Sept. 4, 1945. C. H. LARSON 2,384,423

ELECTRODE STRUCTURE

Filed April 19, 1941 2 Sheets-Sheet 1

Fig. 1

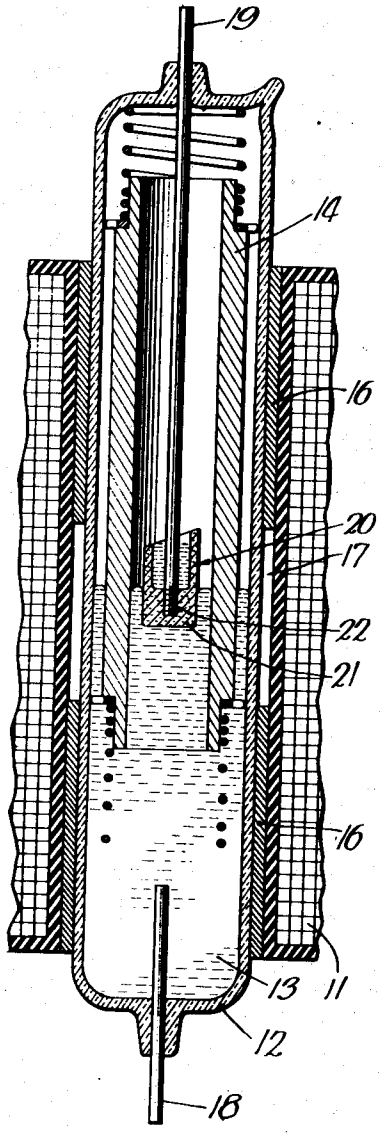


Fig. 2

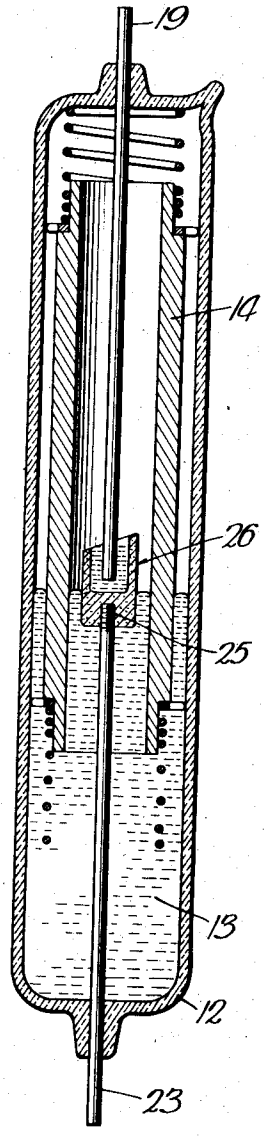
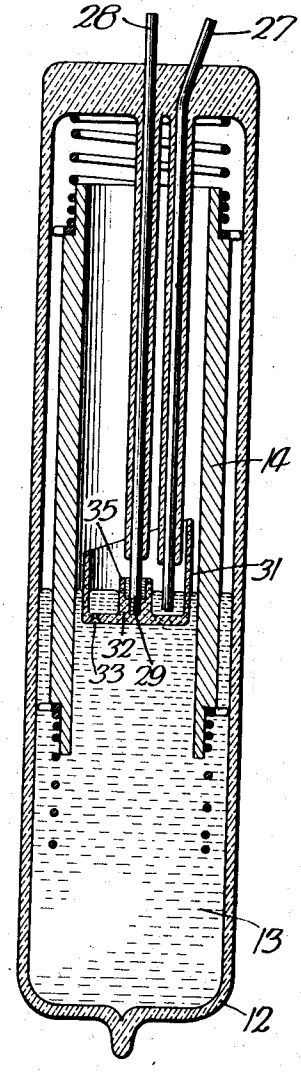


Fig. 3



INVENTOR.
Carl H. Larson
BY Mann, Brown & Co.
Attys

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Fig. 5

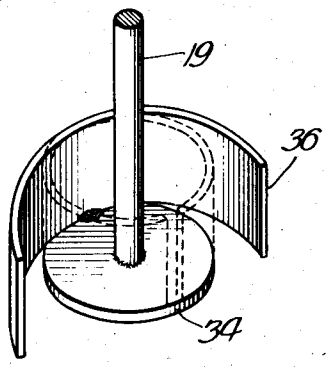


Fig. 4

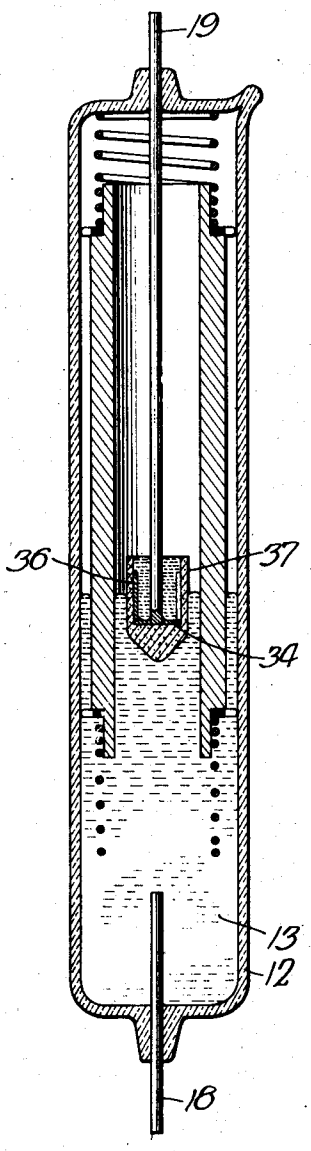


Fig. 7

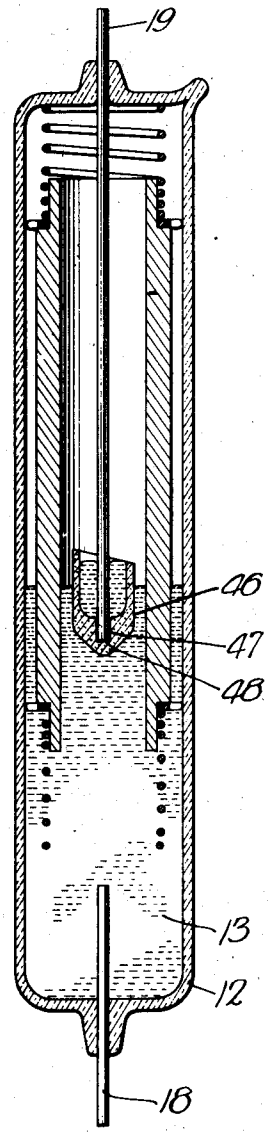


Fig. 6

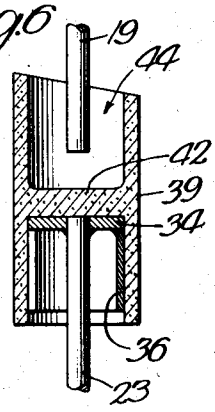
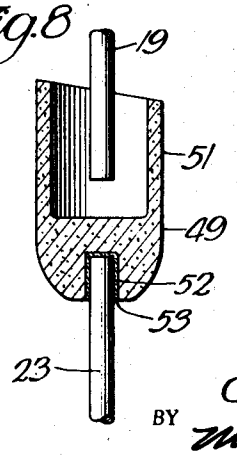


Fig. 8



INVENTOR.

Carl H. Larson

BY Mann, Brown & Orr.

Attys

Patented Sept. 4, 1945

2,384,423

UNITED STATES PATENT OFFICE

2,384,423

ELECTRODE STRUCTURE

Carl H. Larson, Elkhart, Ind., assignor to The Adlake Company, a corporation of Illinois

Application April 19, 1941, Serial No. 389,270

2 Claims. (Cl. 200—112)

My invention relates to mercury switches, and more particularly to an improved electrode structure for use in such devices.

In mercury switches, two electrodes and a body of mercury are ordinarily provided within a sealed envelope, one of the electrodes being disposed within the envelope in such manner as to be intermittently immersed by the mercury and thereby complete the circuit through the electrodes. To prevent premature destruction of the intermittently immersed electrode, a cup is provided within the envelope to retain a small quantity of mercury in continuous contact with the intermittently immersed electrode so that any arcing, which occurs in making or breaking the circuit through the electrodes, will occur between two bodies of mercury. While this arrangement is satisfactory, difficulty has been experienced in mounting the electrode cup within the switch.

There are broadly three methods of mounting the electrode cup, namely, by fusing the electrode cup to a glass electrode sleeve, by the use of cement, or by mechanical means. A fused bond has proved satisfactory, but is slow and expensive to form and the choice of ceramic material which may be used to form the cup is limited, as the material must have substantially the same coefficient of thermal expansion as the glass in order to prevent cracking of the fused portion with temperature changes. Cement bonds are, in general, unsatisfactory as they are subject to unexpected failure and leakage, and tend to introduce objectionable impurities into the mercury and the gas fill. Mechanical means heretofore employed have, in general, been objectionable, either because the cup has not been held firmly in position, or because the breakage of the fragile ceramic material during assembly has been excessive. In substantially all cases, however, where the cup is firmly held in place, some one or more walls of the cup has been formed with an opening adapted to be subsequently sealed by fusion, cement, or other means. This sealed opening is a point of potential leakage, and is, therefore, objectionable.

Among the objects of my invention are the provision of improved and simplified means whereby an integrally formed ceramic cup having imperforate walls may be attached to a switch electrode without regard to the coefficient of thermal expansion of either material, which will provide a strong trouble-free bond, which may be easily formed and attached without danger of breakage, which may be attached directly to an electrode and which does not employ cement.

These and other objects will become apparent from the following specification and from the drawings, in which

Fig. 1 is a vertical sectional view of a displacer type mercury switch illustrating one embodiment of my invention;

Fig. 2 is a vertical sectional view of a displacer type mercury switch illustrating a modification of the embodiment shown in Fig. 1;

Fig. 3 is a vertical sectional view of a displacer type mercury switch illustrating a modified form of my device incorporating a time delay element;

Fig. 4 is a vertical sectional view of a displacer type mercury switch illustrating another embodiment of my invention;

Fig. 5 is an isometric view of the electrode structure illustrated in Fig. 4;

Fig. 6 is a vertical sectional view of a modification of the electrode structure illustrated in Fig. 4;

Fig. 7 is a vertical sectional view of a displacer type switch illustrated in another embodiment of my invention; and

Fig. 8 is a vertical sectional view of another form of my invention similar to that illustrated in Fig. 7.

Referring to the drawings, Fig. 1 illustrates a mercury switch relay including a coil 11 having a central opening, a switch envelope 12 disposed within the coil opening, a mercury fill 13 within the switch envelope and a magnetically responsive displacer 14 for shifting the level of the mercury fill in response to energization by the coil 11. The coil may be provided with an external iron circuit including pole sleeves 16 extending into the coil opening and defining an air gap 17. A continuously immersed foot electrode 18 is sealed through the bottom wall of the envelope 12, the inner end of the electrode being in continuous contact with the mercury fill 13. An electrode 19 extends through the upper end of the envelope 12 and is adapted to be intermittently immersed by the mercury fill. The length of the electrode 19 may be varied with the amount of mercury within the switch and the difference between the high and low levels of the mercury fill, but ordinarily may extend downwardly into the envelope to a point slightly below the low level of the mercury fill. The electrodes 18 and 19 may suitably be formed of molybdenum and the switch envelope 12 may be of a hard borosilicate glass, as these materials have substantially equal coefficients of thermal expansion which permits the formation of a satisfactory metal to glass seal.

A ceramic cup, generally designated 20, is formed of a highly refractory ceramic material and may be shaped as a hollow cylinder having one end closed by a relatively heavy base 21, the internal diameter of the cup 20 being substantially greater than the external diameter of the electrode 19. A threaded opening 22 is formed in the base 21 extending outwardly from the inner surface of the cup partially through the base and is adapted to receive the lower end of the electrode 19, which is provided with cooperating threads.

The cup 20 is secured to the electrode 19 by engaging the threads on the lower end of the electrode with those formed within the opening 22. The height of the cup 20 should be such that when attached, the side walls will extend upwardly around the electrode to a point above the low level but below the high level of the mercury fill. The exact proportions of the cup may be varied as required, but it is essential that the base 21 be imperforate and of sufficient depth to adequately insulate the lower end of the electrode 19 from the mercury fill 13.

I may also mount the ceramic cup on the foot electrode, as shown in Fig. 2, wherein a foot electrode 23 extends through the base of the switch envelope 12 upwardly to a point slightly below the low level of the mercury fill. A ceramic cup 26 is formed with a thick base in which is provided a threaded opening 25 extending inwardly partially through the base and adapted to receive the threaded upper end of the electrode 23. The electrodes 19 and 23 are in axial alinement, so the side walls of the cup 26 will extend upwardly around the lower end of the electrode 19 in a manner similar to that previously described. It will be noted that the cup 26 is similar to the cup 20, illustrated in Fig. 1, and may be formed of similar materials and of similar dimensions, the only essential difference in structure being the position of the threaded opening in the base. It is, of course, immaterial whether or not mercury seeps into the threaded opening in the base of the cup, for such seepage cannot short circuit the switch.

Fig. 3 illustrates a modification of my device incorporating a time delay wherein a foot electrode 27 and an intermittently immersed electrode 28 are sealed through the upper end of the envelope 12 and terminate at substantially the same level, which may suitably be slightly below the low level of the mercury fill 13. Although both electrodes are shown covered with an insulating sleeve, this is not an absolute requirement, although in some instances may be desirable. The intermittently immersed electrode is axially disposed within the envelope and is provided with external threads 29 formed on its extremity. A relatively large ceramic cup 31 is provided with an axially disposed upwardly extending internal boss 32 having a threaded axial opening adapted to receive the threaded lower end 29 of the intermittently immersed electrode 28. The opening in the boss 32 is enlarged at its upper end to form a mercury cup 35 extending around the lower portion of the electrode 28, the sides of the cup 35 extending upwardly to a point above the low level of the mercury fill. A mercury metering orifice 33 is provided in the bottom wall of the ceramic cup 31 below the low level of the mercury fill, whereby a small quantity of mercury is at all times retained within the cup 31. The foot electrode 27 extends downwardly parallel and adjacent to the intermittently immersed electrode 28 and into the mercury retained in the cup 31.

The side walls of the cup extend upwardly around both electrodes, the height of the walls being varied according to the time delay characteristics required. If the side walls of the cup 31 are extended upwardly to a point above the high mercury level, the switch will be of the slow make, slow break type, for in such instance the circuit between the electrodes 27 and 28 cannot be completed until a predetermined amount of mercury has flowed into the cup through the mercury metering orifice 33. If, on the other hand, the side walls of the cup terminate at a point below the high level of the mercury fill, the circuit between the electrodes will be instantly completed upon energization of the displacer 14. In either event, deenergization of the displacer causes the outer level of the mercury fill to fall to a level below the lip of the cup 31 but the circuit through the electrodes will not be immediately broken due to the timing action of the mercury metering orifice 33 which retards the flow of mercury from the cup. When the circuit between the electrodes is broken, the break will occur between the mercury retained within the cup 31 and in contact with the foot electrode 27 and the mercury retained in continuous contact with the intermittently immersed electrode 28 by the cup 30. A switch having the structure described has a relatively high current carrying capacity, for in no instance is the flow of current between the electrodes required to pass through the relatively small metering orifice 33.

Inasmuch as the intermittently immersed electrode 28 is axially disposed within the envelope, the ceramic cup 31 may be attached to the intermittently immersed electrode 28 by engaging the threads 29 on the lower end of the electrode with the threads formed in the opening in the boss 32. This structure has been found particularly desirable in time delay switches, as there are no fused or cemented joints to fail under excessive vibration or shock.

The coarse grain structure of certain refractory ceramic materials makes it difficult to form screw threads within a relatively small opening and hence cups formed of such materials are not well adapted for use in the modifications of my device hereinbefore described. These materials may, however, be used in a switch employing a modification of my device illustrated in Figs. 4 and 5. In this modification one surface of a metallic disc 34 is attached to the end of the intermittently immersed electrode 19 by welding, or other suitable means, in such manner that the disc 34 is transverse to the axis of the electrode. One point of the edge of a flat spring 36 is firmly attached to the edge of the disc 34, as illustrated in Fig. 5. The length of the spring 36 is slightly less than the circumference of the disc 34 so that the spring may be compressed to form a substantially cylindrical section extending upwardly from the disc 34, as shown by the dotted lines in Fig. 5. A ceramic cup 37 having an opening slightly larger than the disc 34 may be secured to the electrode by compressing the spring 36 and inserting the assembly in the cup 37. Upon release, the spring 36 is forced resiliently against the inner walls of the cup 37 and serves to retain the cup in position. As the friction engagement of the spring 36 with the walls of the cup 37 may be increased by the use of a heavier spring, this type of structure may be

employed in conjunction with a relatively heavy electrode cup such as may be employed in a heavy duty switch.

As a modification of the structure shown in Figs. 4 and 5, the transverse disc 34 and spring 36 may be mounted on the lower electrode 23. In this modification a ceramic cup 39 is formed as a hollow cylinder having a transverse intermediate wall 42, the diameter of the cylinder is made substantially equal to the diameter of the disc 34 and may, therefore, be slipped over the upper end of the foot electrode 23 by compressing the spring section 36, which upon release will frictionally engage the inner walls of the cup 39. The walls of the cup extend upwardly above the intermediate partition 42 and around the electrode 19 to form a mercury cup, designated 44.

Another method of attaching an electrode cup is illustrated in Fig. 7, wherein glass is used to bond the cup to the electrode. In this modification, a ceramic cup 46 similar to the cup described in connection with Fig. 1 is provided with an opening 47 extending outwardly partially through the base of the cup, the diameter of the opening being substantially equal to the diameter of the electrode 19. The cup 46 is attached to the electrode 19 by depositing a thin film of molten glass 48 on the end of the electrode and inserting the electrode into the opening formed in the base of the cup 46 while the glass is still in a flowable condition. The glass fuses to both the ceramic material and to the electrode but will form what would ordinarily constitute an unsatisfactory bond, in that the glass will check and crack unless the coefficients of thermal expansion of the electrode, the glass, and the ceramic material are substantially equal. I have found that this checking and cracking does not greatly weaken the bond of the glass to the metal or to the ceramic material and that it is, therefore, immaterial whether or not checking or cracking of the glass occurs; for, in my structure the switch cannot be short circuited by mercury seeping through the cracks formed in the glass.

This type of cup may also be mounted on the foot electrode, as shown in Fig. 8 wherein a ceramic cup 49 is provided with an opening 52 extending inwardly partially through the base of the cup to receive the upper end of the foot electrode 23. A thin film of molten glass 53 may be deposited on the upper end of the electrode 23 and sealed to the cup in a manner previously described. Side walls 51 of the cup 49 extend upwardly and surround the lower end of the electrode 19 thereby forming a cup adapted to retain a small quantity of mercury in continuous contact with the electrode.

It should be noted that in all forms of the invention the means for attaching the cup to the electrode is such that the cup is rigidly supported on the electrode and yet mercury leakage past the attaching means can do no harm, and specifically cannot short circuit the switch.

To comply with section 4888 of the revised statutes, I have described certain specific embodiments of my invention in detail, but as modifications may be made without departing from the true spirit and scope, I do not limit myself to the particular details disclosed except as defined in the appended claims.

I claim:

1. In a mercury switch, a switch envelope, a mercury fill, electrode means for the mercury fill including an electrode sealed through the upper portion of the envelope and extending downwardly therein, a pocket member of refractory clay-type ceramic carried at the lower end of said electrode and having side and bottom walls forming a pocket for mercury, said pocket communicating with the space outside of said walls and within the envelope for the flow of mercury upon operation of the switch, and means for causing the mercury to flow into and from said pocket; said electrode extending downwardly into a recess in said bottom wall and fitting therein with the side walls of the electrode and the adjacent side walls of the recess approximately parallel, and fusible vitreous means in the form of a thin film surrounding the electrode and intimately engaging said approximately parallel wall surfaces whereby the pocket member will be held fast and supported by the electrode in spite of substantial differences of expansion between the pocket member and the electrode.

2. In a mercury switch, a switch envelope, a mercury fill, electrode means for the mercury fill including an electrode sealed through the upper portion of the envelope and extending downwardly therein, a pocket member of refractory material carried at the lower end of said electrode and supported solely by said electrode and having side and bottom walls forming a pocket for mercury, said pocket communicating with the space outside of said walls and within the envelope for the flow of mercury upon operation of the switch, and means for causing the mercury to flow into and from said pocket; said electrode extending downwardly through said pocket and having an end portion fitting into a recess in said bottom wall of smaller internal diameter than the pocket and held therein in spite of substantial differences of expansion between the pocket member and the electrode, said recess being closed at its bottom end by the insulating material whereby a mercury-tight seal between the electrode and the insulating material is immaterial.

CARL H. LARSON.