

Aug. 19, 1952

H. O. STOELTING ET AL

2,607,869

AUTOMATIC CIRCUIT INTERRUPTER

Filed Sept. 8, 1951

2 SHEETS—SHEET 1

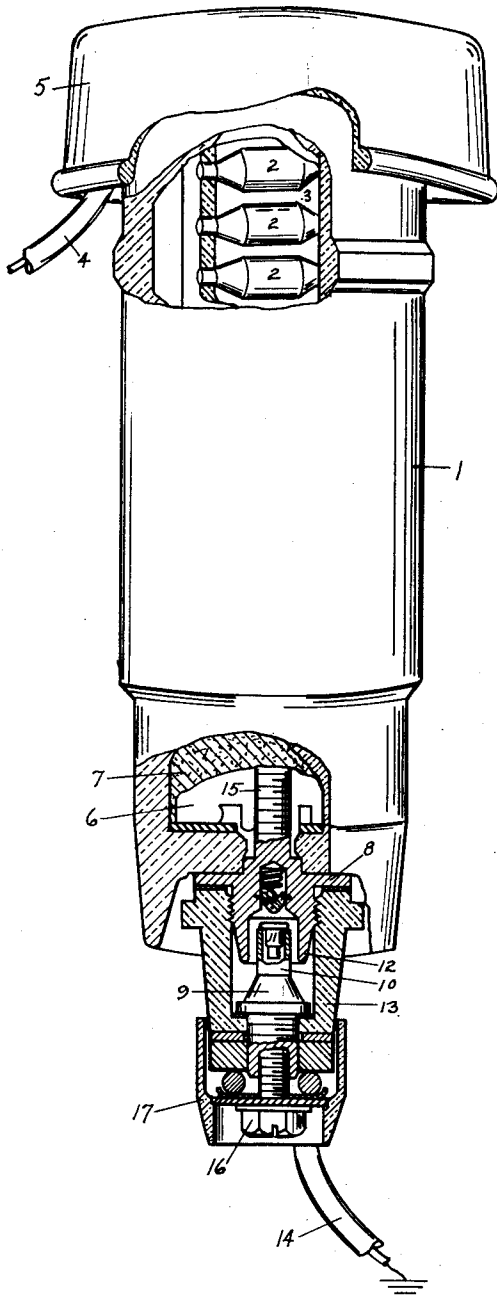


Fig. 1

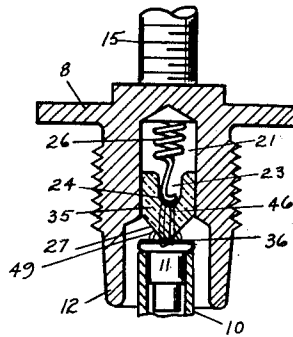


Fig. 3

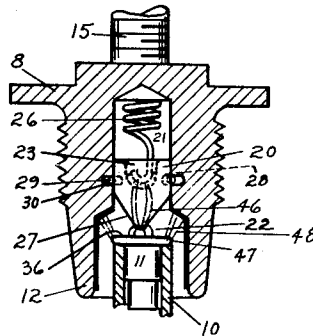


Fig. 2

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2 SHEETS—SHEET 2

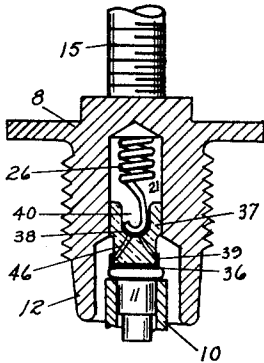


Fig. 4

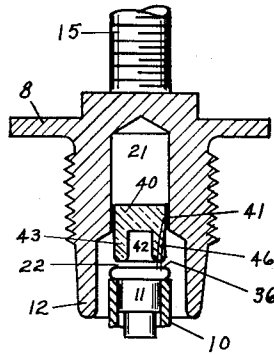


Fig. 5

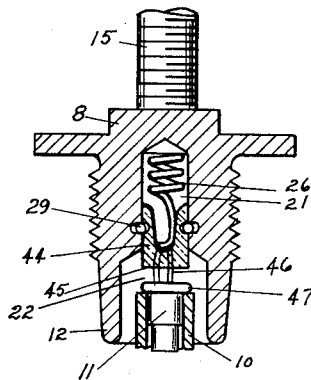


Fig. 6

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AUTOMATIC CIRCUIT INTERRUPTER

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7 Claims. (Cl. 200—115)

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This invention relates to an automatic circuit interrupting device for protective apparatus in electric transmission lines.

Lightning arresters of the class hereinafter described comprise a combined enclosed arc gap and valve material connected in series. The gap is intended to break down when a voltage higher than a predetermined value is impressed thereon and to interrupt current flow across the gap when the voltage and current flow have dropped to predetermined values. The valve material is intended to limit current flow across the gap to an amount determined by the voltage impressed on the gap. Thus the gap and valve material are co-ordinated to permit voltages in an electric line in excess of a predetermined value to be discharged to ground and to interrupt the flow of current to ground when the line voltages have returned to a value below the predetermined value.

Heretofore, it has been the practice to provide circuit interrupters for lightning arresters as described above, and which are so arranged that for ordinary discharges, the interrupter will not function, but for unusually heavy discharges which result from a breaking down of the valve material, for instance, the interrupter will function and permanently open the circuit to the ground of the lightning arrester. This type of structure is shown in the patent to R. H. Earle, No. 2,315,320 granted March 30, 1943 for Automatic Circuit-Interrupting Device, owned by the assignee of the present invention.

It is an object of this invention to provide a novel circuit interrupter which responds in its various embodiments to a materially reduced impulse ratio; the impulse ratio being defined as the ratio of the breakdown voltage under a standard surge test wave front to the breakdown voltage under normal-frequency voltage.

It is another object of this invention to provide an interrupting device for lightning arresters with a pre-ionizing means for reducing its impulse ratio; the pre-ionizing means taking the form, in the preferred embodiment, of a tapered plug of insulating material having a comparatively high dielectric constant proximate to an electrode, the resulting field distribution being such as to cause partial breakdown of the air particles proximate to the discharge surface of the plug with subsequent emission of charged particles in all directions.

It is furthermore, an object of this invention to provide an interrupting device for a lightning arrester in which the spark-over has been mate-

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rially lowered by the use of a ceramic or other high-dielectric-constant body as a spark initiator, and which also provides a more consistent spark-over voltage than when air alone provides the gap, the insulating body serving only as a spark initiating medium.

In the drawings:

Fig. 1 is an elevation of a lightning arrester with the novel circuit interrupter attached with parts broken away and parts in section.

Fig. 2 is a fragmentary sectional view, substantially enlarged, illustrating the novel interrupter in its preferred embodiment.

Figs. 3 through 6 are fragmentary sectional views, substantially enlarged, illustrating various modifications of the novel circuit interrupter.

Referring to the drawings, it will be seen that the lightning arrester comprises a ceramic or other insulating casing 1, within the upper part of which is housed the conductors 2 which are spaced apart to form a series of spark gaps 3. The upper part of the lightning arrester is connected to the line wire or power line by means of the conductor 4 and is capped by means of the insulating cap 5. The lower part of the arrester is provided with a lower terminal 6, and the negative resistance material 7 is interposed between the lower end of the spark gap structure and the lower terminal 6 in accordance with the disclosure in the above mentioned patent granted to R. H. Earle.

The interrupting device has the general characteristics of the structure disclosed in the prior patent hereinabove mentioned, and is composed of an upper terminal indicated by the reference character 8 and a lower terminal indicated by the reference character 9. The lower terminal is provided with a shell-like portion 10 which carries an explosive charge in the form of a cartridge 11. The shell 10 is spaced from a surrounding lip 12 of the upper terminal and is arranged to be heated when heavy sparking occurs and thereby ignite and cause explosion of the explosive during the flow of excessive current from the lightning arrester through the interrupter. The two terminals are held in spaced relation by means of an insulating breakable shell 13 and the ground wire 14 is electrically connected to the lower terminal, such ground wire being grounded as shown in Fig. 1.

The upper terminal 8 may be provided with a threaded stem 15 which screws into the lower terminal 6 of the lightning arrester, the lower terminal 9 being connected to the ground wire 14

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by means of a screw 16, a suitable insulating shell 17 provided for this connection.

In the preferred form of this invention illustrated in Figs. 1 and 2, the improved interrupter includes a novel insulating plug 20, which may be made preferably of steatite or other insulating material having a relatively high dielectric constant. The plug 20 rests in the bore 21 of the upper terminal 8. Laboratory tests have indicated that it is preferable to have the plug positioned directly above the cartridge 11 with a minute air gap 22 therebetween, although satisfactory results have been obtained with the modified structures shown in Figs. 3 and 4, the plug lightly contacting the upper surface of the cartridge 11.

The plug is preferably provided with a well 23, the surface of which has a conducting coating 24. It is within the scope of this invention to use any liquid conducting medium such as mercury, conducting ink, conducting paint, or the like. Electrical contact between the well surface and the upper terminal 8 may be provided as shown with a "cat whisker" biased towards contact with one end formed in a coil spring 26. The free end of the insulating plug 20 is preferably tapered as shown to provide a substantially conical discharge surface 27. A simple way of positioning a plug within the bore 21 of the upper terminal is to construct the plug with an angular groove 28, in which is positioned a spring washer 29 biased outwardly. The plug 20 may then be locked in position on engagement with the spring washer 29 and an annular groove 30 in the upper terminal.

Modifications of the novel structure and within the scope of this invention will now be described, the various components being identified by the same reference characters where they are substantially identical. Certain of the modified structures have insulating plugs in intimate contact with the upper surface of the explosive cartridge while other embodiments of the plug member provide a minute air gap, but it is to be noted that in all cases the plug is immediately adjacent the cartridge.

Fig. 3 illustrates a comparatively simple form of this invention. Here, the plug 35 is devoid of any locking means such as the cooperating spring washer and annular grooves of the embodiment shown in Fig. 2. In this embodiment, the plug is permitted to rest lightly upon the upper surface 36 of the explosive cartridge 11. This embodiment provides satisfactory results and is simpler to manufacture than the preferred embodiment.

Fig. 4 also discloses an embodiment of this invention utilizing an insulating plug 37 resting on the upper surface 36 of the cartridge 11. In this embodiment the plug 37 does not have the exposed end tapered, but employs two conducting coatings 38 and 39. The coating 38 in the well portion 40 is substantially identical to that of the preferred embodiment, while the coating 39 may be cup-like, as shown, extending slightly upwardly from the base.

The embodiment illustrated by Fig. 5 utilizes an air gap 22 between the plug 40 and the upper surface 36 of the cartridge 11. Here the plug preferably has an outer coating 41 of conducting material providing intimate electrical contact with the upper terminal 8. However, it will be apparent that if close tolerances are maintained between the plug and the terminal, the coating may be omitted. Here, the plug is provided with a bore 42 defining an annular projecting wall 43.

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Fig. 6 illustrates an insulating plug 44 similar to the preferred structure of Figs. 1 and 2, but with the tapering omitted. Here, the exposed surface 45 is flattened on a plane substantially parallel to the plane of the upper surface 36 of the cartridge.

Operation of the improved circuit interrupter is as follows:

Referring to Fig. 2, which has been enlarged for convenient explanatory purposes, the insulating plug 20 is shown positioned to provide a minute air gap 22 between the discharge end and the upper surface 36 of the cartridge 11.

It has been found in the practice of this invention that spark-over occurs at lower values when a dielectric gradient is produced in the proximity of the terminals 8 and 9. This gradient is established between the air as a dielectric and the relatively high-dielectric-constant insulating plug. The dielectric flux lines established prior to spark-over are bent or refracted as they pass from one dielectric to the other of a different permittivity. The novel plug 20 is preferably formed as shown, with the free end tapered to provide a conical surface 27 as a convenient means for focusing the refracted flux lines 46. The concentration of refracted flux lines readily serves to pre-ionize the atmosphere in the vicinity of the discharge surface 27 and the upper surface 36 of the explosive cartridge.

A more precise control of the air breakdown is obtained by the use of an insulating plug of a relatively high dielectric-constant which gives the desired low impulse ratio by utilizing the radiation present in the usual enclosed gap. Obviously, the novel insulating plug serves only as a spark-over initiator. After breakdown has been initiated, current flow will be established in the more favorable path between the upper terminal 8 and the conducting shell 47 of the cartridge. This is shown diagrammatically by the lines 48 in Fig. 2. The insulating plug will be by-passed after initial breakdown with the current taking the easier path 48, and heating the cartridge 11 to cause it to explode, thus severing the ground connection from the lightning arrester.

The operation of the various modifications disclosed in Figs. 3 through 6 is based on the same principle underlying the operation of the preferred embodiment described above in connection with Figs. 1 and 2; viz, spark-over occurs at lower values when a dielectric gradient is produced in the proximity of the opposed terminals 8 and 9.

The dielectric flux lines 46 of the embodiment illustrated in Fig. 3 are concentrated by the focusing tapered surface providing discharge surface 27. A satisfactory air breakdown occurs at the fringe areas designated by the reference character 49. This breakdown is not as easily controlled as that of the minute air gap 22 provided in the preferred structure. After the initial breakdown occurs, spark-over takes place between the upper terminal 8 and the shell 47 of the cartridge 11, the cartridge exploding upon heating to interrupt ground connection.

The Fig. 4 structure operates by setting up a concentration of dielectric flux lines 46 between the conducting coating 38 and the cup-like coating 39 as shown.

The structure shown in Fig. 5 provides a means of concentrating flux lines 46 by utilizing an annular wall 43 projecting from the bore 42 of the upper terminal 8, to the air gap 22 between

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the exposed end of the plug 40 and the upper surface 36 of the cartridge.

Fig. 6 illustrates a further modification of the preferred structure of Figs. 1 and 2. An air gap 22 is required here to insure a refracting of the flux lines 46 because of the omission of the tapered discharge surface of the preferred structure. Again, the flux lines 46 produce a breakdown in the air gap 22, from which spark-over occurs. In all embodiments it will be apparent that the insulating plug acts only as a means of concentrating dielectric flux lines for initiating spark-over. After spark-over occurs, the insulating plug will be by-passed with the current taking the easier spark-over path to ground.

We claim:

1. A circuit interrupter including a pair of terminals, an insulating housing embracing said terminals and holding them in releasable spaced relation, one of said terminals having a centrally located bore interiorly of said housing, an explosive cartridge including a metal casing secured to the other terminal within said housing and adjacent said one terminal, and an insulating plug member in said bore and having one end adjacent said cartridge.

2. A circuit interrupter including a pair of terminals, a frangible insulating housing embracing said terminals and holding them in spaced relation, one of said terminals having a centrally located bore interiorly of said housing, an explosive cartridge including a metal casing secured to the other terminal within said housing and adjacent said one terminal, and an insulating plug member in said bore having one end tapered and adjacent said cartridge.

3. A circuit interrupter including a pair of terminals a frangible insulating housing embracing said terminals and holding them in spaced relation, one of said terminals having a centrally located bore interiorly of said housing, an explosive cartridge including a metal casing secured to the other terminal within said housing and adjacent said one terminal, an insulating plug member in said bore having one end open in said bore and the other end closed and adjacent said cartridge, and a contactor in said bore engaged at one end with said one terminal and at the other end with said closed end of said plug member.

4. A circuit interrupter including a pair of terminals, an insulating housing embracing said terminals and holding them in releasable spaced relation, one of said terminals having a centrally located bore interiorly of said housing, an explosive cartridge including a metal casing secured to the other terminal within said housing and

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adjacent said one terminal, an hollow insulating plug member in said bore having one end open in said bore and the other end closed, said closed end being tapered and adjacent said cartridge, and a contactor in said bore engaged at one end with one terminal and the other end with said closed end of said plug member.

5. A circuit interrupter including a pair of terminals, a frangible insulating housing embracing said terminals and holding them in spaced relation, one of said terminals having a centrally located bore interiorly of said housing, an explosive cartridge including a metal casing secured to the other terminal within said housing and adjacent said one terminal, and an insulating plug member in said bore, said plug member being provided with a locking means, said locking means cooperating with said one terminal, said plug member jointly providing an air gap with said cartridge.

6. A circuit interrupter including a pair of terminals, an insulating housing embracing said terminals and holding them in releasable spaced relation, one of said terminals having a centrally located bore interiorly of said housing, an explosive cartridge including a metal casing secured to the other terminal within said housing and adjacent said one terminal, an hollow insulating plug member in said bore having one end open in said bore and the other end closed and adjacent said cartridge, said hollow plug member having a conducting medium contained therein, and a contactor including a biasing portion for maintaining electrical contact between said conducting medium and said one terminal.

7. A circuit interrupter including a pair of terminals, an insulating housing embracing said terminals and holding them in releasable spaced relation, one of said terminals having a centrally located bore interiorly of said housing, an explosive cartridge including a metal casing secured to the other terminal within said housing and adjacent said one terminal, an hollow insulating plug member in said bore having one end open in said bore and the other end closed, said hollow plug member having a conducting medium contained therein, and a contactor including a biasing portion for maintaining electrical contact between said conducting medium and said one terminal, and a locking means arranged to jointly cooperate with said plug member and said one terminal said plug member jointly providing an air gap with said cartridge.

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No references cited.