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R. W. ARMSTRONG ET AL

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MERCURY SWITCH

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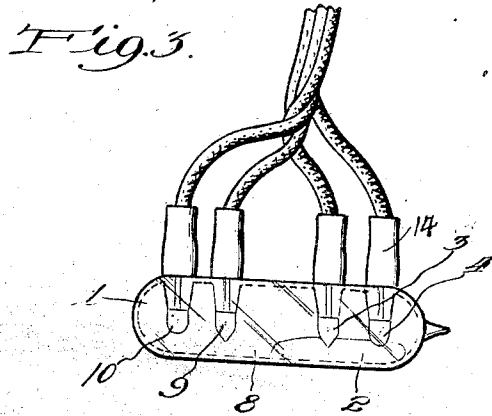


Fig. 1.

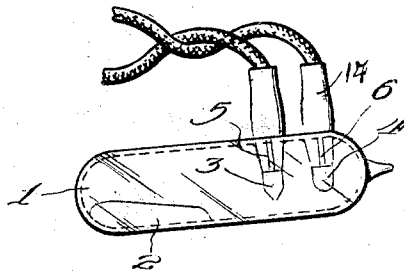
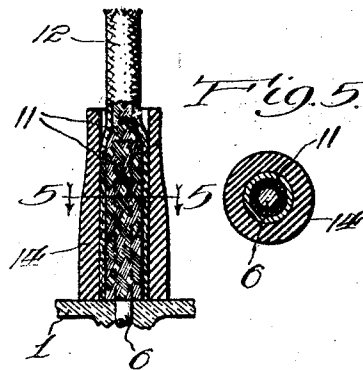
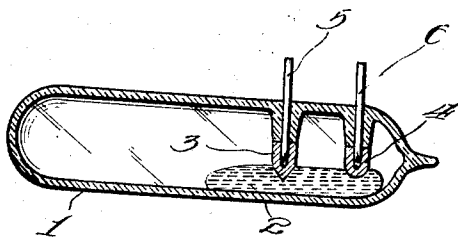


Fig. 4.

Fig. 2.



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UNITED STATES PATENT OFFICE.

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MERCURY SWITCH.

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The present invention has for its object to improve in certain respects small mercury switches that have heretofore already been brought to a comparatively high state of perfection. The most practical form of this kind of a switch is one in which a small body of mercury is contained in a sealed glass tube having within the same terminals connected to suitable lead-in wires, which terminals are adapted to be connected together by the mercury when the tube is laid on its side and tipped to the proper angle. Through the use of an inert gas in the tube and properly purified iron terminals, switches of this kind are now enabled to handle currents as great as 10 amperes at 110 volts. Naturally, during the making and breaking of the comparatively heavy currents, strong arcs are produced within the switches. One of the objects of the present invention is to produce a simple and novel proportioning of the parts of such mercury switches that no arcs that can be formed during the making and breaking of the normal currents can have any injurious effect or even reduce the sensitiveness of action where sensitiveness is required.

The various features of novelty whereby our invention is characterized will hereinafter be pointed out with particularity in the claims; but, for a full understanding of our invention and of its objects and advantages, reference may be had to the following detailed description taken in connection with the accompanying drawing, wherein:

Figure 1 is an elevation of a single-circuit or one-way switch arranged in accordance with our invention;

Fig. 2 is a longitudinal central section through the switch shown in Fig. 1, on a somewhat larger scale, in its closed position;

Fig. 3 is a view similar to Fig. 1 showing a double-circuit or two-way switch embodying our invention;

Fig. 4 is a view, on an enlarged scale, of a fragment of the connection between a terminal of one of the switches with the corresponding conductor or cable; and

Fig. 5 is a section taken on line 5—5 of Fig. 4.

Referring to Figs. 1 and 2 of the drawing, 1 represents a glass tube closed at the ends and sealed and containing a small body of mercury 2. Near one end of the tube,

and within the same, are two terminals 3 and 4, spaced apart in the direction of the length of the tube. The terminals are preferably in the form of small blocks of iron fastened to the inner ends of suitable lead-in wires 5 and 6 that pass through the wall of the tube. Thus the terminals may be said to project inwardly from one side of the tube towards the opposite side, from which latter side, however, they are spaced apart. The tube is preferably filled with hydrogen, an inert gas, or any gas which will not react with the mercury or the terminals in a way to decrease the efficiency of the switch, although this constitutes no part of the present invention. The parts are so proportioned that when the tube is held with its long axis inclined slightly to the horizontal, with the leading-in wires at the top, the mercury will either lie in the end remote from the terminals, as shown in Fig. 1, or in the end containing the terminals, as shown in Fig. 2; electrical connection between the two terminals being interrupted in the first position, while in the second position the two terminals are electrically connected together.

Generally speaking, all that we have heretofore described is old, our invention consisting of refinements which we shall now describe.

When the switch is tilted from the position shown in Fig. 1 to that shown in Fig. 2, if the mercury engages the farthest terminal 4 before it does the other terminal, the current will jump across the gap between the underlying mercury and the terminal 3 as soon as this gap becomes small enough. In other words, the current will "flash" from the terminal 3 to the mercury and, where the current is comparatively heavy, the effect of the flash into the middle of the body of mercury sometimes causes a division of the mercury into two bodies and allows the flash or arc to strike against the underlying glass. Even if no further harm should come from the action just described it would at least result in a failure of the switch to function in the most efficient manner at the instant when it should function, because the flash and partial or total separation of the mercury into two bodies would momentarily delay the completion of the circuit which is closed by the switch. We have also found

that at times when the switch moves from the closed position of Fig. 2 to the open position of Fig. 1 a globule of mercury remains, at least momentarily, to bridge the gap between the two terminals, so that the circuit is not broken as promptly as it should be.

We have discovered that the objections just mentioned can be overcome by a simple proportioning of parts which will insure that contact will always be made first at the terminal 3 and will always be broken last at this terminal. We therefore form the terminal 4 with a blunt rounded end and the terminal 3 with a tapered or pointed end, and locate the terminal 3 somewhat closer to what may be termed the bottom side of the tube than we do the terminal 4. The result is that when the switch is tipped from the position shown in Fig. 1 to the other position, even though very slowly, the mercury must touch the pointed end of the one terminal before it is possible for it to reach the other terminal. Because of the shape of the pointed terminal it offers little resistance to the movement of the mercury traveling past it to the other terminal, and therefore the mercury retains its momentum as it approaches the second terminal. As soon as the mercury comes close enough to the second terminal an arc may form between the mercury and the terminal; but the force of the arc is opposed by the entire body of mercury in motion and the movement of the mercury will therefore not be perceptibly checked and there will be no delay in completing the circuit. On the other hand, the same arc, if powerful enough, extending between the first terminal and a point perhaps midway between the ends of the body of mercury, would break the body of mercury in two and drive the parts away from each other, so as not only to delay the completion of the circuit but also to expose the glass to the action of the arc. When the switch tips back towards its open position the mercury does not adhere to the pointed terminal as it does to a rounded terminal. Therefore, by making the terminal 4 blunt and rounded, the mercury will adhere to the latter as the switch swings toward its open position, but is permitted by the pointed terminal to stretch itself into an attenuated form until finally the effect of gravity will be sufficient to break the mercury away from the rounded contact by a quick snap action; the tube being long enough to permit the break to occur before the mercury strikes the end of the tube remote from the terminals. Furthermore, the rapidity of the break is not dependent upon the speed at which the tube is tilted, but the break is always effected instantaneously. The effect just described is made even more pronounced by reason of the fact that the arcing is al-

ways confined to the rounded terminal which therefore quickly becomes coated with a film of mercury; this film readily uniting with the main body of mercury whenever there is opportunity for it to do so, and increasing the surface tension effect which causes the mercury of the main body to remain in contact with the rounded terminal over a large area of the latter until the break comes. Therefore, because of the unique conditions just described in the making and breaking of the circuit, the current-carrying capacity of our improved switch is very much greater than in previous switches of this general type, due to the fact that the arcing upon making and breaking the circuit is reduced to a minimum and is under control, and the further fact that when the circuit is complete and current flowing, the effective portion of the circuit within the switch is always of large cross-sectional area.

Since the mercury cannot adhere to the pointed terminal because of the shape of the latter, and further because it does not become coated with a film of mercury, all danger of having a globule of mercury remain bridged between the two terminals upon the tilting of the switch to its open position, is avoided.

Instead of having a single-circuit controlled by a switch we may of course control a plurality of circuits; Fig. 3 illustrating a two-way switch, or one controlling two circuits one of which is always closed when the other is open, and vice versa. The tube 8 contains the globule of mercury 2 and, in addition to the terminals 3 and 4 at one end, has a similar set 9 and 10 at the other end. The two rounded or blunt terminals are the two that are farthest apart, while the pointed terminals lie between the other two. Therefore, whenever the globule of mercury is moving toward either end of the tube for the purpose of connecting together the terminals in that end, it will always engage first with the pointed terminal, which is still dead, so that the force of a flash will be opposed by the weight and momentum of the entire body of mercury if such a flash finally comes between the rounded terminal and the body of mercury, which is the only point at which it can come.

In Figs. 4 and 5 we have illustrated one of the connections between a leading-in wire and the corresponding terminal, 11 representing a braided tubular conductor into which the end of the leading-in wire is fitted. The member 11 as shown is made up of two concentric tubes or sleeves, but the number of such tubes or sleeves will depend upon the service to which the conductor is to be put. The conductor is covered with suitable insulating material 12 of any usual or suitable type, which will not interfere with the flexibility of the conductor.

While we have illustrated and described with particularity only a single preferred form of our invention, with a slight modification, we do not desire to be limited to the exact structural details thus illustrated and described; but intend to cover all forms and arrangements which come within the terms employed in the definitions of our invention constituting the appended claims.

10 We claim:

1. A mercury switch including a body of mercury and two terminals adapted to be brought successively into contact with said mercury and to be disengaged therefrom in the reverse order, that terminal which is the first to make contact with and the last to break contact with the mercury being pointed at the end and the other terminal being blunt at the end.

20 2. In combination, a receptacle, a body of mercury in said receptacle, two terminals projecting downwardly in said receptacle and adapted to be brought successively into contact with and to be connected together by the mercury when the receptacle is tipped from one predetermined position into another predetermined position, that terminal which is the first to make contact with the mercury when the receptacle is so tipped being pointed at the lower end and the other terminal being blunt at the lower end.

3. In combination, a receptacle, a body of mercury in said receptacle, two terminals projecting downwardly in said receptacle and adapted to be brought successively into contact with and to be connected together by the mercury when the receptacle is tipped from one predetermined position into another predetermined position, that terminal which is the first to make contact with the mercury when the receptacle is so tipped being pointed at the lower end and being spaced apart from the bottom of the receptacle a lesser distance than the other terminal.

4. In combination, a receptacle, a body of mercury in said receptacle, two terminals projecting downwardly in said receptacle and adapted to be brought successively into contact with and to be connected together by the mercury when the receptacle is tipped from one predetermined position into another predetermined position, that terminal which is the first to make contact with the mercury when the receptacle is so tipped being pointed at the lower end, the other terminal having a blunt, rounded lower end, and the rounded terminal being spaced apart from the bottom of the receptacle a distance greater than the distance between the other terminal and the bottom of the receptacle.

5. In combination, a sealed tube; two terminals, spaced apart in the direction of the length of the tube, projecting from one side of the tube near one end thereof partly across the tube, the terminal nearest said end of the tube being shorter and having a blunter end than the other terminal; and a small body of mercury in the tube adapted to connect said terminals together when the tube is held in a predetermined position and to lie out of contact with both terminals when the tube is held in another position.

6. In combination, a sealed tube; two terminals, spaced apart in the direction of the length of the tube, projecting from one side of the tube near one end thereof and partly across the same, the terminal nearest said end of the tube being shorter than the other terminal so as to be spaced apart from the opposite side of the tube a greater distance than said other terminal; and a small body of electrical conducting fluid in the tube adapted to connect said terminals together when the tube is held in a predetermined position and to lie out of contact with both terminals when the tube is held in another position.

In testimony whereof, we sign this specification.

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