Jan. 22, 1929.

1,699,769

D. ULREY ET AL

CIRCUIT INTERRUPTER

Filed July 3, 1926

2 Sheets-Sheet 1

Fig. 1.

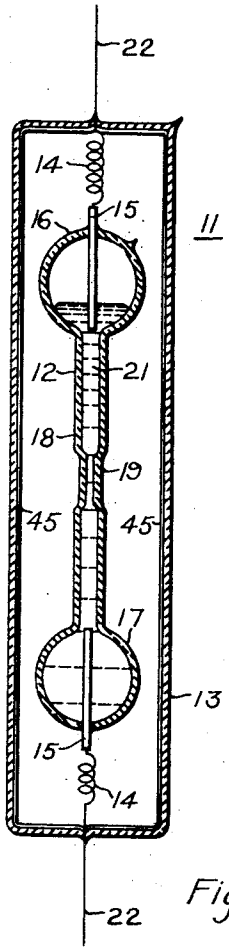


Fig. 2.

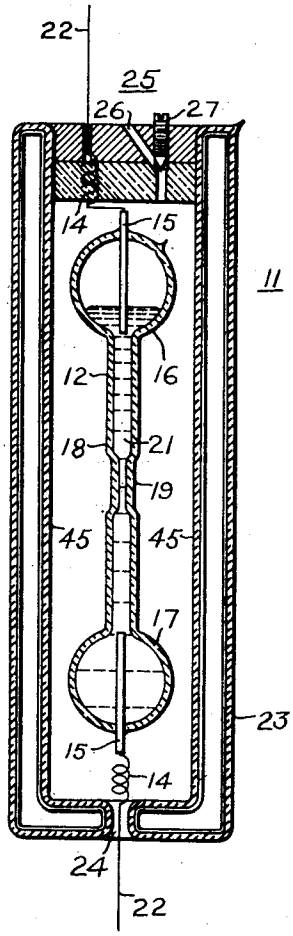
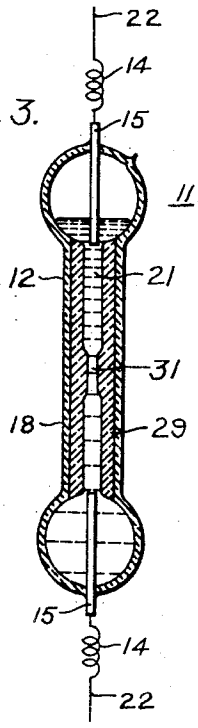


Fig. 3.



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2 Sheets-Sheet 2

Fig. 4.

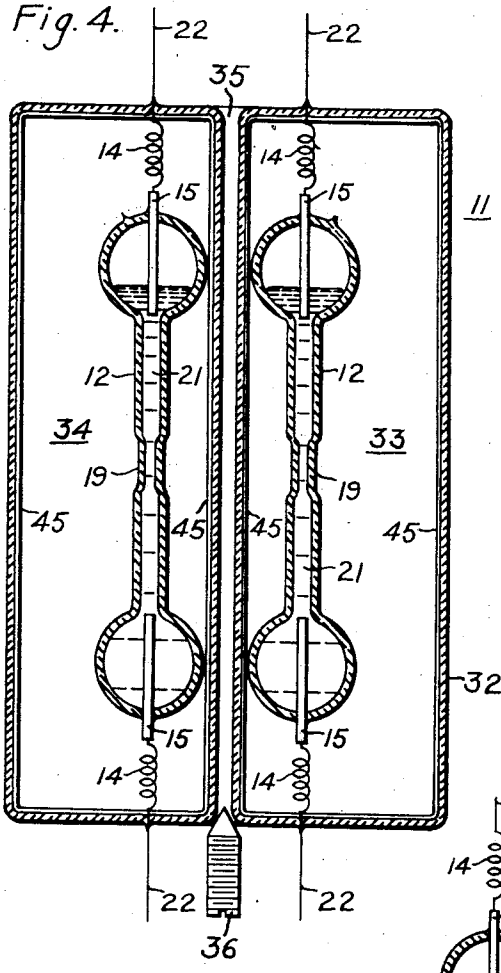


Fig. 5.

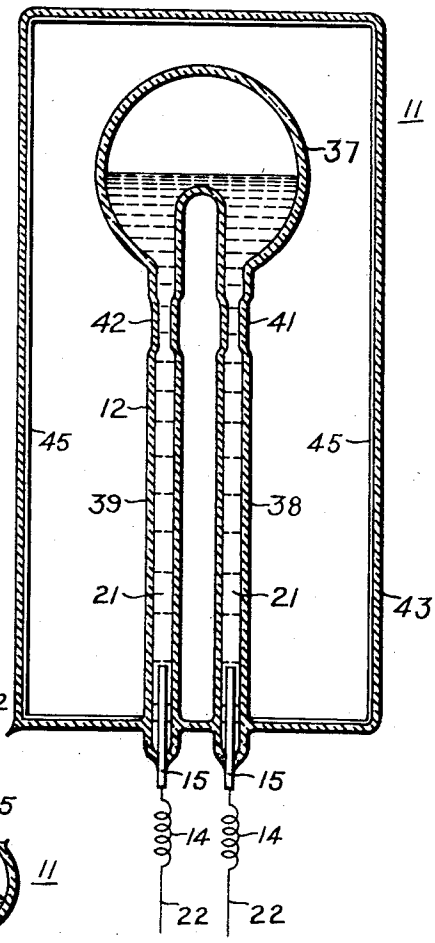
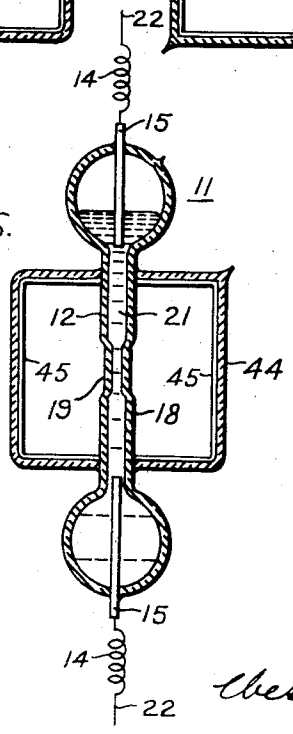


Fig. 6.



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UNITED STATES PATENT OFFICE.

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CIRCUIT INTERRUPTER.

Application filed July 3, 1926. Serial No. 120,427.

Our invention relates to thermo-responsive circuit interrupters and particularly to interrupters of the mercury-capillary-tube type.

An object of our invention is to provide means for a circuit interrupter of the mercury-capillary-tube type, whereby the heat generated in the mercury shall be confined substantially to the portion thereof where the current flowing therethrough is to be interrupted.

Another object of our invention is to provide a circuit interrupter of the mercury-capillary-tube type, in which the heat conducted to the terminals thereof shall be compensated for by resistor members in circuit therewith.

Another object of our invention is to provide means for protecting the surface of a circuit interrupter of the mercury-capillary-tube type, at the point at which the circuit is broken.

Another object of our invention is to provide means for regulating the temperature at which a thermo-responsive circuit interrupter of the mercury-capillary-tube type shall be operable.

In practicing our invention, we provide a capillary tube which has enlarged end portions and an intermediate elongated portion of relatively reduced section, in which a body of current-conducting material, such as mercury, is contained. Terminal members are provided therefor, that extend into the current-conducting fluid, and are suitably sealed to the tube. We provide, also, the intermediate portion of the capillary tube with a restricted portion, whereby the mercury column contained therein shall be vaporized and broken substantially at this portion. We provide, also, means for compensating the heat conducted from the mercury to the terminals by providing resistor members in close proximity thereto and in circuit therewith.

In order to confine the heat generated in the current-conducting fluid contained within the capillary tube to aid in the vaporization of the fluid, we provide thermal insulating means which comprises an evacuated envelope disposed around the capillary tube.

In the accompanying drawings,

Fig. 1 is a view, in vertical section, of a device embodying our invention;

Fig. 2 is a view, in vertical section, of a modification of the device illustrated in Fig. 1;

Fig. 3 is a view, in vertical section, of a modified form of the capillary tube employed in the devices illustrated in Figs. 1 and 2;

Fig. 4 is a view, in vertical section, of another modification of the device embodying our invention;

Fig. 5 is a view, in vertical section, of another modification of the device illustrated in Figs. 1 and 2; and

Fig. 6 is a view, in vertical section, of a modification of the devices illustrated in Figs. 1 and 2.

Referring more particularly to Fig. 1, a circuit interrupter 11 comprises a capillary tube 12 and an evacuated envelope 13. The capillary tube 12 is disposed within the envelope 13 and may be suspended therein by resistor members 14 which are secured to terminal members 15 of the tube 12. The tube 12 is provided with enlarged end portions 16 and 17 and an intermediate elongated portion 18 of reduced section.

The elongated portion 18 is provided with a restricted portion 19 which extends towards the center thereof. A column 21 of current-conducting fluid, such as mercury, is disposed within the tube 12. The terminal members 15 extend into the enlarged portions 16 and 17 of the tube 12 and are so sealed therein as to be in circuit with the mercury column 21. The resistor members 14 are provided with terminals 22 which extend through the ends of the envelope 13 and are sealed therein.

The envelope 13 and the capillary tube 12 may be made of any suitable refractory material such as quartz or glass, having a low thermal coefficient of expansion.

In Fig. 2 of the drawings, we have illustrated a modified form of the circuit interrupter illustrated in Fig. 1. In this particular modification, the capillary tube 12 is disposed within an elongated annular evacuated envelope 23 which has an opening 24 in one end thereof and a closure member 25 which extends into the other end. The closure member 25 is provided with a passageway 26 and a needle valve 27 for adjusting the area of the opening 26. The tube 12 is supported within the envelope 23 from the upper resistor 14 that is connected to the terminal 15. One of the resistor members 14 is so embedded

in the refractory closure member 25 as to be away from the influence of a cooling medium flowing through the passageway 26.

In Fig. 3 of the drawings, we have illustrated a modified form of the capillary tube shown in Figs. 1 and 2. In this particular embodiment of the mercury tube 12, the portion 18 is lined with a refractory member 29, such as porcelain, and should preferably have substantially the same coefficient of expansion as the material of the tube 12. The porcelain tubular member 29 is fused with the portion 18 and is provided with a restricted portion 31.

In Fig. 4 of the drawings, we have illustrated a modification of the circuit interrupter embodying our invention, which may be used for controlling a polyphase circuit. The relay 11, in this modification, comprises an evacuated envelope 32 which is provided with individual compartments 33 and 34 and a passageway 35. The effective opening of the passageway 35 is regulated by an adjusting means or needle valve 36. The capillary tubes 12 are disposed within the compartments 33 and 34 and are supported from the ends of the envelope 32 by the resistor members 14.

In Fig. 5 of the drawings, a modified form of the capillary tube 12 is illustrated and comprises a return-bent tube having an enlarged portion 37 and two elongated portions 38 and 39 of relatively small section. The portions 38 and 39 are provided with restricted portions 41 and 42. The tube 12 is filled to a suitable level with a conducting fluid, such as mercury, after which the tube 12 is evacuated to a suitable degree. In some applications of our invention, it may be desirable to fill the tube 12 with an inert gas.

Terminal members 15 extend into the portions 38 and 39 and are sealed therewith. The tube 12 is disposed within an evacuated envelope 43 which may be sealed to the portions 38 and 39 of the tube 12. The terminal members 15 are provided with resistor members 14 to compensate for heat which may be conducted from the mercury within the portions 38 and 39 to the terminal members 15.

In Fig. 6 of the drawings, the capillary tube 12 has only the elongated portion 18 thereof surrounded by an evacuated envelope 44 which is preferably sealed to the member 18.

The operation of the device illustrated in Figs. 1 to 6, inclusive, is based upon the capillary action of the portions 18 of the capillary tubes illustrated in Figs. 1 to 4, inclusive, and Fig. 6. As current passes through the column of mercury from the terminal members 22, the mercury column is caused to increase in temperature as a result of the I^2R loss which occurs therein. As the mercury is heated, the column expands and, since an evacuated envelope encloses the tube 12, the heat generated therein is confined thereto and causes the mercury to expand. As the mercury increases in temperature, it finally vaporizes and becomes discontinuous at substantially the restricted portions 19 of the elongated portion 18 of the tubes, as illustrated.

The discontinuity of the mercury at the restricted portions 19 therefore, causes the current flowing therethrough to be interrupted. By providing a sealed envelope for enclosing the tubes 12, a thermal insulation is provided whereby the portion 18 of the tube 12 may be made larger in section, so as to have larger current carrying capacity, in order that the device illustrated in the drawings may have more practical value as a circuit interrupting device.

The thermal insulating properties of the envelopes 13, 23, 32, 43 and 44, illustrated in Figs. 1, 2, and 4 to 6, inclusive, may be greatly improved by providing a highly reflecting surface 45, preferably on the inside surfaces thereof. The surface 45 may be obtained by plating with silver or other suitable material. The surface 45 acts as a reflector for the heat rays emitted from the heated mercury 19 and reflects them back again to the mercury. The capillary tubes 12 may be provided with a reflecting surface if desired, although such construction need not, necessarily, be adhered to.

In Fig. 6 of the drawings, the envelope 44 encloses the portion 18 only of the capillary tube 12. In this particular modification, the heat generated in the portion 18 of the tube 12 is confined thereto and aids in vaporizing the mercury at substantially the restricted portion 19. The heat which is conducted from the mercury to the terminals 15 is compensated for by the resistor members 14 which prevents loss of heat from the mercury column 21.

The operation of the device illustrated in Fig. 5 is substantially the same as the operation of the devices illustrated in the other figures, except that the interruption of the circuit may be accomplished at two points located substantially at the restricted portions 41 and 42 of the portions 38 and 39. The vaporization of the mercury columns 19 will take place near the top of the tube 12, as illustrated, because the head of mercury thereabove is not very great, and the pressure tending to retard the disrupting of the mercury column does not have much effect.

The needle valves 27 and 36, illustrated in Figs. 2 and 4, respectively, are provided to control the temperature of the capillary tubes 12 in accordance with a predetermined value of current that is to be permitted to pass through an electric translating device, in circuit with the relay 11. If a large current is to be passed through the electric translating device, the needle valve is turned out-

wardly, whereby the passage 26 of Fig. 2 and the passage 35 of Fig. 4 may have the full effective opening. With the full effective opening, a larger current will be required to increase the temperature of the mercury to the vaporization point to cause the circuit to be broken.

If the needle valves are turned inwardly to reduce the effective opening of the passages 26 and 35, a smaller current will be required to cause vaporization of the mercury column, with consequent interruption of the current flowing therethrough.

By our invention, we have provided a circuit interrupter of the mercury-capillary-tube type in which the heat generated in the mercury column is confined at substantially the points where vaporization thereof occurs for interrupting the circuit. We have also provided adjusting means whereby currents of different values may be interrupted with a given device.

While we have illustrated various modifications of the device embodying our invention, other changes may be made therein without departing from the spirit and scope thereof. We desire, therefore, that only such limitations shall be placed thereon as are imposed by the prior art and the appended claims.

We claim as our invention:

1. In a thermally-actuable circuit interrupter, the combination with an evacuated, refractory electrically non-conducting member; said member having enlarged end portions and a relatively narrow, elongated intermediate portion, said member having electrically-conducting fluid therein, and terminal members extending into said fluid at opposite ends of said intermediate portion, of means for thermally insulating said evacuated refractory member comprising an evacuated and reflecting envelope disposed therearound.

2. In a thermally-actuable circuit interrupter, the combination with an evacuated, refractory electrically non-conducting member, said member having enlarged end portions and a relatively narrow, elongated intermediate portion, said member having electrically-conducting fluid therein and terminal members extending into said fluid at opposite ends of said intermediate portion, of means for thermally insulating the intermediate portion of said evacuated refractory member comprising an evacuated envelope disposed therearound.

3. In a thermally-actuable circuit interrupter, the combination with a refractory electrically non-conducting member, said member having enlarged end portions and a relatively narrow, elongated intermediate portion, said member having electrically-conducting fluid therein, and terminal members extending into said fluid at opposite ends of said intermediate portion, of means for regulating the temperature of said refractory member in accordance with a predetermined value of electric current passing through said fluid, said means comprising a heat insulating envelope disposed thereabout and means for controlling the flow of a cooling medium between inner walls of said envelope.

4. In a thermally-actuable circuit interrupter, the combination with a refractory, electrically non-conducting member, said member having enlarged end portions and a relatively narrow, elongated intermediate portion, said member having electrically-conducting fluid therein and terminal members extending into said fluid at opposite ends of said intermediate portion, of means for maintaining the operating temperature of said refractory member at a predetermined value in accordance with a predetermined value of current passing therethrough, comprising a heat insulating envelope disposed around the intermediate portion thereof and resistor members in circuit with said terminal members for compensating for heat flow from said intermediate portion to said terminal members.

5. In a thermally-actuable circuit interrupter, the combination with a sealed, electrically-insulating container, electrically-conducting fluid disposed therein, said container having enlarged end portions and an elongated intermediate portion of reduced section, and terminal members in circuit with said fluid, of means for regulating the temperature of said container comprising an evacuated envelope disposed therearound and means for permitting a cooling medium to flow between inner walls of said envelope.

6. In a thermally-actuable circuit interrupter, the combination with a plurality of sealed, electrically-insulating containers having current-conducting fluid therein, and terminal members in circuit with the fluid of said containers, of means for regulating the temperature of said containers comprising an envelope disposed therearound.

7. In a thermally-actuable circuit interrupter, the combination with a plurality of sealed, electrically-insulating containers having current-conducting fluid therein, said containers having enlarged end portions and elongated intermediate portions of reduced section, and terminal members in circuit with the fluid of said containers, of means thermally insulating said containers comprising a plurality of integral evacuated envelopes enclosing said containers individually.

8. In a thermally-actuable circuit interrupter, the combination with a plurality of sealed, electrically-insulating containers having current-conducting fluid therein, said containers having enlarged end portions and elongated intermediate portions of reduced section, and terminal members in circuit with

the fluid of said containers, of means for controlling the temperature of said containers comprising an evacuated envelope disposed therearound and means for regulating the flow of a cooling medium therebetween.

9. A thermally-responsive circuit interrupter comprising a sealed electrically insulating capillary tube, said tube having current-conducting fluid therein and terminal members at the ends thereof in circuit therewith, and means for thermally insulating said tube comprising an evacuated envelope disposed therearound.

10. A thermally-responsive circuit interrupter comprising a sealed electrically insulating capillary tube, said tube having current-conducting fluid therein and terminal members at the ends thereof in circuit therewith, and means for thermally insulating said tube comprising an evacuated and reflecting envelope disposed therearound.

11. A thermo-responsive circuit interrupter comprising a sealed electrically insulating capillary tube, said tube having current-conducting fluid therein, and means for thermally insulating said tube comprising an evacuated envelope disposed therearound and integral therewith.

12. A thermally-responsive circuit interrupter comprising a sealed electrically insulating capillary tube, said tube having current-conducting fluid therein and terminal members at the ends thereof in circuit therewith, and means for regulating the temperature of said tube comprising an evacuated envelope disposed therearound, resistor members in circuit with said terminal members and means for controlling the flow of a cooling medium between inner walls of the envelope.

In testimony whereof, we have hereunto subscribed our names this 24th day of June, 1926.

DAYTON ULREY.
LESLIE N. CRICHTON.