Dec. 15, 1942. W. A. McMORRIS 2,305,436

FUSE DEVICE

Filed Oct. 15, 1941

Fig. 1.

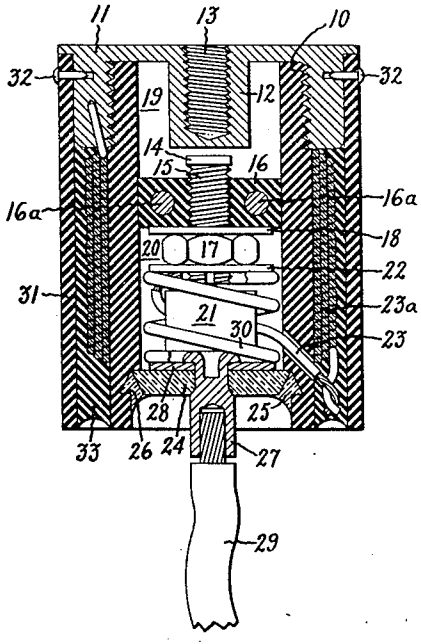
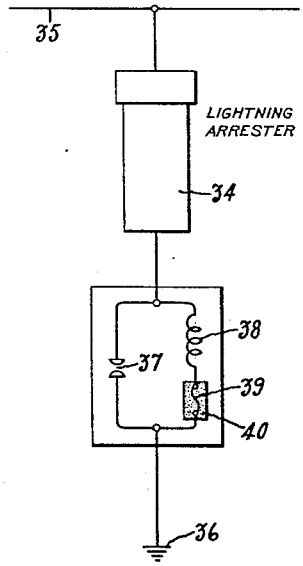


Fig. 2.



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His Attorney.

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UNITED STATES PATENT OFFICE

2,305,436

FUSE DEVICE

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12 Claims. (Cl. 200—115)

My invention relates to fuse devices and more particularly to improved fuses of the type having provision for preventing rupture of the fusible element by steep wave front voltages such as lightning surges.

It has been found desirable in some installations to provide a fuse which will not rupture when the circuit in which it is connected is subjected to steep wave front voltages but which will rupture upon the passage of power frequency current of predetermined duration or magnitude. For example, it is desirable to open the circuit through a lightning arrester in the event that it continues to pass current of power frequency after a discharge due to a voltage impulse such as a lightning surge. It is essential that the fuse blows only if the arrester passes several half cycles of power frequency current which is characteristic of an arrester after failure. When the arrester operates normally it will discharge impulse current which may be followed by power frequency current that will not last longer than one-half cycle, since an arrester in good condition is expected to interrupt the power frequency current at the first zero point. Hence the fuse should not blow due to impulse currents or due to power frequency currents of one or two half cycles' duration. A circuit arrangement of this type is described and claimed in Patent 2,158,859—Horikoshi, dated May 16, 1939, and assigned to the same assignee as the present invention. In the copending application of MacCarthy and Brownlee, Serial No. 390,076, filed April 4, 1941, and assigned to the same assignee as the present invention, there are described and claimed structural embodiments of impulse protected fuse devices of a type suitable for commercial application of the circuit disclosed in the Horikoshi patent. The present invention is in the nature of an improvement over the devices disclosed in the MacCarthy and Brownlee application.

It is, therefore, an object of the present invention to provide a new and improved impulse protected fuse device which is simple and relatively inexpensive to manufacture and which is, at the same time, reliable in operation.

For a further consideration of what I believe to be novel and my invention, attention is directed to the following description and the claims appended thereto, taken in connection with the accompanying drawing. In the drawing, Fig. 1 is an elevational view in section of one embodiment of my invention, and Fig. 2 is a schematic representation of the application of the device of Fig. 1 as an isolator for a lightning arrester.

Referring now to Fig. 1, the fuse device is generally cylindrical in form and comprises an inner cylindrical tube 10 of suitable insulating material such as fiber. The tube is externally threaded at one end to receive a sleeve or terminal cap 11 of conducting material. The cap is provided with an extension 12 which projects into the interior of the tube 10 and forms one electrode of an arc gap. The extension 12 is provided with a threaded opening 13 for the reception of a conductor, such as the grounding stud of a lightning arrester, and in this way forms one terminal of the device. The other electrode of the gap is provided by the end portion 14 of a stud 15 which is mounted in concentric relation with the tube 10 and with the end portion 14 in opposed relation to the end portion of the inwardly extending projection 12 of the cap 11. The stud 15 is threaded in an opening provided in a transverse barrier 16 of insulating material, such as fiber, which is secured in the tube 10 intermediate the ends thereof in any suitable manner, such as by the dowel pins 16a. The stud 15 is locked in position by a suitable nut 17 which is spaced from the fiber support by a washer 18.

The barrier 16 divides the interior of the tube 10 into an upper compartment 19 and a lower compartment 20. The upper compartment produces a sturdy housing for the arc gap provided by the members 12 and 14 which prevents damage thereto by the forces resulting from a lightning discharge while the lower compartment 20 houses a fusible element. In the embodiment shown in Fig. 1 the fusible element is housed within a container 21 and surrounded by a charge of explosive such as gunpowder. The container may well be formed of cardboard or similar material and treated with wax or other suitable impregnant. The fusible element, itself, is not shown in Fig. 1 of the drawing, but one terminal thereof is brought out through the container 21 and attached to a washer 22 which bears against the lower surface of the locknut 17. The other terminal of the fusible element is connected with a flexible conductor 23 which is brought out through the container 21 and an opening in the wall of tube 10 and joined with one end of an inductive winding 23a. As illustrated in the drawing, the inductive winding is in the form of a coil wound about the outer wall of the insulating tube 10 and has the other end thereof electrically connected with the terminal cap 11. In the particular arrangement shown the latter end of the coil is inserted in an opening in the terminal cap and prick-punched or otherwise de-

formed to form a good electrical connection therewith. The lower end of the tube 10 is closed by a disk 24 of porcelain or other suitable insulating material which is secured in position by means of a layer of cement 25 interposed between the edge of the disk and the wall 26 of a groove formed in the lower end of the tube 10. The disk 24 provides a support for a terminal member 27 of the fuse device as well as for the container 21 enclosing a fusible element and associated charge of explosive. As shown in the drawing, the terminal member 27 passes through the disk 24 and through a washer 28 of conducting material over the upper surface of which the end of the terminal member is peened. A suitable flexible conductor 29 is shown associated with the terminal member 27. A coil spring 30 interposed between the washer 28 and the washer 22 forms a conductive connection therebetween. The spring is normally in compression and serves to expel the disk 24 and terminal member 27 from the tube 10 when the fusible element is ruptured and the cemented connection between the disk and tube 10 is shattered by detonation of the explosive charge within the container 21. It will be apparent that other arrangements may be provided for closing the lower end of the tube 10 and that the portion of the tube engaging the terminal support may itself be made to shatter upon detonation of the charge surrounding the fusible element.

The coil 23*a* is protected by a cylinder 31 of mechanically strong insulating material or metal which extends in spaced relation with the coil and is substantially coextensive with the inner tube 10. The tube may be secured in position in any suitable manner and as shown is secured to cap 11 by pins 32. The space between the tube 10 and the tube 31 is filled with suitable insulating compound 33 which renders the fuse device weatherproof.

From the foregoing description it is apparent that the construction provides two parallel paths between the terminal cap 11 and the flexible conductor 29 which may be traced as follows: One path through the gap formed by extension 12 and the end portion 14 of the stud 15 to washer 22, thence through spring 30, washer 28, and terminal 27 to conductor 29; the other path includes the inductive winding 23*a*, conductor 23, the fusible element housed within container 21, washer 22, spring 30, washer 28, and terminal 27. Thus one path includes an arc gap and the other path an inductive winding and fusible element in series.

In Fig. 2 the circuit embodied in the arrangement disclosed in Fig. 1 is shown schematically in a circuit including a lightning arrester. Although Fig. 2 shows the isolating device connected on the ground side of the arrester 34, it may be advantageous to connect the isolating device on the line side of the arrester so that voltage will be removed from the arrester after the isolating device has operated. Referring to Fig. 2, the lightning arrester 34 is connected between a supply line 35 and ground 36 by the fuse device of the present invention which includes a pair of parallel electric paths in one of which is an arc gap 37 and in the other of which is an inductive winding 38 and a fusible element 39 surrounded by a quantity of explosive illustrated generally by the numeral 40. In the operation of the device, a surge current with a steep wave front will be imposed on the fuse device when the lightning arrester gaps spark over to conduct a surge to ground. When this surge current with a high rate of current rise passes through the isolating device, gap 37 will break down and carry the surge current because sufficient voltage will be developed across the inductance 38 to break down the gap 37. Power frequency current which the arrester may discharge following the impulse may or may not flow through the fuse 39, but this fuse is designed to pass without damage at least one-half cycle of power current of the magnitude permitted by the arrester. However, if the arrester does not interrupt the flow of power frequency current after the first half cycle, the gap 37 will stop conducting this current which will now flow through the inductance 38 and the fuse 39 since the voltage developed across the inductance 38 by the low frequency power current is insufficient to maintain the arc across the gap 37. The fuse is designed to blow if it carries several half cycles of power frequency current of the magnitude permitted by the arrester. When the fuse blows, it will detonate the explosive powder 40. With the construction shown in Fig. 1, this will break the cemented joint between the disk 24 and tube 10 and with the aid of the coil spring 30 will expel terminal 27 from the lower end of the tube 10. It will be noted that prior to detonation of powder 40 the spring 30 bears against fixed supports and therefore puts no strain on the fusible element. The device may be designed to interrupt the flow of power current but in many cases it will be more desirable to utilize the line circuit breaker or line fuses with which power circuits are commonly equipped for interrupting the flow of power current under these circumstances and utilize the fuse device connected in series with the lightning arrester to insert a gap sufficient to prevent the reestablishing of the flow of power current through a damaged lightning arrester when voltage is restored to the circuit by the reclosure of the circuit breaker or fuse which opened the circuit when the arrester failure occurred.

When the fusible element is ruptured the terminal 27 will hang downwardly at the end of conductor 29 and in this way provide a positive identification of a lightning arrester that has failed. Lacking a means of identifying a failed arrester, it may be necessary to determine which of the several arresters has failed by disconnecting all of the arresters on the circuit and then reconnecting them one at a time.

Fuse devices constructed in accordance with the present invention have been found very satisfactory from the standpoint of reliability in operation as well as economy in manufacture. The arrangement of the gap within the insulating tube and longitudinally spaced from the portion of the tube housing the fusible element together with the mounting of the coil on the exterior of the tube provides a very compact arrangement in which the relative positioning of the parts is favorable to the proper functioning thereof and to a reduction in the size of the device.

While I have shown and described a particular embodiment of my invention, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from my invention and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A fuse device comprising in combination a cylindrical tube of insulating material, conducting members extending longitudinally of said tube in concentric relation therewith and provided with spaced surfaces forming an arc gap, a fusible element mounted within said tube in spaced axial relation with respect to said gap, a terminal member electrically connected with one terminal of said gap and one terminal of said fusible element, and means operative upon rupture of said fusible element for expelling said terminal from said tube.

2. A fuse device comprising in combination a supporting tube of insulating material, conducting members arranged within said tube and having axially spaced surfaces cooperating to define an arc gap, a fusible element mounted within said tube in axially spaced relation with respect to said conducting members, a terminal element closing one end of said tube and conductively connected with one of said conducting members and one end of said fusible element and a second terminal element conductively connected with said other conducting member and the other end of said fusible element.

3. A fuse device comprising in combination a supporting tube of insulating material, conducting members arranged within said tube and having axially spaced surfaces cooperating to define an arc gap, a fusible element mounted within said tube in axially spaced relation with respect to said conducting members, an inductive winding, means conductively connecting one end of said winding with one of the conducting members of said arc gap, means conductively connecting the other end of said winding with one terminal of said fusible element, means conductively connecting the other conducting member and the other terminal of said fusible element, and terminal means of said device electrically connected with each of said conducting members.

4. An impulse protected fuse device comprising a tube of insulating material, a fusible element and means providing a discharge gap mounted within said tube, a member having a cylindrical wall surrounding said tube in spaced relation therewith to form an open ended annular recess, an inductive winding positioned between said tube and said last mentioned member and a layer of insulating compound surrounding said winding and closing the open end of the recess provided by said tube and the wall of said member.

5. A fuse device comprising in combination a tube of insulating material, a fusible element supported within said tube, axially spaced conducting members forming the electrodes of an arc gap, a terminal member of said device electrically connected with one electrode of said gap, a second terminal member of said device electrically associated with the other electrode of said gap and one terminal of said fusible element, an inductive winding surrounding said tube and having one end thereof connected with the first mentioned electrode of said gap and the other end thereof connected with the other terminal of said fusible element, a protecting member surrounding said inductive winding and supported from one of said terminal elements, and a layer of insulating compound disposed about said winding and between said cover and the exterior of said tube.

6. A fuse device comprising in combination a cylindrical tube of insulating material, a support within said tube intermediate the ends thereof, a conducting member carried by said support and forming one electrode of an arc gap, a terminal member of said device secured to one end of said tube and having a portion extending inwardly and cooperating with said conducting member to form a second electrode of said gap, a fusible element supported within said tube between said support and the other end of said tube, an inductive winding supported on the exterior of said tube and having one end thereof connected with said terminal member, means connecting the other end of said inductive winding with one terminal of said fusible element, means connecting the other end of said fuse with the first mentioned electrode of said arc gap, a second terminal member of said device electrically connected with the electrode of said gap connected to the terminal of said fusible element, and means effective upon rupture of said fusible element for expelling said last mentioned terminal from said tube.

7. A fuse device comprising in combination a pair of terminal elements, a fusible element, an inductive winding, conducting members cooperating to form the electrodes of an arc gap, means conductively connecting one electrode of said gap and one end of said winding to one of said terminal elements, means conductively connecting the other end of said coil with one end of said fusible element, and means conductively connecting the other terminal of said fusible element and the other electrode of said arc gap with said other terminal element, a charge of explosive material surrounding said fusible element, said gap, said coil, said fusible element and said charge having their characteristics correlated so that steep wave front voltages impressed on the terminals of said device are not effective to rupture said fusible element and detonate said charge, and further so correlated that the continued passage of power current by said device following said steep wave front voltage is effective to rupture said fusible element and detonate said charge to expel one of said terminal elements from said device.

8. A fuse device comprising in combination a tube of insulating material having spaced supports therein, a fusible element positioned between said supports, a charge of explosive material surrounding said fusible element, spring means positioned between said supports tending to expel one of said supports from said tube, a terminal electrically connected with said fusible element and mechanically connected to said one support, said one of said supports having a frangible connection with said tube adapted to be fractured upon detonation of said explosive charge so that said spring means is effective to remove said support from said tube and move said terminal to isolating position.

9. A fuse device comprising a fusible element including a terminal portion, a housing for said element, spring means in said housing distorted normally to urge the terminal portion of said fusible element toward isolating position, restraining means for restraining said spring means to prevent stressing of said fusible element, an explosive charge mounted in said housing and adapted to detonate upon rupture of said fusible element and render said restraining means ineffective so that the terminal portion of said fusible element is moved to isolating position by the action of said spring means.

10. A fuse device comprising a fusible element including a terminal portion, a housing for said

element, spring means in said housing distorted normally to urge the terminal portion of said fusible element toward isolating position, restraining means for restraining said spring means to prevent stressing of said fusible element, and means operable in response to rupture of said fusible element to render said restraining means ineffective so that the terminal portion of said fusible element is moved to isolating position by the action of said spring means.

11. In combination, a fuse device comprising a tube of insulating material, spaced members mounted within said tube and providing a closed compartment, a fusible element positioned within said compartment, a terminal element carried by one of said members and electrically connected with one end of said fusible element, said last mentioned member having a frangible connection with said tube, an explosive charge surrounding said fusible element, and spring means in said compartment distorted to exert a force on said last mentioned member in a direction to expel it from said tube, said explosive charge being effective upon passage of a predetermined current through said fusible element to detonate and rupture said frangible connection so that said spring means is effective to expel said member and associated terminal element from said tube to increase the length of insulating path inserted between the ends of said fusible element upon rupture thereof.

12. A fuse device comprising in combination a cylindrical tube of insulating material, a transverse partition of insulating material dividing said tube into axially spaced compartments, an electrode supported by said transverse partition and having a surface extending into one of said compartments to form one electrode of an arc gap, a terminal element of conducting material secured to one end of said tube and including means conductively associated therewith and extending in spaced relation with said first mentioned electrode to form a second electrode on said arc gap, closure means closing the open end of the other of said compartments, a fusible element having one end electrically connected to the first mentioned electrode, a terminal associated with said last mentioned means and electrically connected with the other end of said fusible element, an explosive charge surrounding said fusible element, spring means for expelling said terminal from said tube and normally bearing on said closure means so that said fusible element is not subjected to tension until after said closure means has been separated from said tube by detonation of said explosive charge upon rupture of said fusible element.

WILLIAM A. McMORRIS.

DISCLAIMER

2,305,436.—*William A. McMorris*, Fort Sill, Okla. FUSE DEVICE. Patent dated December 15, 1942. Disclaimer filed June 23, 1944, by the assignee, *General Electric Company*.

Hereby enters this disclaimer to claims 1, 2, and 3 in said specification.

[*Official Gazette August 1, 1944.*]

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