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ELECTRIC SWITCH

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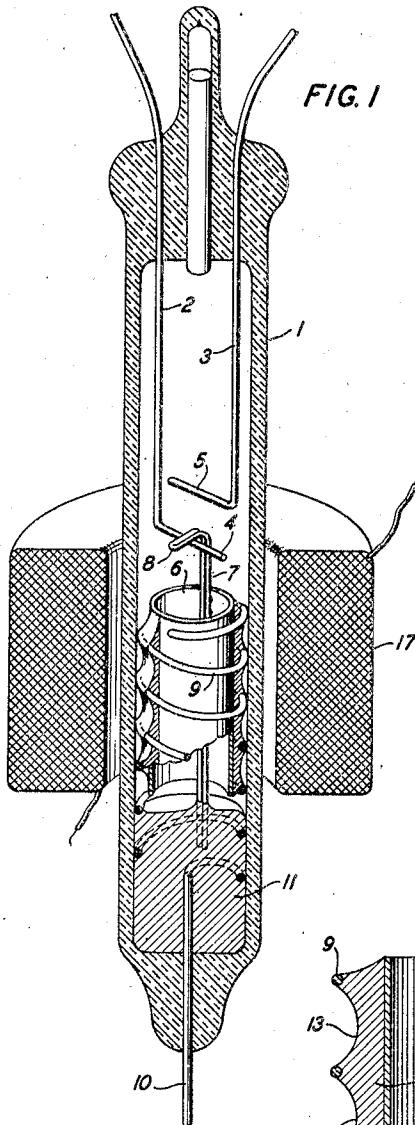


FIG. 1

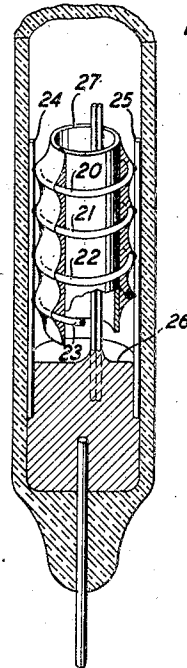
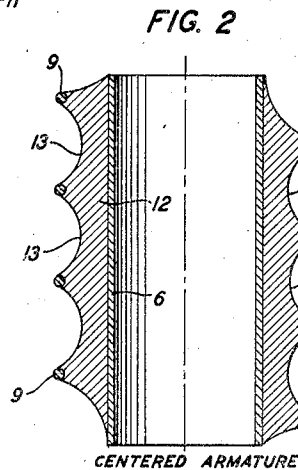
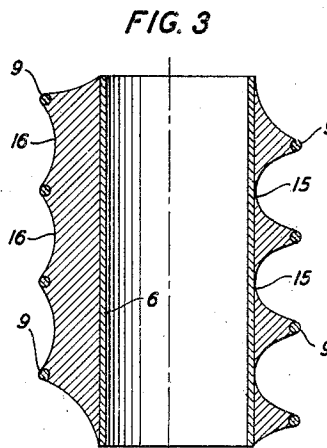


FIG. 4



CENTERED ARMATURE



DISPLACED ARMATURE

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ELECTRIC SWITCH

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8 Claims. (Cl. 200—112)

This invention relates to electrical contact-making devices and particularly to circuit-closing switches and relays.

The objects of the invention are to improve the sensitivity of switches and relays; to maintain a more accurate relationship between the movable and stationary parts; to safeguard against irregularities in the operation of the moving members; to make use of a liquid medium for holding the movable members automatically in place; to make use of the same liquid medium for improving the electrical contacts; and to effect other improvements in devices of this character.

The foregoing objects of the invention are realized by means of a switch or relay having an electromagnetic armature operable in a reciprocating movement for opening and closing electrical contacts and in which a liquid medium, such as mercury, serves to guide and to maintain the armature in a fixed path of movement. More specifically, the switch may comprise a vertical tube or container, a cylindrical magnetic armature mounted therein for vertical movement along the axis of the tube to advance a movable contact into and out of engagement with stationary contacts, a stationary guide in the form of a helical wire, or in any other convenient form, surrounding the armature, and a mass of mercury interposed between the external surface of the cylindrical armature and the stationary guide and adhering both to the armature surface and to the coils of the guide wire to hold the armature in a balanced and centralized relationship with respect to the axis of the containing tube. The mercury mass, which holds the armature in its centralized position, is supplied by capillary action from a pool resting in the lower portion of the containing tube. The adherence of the mercury to the coils of the guide wire sets up a series of curvatures or waves in the external surface of the mercury mass surrounding the armature; the curvature of these waves is uniform throughout the entire external surface of the mercury mass as long as the armature remains in its central position. When, however, the armature is displaced to one side of its central position, the waves in the mercury surface assume different degrees of curvature on opposite sides, and the forces of surface tension immediately act to restore the balance of the mercury mass and the armature to its centralized position. Thus the armature is held in its proper position automatically and is capable of partici-

pating in free and unrestricted movement in response to the operating magnetic field.

A feature of the invention is a switch of this character in which the mercury pool, which maintains the guiding mass of mercury around the armature, also serves to maintain a film of mercury over the circuit-making contacts of the switch. To this end the movable contact, which is secured to the armature for movement therewith, extends into the mercury pool in the bottom of the container and is so shaped that mercury from the pool is attracted by capillary action up the movable contact to the contact-making surfaces thereof.

These and other features of the invention will be discussed more fully in the following detailed specification.

In the drawing accompanying the specification:

Fig. 1 is a cross-sectional view of a switch embodying the features of this invention;

Fig. 2 is an enlarged cross-sectional view of the armature when occupying its centered position in the switch;

Fig. 3 is a similar view showing the armature in a displaced position; and

Fig. 4 is a view partly in cross section of a switch having an alternative form of armature guide.

While the invention is not limited to a switch of any given size or proportions, it may be noted that this switch or relay is particularly useful in electrical systems where relatively small currents are involved, such, for example, as currents of the order commonly used in telephone and telegraph systems. For these purposes the relay may be made to small dimensions, and it should be understood that the figures shown in the drawing are greatly enlarged to facilitate a clearer understanding of the construction.

Referring now particularly to the drawing, the switch illustrated in Figs. 1 to 3 includes a sealed housing tube or container 1, which may be of glass, metal or any other suitable material. Two stationary contact members 2 and 3 are sealed into the tube 1, and the lower ends 4 and 5 of these members are overturned as shown to form the contact-marking surfaces.

An open cylindrical armature 6 of magnetic material is centrally located within the tube 1 and is movable up and down therein along the central axis of the tube. In its normal or lowermost position the armature 6 is supported and held in suspension by the stationary contact member 2. To this end the movable contact

member 7 is firmly secured to the interior surface of the cylindrical armature 6 by welding or by any other suitable means, and the upper end 8 of the movable contact member is over-turned to form a contact-making portion which engages the contact portion 4 of the member 2 to limit the downward movement of the armature. In the uppermost position of the armature 6 the contact portion 8 of the movable contact member 7 engages the stationary contact portion 5. Thus the contact 2 serves as a normal or back contact of the switch, and the contact 3 serves as an alternate or front contact.

The armature 6 is surrounded by a stationary cylindrical guide which is spaced at a substantial distance from the external surfaces of the armature. This guide is in the form of a wire helix 9, the lower end 10 of the wire from which the helix is formed being sealed into the bottom of the tube 1 as illustrated. The cylindrical armature and the helix are substantially concentric as long as the armature remains in its normal or centered position within the housing tube 1.

The lower end of the tube 1 is filled with a pool of conducting liquid 11, preferably mercury, which immerses the lower portion of the helical guide wire 9. By reason of the forces of capillary attraction, a portion of the mercury from the pool 11 creeps up the helical guide wire and surrounds the entire external surface of the cylindrical armature 6. This coating of mercury surrounding the armature adheres both to the armature and to the convolutions of the guide wire and serves as an intermediate medium between the two. The forces of capillary action and adhesion may be augmented by coating the guide wire and the external surface of the armature with certain materials such as platinum, nickel, and copper and by including inert gases in the container 1 to maintain these coated elements free from corrosion.

The effect of the mass of mercury which lies intermediate the movable armature and the stationary guide may be understood more clearly by referring to Figs. 2 and 3. In Fig. 2 the armature 6 is illustrated in its correct centered position within the cylinder formed by the helical guide wire 9. As long as this centered condition prevails the intermediate mercury mass 12 which surrounds the armature 6 is of uniform thickness on all sides of the armature. Being of uniform thickness, the curvature of the waves 13 formed in the external surface of the mercury mass by the adhesion thereof to the convolutions of the guide wire 9 is the same on all sides. That is to say, the curvature of the waves 13 is the same on the left-hand side of the armature and is equal to the curvature of the waves 14 on the right-hand side of the armature, and the same is true on all sides. Thus the tensional forces in the surface of the mercury mass surrounding the armature are equal on all sides, and the armature is held in a centralized position. If, however, the armature 6 becomes displaced by some external force from its central position, as seen in Fig. 3, the thickness of the mercury coating on one side of the armature becomes greater than that on the opposite side thereof. Because of this unequal distribution of the mercury the curvature of the waves 15 on the one side of the armature is steeper than the curvature of the waves 16 on the opposite side thereof. Consequently the forces of surface tension in the steeply curved waves 15 are greater than the forces of surface tension on the opposite side of the armature.

The result of this unbalance of surface tension forces is to immediately transfer mercury from the side where it is thickest to the opposite side of the armature. As this transfer takes place the armature is moved bodily back to its centralized location.

In this manner the armature is always maintained in its correctly centered position to insure its free and unrestricted movement up and down within the guide wire 9 and to insure the correct relative position of the movable contact 8 with respect to the stationary contacts 4 and 5.

The operating force for moving the armature 6 from one position to the other is derived from the electromagnetic coil 17 which surrounds the external surface of the tube 1. When the coil 17 is energized, it sets up a magnetic field which pulls the armature 6 upward, disengaging the movable contact 8 from the stationary contact 4 and moving it into engagement with the alternate contact 5. As the armature 6 moves upwardly under the influence of the magnetic field it passes freely through the helical guide 9 without physically engaging the same. When it is desired to release the switch, the coil 17 is deenergized, and the armature 6 restores under the force of gravity, aided by the forces of surface tension in the mercury, and the movable contact 8 is disengaged from contact 5 and returned to its normal engagement with the contact 4.

The circuit closed through the switch when the armature 6 is in its normal lower position may be traced from the terminal member 10 through the mercury pool 11, through the movable contact 7 to the stationary contact 2; and the circuit through the switch when the armature is in its alternate position is similarly traced by way of the stationary contact 5.

The mercury pool 11 in the bottom of the tube 1 also serves to enhance the contact-making qualities of the switch. To this end the movable contact 7 is formed by doubling a length of wire as illustrated in the drawing, whereby the two vertical parallel sections of the contact 7 serve as a capillary channel to encourage the movement of the mercury out of the pool 11 to the contact surfaces 4, 5 and 8.

Fig. 4 shows an alternate form of the switch in which the armature guide comprises a plurality of wire rings 20, 21, 22 and 23. These rings are welded or otherwise secured to a number of vertical supporting wires 24, 25 which extend down into the mercury pool 26. Thus the mercury creeps up the supporting wires 24 and 25 and around the wire rings 20, 21, 22, etc., and forms the coating around the external surface of the armature 27.

Other forms of guides may be used without departing from the spirit of this invention. For example, the cylindrical guide surrounding the movable armature of the switch may consist of a wire screen having meshes sufficiently large to permit the formation of waved surfaces in the mercury coating which lies between the guide and the armature.

It will be understood, of course, that the invention is not limited to the particular structures used to illustrate it in the present disclosure. If desirable, the housing tube may be made in various shapes and sizes; the armature may vary in its shape and proportions; the shape and location of the stationary and movable contacts may also be varied; and numerous other variations in structure and design may be employed.

What is claimed is:

1. The combination in an electrical switch of a housing member, a stationary circuit-closing contact fixed within said housing member, an armature mounted within said housing member, a movable contact controlled by said armature, means for moving said armature within said housing member to effect circuit-closing engagement between said movable and stationary contacts, and a liquid medium within said housing member for exerting forces on said armature to maintain said armature in a definite relationship with said housing member.

2. The combination in an electrical switch of a housing member, a stationary circuit-closing contact fixed within said housing member, an armature mounted within said housing member, a movable contact controlled by said armature, means for moving said armature within said housing member to effect circuit-closing engagement between said movable and stationary contacts, and a liquid medium surrounding said armature and exerting forces to maintain it in uniform spaced relation with the interior walls of said housing member.

3. The combination in an electrical switch of a housing member, a stationary circuit-closing contact fixed within said housing member, an armature mounted within said housing member, a movable contact controlled by said armature, means for moving said armature within said housing member to effect circuit-closing engagement between said movable and stationary contacts, a guide member surrounding said armature and spaced therefrom, and a liquid medium lying between said armature and guide member and serving to hold said armature in uniform spaced relation with respect to said guide member.

4. The combination in an electrical switch of a housing member, stationary circuit-closing contacts fixed within said housing member, a cylindrical armature movable within said housing member, a movable contact secured to and operated by said armature, means for moving said armature to advance said movable contact into and out of engagement with said stationary contacts, a cylindrical guide surrounding said armature and spaced therefrom a substantial distance, and a liquid medium interposed between said armature and guide for automatically maintaining said armature in its fixed spaced relation with respect to said guide.

5. The combination in an electrical switch of

a housing tube, circuit-closing contacts mounted within said housing tube, a movable armature within said tube, means for operating said armature to control said contacts, a pool of liquid in said tube, and capillary means for drawing liquid from said pool and for maintaining a mass thereof surrounding said armature, the forces within said surrounding mass of liquid serving to hold said armature in a definite relationship with respect to said tube.

6. The combination in an electrical switch of a housing tube, circuit-closing contacts mounted within said housing tube, a movable armature within said tube, means for operating said armature to control said contacts, a pool of liquid in said tube, a guide member surrounding said armature and uniformly spaced therefrom, said guide member serving as a capillary means for drawing liquid from said pool to maintain a mass thereof surrounding said armature and adhering to both the armature and the guide member, the forces of surface tension within said surrounding mass of liquid acting to hold said armature in a definite relationship with respect to said guide member.

7. The combination in an electrical switch of a housing tube, circuit-making contacts within said tube, an armature mounted in said tube for movement along a definite path to control said circuit-making contacts, a pool of mercury in said tube, and means for drawing mercury from said pool and for maintaining a mass thereof around said armature, the forces of tension in the surface of said surrounding mass of mercury serving automatically to restore said armature to its fixed path of movement when disturbed therefrom.

8. The combination in an electrical switch of a vertical housing tube, stationary circuit-making contacts mounted therein, a cylindrical armature mounted in said tube for movement along the axis thereof, a movable contact secured to said armature for engagement with said stationary contacts, a pool of mercury in said tube, means for drawing mercury from said pool and for maintaining a mass thereof around the surface of said armature to hold said armature in its centralized position within said tube, and capillary means including said movable contact for drawing mercury from said pool to maintain a supply thereof on the contact surfaces of said circuit-making contacts.

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