May 29, 1934. H. B. WOLF 1,960,653

LIGHTNING ARRESTER

Filed Sept. 10, 1932

FIG. 1.

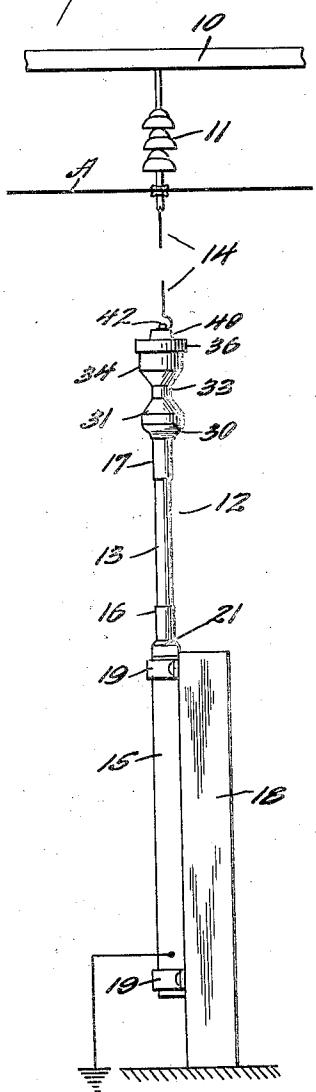


FIG. 2.

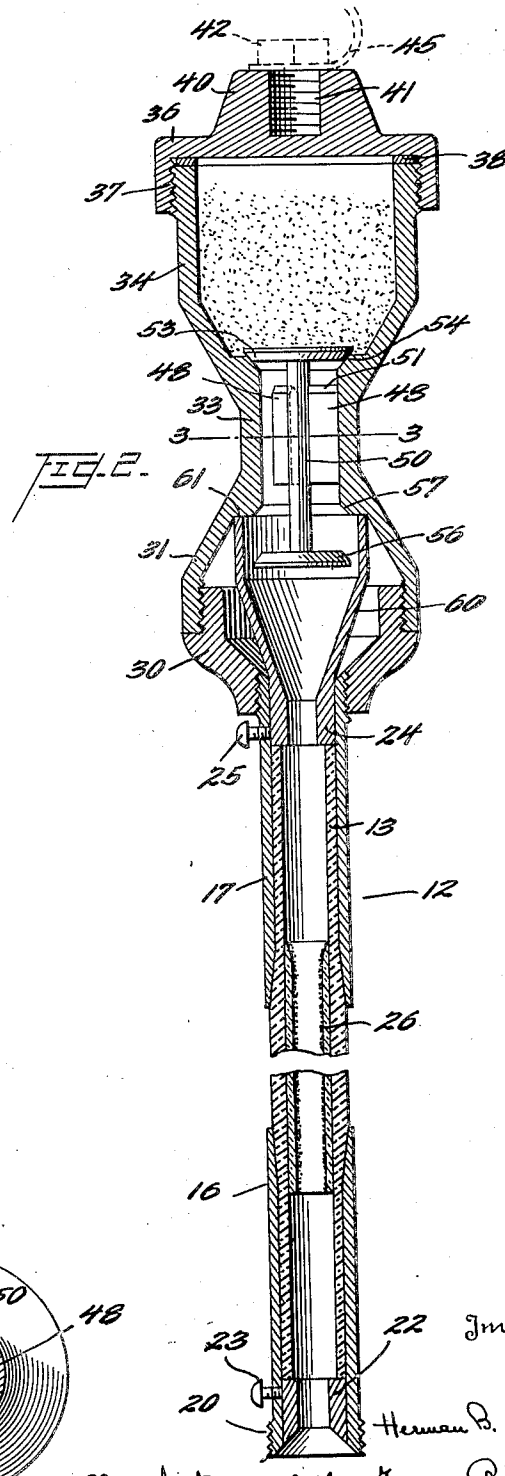
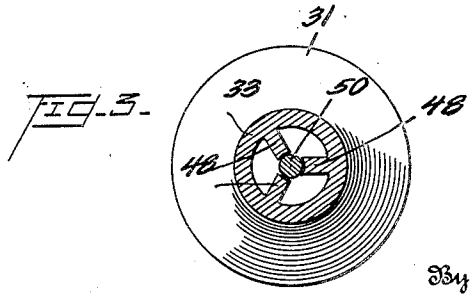


FIG. 3.



Inventor

Herman B. Wolf

By Watson, Cole, Marse & Grindle

Attorneys

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LIGHTNING ARRESTER

Herman B. Wolf, Charlotte, N. C.

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19 Claims. (Cl. 175—30)

This invention relates to electric protective devices and more particularly to devices of this character known as lightning arresters and designed primarily for the protection of electrical equipment from damage by lightning discharges or other abnormal potentials.

It is customary to deal with the effects of a lightning discharge by providing a high resistance electrical path between an element to be protected and the ground, the resistance being sufficient to prevent loss of electrical energy from the protected member under normal conditions of voltage and frequency. On occurrence of a lightning discharge, resulting in the application to the protected member of electrical energy of extremely high voltage, this high voltage energy breaks down the resistance of the electrical path and is discharged harmlessly into the ground, thereby relieving the protected member of the abnormal charge. The high resistance electrical path usually includes one or more spark gaps, and when the high voltage disturbance causes arcing across these gaps, the air in the vicinity of the gap becomes ionized, thus greatly reducing the resistance, and it is necessary to provide some means for opening the circuit after each discharge.

It is an object of the invention to provide a high resistance electrical path of the aforementioned character including means forming a portion of the path offering a comparatively low initial resistance, this means being dissipated by the heat developed by the electrical discharge, whereby the resistance of the path is increased to facilitate the extinguishing of the arc.

It is a feature of the invention that the means thus dissipated by the electrical discharge is automatically replaced in response to the effect of the discharge so that the electrical path between the member to be protected and the ground will be restored to its initial condition after each discharge.

A more specific object of the invention is the provision of a device affording an electrical discharge path and including conducting material adapted to be destroyed by the heat of the electrical discharge together with means automatically operable to replace the conducting material thus destroyed in response to pressure developed by the discharge.

Further objects and features of the invention will be apparent from the following description taken in connection with the accompanying drawing, in which:

Figure 1 is an elevational view illustrating one application of the lightning arrester constructed in accordance with the present invention;

Figure 2 is a sectional view of an embodiment of the arrester; and

Figure 3 is a transverse sectional view on the line 3—3 of Figure 2.

In order to facilitate an understanding of the invention, specific language is used herein in describing the single embodiment of the invention selected for the purpose of illustrating the principles thereof. It will nevertheless be understood that various alterations and changes in this specific construction may be made without departing from the principles of the invention and that no restriction of the invention is intended by the use of specific descriptive language.

Referring to the drawing, it will be observed that the reference numeral 10 designates a supporting arm or girder to which are suspended insulators, from which insulators is suspended the member or conductor A to be protected, which has been shown as a power line or busbar, it being appreciated that the device is applicable in substantially the same manner to transformers and other electrical equipment. The arresting device is indicated generally at 12 and is connected in a high resistance electrical path between the member A and the ground, this path including a spark gap comprising spaced electrodes 14 and a pipe or conduit 15. The pipe 15 is grounded as indicated in the drawing and is mounted on a suitable support 18 by means of brackets 19, this conduit being open at both ends and communicating with the interior of the arresting device 12 as described more particularly hereinafter.

The portion of the arresting device 12, in which the arc is formed during discharge, is illustrated as consisting of a substantially cylindrical tube 13 of bakelite or other insulating material, having an inner liner or shell 26 of fibrous material. The tube 13 is open at each end and is supported in metal ferrules 16 and 17 adjacent its lower and upper ends respectively. The lower end of the ferrule 16 is threaded as indicated at 20 for connection to the pipe 15 through a suitable reducing coupling 21 whereby the device 12 may be adequately supported and grounded. A conductor 22 is retained in position in the lower end of the ferrule 16 in any suitable manner, for instance by the set screw 23, and a corresponding conductor 24 is secured in the upper ferrule 17 by means of a set screw 25, it being observed that these conductors abut the opposite ends of

the composite tube 13 and 26 which serves as a spacing member for the conductors.

It will now be appreciated that the bakelite tube 13 and the shell 26 constitute a chamber of elongated shape in which a discharge may occur between the conductors 22 and 24 upon the application of electrical energy of sufficient voltage and frequency thereto, and while it is found convenient to construct this chamber of tubular shape to facilitate manufacture of the device and reduce the cost of materials, the precise shape of the chamber is not of major importance.

If the interior walls of this chamber are coated with conducting material, for instance an aluminum powder, the resistance of the path between the conductors 22 and 24 will be materially reduced, and the formation of an arc between the conductors will be facilitated. The heat from this arc, however, will rapidly vaporize the conducting coating, thus materially increasing the resistance between the conductors, and the heated gas including the vapors of the coating will be expelled violently from the lower end of the chamber and through the pipe 15 to a point adjacent the ground where they are exhausted harmlessly, this expulsion of gas serving to blow out or extinguish the arc formed within the chamber. It will be appreciated that the opening of the circuit is facilitated by the destruction of the conducting coating and the consequent increase in the electrical resistance of the path between the conductors 22 and 24.

The ferrule 17 is threaded at its upper end to receive a member 30 which is in turn threaded within a member 31, the latter having formed integrally therewith a tubular portion 33 and an enlarged portion 34, the latter constituting a reservoir for the metal coating hereinbefore referred to.

The open upper end of the reservoir 34 is normally closed by means of a cap 36 which is threaded thereon as indicated at 37, a washer 38 being placed between the cap and reservoir to effectively seal the latter.

The upper portion of the cap 36 is provided with a boss 40 having a threaded aperture 41 therein adapted to receive a bolt 42. A conducting element 45 is clamped beneath the head of the bolt 42, this conducting element preferably comprising a portion of one of the electrodes 14 of the spark gap hereinbefore described and shown in Figure 1 of the drawing.

The cylindrical portion 33 of the member 31 is provided with a plurality of inwardly extending lugs 48 which serve as a guide for a reciprocating valve stem 50, the upper ends of the lugs 48 being preferably beveled as indicated at 51. At its upper end the valve stem 50 is provided with a valve head 53 cooperating with a seat 54 formed at the lower end of the reservoir 34. At its lower end the valve stem 50 is provided with a valve head 56 which is designed for cooperation with a seat 57 formed in the member 31.

It will thus be seen that the valve stem 50 is supported for free vertical sliding movement in the guide lugs 48, and when in the lower position, as shown in Figure 2 of the drawing, the valve head 53 engages the seat 54 to seal the lower open end of the reservoir 34. When the valve stem 50 is raised to engage the valve head 56 with the valve seat 57, coating material may flow out of the reservoir 34 and between the lugs 48, substantially filling the cylindrical portion 33 of the member 31. When the valve stem 50 now drops to the lower position in which it is shown in Figure 2, the coating material collected in the cylindrical portion 33 of the device will be discharged downwardly through the tubular chamber and will lodge principally on the fibrous liner 26 of this chamber, any excess material being discharged through the lower end of the chamber and through the pipe 15 to the ground.

In order to facilitate discharge of the coating material into the chamber between the electrodes 22 and 24, the latter is preferably provided with an integrally formed funnel shaped portion 60 which abuts at its upper end an annular shoulder 61 on the member 31.

The operation of the device will now be apparent. On the occurrence of abnormal conditions in the member A, such as the setting up of a high voltage disturbance thereon as the result of a flash of lightning or other abnormal voltage, a discharge will be effected across the spark gap 14 and through the metal parts of the device 12 to the conductor 24. The current will now readily flow between the conductors 24 and 22 by reason of the deposit of conducting coating, for instance powdered aluminum, on the fibrous shell 26. As the result of the heat developed by this current, the conducting coating will be vaporized and the heated air, gas, or vapor will be forcibly expelled from the lower end of the device 12 and through the pipe 15 to a point adjacent the ground as hereinbefore explained.

The pressure developed in the chamber defined by the tube 13 will be communicated through the funnel 60 to the valve heads 56 and 53 and will force the valve stem 50 upwardly, thus permitting a fresh supply of the coating material to fall within the cylindrical portion 33 of the device. As the pressure is relieved by the expulsion of gas from the lower end of the device, the valve stem 50 will fall to its initial position, and the fresh supply of coating will be discharged downwardly through the funnel 60 and upon the walls of the chamber. The formation of gas within the chamber is facilitated to some extent by the decomposition of the fibrous liner 26.

It will be observed that the arrangement just described constitutes in effect an automatically operable fuse capable of relieving the excessive electrical pressure caused by a series of successive lightning discharges, it being only necessary to initially set the arrester by manually lifting the valve stem 50 to permit a measured quantity of the conducting coating to fall within the discharge chamber. Preferably the supply of coating material in the reservoir 34 is limited so that on the occurrence of such an abnormal condition as would result in persistant discharge through the device, the conducting coating in the reservoir will be exhausted and the device will cease to function.

It will be observed that the arrangement shown in Figure 2 of the drawing is of a relatively simple nature, is light and readily constructed, and may be quickly installed in any protective system. The occurrence of an abnormal condition in the line is very readily detected by the flash of the discharge through the lower end of the device so that any necessary steps to correct the condition may be taken promptly.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In a lightning arrester, the combination with a pair of spaced conductors, of a member of low conductivity positioned intermediate said

conductors and receiving a coating of finely divided conducting material destructible by heat, and means responsive to an electrical discharge between said conductors and through said coating for depositing a fresh coating on said member.

2. In a lightning arrester, the combination with a pair of spaced conductors, of a member of low conductivity positioned between said conductors and receiving a conducting vaporizable finely divided material, whereby on application of high voltage electrical energy to said conductors, the resulting discharge between said conductors and through said material will vaporize the latter, and a resetting device actuated by the pressure developed on vaporization of said material for delivering a fresh charge of material on said member.

3. In a lightning arrester, a pair of conductors, means intermediate said conductors affording a partial electrical path therebetween, said means including a charge of powdered conducting material which is dissipated on the occurrence of an electrical discharge between said conductors, and means automatically operable on the occurrence of a discharge for renewing said charge.

4. In a lightning arrester, a pair of conductors, means intermediate said conductors affording a partial electrical path therebetween, said means including a charge of powdered conducting material which is dissipated on the occurrence of an electrical discharge between said conductors, and a device responsive to the force developed by an electrical discharge for renewing the dissipated charge.

5. In a lightning arrester, the combination with a pair of spaced conductors, of means forming a chamber having a non-conducting interior surface disposed between said conductors, and means for depositing a coating of powdered conducting material which is dissipated by heat caused by flow of current upon said interior surface, said chamber having an opening communicating with the atmosphere, whereby an electrical current flowing between said conductors will dissipate said coating and interrupt the flow of current.

6. In a lightning arrester, the combination with a pair of spaced conductors, of means forming a chamber having a non-conducting interior surface disposed between said conductors, and means for depositing a coating of powdered conducting material which is dissipated by heat upon said interior surface, said chamber having an opening communicating with the atmosphere, whereby an electrical current flowing through the coating will dissipate said coating and cause an expulsion of hot gas through the opening to interrupt the flow of current, said means acting automatically in response to the pressure thus developed in said chamber to deposit a fresh coating of conducting material on the inner surface of said chamber.

7. In a lightning arrester, the combination with a pair of spaced conductors, of means forming a chamber having a non-conducting interior surface disposed between said conductors, and means for depositing a coating of powdered conducting material which is dissipated by heat upon said interior surface, said chamber having an opening communicating with the atmosphere, whereby an electrical current flowing between said conductors will dissipate said coating and cause an expulsion of hot gas through the opening to interrupt the flow of current, said means including a pressure actuated valve associated with said chamber for depositing a fresh coating of conducting material on the inner surface of said chamber after completion of the electrical discharge.

8. In an electric protective device, the combination with a destructible conductor composed of powdered conducting material, of means in series with said conductor affording a high resistance electrical path, whereby the application of a high voltage electrical disturbance to the ends of the said path will effect an electrical discharge therethrough, destroying said conductor, and means operable in response to such discharge for automatically replacing the destroyed conductor.

9. In an electric protective device, the combination with means affording a substantially tubular chamber, said chamber being open at one end and having an intermediate portion provided with a non-conducting surface, means comprising powdered conducting material carried on said surface, said conducting material being vaporizable in response to heat, and spaced conductors positioned to form an electrical arc within said chamber and through said conducting material, whereby on the application of a high voltage disturbance to said conductors, the heat provided by the flow of current will vaporize said conducting material and cause expulsion of the hot vapor through the open end of the chamber and thus interrupt the flow of current.

10. In an electric protective device, the combination with means affording a substantially tubular chamber, said chamber being open at one end and having an intermediate portion provided with a non-conducting surface, means comprising finely divided conducting material carried on said surface, said conducting material being vaporizable in response to heat, spaced conductors positioned to form an electrical circuit within said chamber and through said conducting material, whereby on the application of a high voltage disturbance to said conductors, the heat provided by the flow of current will vaporize said conducting material and cause expulsion of the hot vapor through the open end of the chamber to open the circuit, and a pressure operated device associated with said chamber for depositing said means on said surface after the arc is blown out.

11. In an electric protective device, the combination with means affording a high resistance electrical path and including a member of low conductivity receiving a deposit of finely divided conducting material destructible by heat, of a reservoir for such material positioned above said member, and a pressure responsive metering device associated with said reservoir for depositing a fresh supply of the said material on said member, whereby the pressure resulting from the destruction of the deposit of material on discharge of current through the said path will initiate operation of said device to replace the destroyed deposit of material on the said member.

12. In an electric protective device, the combination with a chamber having an opening therein through which hot gas may be expelled, of spaced conductors associated with said chamber, said chamber having a portion receiving a finely divided conducting coating disposed in the electrical path between the conductors and destructible when heated, a reservoir constituting a source of supply of such coating, and a valve for controlling the supply of coating from the reservoir to the chamber, said valve being auto-

matically operable in response to pressure developed in the chamber on electrical discharge between said conductors.

13. In an electric protective device, the combination with a chamber having an opening therein through which hot gas may be expelled, of spaced conductors associated with said chamber, said chamber having a portion receiving a finely divided conducting coating disposed in the electrical path between the conductors and destructible when heated, a reservoir constituting a source of supply of such coating, a valve for controlling the supply of coating from the reservoir to the chamber, said valve being automatically operable in response to pressure developed in the chamber on electrical discharge between said conductors, and a conduit associated with the opening in said chamber and extending to a point remote from said chamber.

14. In apparatus for effecting an electrical discharge from a member to be protected on the occurrence of abnormal conditions in the latter, the combination with a grounded conductor, of means affording a high resistance path between the member and the conductor, said means including, in series connection, a spark gap and a chamber receiving a destructible finely divided conducting material, and a grounded conducting passage communicating with said chamber and open to the atmosphere at a point adjacent the ground, whereby a high voltage discharge will produce a flow of current in said chamber, destroying said material, expelling the resulting hot gas through said passage, and thereby interrupting the flow of current.

15. In apparatus of the class described, the combination with an expulsion chamber having an exhaust opening therein and provided with a non-conducting interior surface, a coating of metallic conducting powder on said surface, and a pair of electrodes positioned to discharge within said chamber and through said powder.

16. In apparatus of the class described, the combination with an expulsion chamber having an exhaust opening therein and provided with a non-conducting interior surface, a coating of metallic conducting powder on said surface, a pair of electrodes positioned to discharge within said chamber and through said powder, and means operable by pressure developed in said chamber for depositing a fresh coating of metallic powder on the said surface.

17. An automatically renewable electrical fuse comprising, in combination, an insulating member receiving thereon a powdered conducting coating destructible by heat, a supply container for such coating, and means operable by the pressure developed on discharge of current through the coating on the said member for effecting transfer of a fresh coating from the supply container to the said member.

18. In a lightning arrester, the combination with a pair of spaced conductors, of a member of fibrous material and of low conductivity positioned intermediate said conductors and receiving a coating of finely divided conducting material destructible by heat, and means responsive to an electrical discharge between said conductors and through said coating for depositing a fresh coating on said member.

19. In a lightning arrester, the combination with a pair of spaced conductors, of a tubular member of fibrous material and of low conductivity positioned between said conductors and receiving a conducting vaporizable finely divided material, whereby on application of high voltage electrical energy to said conductors, the resulting discharge between said conductors and through said material will vaporize the latter, and a resetting device actuated by the pressure developed on vaporization of said material for delivering a fresh charge of material on said member.

HERMAN B. WOLF.