June 10, 1930. G. F. CALLAHAN 1,762,213

MERCURY SWITCH

Filed Aug. 31, 1929

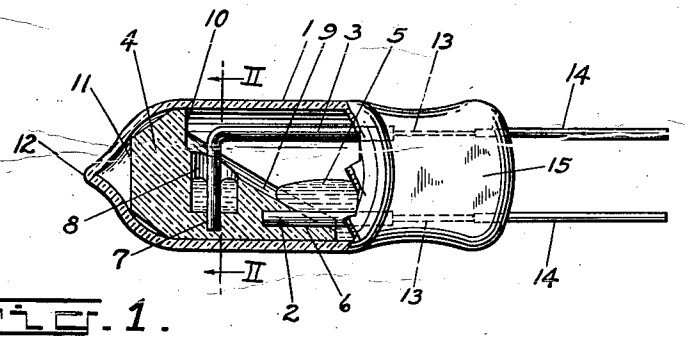


Fig. 1.

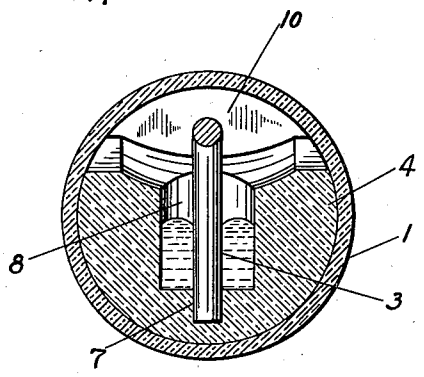


Fig. 2.

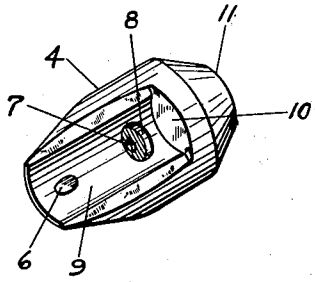


Fig. 3.

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UNITED STATES PATENT OFFICE

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MERCURY SWITCH

Application filed August 31, 1929. Serial No. 389,735. REISSUED

This invention relates to mercury switch devices and more particularly relates to mercury switch devices of the tilting make and break type wherein electrical make and break contacts are made between two pools of mercury bridging the gap between stationary electrodes.

One of the objects of this invention is to provide a mercury switch of the type above described which may be readily manufactured by machine assembly methods.

Another object of this invention is to provide a mercury switch of the type above described having a simple and compact assembly of elements which are adapted to machine assembly methods of modern lamp and radio tube manufacturing processes.

Another object of this invention is to facilitate the assembly and manufacture of mercury switch devices of the above identified type.

Another object of this invention is to provide a new and efficient type of make and break mercury arc switch.

Other objects will become apparent as the invention is more fully disclosed.

Heretofore in the art many types of mecury switches have been devised. In mercury switches of the make and break contact type it is customary in order to prevent deterioration of one or both electrodes as a result of the electric arc developed during the make and break contact, to cause the arc to develop between a mercury pool surrounding one electrode and a movable pool of mercury. It is also customary to break the arc across a refractory lining within the device to prevent deterioration of the enclosing glass envelope or to employ a refractory cup member surrounding one of the electrodes and retaining a pool of mercury therearound, the arc breaking across the lip of the cup member.

It is also customary to incline the wall of the device intermediate the electrodes and away from one or both electrodes so as to accelerate the movement of the mercury pool away from said electrodes and to make positive the current break. It has also been proposed in prior art devices to bring the electrodes through one end of the enclosing glass envelope in a seal portion.

The devices heretofore proposed, however, have not been adapted to machine assembly methods of present day lamp and radio tube manufacture and no single device heretofore proposed has embraced all of the desired qualities of a rapid make and break mercury switch device. By the present invention and through the use of an especially designed inner refractory member which will hereinafter be more fully disclosed I am enabled to provide a mercury switch device having substantially all of the desired characteristics of prior art devices and also one which may be readily and efficiently assembled by rapid, high speed machine assembly, sealing-in, and exhaust methods heretofore employed in lamp and radio tube manufacture.

Before further disclosing the nature of my invention reference should be had to the accompanying drawing wherein—

Fig. 1 is a side elevational view partly in cross-section of a mercury switch device constructed in accordance with the present invention.

Fig. 2 is a cross-sectional view of the device shown in Fig. 1 taken through plane II—II; and

Fig. 3 is a perspective view of the specially designed refractory element which is shown in Fig. 1, which is one of the features of the present invention, and through the use of which the assembly and manufacture of the device by modern machine assembly methods is effected.

A mercury switch device constructed in accordance with the present invention is comprised substantially of an enclosing glass envelope which may be either evacuated or filled with an inert gas, a mercury pool, two electrodes extending through a wall of the enclosing glass envelope through a seal portion thereof in substantially parallel spaced relationship and in substantially the same vertical plane of the press of the said seal, said electrodes interiorly supporting a refractory element independent of said enclosing glass envelope, said refractory element being shaped so as to provide means therein when

the device is in operating position for retaining about one of said electrodes a part of the mercury as a stationary pool, means about the other electrode for retaining adjacent the same the remainder of the mercury as a movable mercury pool, means intermediate said supporting electrodes for directing the flow of the movable pool of mercury to the said stationary pool of mercury upon applying to the device a tilting motion away from the horizontal about an axis perpendicular to the plane of said electrodes, and means for definitely effecting the separation of said movable pool of mercury from said stationary pool of mercury upon returning the device to a horizontal position subsequent to such tilting motion.

The assembled device is shown fully in Fig. 1 of the drawing and comprises a tubular enclosing glass envelope 1 having a press portion 15 through which extend parallel spaced electrodes 2 and 3 which lie substantially in the same vertical plane along the longitudinal axis of the tubular enclosing glass envelope said electrodes interiorly supporting a refractory member 4, which is shaped to have an exterior contour approximately the same as the interior contour of the enclosing glass envelope but of slightly smaller diameter, and which is further shaped or designed to provide means comprising a cup shaped depression 8 adjacent one of the electrodes 3 for retaining a portion of the mercury pool 5 as a stationary mercury pool adjacent said electrode, means also comprising a grooved section 9 intermediate electrodes 2 and 3 for directing the flow of said movable mercury pool 5 adjacent electrode 2 to said stationary pool of mercury in cup 8 adjacent electrode 3 upon a tilting of the device in a direction away from the horizontal about an axis perpendicular to the plane of the electrodes, and additional means comprising an angular grading of said grooved section 9 away from the lip of said cup 8, for accelerating the flow of said movable mercury pool 5 away from the cup 8 upon returning the device to the horizontal position subsequent to said tilting motion, in order to render the separation of the movable pool of mercury 5 from the stationary pool of mercury adjacent electrode 3 more positive.

The structural details of the refractory insulator member 4 which may be comprised of any suitable electrical insulating material such as magnesia, alumina, porcelain, magnesium silicate, lavite or the like may be more readily discerned by examining Figs. 2 and 3 of the drawing, Fig. 3 in particular showing in perspective the insulator member independent of the cooperating elements of the device in Fig. 1.

I prefer to employ for the refractory member 4 the refractory material known in the art as Lavite, a commercial product comprised in major part of finely pulverized lava rock which is compacted under great pressure to coherent form. This material may be machined to any desired dimension and subsequently fired to elevated temperatures to render strong and refractory. I may, however, employ other suitable materials which may be molded to the desired shape and size.

In the present illustration the mercury switch device shown in Fig. 1 is designed to operate while carrying an electric current averaging about 10 amperes at approximately 110 volts. The outside diameter of the refractory member 4 is approximately .475 inches and the inside diameter of the enclosing glass envelope averages about .485 inches. The overall length of the insulator 4 is about $\frac{27}{32}$ inches, and the overall length of the completed device from tip 12 to the edge of press 15 approximates 1,8 inches.

The holes 6 and 7 in the insulator into which electrodes 2 and 3 are inserted are approximately of the same diameter as said electrodes so that a substantially tight supporting fit may be obtained, hole 7 being made in the member at right angles to hole 6 in a plane which passes substantially along the central longitudinal axis of the refractory member.

Intermediate these two holes the refractory material is cut away to form an angular grooved section 9 tapering downwardly from the lip of the cup 8 to the edge of the refractory article intercepting the edge of hole 6.

The interception of the angle of the grooved section 9 and the lip of the cup 8 is arranged to be approximately along the center longitudinal axis of the refractory element, and the cut away portion ends abruptly at or just beyond the further edge of the cup to form a shoulder 10. This end of the element adjacent the shoulder 10 is then turned down along the outer edge to form a tapered end section 11. The specific angle imparted to the grooved section 9 is dependent in part upon the spacing of the electrodes 2 and 3, the current carrying capacity of the device and upon the desired operating characteristics of the device.

In the present illustration the spacing of the electrodes in the refractory insulator 4 approximates $\frac{17}{32}$ inches along the horizontal or longitudinal axis of the device. This is obtained by positioning hole 7 in the side of the insulator at a distance of about $\frac{5}{16}$ inches from the end opposite where hole 6 was made. The angle of the groove section 9 from the lip of the cup 8 to intercept the edge of the insulator 4 at hole 6, is approximately 60 degrees. This spacing of electrodes may be altered if desired and the angle of the grooved section varied widely, without materially departing from the nature of the present invention.

The element thus machined is then fired to elevated temperatures to consolidate and is ready for mounting in the mercury switch device. This is accomplished by inserting the two electrodes 2 and 3 in the respective openings 6 and 7, electrode 3 being bent at right angles so as to lie in the same vertical plane as electrode 2, as shown in the illustration, Fig. 1.

The tubular glass envelope 1, having a tubulature not shown but which may subsequently be tipped off at 12 is then slipped over the element and engaged electrodes and the free ends of the electrodes fusibly united therewith by the usual sealing in or stem making methods of lamp and radio tube manufacture.

In the forming of stems by modern mechanical machine assembly methods it is customary to interiorly position the lead wires within a glass tube to the exterior surface of one end of which heat is applied until the glass is nearly fused. Mechanically operated clamp jaws are brought together on opposite sides of the nearly molten glass and the glass and interiorly positioned leading in wires pressed together into intimate contact.

In the present example the enclosing glass envelope 1 is composed of soft glass and the electrodes 2 and 3 are of nickel. In order to obtain heremetic union between leading in wires extending through the walls of the envelope 1, it has been found desirable to employ what is known as "dumet" seals therewith. "Dumet" is copper clad nickel steel wire having a coefficient of expansion substantially equal to soft glass, the copper clad surface of which readily "wets" or unites with the glass.

A short segment 13 of the "dumet" is employed to one end of which is welded the nickel electrodes 2 and 3 and to the other end heavy copper lead wires 14. In forming this seal by mechanical means the elements of the present device are positioned relatively in the stem making machine so that when the clamp jaws of the stem making machine compresses the softened glass, the glass seal thus made engages all of the "dumet" portion of the three piece welded leading in wire and a portion of the ends of the electrodes 2 and 3 and of the ends of the heavy copper lead wires 14.

Although the specific combination of soft glass envelope and dumet seals therethrough is hereindisclosed, it is not to be considered that I am limited thereby as it is obvious that I may employ if desired a hard glass enclosing glass envelope with suitable electrode material that may be sealed therewith, such as tungsten, molybdenum, and the like, or I may employ with soft glass other electrode material that may be suitably sealed therethrough such as iron, iron-chromium alloys, platinum and the like.

The device thus assembled and tubulated is attached by means of said tubulature 12 to any desired exhaust system and exhausted by mechanical means, such as vacuum pumps, after which it may be filled with an inert gas such as nitrogen, argon and the like, or with hydrogen, if desired. The tubulature is then tipped off as shown in Fig. 1 at 12 and the device is ready for use. The desired amount of mercury may be introduced within the device in any convenient manner prior to tipping off the device.

It may be seen that such an assembly and manufacturing procedure may be readily applied to mass production methods utilizing automatic stem-making and exhaust machinery commonly utilized in lamp and radio tube manufacturing methods.

In addition it may be noted that the assembled device includes all of the desirable features heretofore separately applied in prior art devices. The make and break contacts are made between the movable mercury pool 5 and the stationary pool of mercury retained in cup 8 around electrode 2; the electric arc is broken over a lip of the cup which is of refractory material; the rate of said break of electrical contact is accelerated by the grooved incline plane 9; and the electrodes 2 and 3 pass through the enclosing glass envelope through a single press portion thereof.

In addition to these advantages I obtain a rigidity of construction due to the supporting of the refractory element 4 by both of the electrodes 2 and 3 independent of the enclosing glass envelope 1 and a relatively simple and efficient method of assembling and manufacturing, not heretofore obtainable in prior art devices.

There may be many variations and departures from the specific embodiment of the present invention as set forth in the above specification and drawing without substantially departing from the nature and scope of the invention and such variations and departures are anticipated as may fall within the scope of the accompanying claims.

What is claimed is:

1. A mercury switch device comprising an enclosing glass envelope, electrodes sealed therethrough, a refractory element supported on both of said electrodes and a movable pool of mercury to bridge said electrodes upon a tilting of said device in one direction, along the surface of said refractory element.

2. A mercury switch device comprising an enclosing glass envelope, electrodes sealed therethrough, a refractory element supported by said electrodes, a stationary pool of mercury about one of said electrodes and a movable pool of mercury adjacent the other, said refractory element serving to direct the flow of the said movable mercury pool along one of its surfaces so as to electrically connect the two electrodes upon a tilting of the device in one direction.

3. A mercury switch device comprising an

enclosing glass envelope, electrodes sealed therethrough, a refractory element bridging said electrodes and supported thereby and a movable pool of mercury, said refractory element serving to direct the flow of the said mercury along one surface thereof to electrically bridge said electrodes upon a tilting of the device in one direction.

4. A mercury switch device comprising an enclosing glass envelope, electrodes sealed therethrough, a refractory element bridging said electrodes and supported thereby, a stationary pool of mercury adjacent one of said electrodes, a movable pool of mercury, said refractory element being arranged so as to provide a restraining path for said movable pool of mercury intermediate said electrodes.

5. A mercury switch device comprising an enclosing glass envelope, electrodes sealed therethrough, a refractory element bridging said electrodes and supported thereby, a stationary pool of mercury adjacent one of said electrodes, a movable pool of mercury, and means comprising a grooved section of said refractory element bridge member intermediate said electrodes for directing the flow of said movable pool of mercury to electrically bridge said electrodes.

6. A mercury switch device comprising an enclosing glass envelope, electrodes sealed therethrough, a refractory element bridging said electrodes and supported thereby, a stationary pool of mercury adjacent one of said electrodes, a movable pool of mercury, and means comprising a grooved inclined section of said refractory element intermediate said electrodes for directing the flow of said movable pool of mercury to electrically bridge said electrodes and to accelerate the rate of said flow.

7. In a mercury switch device, the combination with a sealed envelope, of a refractory element, two electrodes engaging and supporting said element and extending through the walls of said envelope, a pool of mercury in said envelope and means comprising a grooved path in said refractory element intermediate said electrodes for directing the flow of said mercury upon a tilting of the device in one direction so as to electrically bridge the two electrodes.

8. In a mercury switch device, the combination with a sealed envelope, of a refractory element, two electrodes engaging and supporting said element and extending through the walls of said enevelope, a pool of mercury and means comprising a grooved inclined section of said refractory element intermediate said electrodes for directing the flow of said mercury upon a tilting of the device in one direction, so as to electrically bridge the two electrodes, the incline serving to accelerate the rate of flow of said mercury.

9. In a mercury switch device, the combination with a sealed envelope of a refractory element, two electrodes engaging and supporting said element and extending through the walls of said envelope, a pool of mercury surrounding one of said electrodes in a recessed portion of said refractory element, a movable pool of mercury and means comprising a grooved inclined section of said refractory element intermediate said electrodes for directing the flow of the movable mercury pool upon a tilting of the device in one direction, so as to electrically bridge the two electrodes, the incline serving to accelerate the rate of flow of said movable mercury pool.

10. In a mercury switch device, the combination with a sealed envelope of a refractory element, a cavity therein, a mercury pool in said cavity, a support wire having one end disposed in said cavity and extending through a wall of said envelope, a second support wire extending from a second cavity in said refractory element and through a wall of said envelope and a movable mercury pool adjacent said second support wire serving to electrically connect said two support wires upon a tilting movement of said envelope in one direction.

11. In a mercury switch device, the combination with a sealed container, of a refractory element having a grooved inclined surface, a cavity at either end of said inclined surface, electrodes disposed in said cavities and extending through the walls of said envelope, and a pool of mercury, said pool of mercury serving to bridge said electrodes along said grooved inclined surface upon a tilting of the device in one direction.

12. In a mercury switch device, the combination with a sealed container, of a refractory element having a grooved inclined surface, a cavity at either end of said inclined surface one of which cavities is enlarged for a portion of its depth to receive and retain a small pool of mercury, electrodes disposed in said cavities and supporting said refractory element, said electrodes extending in parallel spaced relationship through the wall of said electrode, and a pool of mercury adapted to electrically connect said electrodes along said grooved inclined portion of said refractory element when the device is tilted in one direction.

13. A mercury switch device comprising an enclosing glass envelope, an inert gas filling, a mercury pool, two electrodes extending through a wall of the enclosing glass envelope through a seal portion thereof, said electrodes interiorly supporting a refractory element independent of said enclosing glass envelope, said refractory element being shaped so as to provide means therein when the device is in operating position for retaining about one of said electrodes a part of the mercury as a stationary pool, means about the other electrode for retaining adjacent the same the remainder of the mercury as a mov-

able mercury pool, means intermediate said supporting electrodes for directing the flow of the movable pool of mercury to the said stationary pool of mercury upon applying to the device a tilting motion in one direction, and means for indefinitely effecting the separation of said movable pool of mercury from said stationary pool of mercury upon returning the device to the original position subsequent to said tilting motion.

In testimony whereof, I have hereunto subscribed my name this 30th day of August, 1929.

GEORGE FRANCIS CALLAHAN.

CERTIFICATE OF CORRECTION.

Patent No. 1,762,213. **Granted June 10, 1930, to**

GEORGE FRANCIS CALLAHAN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, line 6, claim 13, for the word "indefinitely" read "definitely"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 22nd day of July, A. D. 1930.

Wm. A. Kinnan,
Acting Commissioner of Patents.

(Seal)