Jan. 13, 1942. E. W. RICKMEYER 2,269,690

ELECTRIC CIRCUIT BREAKER

Filed Sept. 5, 1935

Fig. 1

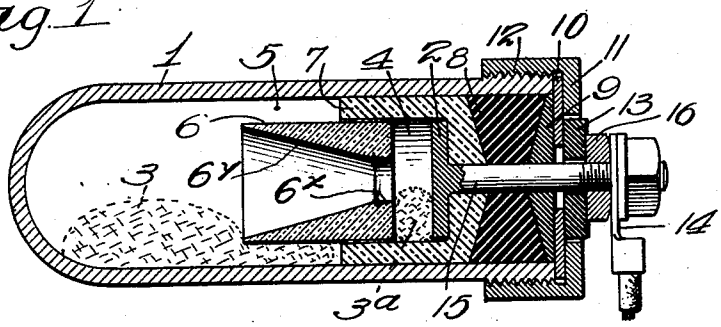
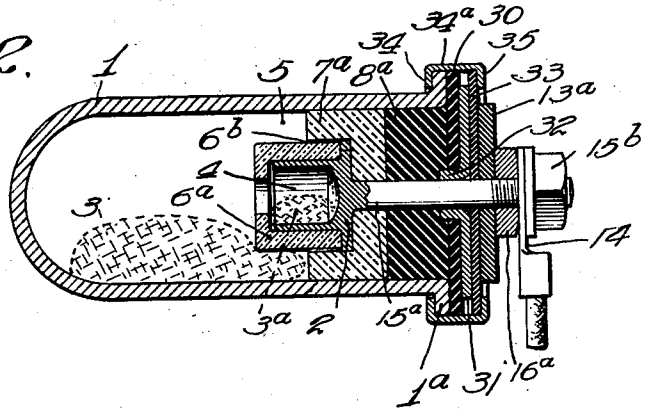


Fig. 2.



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ELECTRIC CIRCUIT BREAKER

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5 Claims. (Cl. 200—152)

This invention relates to electric switches of the liquid flow type having a metal tubular shell permanently closed at one end and sealably open at the other end, the said sealable end providing means for introducing therethrough a metal electrode. The shell contains a quantity of mercury for making contact between the electrode and the metallic shell.

One of the objects of the invention is to provide a device of the character indicated which is capable of withstanding mechanical shocks.

Another object of the invention is to provide a structure of this character which will be capable of resisting fairly high internal pressure.

A further object of the invention is to provide means for quenching the arc incidental to changing the condition of the circuit.

A still further object of the invention is to provide means for guarding the metallic parts of the device against damage due to the arcing.

A still further object of the invention is to produce a device that will be low in cost and efficient in operation and that will accomplish all of these and other objects which will be hereinafter more particularly apparent in the following specification and pointed out in the appended claims, reference being had to the accompanying drawing forming a part of this specification in which:

Fig. 1 is a longitudinal section through one embodiment of my invention.

Fig. 2 is an axial section of a slightly modified form of my invention.

My invention contemplates the use of a tubular metallic container self-closed at one end while the other end is arranged to be closed by a compressible distortable plug or washer, within which container mercury is caused to flow longitudinally thereof upon angular tilting of the axis thereof. I employ metal for the container not only because it is more serviceable than glass, as the majority of such devices have heretofore been made, but because I find it is desirable to introduce some kind of inert gas such as hydrogen, for instance, under super-atmosphere pressure, and I found that glass enclosures as heretofore used could not be sealed to withstand the desired pressure, at least, by the method of sealing now known.

In both forms which I have chosen to illustrate the invention I have shown a metallic container shell or casing 1 and a contact or electrode 2 insulatedly mounted within the container shell 1. A quantity of mercury 3 is employed as a medium to electrically connect the elements 1 and 2 when the contact end of the device is sufficiently tilted downwardly.

It is desirable that the make and break be caused to occur between mercury and mercury in contradistinction to mercury and metal, and that is the purpose of the chamber 4 in each type shown, which chamber retains a small amount of mercury 3a. A further feature common to both is that the ceramic within the container is formed so as to produce an annular space or recess 5 to accommodate and allow a portion of the main body 3 of the mercury to enter, the purpose of which will now be explained.

It is desirable that all provisions be made to allow and assist the mercury to move with the greatest possible rapidity longitudinally of the tube, particularly in the direction for breaking the circuit, and it is found that if a relatively small amount of mercury be employed, it will not travel as rapidly as a larger one with a consequent increase of arcing period. While the increased mass is desirable for that reason, still it is not the only, or more important one. It is found that there is more frictional resistance between metal and mercury than between mercury and mercury, and that upon the provision of the recess 5 where a portion of the mercury may enter, the portion of the mercury lying on the shell 1 and contiguous thereto, will form a "track-way" for the upper portion of the mercury which travels into, and out of, the chamber 4; otherwise stated, the mercury, in its movement, will travel upon itself, and with minimum friction and maximum speed, with consequent decrease in arcing period.

To now more specifically describe the structure shown in Fig. 1, the shell or casing 1 contains a breaker cup 6 preferably made of a particular grade of porcelain, supported by a bushing 7 of dielectric material such as ceramic or vulcanized fiber. A resilient plug 8 preferably made of a special grade of soft, compressible rubber, is interposed between the element 7 and a conical washer 9 preferably made of some material not easily deformable, such as vulcanized fiber; beyond this, a metal disk 10 is arranged to overlie the edge of the shell 1 and clamped in position by a flanged ring 11. The ring 11 has screw threaded engagements with the open end of the shell 1 at 12. A washer or disk 13 of dielectric material, such as fiber or the like, serves as a means of insulatingly attaching the lead 14 which is thus in electrical communication with the contact 2 through the stem 15. It will be understood that the circuit is then completed

through the mercury 3^a, 3 and the shell 1 when the tube is tilted. It will be noted that the end of the element 7 which engages the plug 8 is conical and oppositely convex to the corresponding face of the washer 9. When the nut 16 is screwed down, the elements 7 and 9 will therefore compress the plug 8 and operate to deform the plug sufficiently to seal the shell or casing 1 and the stem 15 against leakage.

In the form shown in Figure 1, the breaker cup 6 has a short cylindrical bore 6^x axially disposed in relation to the chamber 4 but of much smaller diameter, and from this short cylindrical portion the bore flares at 6^y, to a diameter nearly as great as the external diameter of the cup 6. When the circuit is broken upon tilting the closed end of the tube downwardly, a globule of mercury 3^a is retained in the chamber 4 while the remainder separates and flows through the cylindrical bore 6^x and flaring bore 6^y toward the end of the tube. I have found by experiment that the break actually occurs adjacent the junction between the cylindrical bore 6^x and the flaring bore 6^y and I have also found that it is of advantage to have this short cylindrical portion 6^x; it seems to facilitate a clean break of the mercury which is perhaps assisted by the sudden change of angle from the cylindrical wall to the flaring wall as the mercury rolls over this surface. It is also of advantage to have the cylindrical portion 6^x of substantial length at the point where the arcing occurs with corresponding high temperature. This surface naturally becomes highly heated, and this form renders it more durable than if the taper 6^y extended throughout the length of the breaker, producing a thin feather-edge at its inner end. There is also an advantage in the flaring form of the bore at 6^y, which may be due to the fact that at the instant of break the gases adjacent the arc tend to expand rapidly and are forced from the chamber 4 through the bore of the breaker 6. The flaring form of the bore affords increasingly larger surface and volumetric area for the absorption of heat in the gases, and expansion thereof, tending to reduce the temperature of the mercury and prevent undue formation of mercury vapor, thus resulting in an exceptionally efficient device having an unusually long life. I have found that this form of breaker results in an exceptionally efficient switch having a remarkably long useful life.

The modified form indicated in Fig. 2, comprises, as in the previously described form, a shell or casing 1, a contact 2 which, together with the ceramic breaker 6^a, forms a chamber 4. A bushing 7^a of dielectric material such as ceramic or possibly vulcanized fiber, supports the breaker element 6^a which is made of a ceramic such as porcelain or of a vitreous, glass-like substance; these parts are secured together as by cement at 6^b.

The shell 1 has a flange 1^a. A compressible disk 30 overlies the flange and a compressible, deformable plug 8^a preferably of rubber. A metallic disk 31 having an inturned flange 32 retains the sealing elements 8^a and 30 in position; the flange 32 serves to prevent the displacement of the portion of the plug which at its central opening accommodates the stem 15^a. A dielectric washer 33 overlies the disk 31. A ring 34^a encircles the elements 1^a, 30, 31 and 33 and holds these elements together by virtue of the spun-over flanges 34, 35. A metallic washer 13^a is secured in place by a nut 16^a screwed onto the stem 15^a and operates to compress and deform the plug 8^a in the same manner and for the same purpose as the plug 8 in Fig. 1, previously described. A lead 14 is secured to the stem 15^a by the nut 15^b.

In this modified form, the chamber 4 is formed by hollowing out or cupping the contact 2. This cupping provides additional contact surface for the mercury, and produces a device having a higher amperage capacity than that shown in Fig. 1, though it will require a greater angular movement and be required to be tilted faster, to produce a desirably safe break.

In both forms of this switch it may be understood that the rubber plug 8 or 8^a employed for sealing the shell or casing 1 and the stem of the electrode, is preferably composed of what may be termed "sulphur free rubber," which is commercially considered as pure rubber, and has such a low sulphur content employed for vulcanization that there is no free sulphur in the rubber available, which would contaminate the mercury or the hydrogen in the tube. It has heretofore been considered that the lowest amount of sulphur content dependable to properly vulcanize rubber for commercial purposes, would be approximately three percent, but in the device here described it is imperative that the sulphur or antimony content be reduced to a minimum and I have found that a proportion as low as two tenths of one percent is sufficient for the purpose and that with this amount there is no possibility of any being freed by chemical reaction, but in fact is combined with the rubber and is thereafter entirely inactive. The material of the shell is also desirably of great purity and I have found that the best results are obtained by using iron of a specification approximately equal to Fe 99.9973, the remaining quantity, .0027— composed of such "impurities" as carbon, silicon, phosphorus, sulphur and manganese which are present in negligible quantities. For best results the gas is forced into the shell at a pressure of about 27½ pounds to the square inch at ordinary temperature, say 70 degrees.

I have described two forms to illustrate my invention, and it will be understood that many modifications may be made without departing from the spirit of the invention.

I claim:

1. A mercury switch comprising a metallic cup-shaped envelope having an open end, a ceramic in said end having an axial bore, an electrode having radial and axial seating engagement in the outer end of said ceramic and having its periphery spaced from said envelope by said ceramic, resilient sealing means engaging said ceramic and envelope, a rigid insulating gasket for axially compressing said sealing means, and an annular compression ring engaging said gasket and having an internal diameter such that it overhangs the periphery of said electrode.

2. A switch comprising a metallic envelope, a ceramic having a large portion of its outer surface in thermally conductive contact with the inner surface of the envelope, an electrode supported by said ceramic and insulated thereby from said envelope, a body of mercury retained in contact with said electrode, a frustro-conical recess in said ceramic extending outwardly from said retained body of mercury to the interior of said envelope, and a body of mercury in said envelope movable along a defining surface of said recess into and out of contact with said retained body of mercury.

3. A switch comprising a metallic envelope, a ceramic in one end of said envelope having ther-

mal contact about its peripheral surface with the interior of said envelope, an electrode carried by said ceramic and radially insulated thereby, and resilient sealing means comprising a member axially wider at its periphery than at its mid-portion, the radial mid-portion of said ceramic extending into said mid-portion of the sealing means.

4. A switch comprising a metal envelope having a ceramic insert seated in one end thereof, said insert carrying at its outer end an electrode radially insulated thereby from said envelope, resilient sealing means closing the insert end of said envelope about said electrode and radially overlapping said one end of said insert, and means for axially compressing said sealing means in position.

5. A switch comprising a metal envelope having a ceramic insert seated in one end thereof, said insert carrying at its outer end an electrode radially insulated thereby from said envelope, resilient sealing means closing the insert end of said envelope about said electrode and radially overlapping said one end of said insert, and means for axially compressing said sealing means in position, said sealing means being radially expanded into sealing engagement with said envelope by said axial compression thereof.

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