Dec. 15, 1942. S. R. SMITH, JR 2,305,394

FUSE DEVICE

Filed Oct. 15, 1941

Fig. 1.

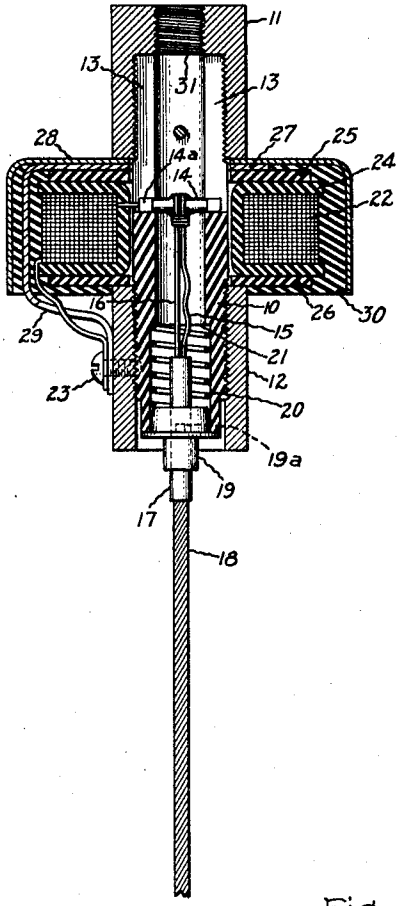


Fig. 3.

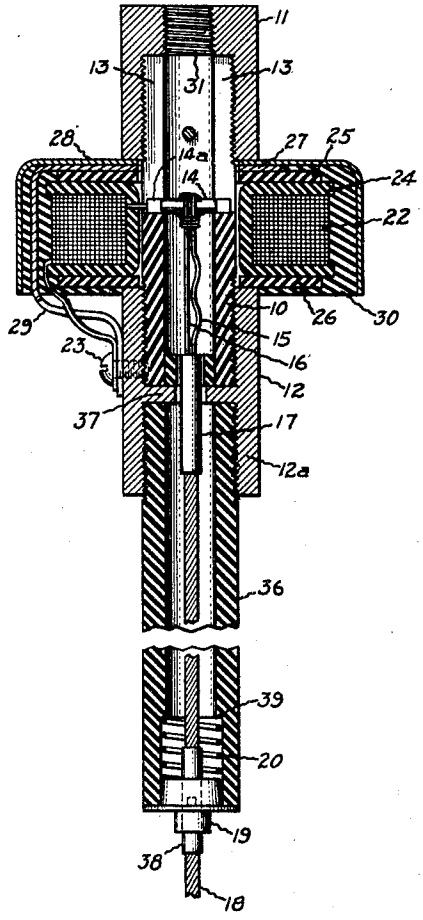
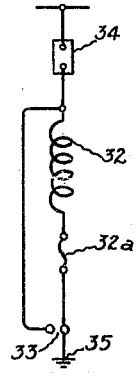


Fig. 2.



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FUSE DEVICE

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Application October 15, 1941, Serial No. 415,053

5 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 a longitudinal view in section of a fuse device embodying one form of the invention; Fig. 2 is a schematic representation of the circuit employed in the fuse devices constructed in accordance with the present invention, and Fig. 3 is a longitudinal view in section of a modification.

In the embodiment illustrated in Fig. 1 an elongated cylindrical tube 10 of suitable insulating material, such as fiber, is externally threaded at its opposite ends for the reception of conducting sleeves 11 and 12. The tube 10 is also provided with opposed longitudinal slots or recesses 13 extending inwardly from one end thereof for the reception of a transverse supporting member 14 of good conducting material, such as a piece of copper tubing. The member 14 provides a support for one end of the fusible element 15 and associated strain wire 16 which extend longitudinally of the tube 10 and terminate in an electrode at the lower end of the tube. The electrode may comprise a conducting sleeve 17 which is swaged onto the lower end of the strain wire 16, fusible element 15 and a flexible stranded conductor 18 which provides one terminal of the fuse device. The electrode also includes a flanged collar 19 which fits into the lower end of the tube 10 and cooperates with an inner surface of the lower conducting sleeve 12 to provide the electrodes of an arc gap which functions in a manner to be described more in detail at a later point in the specification. A suitable tab, 19*a*, may be provided on the collar 19 for preventing relative rotation of tube 10 and collar 19. A coil spring 20 is interposed between the collar 19 and a shoulder 21 on the inside of the tube 10 to provide means for expelling the collar 19 and conductor 18 from the tube 10 upon the rupture of the fusible element 15 and associated strain wire 16.

As mentioned earlier in the specification, an inductive element is provided in series with the fusible element to provide a high impedance to steep wave front voltages. In the embodiment of Fig. 1 an inductive winding or coil 22 is positioned on the tube 10 between the sleeves 11 and 12. One terminal of the coil is connected to the sleeve 12 by a suitable binding screw 23 while the other terminal of the coil passes through the slot 13 of the tube 10 and is received within the end of the copper tube 14 which may be compressed upon the coil end to form a good electrical connection as shown at 14*a*. The fusible element and strain wire are preferably soldered to the copper tube to complete the electric circuit from the sleeve 12 through the inductive winding, tube 14, fusible element 15 to the electrode comprising sleeve 17 and collar 19.

In order to render the fuse device mechanically strong and reasonably weatherproof the coil 22 is mounted and protected in a novel manner.

As shown, the coil 22 is positioned within an annular insulating member 24 having a U-shaped cross section and is spaced between the conducting sleeves 11 and 12 by insulating washers 25 and 26. Between the upper sleeve 11 and the coil there is also interposed a conducting member 27 and a projecting casing 28 of conductive material. The conducting member 27 is in the form of a ring or washer having an extending portion 29 connected to the lower sleeve 12 by means of the binding screw 23. The casing 28 is in the form of an open-ended cylinder and the side wall conforms generally to the shape of the coil and extends in spaced relation thereto to provide a space which is filled with insulating compound designated by numeral 30 to form a reasonably weather-tight casing about the coil. The casing 28 may be formed of insulating material of good mechanical properties in which case provision must be made for electrically connecting member 11 and sleeve 12 such as, for example, locating conducting member 27 outside the casing 28 so that it directly contacts sleeve 11. The sleeve 11, secured to the upper end of the tube 10, is internally threaded at 31 to receive a suitable connector such as the grounding stud of a lightning arrester.

From the foregoing description it is apparent that one circuit from the sleeve 11 is completed to the conductor 18 through conducting member 27 and sleeve 12, across an air gap to the collar 19 and associated sleeve 17, and that a parallel path also extends from the sleeve 11 through member 27, coil 22, tube 14, the fusible element 15 and strain wire 16, and the sleeve 17 to the conductor 18. Thus we have a circuit between sleeve 11 and conductor 18 which is illustrated schematically in Fig. 2 and comprises an inductive element 32 and a fusible element 32*a* connected in parallel with a gap 33. A lightning arrester 34 and ground connection 35 have been shown in Fig. 2 to illustrate the application of the fuse device of the present invention as an isolator for a lightning arrester.

In accordance with the teachings of the above-identified Horikoshi patent, the inductive winding and the gap are designed so that for voltages of steep wave front, as compared to the voltages of normal line frequency, the winding 32 offers such high impedance that the gap 33 will break down and prevent rupture of the fuse. However, if power current continues to flow after the surge is discharged the impedance of winding 32 thereto is sufficiently low that the voltage across gap 33 will not maintain an arc thereacross and current is allowed to pass through fuse 32*a* to rupture the same to open the circuit between the sleeve 11 and the conductor 18. Such a device is of particular value for connection in circuit with a lightning arrester to isolate the same from the power circuit by opening the ground connection thereof in the event that the arrester continues to pass current of power frequency after a lightning discharge. It is not essential that the rupture of the fusible element and the resulting expulsion of the conductor 18 from the lower end of the tube interrupt the arc in all cases since this may be accomplished by other protective devices of the system and the isolation provided by the impulse protected device of the present invention may be utilized solely to isolate the lightning arrester, for example, when power is reapplied to the circuit.

In Fig. 3 I have shown a modification of my invention which is essentially the same as that described in Fig. 1 with the exception that an expulsion tube has been provided at the lower end of the fuse tube in order that the device may be capable of interrupting the arc which is established upon rupture of the fusible element and associated strain wire. In Fig. 3 the same reference numerals as used in connection with Fig. 1 have been used to designate corresponding parts. In the arrangement of Fig. 3 the conducting sleeve 12 at the lower end of the tube 10 is extended to provide an internally threaded portion 12*a* for the reception of the externally threaded expulsion tube 36. Between tubes 10 and 36 the sleeve 12 is provided with an inwardly extending circuit flange 37 which cooperates with the sleeve 17 to provide an arc gap.

In the modification shown in Fig. 3 the collar is not provided on the sleeve 17 but is located at the lower end of the expulsion tube 36 on a sleeve 38 swaged on the conductor 18. The collar 19 fits the lower end of the tube 36 in the same manner as it fits tube 10 in the modification shown in Fig. 1. The spring 20 is positioned between the collar 19 and a shoulder 39 formed in spaced relation to the collar on the inner surface of the expulsion tube 36.

The circuit between the sleeve 11 and the conductor 18 of the arrangement shown in Fig. 3 is the same as that illustrated in Fig. 2 and described in connection with Figs. 1 and 2. In the operation of the modification shown in Fig. 3, however, the expulsion of the fuse from the tube 36 may be made effective to interrupt the arc established upon rupture of the fusible element and associated strain wire.

The embodiments of the invention illustrated in Figs. 1 and 3 and described in the foregoing specification provide a compact arrangement of the elements utilized for the impulse protected isolating fuse which is very compact and economical from a manufacturing standpoint, and which at the same time provides an isolator which is very acceptable from the standpoint of operation and reliability. When the conductor 18 and associated terminal are expelled from the lower end of the device it serves as an indicator of the blown condition of the fuse and when connected in circuit with an arrester indicates a faulty arrester.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that 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 tube of insulating material, a fusible element extending longitudinally of said tube, an electrode electrically connected with one end of said fusible element, a conducting sleeve positioned on one end of said tube and having a portion thereof extending in spaced relation with respect to said electrode to provide a discharge gap, a conducting sleeve positioned on the other end of said tube and providing a line terminal for said device, an inductive winding surrounding said tube and positioned with respect thereto by said sleeves, means electrically connecting one end of said winding with both of said sleeves, means electrically connecting the other end of said winding and the end of said fusible element opposite

said electrode, and conducting means associated with said electrode and providing a second line terminal of said device.

2. A fuse device comprising in combination, a tube of insulating material, a fusible element positioned in said tube, an inductive winding positioned on the exterior of said tube intermediate the ends thereof, a sleeve of conducting material secured to one end of said tube and electrically connected to one end of said inductive winding and forming a line terminal of said device, a second sleeve of conducting material secured on the oppositie end of said tube and engaging said inductive winding to hold it assembled on said tube, an electrode electrically connected with one end of said fusible element, said last mentioned conducting sleeve cooperating with said electrode to form an arc gap in parallel with said fusible element and said inductive winding.

3. A fuse device of the type providing an inductive element and a fusible element in series between a pair of line terminals with a discharge gap in parallel with said series connected inductive element and fusible element comprising a tube of insulating material, a fusible element positioned within said tube, a conducting sleeve positioned on one end of said tube and forming a line terminal of said fuse device, a conducting sleeve secured to the other end of said tube and forming one electrode of said discharge gap, an inductive winding positioned about said tube intermediate said sleeves, the inner ends of said sleeves providing opposed surfaces for positioning said coil and holding it in assembled relation on the exterior of said tube.

4. A fuse device comprising in combination a tube of insulating material having opposed longitudinal recesses extending inwardly from one end thereof, a supporting member positioned in said recesses extending transversely of said tube, a fusible element secured to said support and extending longitudinally of said tube, an electrode electrically connected with the other end of said fusible element and positioned adjacent one end of said tube, a sleeve of conducting material secured to the exterior of each end of said tube, one of said sleeves having a surface extending in spaced relation with said electrode and cooperating therewith to form an arc gap, and an inductive winding surrounding said tube and interposed between said sleeves, one end of said winding being electrically connected to one said sleeve and the other end of said winding being electrically connected with the end of said fusible element attached to said support.

5. A fuse device comprising in combination a tube of insulating material, an inductive winding surrounding said tube intermediate the ends thereof, a conducting sleeve secured to each end of said tube and providing means for maintaining said inductive winding in assembled relation with said tube, an enclosing casing for said inductive winding in the form of a cylinder having an opened end and a closed end apertured to receive said tube of insulating material, the end wall of said cylinder being engaged by one of said conducting members to hold said casing in position about said inductive winding, the side walls of said casing extending in spaced relation to the outer surface of said inductive winding and a layer of insulating compound interposed between said casing and said inductive winding for substantially sealing the open end of said casing, a fusible element housed within said tube and extending longitudinally thereof, said element having one end electrically connected with one end of said inductive winding, an electrode electrically connected with the other end of said inductive winding and having a portion extending in spaced relation with one of said conducting elements to provide an arc gap, means electrically connecting the other end of said inductive winding with the other conducting sleeve, and conducting means conductively associated with said other electrode and forming a terminal element of said device.

SIDNEY R. SMITH, JR.