

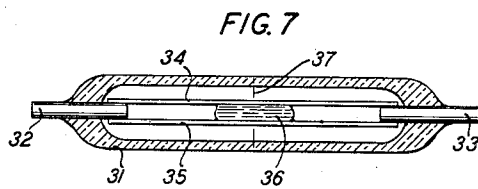
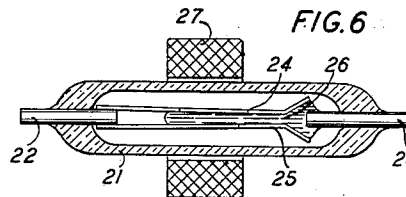
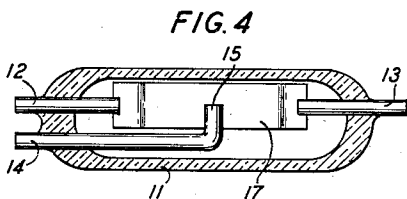
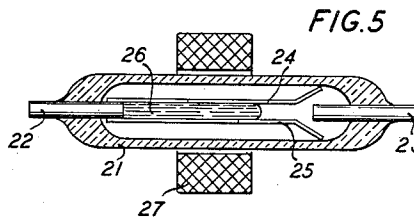
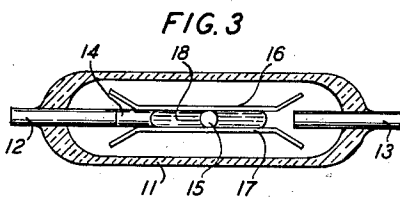
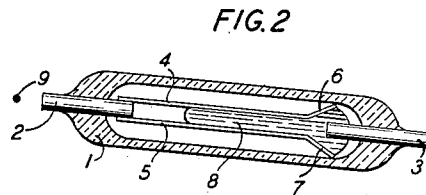
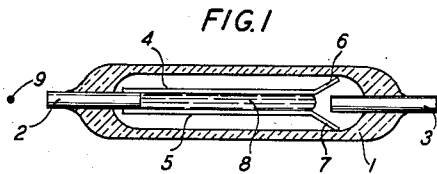
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2,312,672

SWITCHING DEVICE

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2,312,672

SWITCHING DEVICE

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7 Claims. (Cl. 200—97)

This invention relates to switching devices and relays and, more particularly, to those in which a conducting liquid, such as mercury, is used as the contact-making medium.

The objects of the invention are to simplify devices of this character, to render such devices more stable and resistant to shock and to render such devices responsive to small operating forces.

It is well recognized that mercury has certain distinct advantages over solid elements as a contact-making medium for electrical circuits. For instance, a body of mercury presents a fresh surface for each successive contact closure and is not subject to the pitting and corroding effects that gradually reduce the usefulness of solid contact elements. With these advantages in view several forms of mercury switches have been devised in the past which may be divided into two general classes. In one of these classes the container is tilted or otherwise moved to cause the body of mercury within it to shift its position thus opening or closing the desired connections. In the other class an armature or other movable element is forced into a pool of mercury, the free surface of the mercury being displaced into engagement with circuit-making contacts. In either case it has heretofore been necessary to move all or a considerable part of the mercury mass into a position in which it physically engages or disengages the desired circuit contact or contacts.

In accordance with the present invention a very small mass of mercury is employed which may be moved either by tilting the switch unit, subjecting it to the physical action or subjecting it to the influence of a magnetic field. In view of the small amount of mercury employed the inertia of the mercury mass is small and the switch unit is therefore quickly responsive to a small operating force applied to the switch unit. The objects of the invention are attained by supporting two reed members parallel to and in close proximity to each other in an enclosing envelope from a contact member extending into the envelope, between which reeds a small mass of mercury is held by adhesion to the adjacent surfaces of the reeds which are of a material easily wettable by the mercury. One or more contact members may extend through the walls of the envelope into positions in which they may be engaged by the mercury when the mercury is forced to the end or ends of the reeds.

With the switch unit in its normal or horizontal position the mercury mass occupies a position

approximately midway between the opposite ends of the reeds and out of contact with all contact members except the contact member which supports the reeds. If the switch unit is of the tiltable type the tilting of the unit will cause the mercury to move by gravity to a position at the depressed ends of the reeds into engagement with a contact member. If the switch unit is of the centrifugal type the rotation of the unit about an outside axis will cause the mercury to be forced by said centrifugal action to the outer ends of the reeds where it will engage a contact member. The switch unit may also be applicable to a relay structure in which the reeds may be made of magnetic material and attractive toward each other when subjected to a magnetic field to force mercury from between them into engagement with a contact member.

The invention is further applicable to replace the usual bubble element of a spirit level. When so used the wettable reeds between which the mercury is held are supported at each end by non-wettable supports sealed into the ends of a glass envelope. With the envelope perfectly level the small bubble of mercury is positioned midway between the ends of the reeds and centralized with respect to the level indicating gauge line on the glass envelope.

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

Figs. 1 and 2 disclose, in partial cross section, the normal and operated positions, respectively, of a switch unit of the tiltable or centrifugal type constructed in accordance with the invention;

Fig. 3 shows a side view, partly in cross section, of a switch unit of the tiltable type which may be tilted in either one of two directions to cause the establishment of a connection through the mercury with either one of two contact members;

Fig. 4 shows a bottom view partly in cross section of the switch unit of Fig. 3;

Figs. 5 and 6 show, in partial cross section, the normal and operated positions, respectively, of a switch unit in accordance with the invention and operable by magnetic means; and

Fig. 7 shows a side view partly in cross section of an application of the invention to a spirit level.

Having reference first to Figs. 1 and 2 of the drawing, the switch unit disclosed therein comprises a glass envelope 1 through one end of which is sealed a contact member 2 and through the

other end wall of which is sealed a second contact member 3. Welded or otherwise secured to the member 2 and extending parallel to each other toward the end of the contact member 3 are two thin reeds 4 and 5, the adjacent surfaces of which are of material, such as nickel, wettable by mercury. The free ends 6 and 7 of these reeds are flared outwardly over the end of the contact member 3 but out of engagement therewith. The space between the reeds is filled with mercury 8 to the point where they spread apart as disclosed in Fig. 1.

When the switch unit is vibrated about a pivotal point, such as indicated by the point 9, centrifugal force will drive the mercury column out into the position illustrated in Fig. 2, since the contact member 2 being of material non-wettable by the mercury will not hold the mercury against the centrifugal force acting upon it. In this position the mercury will engage the contact member 3 thereby establishing a connection through the mercury, between the contact members 2 and 3. When the oscillation ceases the surface tension of the mercury will snap it back into its original position illustrated in Fig. 1. The time constants of this switch unit are determined by the length and mass of the mercury column and by the stiffness of the mercury drop formed between the flared ends of the reeds.

By proper design this switch unit may be made to operate over a range of frequencies and time constants. One of the chief advantages of a switch unit of this character is that the mercury column is held with considerable force between the reeds and if, due to shock, some of the mercury becomes displaced momentarily, it will, due to the surface tension, return to its proper position between the reeds. To insure this the envelope fits the reeds as closely as possible.

The switch unit of Figs. 1 and 2 may also be operated as a tilt type switch. When so operated the free flow of mercury between the wetted surfaces of the reeds 4 and 5 added to the fact that by proper design a balance of surface tension forces may be obtained between the reeds and the wetted end of the contact member 3, allows great sensitivity to be obtained by moving only a small amount of mercury.

Figs. 3 and 4 illustrate a modification of the switch unit for the purpose of securing a double throw tilt type switch. In this modification two contact members 12 and 13 are sealed in alignment through the opposite end walls of the envelope 11 and a third contact member 14 is also sealed through one end wall of the envelope 11 and extends to a point midway of the length of the envelope where it is bent at right angles to afford a support 15 for two parallelly disposed reeds 16 and 17 which are welded or otherwise secured thereto at the mid-point of their length. The supporting end 15 of the member 14 lies in the plane of the contact members 12 and 13 so that the reeds 16 and 17 are supported with their flared ends embracing but out of engagement with the ends of members 12 and 13. The inner surfaces of the reeds 16 and 17 are of a material, such as nickel, which is wettable by mercury and a column 18 of mercury is held by surface tension in a mid-position between the ends of the reeds and in engagement with the contact member 14 when the switch unit is held in its normal or horizontal position.

Should the right end of the switch unit be depressed, the mercury column 18 will flow along the reeds to a position between the right flared

ends thereof and into engagement with the contact member 13. Should the left end of the switch unit be depressed the mercury column 18 will flow along the reeds to a position between the left flared ends thereof and into engagement with the contact member 12. When the switch unit is returned from either depressed position to a horizontal position the mercury will by surface tension move back into the original position at the central portion of the reeds.

The invention is also applicable in accordance with a further modification thereof disclosed in Figs. 5 and 6, for magnetic operation as the switching unit of a relay structure. This switch unit comprises an envelope 21 through the opposite end walls of which two contact members 22 and 23 extend in alignment with each other. Welded or otherwise secured to the member 22 and extending parallel to each other are two reeds 24 and 25. The portion of reed 24 which is secured to the contact member 22 and the outer portion of reed 25 are made of non-magnetic material whereas the outer portion of reed 24 and the portion of reed 25 which is secured to the contact member 22 are made of magnetic material. The flared outer ends of both reeds embrace the inner end of contact member 23 but are out of engagement therewith and the inner surfaces of both reeds and the end of contact member 23 are wettable by mercury. It will be noted that the inner end of the magnetic portion of reed 24 overlaps the outer end of the magnetic portion of reed 25. A short column 26 of mercury is held by surface tension between the reeds in the position illustrated in Fig. 5. An energizing coil 27 surrounds the envelope 21 at such a point that the overlapping magnetic portions of the reeds are positioned within the coil.

When the coil 27 is energized flux enters the magnetic portion of reed 24, flows across the air-gap between the inner end of such magnetic portion and the outer end of the magnetic portion of reed 25, and leaves by such portion where by the reeds are attracted toward each other to force mercury out between the flared ends of the reeds into engagement with the contact member 23 thereby interconnecting the contact members 22 and 23 through the mercury as illustrated in Fig. 6. When the coil thereafter becomes deenergized, the reeds move away from each other and the mercury, due to its surface tension, returns between the reeds to the position illustrated in Fig. 5.

The invention is also applicable as disclosed in Fig. 7 as the testing element of a level to replace the usual spirit element. For this purpose two supports 32 and 33 are sealed to the opposite ends of a glass envelope 31 and have secured between their inner ends two parallelly disposed reeds 34 and 35, the inner surfaces of which are wettable by mercury. The supports 32 and 33 are of a material which is not wettable by mercury. Disposed between the reeds is a short column 36 of mercury which, when the envelope 31 is in a perfectly level position is disposed at the mid-point of the reeds as indicated by the gauge line 37 on the glass envelope. Due to the lack of adhesion of the mercury to the envelope and its free flow between the wetted reeds, this element when applied to a level enables very accurate determinations to be made.

It will, of course, be understood that the invention is not limited to the particular structures illustrated. If desirable, the envelope might be

made in various shapes and sizes and of various materials; the shape, location and number of the contact members may be varied and various modifications of the magnetic structure disclosed in Figs. 5 and 6 may be used.

What is claimed is:

1. In an electric switch, an envelope, contact members extending into said envelope, a pair of reeds supported in parallel spaced relationship within said envelope, the adjacent faces of said reeds being of a material wettable by mercury, a body of mercury held by surface tension between said reeds and means for overcoming said surface tension to cause said mercury to move freely between said reeds to interconnect said contact members.

2. In an electric switch, an envelope, contact members extending into said envelope, a pair of reeds supported in parallel spaced relationship within said envelope on one of said members and having their corresponding ends flared away from each other to embrace the inner end of another of said contact members but out of engagement therewith, said reeds having their adjacent faces made of a material wettable by mercury, a body of mercury held by surface tension between said reeds and normally out of engagement with said other contact member, and means for overcoming said surface tension to cause said mercury to protrude between the flared ends of said reeds to interconnect said contact members.

3. In an electric switch, an envelope, a pair of contact members extending toward each other through the opposite ends of said envelope, a pair of reeds supported at one end on the inner end of one of said members and extending in parallel spaced relationship towards said other member and having their free ends flared away from each other to embrace the inner end of said other member but out of engagement therewith, said reeds having their adjacent faces of a material wettable by mercury, a body of mercury held by surface tension between said reeds and normally out of engagement with said other contact member, and means for overcoming said surface tension to cause said mercury to protrude between the flared ends of said reeds to interconnect said contact members.

4. In an electric switch, an envelope, a pair of contact members extending toward each other through the opposite ends of said envelope, a third contact member, a pair of reeds supported in parallel spaced relationship on said third contact member and flared away from each other at each end to embrace but not engage said other contact members respectively, said reeds having their adjacent faces made of a material wettable by mercury, a body of mercury held by surface tension between said reeds and normally out of engagement with said other contact members, and means for overcoming said surface tension to cause said mercury to protrude between the flared portions of said reeds at one or the other end thereof to interconnect said third contact mem-

ber with one or the other of said other contact members.

5. In an electric switch, an envelope, a pair of contact members extending toward each other through the opposite ends of said envelope, a pair of reeds supported at one end on the inner end of one of said members and extending in parallel spaced relationship towards said other member and having their free ends flared away from each other to embrace the inner end of said other member but out of engagement therewith, said reeds having their adjacent faces made of a material wettable by mercury, a body of mercury held by surface tension between said reeds and normally out of engagement with said other contact member, and electromagnetic means for moving the free ends of said reeds toward each other to cause said mercury to protrude between the flared ends of said reeds to interconnect said contact members.

6. In an electric switch, an envelope, a pair of contact members extending towards each other through the opposite ends of said envelope, a pair of reeds supported at one end on the inner end of one of said members and extending in parallel spaced relationship towards said other member and having their free ends flared away from each other to embrace the inner end of said other member but out of engagement therewith, said reeds having portions of magnetic material and having their adjacent faces wettable by mercury, a body of mercury held by surface tension between said reeds and normally out of engagement with said other contact member and electromagnetic means for causing said reeds to become attracted toward each other to cause said mercury to protrude between the flared ends of said reeds to interconnect said contact members.

7. In an electric switch, an envelope, a pair of contact members extending toward each other through the opposite ends of said envelope, a pair of composite reeds supported at one end on the inner end of one of said members and extending in parallel spaced relationship towards said other member and having their free ends flared away from each other to embrace the inner end of said other member but out of engagement therewith, one of said reeds having its supported end made of non-magnetic material and its free end made of magnetic material and the other of said reeds having its supported end made of magnetic material and its free end made of non-magnetic material and having their adjacent faces wettable by mercury, a body of mercury held by surface tension between said reeds and normally out of engagement with said other contact member, and a coil surrounding said envelope and energizable to cause said reeds to become attracted toward each other to thereby cause said mercury to protrude between the flared ends of said reeds to interconnect said contact members.

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