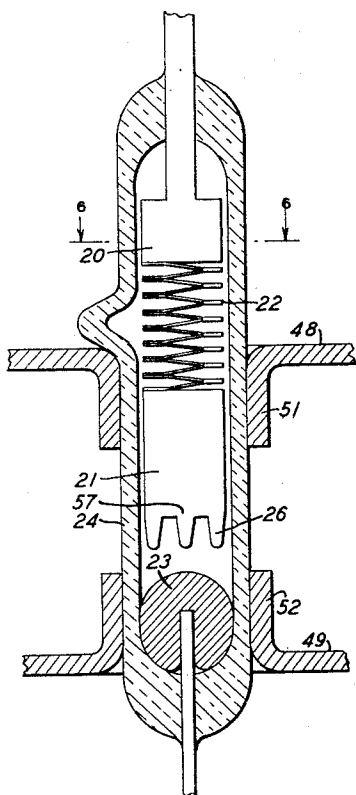


FIG. 7

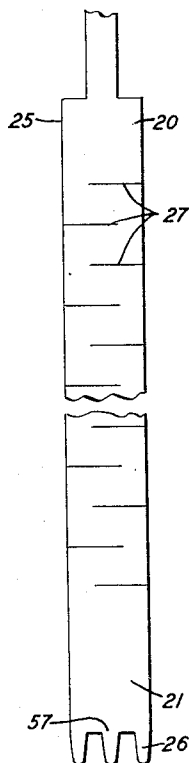


FIG. 8

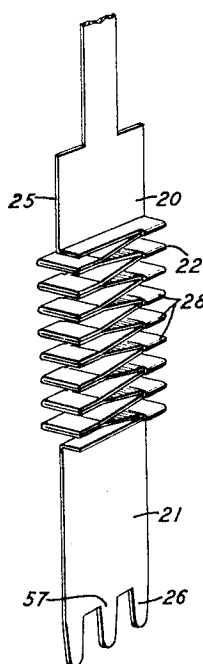


FIG. 6

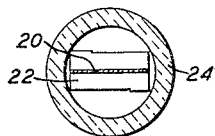
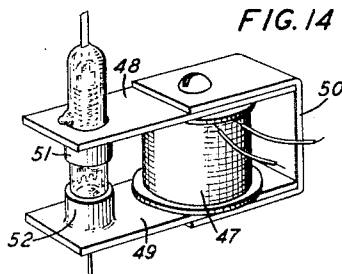


FIG. 14



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FIG. 9

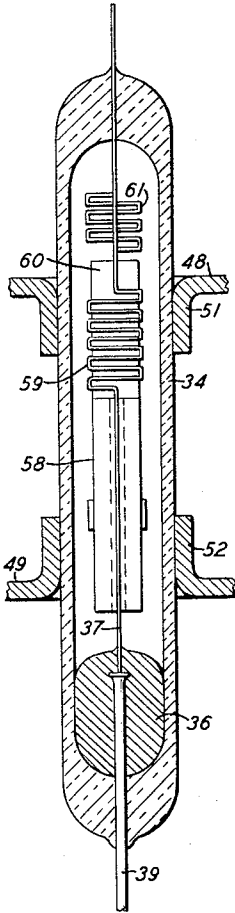


FIG. 10

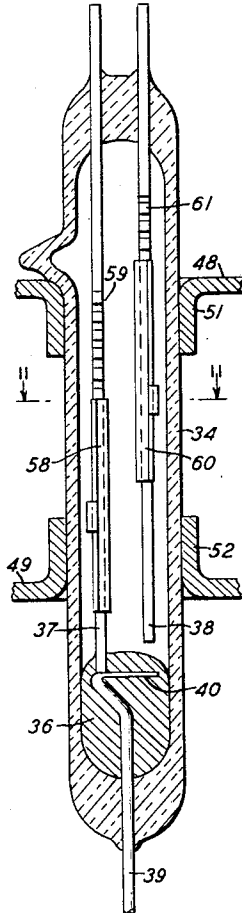


FIG. 12

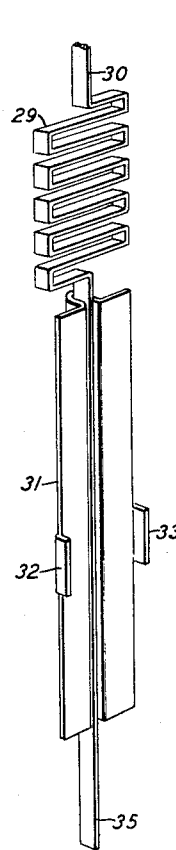


FIG. 13

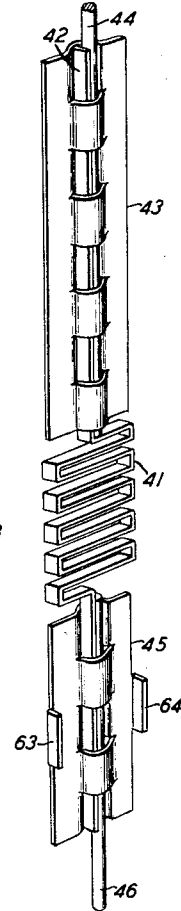
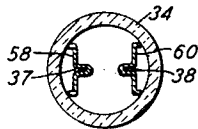


FIG. 11



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UNITED STATES PATENT OFFICE

2,288,451

ELECTRIC SWITCH

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Application June 15, 1940, Serial No. 340,651

7 Claims. (Cl. 200—112)

This invention relates to switches and relays for controlling electric circuits and particularly to those in which a conducting liquid, such as mercury, is used.

The objects of the invention are to obtain a simple and efficient operating mechanism; to minimize the number of movable parts; to obtain fast and positive operation; and to improve these devices in other respects.

While numerous varieties of circuit-making switches and relays have been devised in which mercury is employed as the contact element, it is generally true that they rely on a common operating principle, which involves the movement of all or a substantial portion of the mercury mass from one part of the switch to another. An objection to this principle is that the movement of any substantial mass of mercury requires the expenditure of a corresponding amount of energy. Also the time required for moving the mercury to its circuit-controlling position may be comparatively large.

According to the present invention these difficulties are surmounted and the foregoing objects are realized by means of a switch comprising a closed tubular envelope containing a pool of mercury in the bottom thereof and a combined armature, contact, and retractile spring formed from a sheet of magnetic material and mounted in the upper end of the housing tube. The combined armature and retractile spring member is formed from a thin strip or ribbon of magnetic material by the simple process of shearing and folding. In one alternative transverse slits are made at uniform spacings on both sides of the strip throughout the upper portion of its length, the series of cuts on one side alternating with those on the opposite side. Thereafter the strip is folded at each successive slit and stretched to form a resilient or spring section. When mounted in the tube the lower or unfolded portion of the strip is suspended above the pool with the tip end normally just out of contact with the surface of the pool or immersed therein. This lower, unfolded section serves as the armature and may be attracted magnetically either down or up, as the case may be, to establish or to break electrical connection between the current conducting spring armature and the mercury pool. When the magnetic attraction is removed, the resilient section acts to restore the armature quickly to its normal position. In another alternative the armature and spring sections are prepared separately and are

assembled to form a single structure which is suspended in place in the housing tube.

A feature of the invention is a switch of this character in which two spring-armature strips are mounted in the same envelope with the armature sections so displaced that one normally engages the mercury and the other normally rests above it. With this arrangement a common coil, when energized, pulls one armature down, thereby expanding the associated spring to make contact, and pulls the other armature up, thereby contracting the associated spring to break contact with the mercury pool.

The foregoing and other features of the invention will be discussed more fully in the following specification.

In the drawings accompanying the specification:

Figs. 1 and 2 are side views, partly in section, of a switch or relay incorporating the features of this invention. These figures illustrate the relay in its normal condition;

Fig. 3 is a view similar to Fig. 1 showing the relay in its operated condition;

Fig. 4 is a cross-sectional view taken on the line 4—4 of Fig. 3;

Fig. 5 shows an alternative form of the relay having a single armature instead of a plurality of armatures as illustrated in Figs. 1 to 4, inclusive;

Fig. 6 is a cross-sectional view taken along the line 6—6 in Fig. 5;

Fig. 7 illustrates a prepared blank from which the operating element is formed;

Fig. 8 is a perspective view illustrating the operating element after it has been formed from the blank shown in Fig. 7;

Figs. 9 and 10 are views of a modified form of the relay;

Fig. 11 is a cross-sectional view taken along the line 11—11 of Fig. 10;

Fig. 12 is a perspective view of the operating element used in the relay of Figs. 9 to 11, inclusive;

Fig. 13 shows a further modification of the operating element suitable for use with these relays; and

Fig. 14 illustrates a magnetic structure suitable for operating the elements disclosed in the preceding figures.

While the invention is not limited to any particular size or proportions for the relay it may be noted that this relay is especially useful in electrical systems where relatively small currents are involved, such, for example, as cur-

rents of the order commonly used in telephone and telegraph systems. For these purposes the dimensions of the relay may be relatively small, and it should be understood that the figures shown in the drawings are much enlarged in order to facilitate a clearer understanding of the construction.

Referring to the drawings and first to Figs. 1 to 4, inclusive, the operating unit here illustrated comprises a housing vessel or container in the form of a tube 1 of glass or other suitable material. The tube 1 contains two operating elements 2 and 3, each of which comprises in combination an armature, a restoring spring, and an electrical contact. In particular the element 2 has an armature portion 4, the electrical contact portion 5 integral therewith, and the integral spring portion 6 for restoring the armature to its normal position. Furthermore the operating element 2 includes a terminal portion 7 which serves to support the element when sealed into the glass tube and also to feed current thereto. In like manner the second operating element 3 has an armature portion 8, a contact portion 9, a spring portion 10, and a current feeding and supporting terminal 11.

The armatures and contacts of these operating elements 2 and 3 are arranged to move up and down within the housing tube for the purpose of engaging and disengaging a pool of mercury 12 which rests in the bottom of the tube. They are actuated by a magnetic field, which is produced as explained hereinafter, and the effectiveness of this field upon the operating elements may be increased by reducing the section 55 between the armature 4 and the spring 6 and similarly by reducing the section 56 between the armature 8 and the contact member 9. The effect of these reduced sections is to concentrate the magnetic field upon the armatures. The operating elements are guided in the upward and downward movements by a guide rod 13 of insulating material centrally located in the tube and by ribs 14 and 15 integrally formed on opposite sides of the interior of the tube 1. The armature 4 is provided with integral tabs 16 which are bent to loosely embrace the central rod 13 and also with tabs 17 for embracing the rib 15, thus guiding the armature along a fixed path of movement within the tube. Similarly the armature 8 is provided with tabs 18 for engaging the central rod 13 and corresponding tabs 19 for engaging the rib 14. In the normal position of the relay the contact portion 5 associated with the element 2 is immersed in the mercury pool 12, and the contact portion 9 of the element 3 is poised above the pool as seen more clearly in Fig. 1.

The relay shown in Fig. 5, which is similar to the one above described, includes a single operating element 20 having armature and spring portions 21 and 22, respectively, and a contact portion 23 for engaging and disengaging the mercury pool 24 in the bottom of the housing tube 25.

The combined armature, contact and retractile spring unit used in these relays is formed from a strip 25 of thin magnetic material by shaping the contact portion 26 as illustrated in Fig. 7 or in any other desired manner and by shearing the strip on opposite sides to provide two series of alternate transverse slits or cuts 27. After the strip is thus prepared, transverse folds are made opposite each successive cut, and the folded section is stretched to give it a permanent set

and to form the desired spring portion 28, as shown in Fig. 8.

In the relay shown in Figs. 9 to 11, inclusive, the operating element, which is shown in perspective in Fig. 12, comprises a spring portion 29 formed from a thin narrow strip 30 of any suitable resilient material and an armature 31 formed from a strip of magnetic material and secured to the strip 30 below the spring portion 29. The armature 31 is provided with tabs 32 and 33 which engage the inner surfaces of the housing tube and serve to guide the operating unit in its movement up and down within the tube. The lower end 35 of the strip 30 serves as a movable contact for engagement with the mercury pool in the bottom of the tube.

There are two of these operating units provided for the relay shown in Figs. 9 to 11, one having its movable contact 37 normally immersed in the pool 36, and the other having its movable contact 38 normally poised above the pool. The feed terminal 39, which is sealed in the bottom of the tube, is formed with a horizontal section 40, which serves as a stop to limit the downward movement of both of the movable contacts 37 and 38.

The alternative operating unit, shown in Fig. 13, comprises a spring 41 formed from a thin narrow strip 42. The spring member 41 is secured to a supporting plate 43 by passing the upper end of the strip 42 through loops formed by cutting and pressing the plate 43 and by forcing a rod 44 through the loops to wedge the strip and hold it firmly in place. The upper end of the rod 44 may be sealed into the housing tube for supporting the unit. The armature 45 is secured to the lower end of the strip 42 in a similar manner, and the fastening rod 46 projects downward for engagement with the mercury pool. The integral tabs 63 and 64 serve to guide the unit in its movement within the tube.

A magnetic structure suitable for use with the operating units above described is illustrated in Fig. 14. It comprises an operating coil 47 and pole members 48 and 49 which are held in place by a non-magnetic member 50. The ends of the pole members 48 and 49 are punched to present hollow cylindrical pole-pieces 51 and 52, which also form a receptacle for receiving and holding the operating unit. When one of these operating units is inserted in the receptacle formed by the pole-pieces 51 and 52, a protuberance on the side of the tube, formed by the sealing operation, engages the pole member 48 and locates the armature members within the tube in their proper relation with respect to the air-gap. For example, the protuberance 53 on the side of tube 1 (Fig. 2) locates the tube so that the armature 4 is normally below the center of the air-gap between the pole-pieces 51 and 52 and the armature 8 is normally above the center of the air-gap. When, therefore, the coil 47 is energized and a field is produced around the pole-pieces 51 and 52, the armature 4 is moved upwardly, compressing the spring 6 and withdrawing the contact member 5 from the mercury pool. At the same time the armature 8 is moved downwardly, stretching the spring 10 and immersing the contact member 9 in the pool. This condition of the relay, with the spring 6 under compression and the spring 10 under tension, is clearly shown in Fig. 3. Thus the normally closed circuit, which may be traced from the feed contact 54 through the pool 12, terminal 5, armature 4, spring member 6 to the terminal 7, is opened; and instead

a circuit is established from the feed contact 54, mercury pool 12, terminal 9, armature 8 and spring 10 to the terminal 11. When it is desired to release the relay, the coil 47 is deenergized whereupon the compressed spring 6 forces the armature 4 and terminal 5 downwardly into the mercury pool, and the tensioned spring 10 contracts and withdraws the terminal 9 out of the pool.

The operation of the relays shown in Figs. 5, 9 and 10 is similar to that above described. When magnetic flux is produced in the air-gap between pole-pieces 51 and 52, the armature 21 (Fig. 5) is pulled downwardly against the tension of spring 22, and the contact member 57 is immersed in the pool 23. In the relay of Figs. 9 and 10 the field produced by the operating coil pulls the armature 58 up against the compression of spring 59 and withdraws the contact 37 from the pool 36. At the same time the magnetic field pulls the armature 60 downwardly against the tension of spring 61, and the contact 38 is immersed in the mercury pool.

It will, of course, be understood that the invention is not limited to the particular structures shown in the present disclosure. If desirable, the housing container may be made in various shapes and sizes; the armatures may vary in their shape and proportion and in the methods by which they are formed; the shapes and locations of the stationary and movable terminals may also be varied; and numerous variations of the magnetic structure may be employed.

What is claimed is:

1. The combination in an electric switch of a closed vertical tube having a pool of mercury in the bottom thereof, a combined armature and spring member suspended from the top of said tube and normally out of engagement with said pool, a second combined armature and spring member suspended from the top of said tube and normally in engagement with said pool, the armature portions of said members being normally displaced with respect to each other, means for guiding said armatures in their vertical movements in said tube, and means for setting up a magnetic field which acts on the first of said armatures to draw it down into engagement with said pool against the effort of the associated spring and on the other armature to draw it up out of said pool against the effort of its associated spring.

2. In an electric switch, a vertical housing envelope having a pool of mercury therein, a combined armature and spring member suspended from the top of said envelope and normally out of engagement with said pool, a second combined armature and spring member suspended from the top of said envelope and normally in engagement with said pool, the armature portions of said members being normally displaced in a vertical direction with respect to each other, means for guiding said armatures in their vertical movements in said housing envelope, and electromagnetic means for moving said armatures simultaneously in opposite vertical directions to bring them into alignment with each other, the first-mentioned armature being drawn down into engagement with said pool against the force of the associated spring and the other of said armatures being drawn up out of said pool against the force of the associated spring.

3. In an electric switch, a housing tube having a pool of mercury therein, a combined arma-

ture and spring member secured in said tube and normally out of engagement with said pool, a second combined armature and spring member suspended in said tube and normally in engagement with said pool, the armature portions of said members being normally displaced with respect to each other, means for guiding said armatures in their movements in said housing tube, and electromagnetic means acting on the first-mentioned armature to extend the associated spring and on the second-mentioned armature to contract the associated spring to move said armatures in opposite directions into alignment with each other, the first-mentioned armature engaging said pool of mercury and the second-mentioned armature disengaging said pool.

4. The combination in an electric switch of a closed vertical tube having a pool of mercury in the bottom thereof, a combined armature and contact and spring member suspended from the top of said tube and normally out of engagement with said pool, a second combined armature and contact and spring member suspended from the top of said tube and normally engaging said pool, the armature portions of said members being displaced with respect to each other along the axis of said tube, guide members formed integrally with said armature portions and engaging the inner walls of said tube to guide the armatures in their vertical movements within said tube, and electromagnetic means for creating a magnetic field which acts on the first-mentioned armature to stretch the associated spring and on the second-mentioned armature to compress the associated spring until said armatures are brought into vertical alignment with each other, the movement of the first armature engaging the associated contact with said mercury pool and the movement of said second armature disengaging the associated contact from said pool, said springs serving to restore their associated armatures to the normal positions when said electromagnetic means becomes ineffective.

5. The combination in an electric switch of a housing having a pool of mercury therein, a strip of resilient and magnetic material having a section comprising an armature and a section cut with series of slits on opposite sides and folded to form a spring, said combined armature and spring mounted within said housing with the end of said armature normally out of engagement with said pool of mercury, and electromagnetic means for attracting said armature against the tension of said spring to move said armature into engagement with said pool of mercury.

6. The combination in an electric switch of a closed vertical tube having a pool of mercury therein, a strip of resilient and magnetic material having a section provided with alternately occurring cuts on the opposite sides and folds to form a spring, said combined armature and spring mounted within said tube with the lower end of said armature in contact-making relation with respect to said pool of mercury, and electromagnetic means for moving said armature against the force of said spring, said spring serving to restore the armature to its normal position when said electromagnetic means becomes ineffective, said armature in its movement serving to engage and disengage the mercury in said pool.

7. In an electric switch, a sealed housing tube having a pool of mercury in one end thereof,

a single strip of flat stock of magnetic material mounted longitudinally within said tube and divided along its length into a plurality of successive integral portions, one of said portions being sealed into the other end of said tube and extending exterior thereof to serve as a terminal, another portion being cut and formed to provide a spring section, another portion being shaped to serve as an armature, and another portion being shaped to serve as an electric contact for cooperation with said pool of mercury,

and electromagnetic means for attracting said armature portion to move it and the integral contact portion longitudinally in said tube against the tension of said spring portion to cause the immersion of said contact portion in the mercury pool, said spring portion serving to withdraw the contact portion from the mercury pool when the electromagnetic means becomes ineffective.

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