April 8, 1958 G. L. HILL 2,830,151

CIRCUIT BREAKER

Filed Dec. 9, 1955

Fig. 1

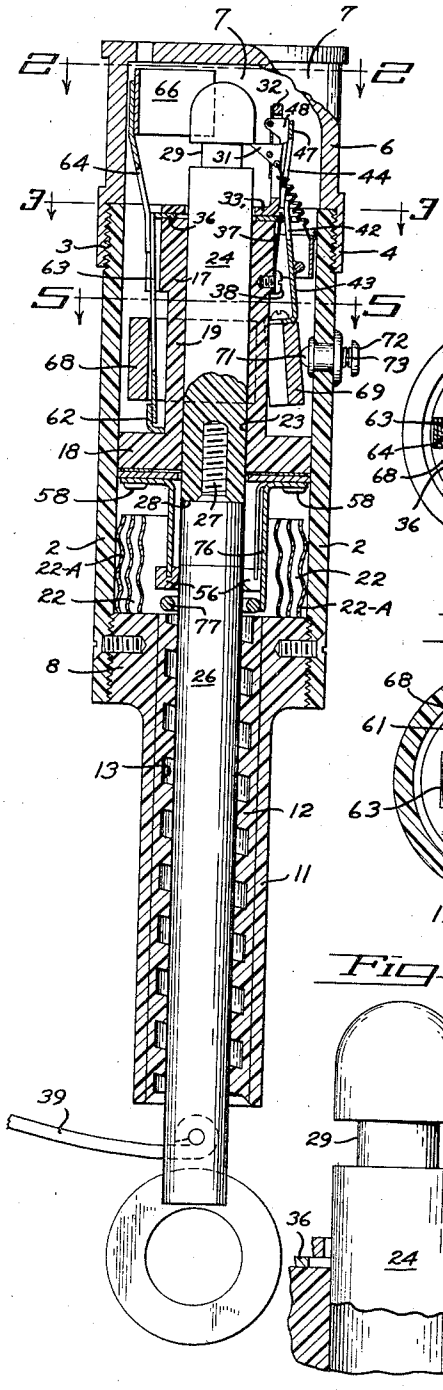


Fig. 2

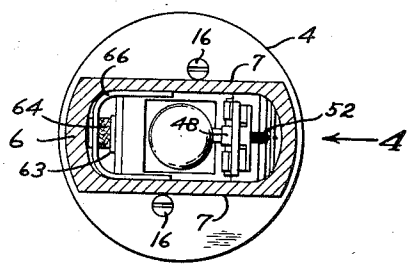


Fig. 3

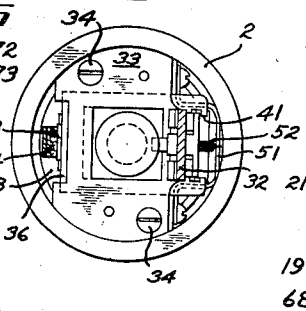


Fig. 4

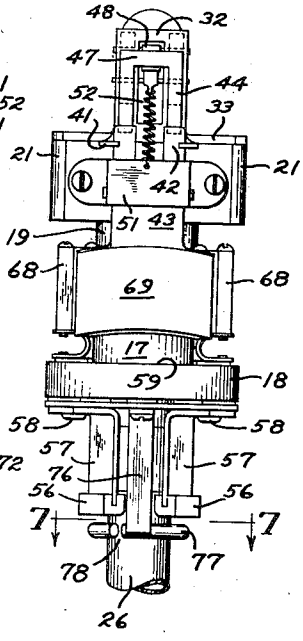


Fig. 5

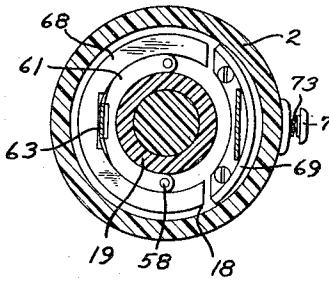


Fig. 6

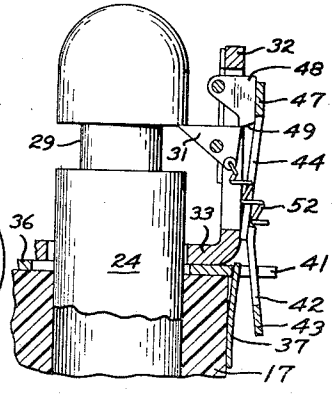
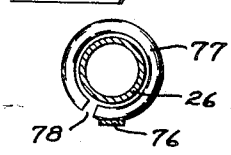


Fig. 7



INVENTOR

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CIRCUIT BREAKER

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16 Claims. (Cl. 200—88)

My invention relates to circuit breakers; and particularly to an air-gap type circuit breaker for use in high voltage overhead distribution lines.

One of the objects of my invention is the provision of a circuit breaker automatically operated by thermal and/or electromagnetic means.

Another object is the provision of a circuit breaker which may be manually tripped so as to function as a load break device.

Still another object is the provision of a circuit breaker in which the tripping mechanism is substantially frictionless in its operation.

Another object is the provision of a circuit breaker having a cooling and de-ionizing chamber within which the arc is confined during circuit interruption.

Another object is the provision of means utilizing the magnetic field around an arc to propel the arc along a conductor to prevent burning of the contact points by the arc.

Other objects and features of value will be apparent from the following description and the drawings. I do not limit myself however to the embodiment shown, since I may adopt variant forms within the scope of the appended claims.

Referring to the drawings:

Fig. 1 is a longitudinal half sectional view of my circuit breaker shown in closed condition, ready for insertion in a circuit.

Fig. 2 is a transverse sectional view taken in the plane indicated by the line 2—2 of Fig. 1.

Fig. 3 is a transverse sectional view taken in the plane indicated by the line 3—3 of Fig. 1.

Fig. 4 is a side elevation of the tripping mechanism apart from the housing and taken in the direction indicated by the arrow 4 in Fig. 2.

Fig. 5 is a transverse sectional view taken in the plane indicated by the line 5—5 of Fig. 1.

Fig. 6 is an enlarged fragmentary sectional view partly in elevation and showing the latch mechanism in locked position.

Fig. 7 is a transverse sectional view taken in the plane indicated by the line 7—7 of Fig. 4 and showing the relationship of the interrupted arcing ring to the movable electrode.

Broadly, the circuit breaker of my invention comprises an elongated cylindrical housing of dielectric material closed at one end by a metallic mounting ferrule, and at its other end provided with a passageway or expulsion tube through which extends a movable electrode or conductor. The mounting ferrule serves to mount the circuit breaker on an insulator in the conventional manner, and connects the circuit breaker with one terminal of the circuit. Means within the housing electrically connects the mounting ferrule with the movable conductor or electrode. Latch means within the housing locks the movable electrode in conducting position and provides for quick releasability when an overload occurs, or when the device is manually tripped.

In more specific detail and referring to the drawings, my circuit breaker comprises a hollow cylindrical housing 2 formed conveniently from Bakelite impregnated rolled paper for high mechanical strength and high dielectric properties.

At its upper end, the dielectric housing is provided with external threads 3 engaged by the cylindrical threaded skirt portion 4 of the hollow metallic ferrule 6. The flat side surfaces 7 of the ferrule are adapted to be inserted in resilient contact terminals mounted on the top hardware of an insulator in the conventional manner.

The lower end of the hollow cylindrical housing is closed by the enlarged portion 8 formed integrally on one end of the dielectric expulsion tube 11. This tube is conveniently formed of an outer Bakelite impregnated rolled paper, and an inner tubular lining 12 of horn fibre. A spiral groove 13 interiorly formed in the inner tubular lining 12 of the expulsion tube serves to relieve pressure within the hollow housing when an arc occurs during circuit interruption.

Fixed to the mounting ferrule 6 by screws 16, and extending into the dielectric housing 2 is a substantially spool-shaped dielectric mounting plug 17. As seen in Fig. 1, the mounting plug is provided adjacent its lower end with an integral annular flange 18 conforming to the inside diameter of the housing 2. From the flange 18, the mounting plug extends upwardly in a concentric central section 19 which terminates adjacent the top of the cylindrical housing in a pair of integral oppositely extending radial lugs 21. It is into these lugs that the screws 16 are threaded to secure the mounting plug to ferrule 6. The proportions of the parts are such as to provide a chamber 22 between the lower flange 18 and the top surface of the enlarged portion 8 of the expulsion tube. This chamber constitutes a cooling and de-ionizing chamber, and is provided with coils of fine mesh screen 22–A. The efficiency and interrupting ability of the device is thus increased, since the screen coils cool the gases resulting from the arc and aid in reducing the pressure generated by the gases, permitting the interruption of a higher current. The chamber communicates with the central bore 23 formed in the mounting plug 17, which is axially aligned with the bore of expulsion tube 11.

As shown best in Fig. 1, the plug 17 and expulsion tube 11 are adapted to slidably receive within their respective bores, a cylindrical latch rod 24 and the metallic electrode 26. A threaded stud 27 on the metallic electrode detachably secures the two in coextensive alignment, and their lengths are gauged so as to position their juncture 28 immediately below the flange 18 and within the chamber 22. The latch rod 24 may be of an insulating material such as horn fibre or a synthetic resin or a semi-insulating material such as thyrite.

The latch rod 24 is provided adjacent its upper end with an annular groove 29 adapted to receive therein in locking relation the latch lug 31. The latch lug is pivotally journaled on the upwardly projecting bearing portion 32, integral with plate 33 secured to the top surface of the mounting plug by suitable screws 34. The plate 33 is centrally apertured to permit the passage of the latch rod 24; and the mounting plug is undercut sufficiently beneath the plate 33 to provide a slideway for a centrally apertured slide plate 36. The slide plate 36 is resiliently pressed to the left in Fig. 1 by a leaf spring 37 secured to the plug by screw 38.

The lateral force exerted by the leaf spring 37 on slide plate 36 is utilized to lock the latch rod 24 and movable electrode 26 against the downward force exerted by the conventional terminal spring arm 39, shown in Fig. 1.

As seen in Figs. 1, 3 and 4, the right end of slide plate 36 is provided with mutually extending hooks 41 en-

gaging the upper bifurcated end 42 of the pivotally mounted rocker arm 43. The upper bifurcated ends of the rocker arm impinge against the mutually bifurcated lower ends 44 of lever bracket 47. A latch retaining cam 48 pivoted on bearing portion 32 above the latching lug, is integrally united to the lever bracket 47, and, in the position shown, provides a cam surface 49 impinging against the latching lug so as to prevent pivotal movement of the latching lug and consequent withdrawal of the electrode 26. A bracket plate 51 secured to the mounting plug serves to pivotally journal the rocker arm 43; and also serves to anchor one end of a tension spring 52, the other end of which is secured to the latching lug. The function of spring 52 is to return the latching lug to the position shown after circuit interruption has been effected by withdrawal of the electrode 26.

Means are provided to complete a conducting path between the metallic ferrule 6 and the movable electrode 26 when the latter is in the position shown.

Within the chamber 22 and spaced from flange 18, are a plurality of metallic contact points 56, conveniently placed at 120° intervals around the metallic electrode and held resiliently thereagainst by spring arms 57. The spring arms extend upwardly and are secured to the mounting plug flange 18 by screws or rivets 58. Secured to the inner surface 59 of the flange by any suitable means is an arcuate plate 61 having an integral lug 62 extending from its outer periphery. The plate is electrically connected to the spring arms 57 and contact points 56 by screws 58; and the lug 62 is integrally united to a bi-metallic strip 63 projecting substantially parallel to the mounting plug axis. The upper end of the bi-metallic strip impinges against the left end of slide plate 36. Thus, flexure of leaf spring 37 slides the plate 36 to the left against the resistance of the strip; and flexure of the bi-metallic strip due to an increase in temperature slides the plate to the right against the resistance of spring 37. The upper end of the bi-metallic strip is electrically connected with the metallic ferrule 6 by flexible conductor 64, secured to the strip as by soldering, and provided at its upper end with the integral U-shaped spring clip 66, resiliently and electrically engaging the mounting ferrule within the flat side walls 7.

An electrical conducting path is thus completed between the ferrule 6 and the metallic electrode 26. The thermo-responsive bi-metallic strip 63 is selected to normally permit the rated current load to flow through the device. A dangerous overload however will heat the strip beyond its selected critical value, causing flexure and movement of slide plate 36 to the right. This results in pivotal movement of rocker arm 43 and lever bracket 47 with its integral latch retaining cam 48. The latch lug 31 is thus freed to pivot counterclockwise, allowing the tensioned terminal spring arm 39 to rapidly withdraw the electrode 26 and latch rod 24, thus interrupting the circuit.

When the latch rod and electrode are reinserted to reestablish the circuit, the rounded upper end of the latch rod tips or pivots the latch lug clockwise, permitting the latch retaining cam to be repositioned above the latch lug, locking it against counterclockwise movement until another overload occurs or until the mechanism is otherwise tripped. Latching is thus automatically accomplished with insertion of the latch rod.

Circuit interruption is insured by electromagnetic means, including a ferrous core 68, cooperating with armature 69 secured to the lower end of rocker arm 43. The core is conveniently arcuate, and concentrically positioned about the reduced diameter central section 19 of the mounting plug 17. The core passes around the current carrying bi-metallic strip 63, and is magnetically energized thereby. When a dangerous overload occurs in the circuit, the magnetic field is intensified, and the pivotally mounted armature is magnetically attracted by the core. Inward movement of the armature results in pivotal movement of rocker arm 43 against leaf spring 37, thus releasing the latch mechanism as previously explained.

In some instances it may be desirable for a lineman to manually trigger the latching mechanism in order to break the circuit. For this purpose I provide a dielectric stem 71, extending through the housing wall and impinging against the armature 69. Outside the housing the stem is provided with a head 72 between which and the housing is interposed the compression spring 73. Pushing the button inwardly to compress the spring causes armature 69 to pivot inwardly, unlatching the latching mechanism.

When electrical circuits are suddenly broken, a heavy arc tends to form at the point of separation of the conductors. In this case the point of separation occurs between the spring pressed contact points 56 and the movable electrode 26. As the movable electrode or conductor moves outwardly within the expulsion tube, an arc may form between the conductor and the contacts. To prevent the arc from burning the contacts, I provide a secondary path for the arc to follow.

Positioned below the contact points 56 and suspended from the flange 18 by a conducting hanger 76 (Fig. 4) is an open circular contact ring 77 having a gap 78 between its ends. The ring substantially encircles the movable electrode, as shown in Fig. 7, and is positioned closely under the spring pressed contact points so that the arc from the contacts tending to follow the movable conductor will immediately be transferred to the open or interrupted contact ring 77. Due to the separate magnetic fields around the arc and around the circular contact ring, the arc will be driven counterclockwise as viewed in Fig. 7. If the arc persists it will reach the open gap 78 in the open contact ring, jump the gap and start around again. In this way the arc is kept moving and concentrated burning of contact points or electrode does not occur, and long life is insured.

Since the device is provided with an expulsion tube having internal spiral grooves, the gases generated by an arc are permitted to escape to the atmosphere, from the housing along the groove before the movable electrode has moved out of the expulsion tube thus permitting a very small clearance between the movable electrode and the bore of the tubular lining. The small clearance results in a high volts per inch interrupting ability on light currents and the spiral groove provides for the interruption of large currents without the pressure exceeding a safe amount.

When an overcurrent has caused the device to trip, the movable electrode remains suspended on the resilient switch arm as a visual indication to the lineman to show him the circuit is open. It should be noted that two or more of my circuit breakers may be mounted so that successive circuit breakers will trip out of the circuit if a fault persists. When the circuit breakers are ganged in this manner, the first circuit breaker tripped by the fault completes the circuit through the second. If the fault persists, the second circuit breaker trips out and completes the circuit through a third. If the fault has by then been cleared, the circuit remains energized through the third circuit breaker, thus preventing an outage.

I claim:

1. A circuit breaker for interrupting high tension electrical circuits comprising a hollow dielectric housing symmetrical about a longitudinal axis, a deionizing chamber therein adjacent one end, a metallic terminal cap closing the other end of the housing, a hollow expulsion tube axially extending from the deionizing chamber, a movable metallic electrode within the expulsion tube and terminating in the deionizing chamber, means within the housing interposed between the terminal cap and said movable electrode to form a current conducting path therebetween, latch means pivotally mounted within the

housing and isolated from said deionizing chamber to releasably lock the movable electrode in series circuit with said terminal cap, and means resiliently engaging said electrode to expel the electrode from the housing when the latch is released.

2. A circuit breaker in accordance with claim 1, in which the expulsion tube is provided with an interiorly formed spiral groove communicating between the deionizing chamber of the hollow housing and the atmosphere.

3. A circuit breaker in accordance with claim 1, in which the means forming the current conducting path between the terminal cap and the electrode terminating within the deionizing chamber and includes a thermo-responsive bi-metallic strip.

4. A circuit breaker in accordance with claim 1, in which the means forming the current conducting path between the terminal cap and the electrode includes a thermo-responsive bi-metallic strip and a plurality of contact points resiliently engaging the metallic electrode within the deionizing chamber.

5. A circuit breaker in accordance with claim 1, in which electromagnetic means are provided to release said latch in response to a current overload in the circuit, said electromagnetic means isolated from said deionizing chamber.

6. A circuit breaker in accordance with claim 1, in which a dielectric mounting plug is fixed within the housing to define one wall of the deionizing chamber within the housing, and said latch means is pivotally mounted on the mounting plug.

7. The circuit breaker according to claim 1, in which metallic means are provided within the deionizing chamber in circuit with said current conducting path means and spaced concentrically about said movable electrode whereby when said electrode is expelled from said housing said metallic means forms a secondary conducting path having an air-gap and along which an arc may travel.

8. A circuit breaker in accordance with claim 1, in which said isolated latch means includes a spring pressed pivotally journaled latch lug cooperating with a spring pressed latch retaining cam to releasably lock the electrode in series circuit with said terminal cap.

9. A circuit breaker in accordance with claim 2, in which said isolated latch means includes a spring pressed pivotally journaled latch lug cooperating with a spring pressed latch retaining cam to releasably lock the electrode in series circuit with said terminal cap.

10. A circuit breaker in accordance with claim 4, in which a releasable spring clip resiliently engaging the terminal cap and fixed to the bi-metallic strip is included in said means forming a conducting path between the terminal cap and the electrode.

11. A circuit breaker in accordance with claim 4, in which electromagnetic means isolated from said deionizing chamber are provided responsive to a current overload in said bi-metallic strip to release said latch to unlock said electrode.

12. A circuit breaker in accordance with claim 6, in which said latch means includes a spring pressed pivotally journaled latch lug cooperating with a spring pressed latch retaining cam to releasably lock the electrode in series circuit with said terminal cap.

13. A circuit breaker in accordance with claim 6, in which the means forming the current conducting path between the terminal cap and the electrode includes a thermo-responsive bi-metallic strip and a plurality of contact points resiliently engaging the metallic electrode within said deionizing chamber.

14. A circuit breaker in accordance with claim 6, in which metallic means are provided within said cooling and deionizing chamber in circuit with said current conducting path means and spaced concentrically about said movable electrode whereby when said electrode is expelled from said housing said metallic means forms a secondary conducting path having an air-gap and along which an arc may travel.

15. A circuit breaker for interrupting high tension electrical circuits comprising a hollow dielectric housing symmetrical about a longitudinal axis, a metallic terminal cap closing one end of the housing, a hollow expulsion tube axially extending from the other end of the housing and having an interiorly formed spiral groove communicating between the interior of the hollow housing and the atmosphere, a dielectric mounting plug within the housing and spaced from said expulsion tube to define a cooling and deionizing chamber therebetween, said mounting plug having a longitudinal bore axially aligned with said expulsion tube, a movable metallic electrode within the expulsion tube and extending into the cooling and deionizing chamber within the housing, means within the housing interposed between the terminal cap and said movable electrode to form a current conducting path therebetween, latch means pivotally mounted on said mounting plug wtihin the housing and isolated from said deionizing chamber to lock the movable electrode in series circuit with said terminal cap, and means resiliently engaging said electrode to expel the electrode from the housing when the latch is released.

16. A circuit breaker in accordance with claim 15, in which a latch rod is provided fixed on said electrode and projecting through said mounting plug bore, and said latch means releasably engages the latch rod.

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