Sept. 26, 1939. R. R. PITTMAN ET AL 2,174,477

SURGE-PROTECTED FUSE LINK

Filed Oct. 29, 1938

Fig. 1

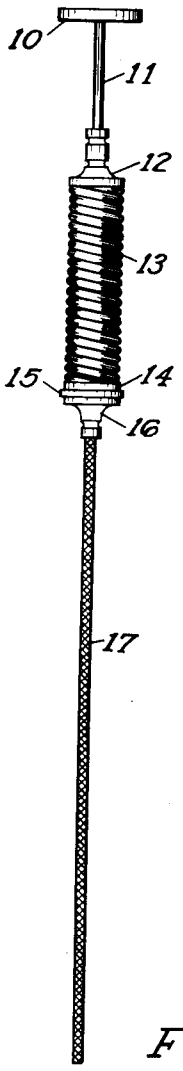


Fig. 2

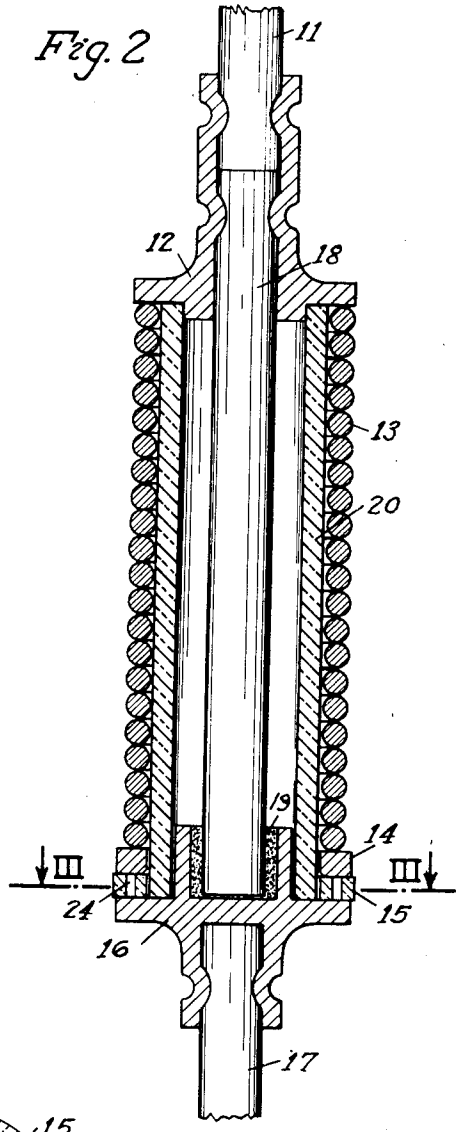
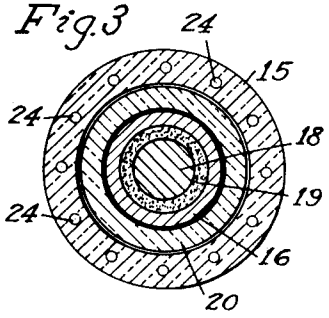


Fig. 3



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SURGE-PROTECTED FUSE LINK

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7 Claims. (Cl. 200—115)

This invention relates generally to protective devices for alternating current electrical circuits, and particularly to fusible devices used to prevent the passage of excessive amounts of electrical energy through said circuits.

Many circuit-interrupting devices, such as the expulsion fuses illustrated in Patent No. 2,109,090, dated Feb. 22, 1938, and issued to Ralph R. Pittman et al., depend for their operation upon the fusing of a fuse link in response to the passage therethrough of a predetermined alternating current for a predetermined time. When such devices are connected to overhead electrical circuits which are exposed to lightning discharges, the superimposed or surge currents attending such discharges cause the fuse links to fuse while the alternating current through the fuse link may be well within the rating of the link. The energy transmitted by the surge current through the fuse link is the result of a relatively high current for a very short time, so that the voltage appearing across the fusible element of the link may be sufficient to cause breakdown of a spark gap connected in shunt-circuit relation with the fusible element, thereby by-passing a substantial portion of the surge energy around the fusible element and thus limiting its temperature rise to a value below the fusing temperature.

It is an object of the present invention to provide means for shunt-circuiting the fusible element of a fuse link forming a part of a circuit upon which is impressed a high superimposed current of surge characteristics, such shunt-circuiting preventing the heating of the fusible element to the fusing temperature, together with means for effecting the desired by-passing through an auxiliary circuit without affecting the desired protective features of the fuse link under excessive current of a normal alternating character. Other objects will in part be obvious, and in part pointed out hereinafter.

The purpose of the present invention is in some respects similar to that set forth in our copending application Serial No. 230,076, filed Sept. 15, 1938, but the structural distinctions herein will be quite apparent.

The invention comprises the elements and combinations thereof, features of construction, and arrangement of parts exemplified in the following description, and the scope of the invention will be indicated in the accompanying claims.

In the drawing: Fig. 1 is an elevational view of the fuse link; Fig. 2 is an enlarged view of the fusible element assembly, shown partly in section; and Fig. 3 is a sectional view as seen from the plane indicated by the line III—III in Fig. 2. Similar reference characters indicate corresponding parts in the several figures of the drawing.

It is well known that fuse links, particularly those of relatively small amperage, are susceptible to blowing or fusing due to passage of surge currents of atmospheric origin which are of a transient nature and have no harmful effect upon the connected apparatus. The undesirability of such unnecessary interruptions to service have heretofore been well recognized. On the other hand, should the disturbance be sufficiently severe to cause failure of insulation in connected apparatus, the abnormally excessive alternating current follow current should be promptly interrupted by the fusing of the fusible element of the protective device.

With the foregoing requirements in mind, reference is made to the drawing illustrating the invention. The fuse link includes the axially spaced longitudinally extending conducting members 11 and 17, which are electrically connected and mechanically joined by the fusible heating element 18, the upper end of the latter being joined to the member 11 by means of the upper fuse element terminal 12, into which the respective members extend and are die-pressed. For convenience in connecting the fuse link in an expulsion fuse tube, a metal terminal button 10 is secured at the upper end of the conducting member 11. The lower end of the fusible heating element 18 extends into a downwardly extending recess in the lower fuse element terminal 16, and these elements are joined by means of a layer of low melting point solder 19, placed therebetween. The conducting member 17 extends upwardly into a centrally positioned recess in the lower fuse element terminal 16, and is conveniently die-pressed therein.

To reduce arcing time following fuse blowing, the fusible heating element 18 is housed within a hollow tube of insulating material 20, which is conveniently formed of hard fiber, the respective ends of which are closed by but not fastened to the fuse element terminals 12 and 16.

In the fuse link just described, the point of rupture of the fusible element is related to the rate of increase in excess current. A small overload current will eventually heat the solder 19 to its melting point, while a relatively high current may fuse the heating element without melting the solder 19. The latter is preferably a bismuth-tin-lead alloy, and the material of the fusible

heating element is conveniently a nickel-chromium-steel alloy.

The fuse element terminals 12 and 16 are each provided with axially aligned outwardly extending integral flanged portions, and a stressed helical metal spring 13 engages the lower surface of the flange of the upper fuse element terminal 12 and extends downwardly therefrom along the outer surface of the tube 20 to a point near the flange of the lower fuse element terminal 16. A perforated or apertured washer of insulating material 15, preferably of mica, which is provided with a plurality of circumferentially spaced apertures 24, is positioned upon the upper surface of the flange of the lower fuse element terminal 16, encircling and in coaxial relation with the tube 20, and a metal washer 14 is interposed between the lower end of the spring 13 and the upper surface of the apertured washer 15, the arrangement being such that the spring 13 urges the metal washer 14 against the insulating washer 15, which in turn is urged against the flange of the lower fuse element terminal 16.

From the above description, it will be seen that the metal washer 14 and the lower fuse element terminal 16 form the respective electrodes of a dielectric element of the nature of a spark gap, the break down of which is determined by the thickness of the spacing washer 15, or by the length of the perforations between the electrodes. It will also appear that the spring 13 electrically connects the upper end of the fusible heating element 18 to the metal electrode or washer 14, and further, that the voltage impressed upon the spark gap is the voltage required to cause a current to flow through the fusible heating element 18.

For best operation, it is desirable that the thermal capacity of the fusible heating element be not less than 300–500 crest amperes when subjected to a current wave rising to crest in 1½ micro-seconds, and decreasing to half value in 40 micro-seconds, and that the resistance of the fusible heating element be such that a crest voltage of the order of 1500 volts appear across the spark gap when such a surge current passes through the fusible heating element. For example, one practical construction embodies a nominally rated ¼ ampere link having a surge current capacity of 600 amperes, and a resistance of 5 ohms. Under such a set of conditions, a current of 300 amperes causes a voltage drop of 1500 volts for breaking down the spark gap in the by-pass circuit, thus providing a factor of safety of 2. Similarly, another practical construction embodies a nominally rated 1 ampere link having a surge capacity of 2000 amperes, and a resistance of 1½ ohms, which organization provides a similar factor of safety in preventing the fusing of the link.

In the event the invention is connected in a circuit to apparatus the insulation of which fails coincident with the spark over of the spark gap, the arc voltage maintained by the alternating current follow current will be impressed across the fusible heating element. This arc voltage is ample to cause sufficient current to be maintained through the fusible heating element to cause the melting of the solder 19, permitting the spring 13 to urge the conducting members apart and thus interrupt the circuit. As the conducting member 17 moves away from the conducting member 12, the elements constituting the spark gap move along with the former, so that neither the spark gap nor the fusible heating element remain in position to carry current.

Under abnormally high alternataing currents, and in the absence of surge currents, the voltage drop across the fusible heating element prior to its fusing is insufficient to cause operation of the spark gap, so that the normal operation on excess dynamic currents is unaffected in any way by the presence of the dielectric element or shunting spark gap.

While we have shown and described a specific embodiment of our invention, it will be apparent that changes and modifications may be made therein without departing from the spirit and scope of our invention, and we desire that our invention be limited only as is necessitated by the prior art and the accompanying claims.

We claim, as our invention:

1. In a fuse link, longitudinally spaced conducting members, a hollow tube of insulating material, a fusible element within said tube electrically connecting said conducting members, a helical metal spring urging the separation of said conducting members, said helical spring being electrically connected to one of said conducting members, and elements constituting a discharge gap interposed between the other of said conducting members and said spring.

2. In a fuse link, axially spaced longitudinally extending conducting members, a hollow tube of insulating material interposed between the adjacent ends of said conducting members, a fusible element within said tube which electrically connects and mechanically joins said conducting members when said element is unfused, electrically conducting resilient means arranged to urge said conducting members apart in response to the fusing of said fusible element, means electrically connecting said resilient means to one of said conducting members, and dielectric means responsive to a predetermined voltage interposed between said resilient means and the other of said conducting members.

3. In a fuse link, longitudinally spaced conducting members, a hollow tube of insulating material disposed therebetween, a fusible element within said tube electrically connecting and mechanically joining the adjacent ends of said conducting members when said fusible element is unfused, conducting resilient means urging said conducting elements apart, means electrically connecting said resilient means to one of said conducting members, and a dielectric element interposed between said resilient means and the other conducting member.

4. In a fuse link, longitudinally spaced conducting members, a hollow tube of insulating material disposed therebetween, a fusible element within said tube, and helical metal spring mounted externally of said tube, elements constituting a spark gap positioned adjacent one of said conducting members, and means including said metal spring for electrically connecting said spark gap in shunt-circuit relation with said fusible element.

5. A fuse link comprising axially spaced conducting members, fuse element terminals secured to the adjacent ends of said conducting members, a hollow tube of insulating material bridging said terminals, a fusible element within said tube electrically connecting said terminals, conducting spring means engaged with one of said terminals and extending along the outer surface of said fuse tube toward the other terminal, a metal washer encircling said tube and engaged with the

extended end of said spring means, and a washer of insulating material having therein a plurality of circumferentially spaced apertures extending therethrough in the direction of the axis of said tube, said washer of insulating material being engaged on one side by said metal washer and on the other by a portion of said other terminal.

6. A fuse link comprising axially spaced conducting members, fuse element terminals secured to the adjacent ends of said conducting members, a hollow tube of insulating material bridging said terminals, a fusible element within said tube electrically connecting said terminals, conducting spring means engaged with one of said terminals and extending along said fuse tube toward the other terminal, a metal member engaged with the extended end of said spring means, and an element of insulating material having therein an aperture extending therethrough in the direction of the axis of said tube, said element of insulating material being engaged on one side by said metal member and on the other by a portion of said other terminal.

7. A fuse link comprising axially spaced conducting members, resilient means of conducting material arranged to urge said conducting members apart, a fusible element electrically connecting said members and restraining the movement thereof, means electrically connecting said resilient means to one of said conducting members, and normally non-conducting means responsive to an abnormal current of a transient character through said fusible element interposed between said resilient means and the other of said conducting members, said normally non-conducting means being adapted to break down and carry current during that period when the abnormal transient current exceeds a predetermined value and to resume the normal non-conducting condition following the passage of the abnormal current.

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