Oct. 12, 1943. G. L. HILL 2,331,778

CIRCUIT BREAKER AND SWITCH

Filed Jan. 2, 1940 2 Sheets-Sheet 1

Fig. 1.

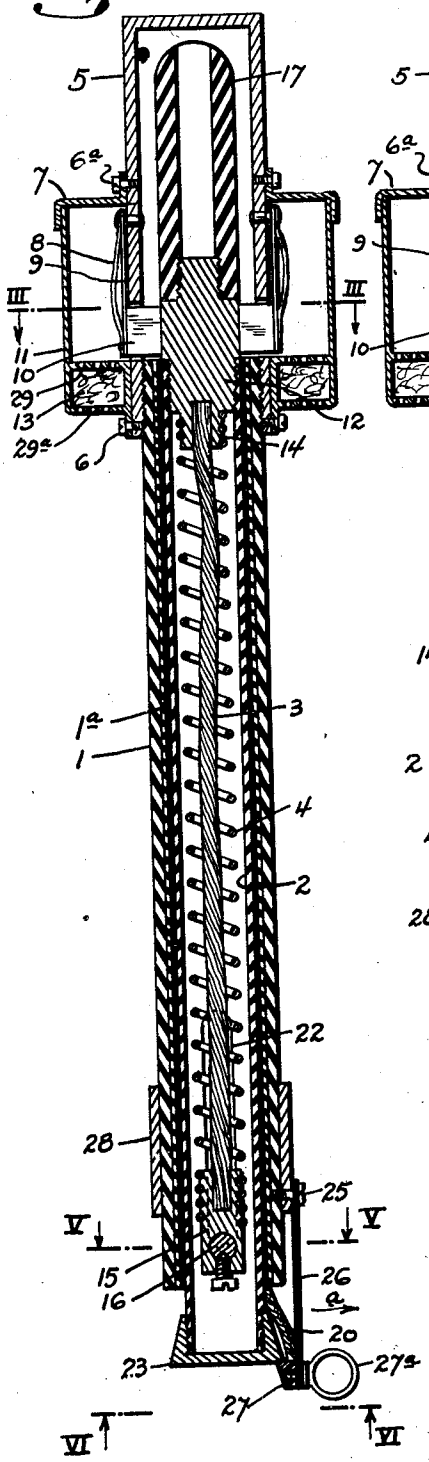



Fig. 2.

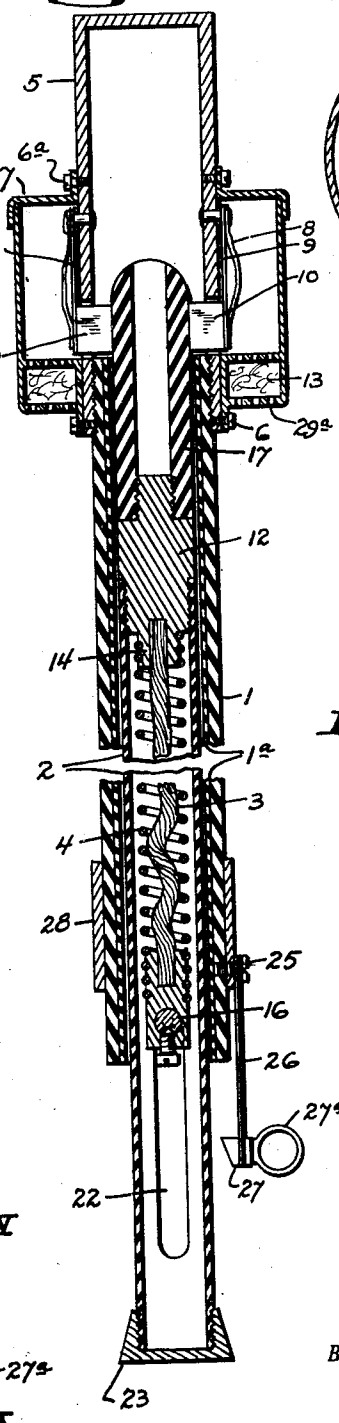



Fig. 3.

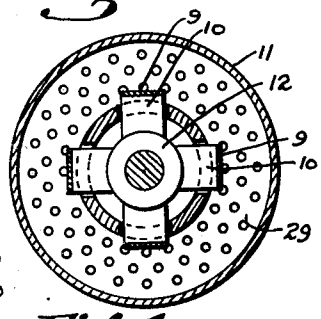



Fig. 4.

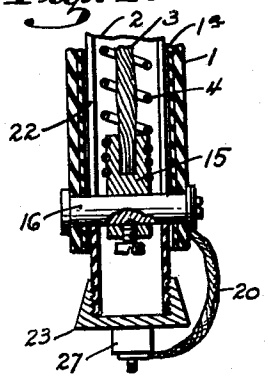



Fig. 5.

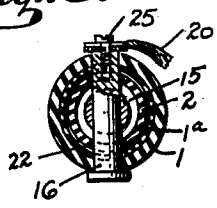
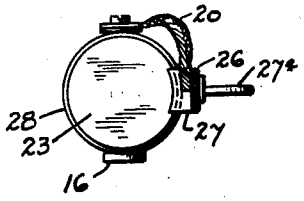



Fig. 6.




INVENTOR.
George Leslie Hill.

BY
Chas. E. Townsend.
ATTORNEY

Oct. 12, 1943. G. L. HILL 2,331,778

CIRCUIT BREAKER AND SWITCH

Filed Jan. 2, 1940 2 Sheets-Sheet 2

Fig. 8.

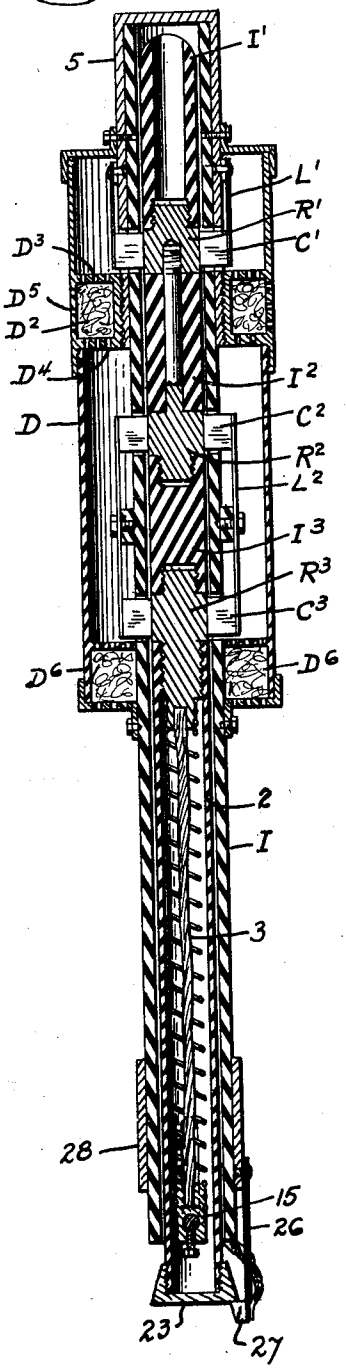



Fig. 9.

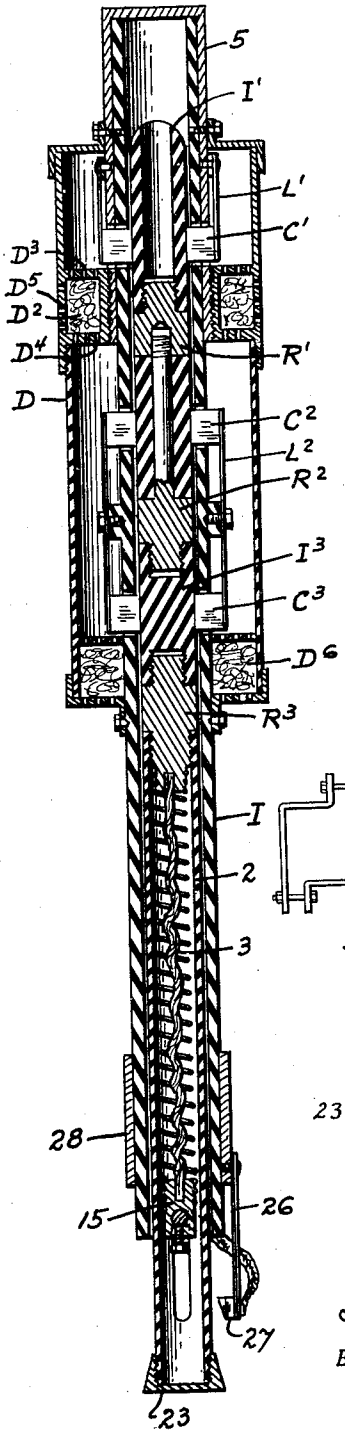
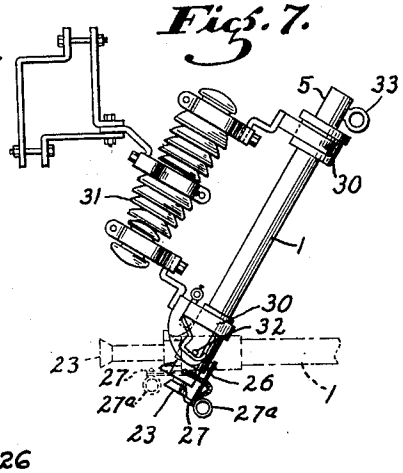



Fig. 7.




INVENTOR.
George Leslie Hill.

BY
Chas. E. Townsend.
ATTORNEY

Patented Oct. 12, 1943 2,331,778

# UNITED STATES PATENT OFFICE

2,331,778

## CIRCUIT BREAKER AND SWITCH

George Leslie Hill, Oakland, Calif.

Application January 2, 1940, Serial No. 312,073

9 Claims. (Cl. 200—149)

This invention relates to improvements in electric circuit interrupters.

The object of the invention is the utilization of a tube or chamber wherein a rapid de-ionization of the arc path or arc stream is obtained, when breaking a circuit, by introducing a mass of insulating and de-ionizing medium in such a position that it will instantly reduce and confine the area through which the arc stream must nominally flow in order to complete the electric circuit, and at the same time inject a de-ionizing agent into said area, as the electrodes are separated from the contacts by the actuating mechanism. A further object is to provide a metallic cooling or condensing medium suitably located in the circuit breaker for quickly cooling and condensing any hot gases, metallic parts or vapor that may be expelled during circuit interruption so as to render them non-conducting and prevent a short circuit to grounded structures or between adjacent phases; to provide a circuit interrupter which may be utilized on overhead distribution lines or structures wherein it is desired to interrupt the circuit by a dry-type device conveniently arranged so that it may be operated as a disconnect switch after the circuit has been interrupted either by current-responsive, thermal, or manual tripping means; to provide a circuit interrupter which will visibly indicate whether the circuit through it is closed or interrupted (open); and further, to provide a circuit interrupter which is adapted to be placed in an enclosed tank or box so that it may be operated safely from the exterior either as an automatic circuit breaker, as a manually operated disconnect switch, or for interrupting the load current in a junction box.

The invention is shown by way of illustration in the accompanying drawings, in which

Fig. 1 is a central vertical longitudinal sectional view of the circuit interrupter as designed for overhead lines;

Fig. 2 is a section similar to Fig. 1, showing the device in tripped position and the circuit open;

Fig. 3 is a cross section taken on line III—III of Fig. 1;

Fig. 4 is a longitudinal vertical section of the lower end of the circuit interrupting device, said section being taken at right angles to Figs. 1 and 2;

Fig. 5 is a cross section on line V—V of Fig. 1;

Fig. 6 is a bottom view looking in the direction of arrow VI—VI in Fig. 1;

Fig. 7 shows a complete assembly of the device on a supporting insulator and ready for mounting on a cross-arm or similar structure;

Fig. 8 is a central vertical longitudinal section showing a further modification of the invention, said view showing the circuit closed; and

Fig. 9 is a section similar to that shown in Fig. 8, showing the circuit broken.

Referring to the drawings in detail, and particularly to Figs. 1 to 6 inclusive, the circuit breaker disclosed comprises in general a pair of longitudinally extending insulating tubes 1 and 1*a*, which are provided with end terminals 5 and 28. The tubes, and particularly the terminal members 5 and 28, are adapted to be mounted and supported in typical clips 30 (see Fig. 7), which in turn are supported on an insulator 31.

Within the tubes 1 and 1*a* is a secondary tube 2 which is also constructed of insulating material, and fastened to the upper end of said tube is a metal electrode 12, while to the lower end is secured a cap-like ferrule 23. The lower end of the tube is slotted longitudinally as shown at 22, and supported in the lower end of the tube 1 and projecting through the slot is a pin which forms a metallic conductor 16. Secured on the pin 16 within the inner tube 2 is an anchor member 15, and secured thereto is one end of a spring 4 and a flexible metallic conductor 3. Formed on the lower end of the electrode 12 is a similar anchor member 14, and secured thereto is the opposite end of the flexible conductor 3 and the spring 4. Secured to the upper end of the electrode 12 is a member 17 which may be solid or tubular, as shown. This member is made of any suitable insulating material, such as horn fiber or compressed materials such as boric acid, and the same is true of the tube 1*a*. The member 17 and the tube 1*a* are provided for the purpose of confining any arc formed during the breaking of a circuit to a narrow annular space. These surfaces also serve for cooling purposes and for the liberation of de-ionizing gases, as will hereinafter be described.

Surrounding the upper end of the device is a chamber which is formed within a cup-like member 11 and a cover 7. These members are fastened in any suitable manner, as by the screws 6 and 6*a*. Within the chamber are mounted four contacts such as indicated at 10. They are connected to the metal member or tube 5 by spring arms 9 and braided copper conductors 8, the spring arms having sufficient tension to maintain the contacts in engagement with the electrode 12 and to maintain the desired contact pressure.

On the lower end of the tube 1 is shown a bi-metallic strip 26 which is fastened to the end of the sleeve or terminal 28 as at 25. The lower end of the bi-metallic strip carries a latch 27 which normally engages the under side of the ferrule 23, thereby normally maintaining the inner tube 2 in the raised or elevated position shown in Fig. 1. In this position the spring 4 is maintained under tension, and a circuit is closed which can be traced through the members 5, 8, 10, 12, 3, 15, 16, 20, 26 and 28.

Circuit interruption is accomplished in the following manner: When the current is on, it flows through the several members already specified, and also through the bi-metallic strip 26, causing this to heat to a certain degree and to expand outwardly in the direction of arrow *a* (see Fig. 1). If the current exceeds a predetermined amount, the bi-metallic strip will expand further, and the latch 27 will release the ferrule 23 and the tube 2, allowing the spring 3 to retract and pull the tube 2, together with the electrode 12 and the member 17, downwardly to assume the position shown in Fig. 2. During this movement there is a tendency for an arc to be formed or drawn between the contacts 10 and the electrode 12, but as the member 17 is secured to the upper end of the electrode 12, it will also be pulled downwardly through the tube 1*a*, thus instantly reducing and confining the path through which the arc stream must flow to a very narrow annular space, of small area. The close proximity of the arc stream to the surrounding walls of the member 17 and the tube 1*a* will cool it rapidly and aid in interrupting the circuit. In addition to the cooling effect, the heat of the arc will tend to decompose the walls of the member 17 and the tube 1*a*, and gases will be evolved, causing a very high pressure in the narrow annular space, resulting in an exceedingly fast expulsion of the hot arc gases and also a rapid de-ionization of the arc stream, thereby interrupting the circuit in a rapid and efficient manner.

The insulating tubes 1 and 1*a* may be similar to the typical combination expulsion fuse tubes, wherein 1*a* is an inner tube of gray horn fiber and the outer tube 1 is rolled paper Bakelite, rolled fabric-Bakelite, or molded Bakelite tube, to insure weather-protection and additional strength.

Fig. 2, as previously stated, shows the circuit breaker in the tripped or open position, with the tube 2 projecting a considerable distance below the lower end of the main tube 1. This is important as it provides a definite visual indication that the circuit is open. Fig. 7 shows a method of mounting the circuit breaker shown in Figs. 1 to 6 so that it may also be used as an air break disconnect switch, in addition to interrupting the circuit. The insulator 31, with its supporting hardware for crossarm mounting, has the spring terminal clips 30—30 mounted on opposite ends. The tube 1 with its metal end terminals is inserted in these clips by pivoting around any suitable point, as the trunnions and bearing member 32.

If it is desired to open a load current, the breaker may be manually tripped by exerting an outward pull on the ring indicated at 27*a*. When this is done the device may be opened as a disconnect switch by pulling on the ring indicated at 33 (see Fig. 7) without danger of drawing an arc and causing injury to the operator, or establishing an arc to grounded structures or between phases.

The assembly view shown in Fig. 7 is the normal position of the circuit interrupter when the circuit is closed. In dotted lines the circuit breaker is shown in open position and also in the position of an open air break disconnect switch. The device may be reset by removing it from the bearings 32 and pushing the tube 2 inwardly until the latch 27 engages the ferrule 23, then placing the device back in the bearing 32 and swinging it into the full-line position, so as to engage the clips 30—30. This can be done by a switch stick hooked into the ring 33. If the short circuit or trouble still persists, the breaker will automatically trip out again, and if the operator desires the cycle may be repeated.

As an additional feature of the circuit interrupter disclosed, a metallic cooling and condensing medium 13 is preferably placed in the bottom of the cup-shaped housing 11. In this position it is close to the contacts 10 but is separated therefrom by a perforated plate or screen 29. The bottom of the cup-shaped member may also be perforated as shown at 29*a*. The metallic cooling means may be in the form of granular copper, indented and perforated metal discs, or bare copper wire wound in the form of a honeycomb coil, etc. The cooling or condensing means 13 will insure against the escape of hot conductive gases which would cause short circuits to adjacent grounded metallic parts, or a flashover of the supporting insulators. Also, the chamber will trap any expelled hot molten metal which might be burned off the contacts 10 or the electrode 12.

Figs. 14 and 15 show another form of the invention, wherein a plurality of breaks or opening points are placed in spaced longitudinal arrangement. A long insulating tube I is shown with slots cut in its walls to permit contacts such as indicated at C1, C2 and C3 to pass through and engage the metal contact rods or electrodes indicated at R1, R2 and R3. Insulating members I1 and I3 are shown as attached to the adjacent metal rods, and they are slidable within the insulating tube I. It will be noted that an insulating tube I2 is also provided. This is pressed over the metal rod R2 and forms in effect the same small annular space between its outer periphery and the inner perpihery of the tube I as insulating rods I1 and I3 do. The contacts C1, C2 and C3 are mounted on the usual spring arms, indicated at L1 and L2, and these arms also function to form the circuit connection through the interrupter.

Circuit interruption is accomplished by movement of the inner tube, or in other words the electrodes R1, R2 and R3, away from the contacts C1, C2 and C3. In breaking the circuit there is a tendency for arcs to be formed, but this is interrupted in the usual way, as previously described, by confinement of the arc to the narrow annular spaces shown, and the liberation of the de-ionizing gas, as the insulating members I, I1, I2, and I3 are made of material that will give off a de-ionizing gas and at the same time have a cooling effect upon the arcs. Thus arc extinction will be accomplished in the same efficient and rapid manner as above described.

A plurality of arc extinctions in series will have the beneficial effect of reducing the duty upon one single break or a single arc extinction. For instance, if an 11,000-volt circuit is interrupted

by one break, as shown in Fig. 1 of the drawings, it may be desirable to use six or more breaks, in place of the three breaks shown in Figs. 14 and 15, to interrupt a 66,000-volt circuit. The gases formed during circuit interruption will be cooled and condensed in the same manner as heretofore described, as a housing D is provided, in which is mounted a cooling medium D2. The gases pass through perforated plates D3 and D4, then through the cooling or condensing medium D2, and finally pass to the atmosphere through perforations indicated at D5. In as much as the housing D is of considerable length, it is desirable that gases produced during circuit interruption shall have as free an escape as possible; hence a second cooling and condensing chamber may be provided at the lower end of the housing, as indicated at D6.

In the structure shown in Figs. 8 and 9, as well as in the structures shown in the other figures, the inner member alone is movable. A relative movement between the member carrying the contacts and the member carrying the electrodes is all that is required; hence it should be understood that either the outer or the inner member may be movable, or that both may be movable in opposite directions, thus producing the effect of doubling the speed when making a circuit interruption.

In Figs. 8 and 9 the housing D is shown as constructed partially of metal and insulating material. Inasmuch as high pressures may be generated, it is to be understood that the housing may be constructed of metal throughout and insulated as required, or it may be made entirely of heavy insulating material.

While certain other features of my invention have been more or less specifically described and illustrated, I nevertheless wish it understood that changes may be resorted to within the scope of the appended claims.

Having thus described and illustrated my invention, what I claim and desire to secure by Letters Patent is:

1. A circuit breaker comprising an inner and an outer tubular member of insulating material, said inner tube being slidably mounted in the outer tube, cooperating contact members on the inner and outer tubes and at one end thereof, metallic means within the inner tube for establishing an electric circuit through the contacts and through the inner tube, and means within the inner tube for imparting relative longitudinal movement to the tubes to separate the contacts and thereby interrupt the circuit.

2. A circuit breaker comprising an inner and an outer tubular member of insulating material, said inner tube being slidably mounted in the outer tube, cooperating contact members on the inner and outer tubes and at one end thereof, metallic means within the inner tube for establishing an electric circuit through the contacts and through the inner tube, means within the inner tube for imparting relative longitudinal movement to the tubes to separate the contacts and thereby interrupt the circuit, means carried by the inner tube for confining the arc established upon breaking the circuit to an annular narrow space, said means containing and liberating an arc-extinguishing substance, and a liner within the outer tube containing and liberating an arc-extinguishing substance.

3. A circuit breaker comprising an inner and an outer tubular member of insulating material, said inner tube being slidably mounted in the outer tube, cooperating contact members on the inner and outer tubes and at one end thereof, metallic means within the inner tube for establishing an electric circuit through the contacts and through the inner tube, means within the inner tube for imparting relative longitudinal movement to the tubes to separate the contacts and thereby interrupt the circuit, a retainer maintaining the contacts in engagement, tripping means in the circuit for releasing the retainer to permit longitudinal movement by separation of the contacts and breaking of the circuit, and means carried by the inner tube for confining the arc established upon breaking the circuit to an annular narrow space, said means containing and liberating an arc-extinguishing substance.

4. A circuit breaker comprising an inner and an outer tubular member of insulating material, said inner tube being slidably mounted in the outer tube, cooperating contact members on the inner and outer tubes and at one end thereof, metallic means within the inner tube for establishing an electric circuit through the contacts and through the inner tube, means within the inner tube for imparting relative longitudinal movement to the tubes to separate the contacts and thereby interrupt the circuit, a retainer maintaining the contacts in engagement, tripping means in the circuit for releasing the retainer to permit longitudinal movement by separation of the contacts and breaking of the circuit, means carried by the inner tube for confining the arc established upon breaking the circuit to an annular narrow space, said means containing and liberating an arc-extinguishing substance, and a liner within the outer tube containing the liberated arc-extinguishing substance.

5. A circuit breaker comprising an outer tube constructed of insulating material, a metallic member slidably mounted within the tube, a pair of contact members carried by the outer tube and normally engaging the metallic member, an insulating member secured to one end of the metallic member, an inner tube constructed of insulating material secured to the opposite end of the metallic member and extending substantially the length of the outer tube, an electric terminal connected with the contact members at one end of the outer tube, a second electric terminal at the opposite end of the outer tube, and a flexible conductor within the inner tube connected at one end with the slidable metallic member and at the other end with the last named terminal to establish a circuit from the first named terminal through the contacts, the metallic member, and the flexible conductor to the last named terminal.

6. A circuit breaker comprising an outer tube constructed of insulating material, a metallic member slidably mounted with the tube, a pair of contact members carried by the outer tube and normally engaging the metallic member, an insulating member secured to one end of the metallic member, an inner tube constructed of insulating material secured to the opposite end of the metallic member and extending substantially the length of the outer tube, an electric terminal connected with the contact members at one end of the outer tube, a second electric terminal at the opposite end of the outer tube, a flexible conductor within the inner tube connected at one end with the slidable metallic member and at the other end with the last named terminal to establish a circuit from the first named terminal

through the contacts, the metallic member, and the flexible conductor to the last named terminal, releasable means normally maintaining the metallic member in engagement with the contacts, a spring within the inner tube normally tending to impart longitudinal movement to the metallic member to separate it from the contacts to interrupt the circuit, and means for releasing the first named means.

7. A circuit breaker comprising an outer tube constructed of insulating material, a metallic member slidably mounted within the tube, a pair of contact members carried by the outer tube and normally engaging the metallic member, an insulating member secured to one end of the metallic member, an inner tube constructed of insulating material secured to the opposite end of the metallic member and extending substantially the length of the outer tube, an electric terminal connected with the contact members at one end of the outer tube, a second electric terminal at the opposite end of the outer tube, a flexible conductor within the inner tube connected at one end with the slidable metallic member and at the other end with the last named terminal to establish a circuit from the first named terminal through the contacts, the metallic member, and the flexible conductor to the last named terminal, a pin secured to the outer tube and extending transversely through the inner tube, said inner tube being slotted to permit it to move longitudinally with relation to the pin and the outer tube, a tension spring within the inner tube connecting the pin and the inner tube and tending to impart longitudinal movement to the inner tube and the metallic member to interrupt the circuit, and a releasable latch controlling the position of the inner tube to maintain or interrupt the circuit.

8. A circuit breaker comprising an inner and an outer tubular member of insulating material, said inner tube being slidably mounted in the outer tube, a plurality of spaced contact members on one end of the inner tube, metallic means within the inner tube for establishing an electric circuit through one of the contacts and the inner tube, a plurality of cooperating contacts on the outer tube engaging the spaced contacts on the inner tube and completing a circuit from the outer tube through all of the contacts and the metallic means extending through the inner tube, and means within the inner tube for imparting relative longitudinal movement to the tubes to separate the contacts and thereby interrupt the circuit at a plurality of spaced points.

9. A circuit breaker comprising an inner and an outer tubular member of insulating material, said inner tube being slidably mounted in the outer tube, a plurality of spaced contact members on one end of the inner tube, metallic means within the inner tube for establishing an electric circuit through one of the contacts and the inner tube, a plurality of cooperating contacts on the outer tube engaging the spaced contacts on the inner tube and completing a circuit from the outer tube through all of the contacts and the metallic means extending through the inner tube, means within the inner tube for imparting relative longitudinal movement to the tubes to separate the contacts and thereby interrupt the circuit at a plurality of spaced points, and means carried by the inner tube for confining the arcs established at the plural spaced points upon breaking the circuit to an annular narrow space, said means containing and liberating an arc-extinguishing substance.

GEORGE LESLIE HILL.