March 30, 1965 H. J. BARTA 3,176,100

FUSE CONSTRUCTION IN WHICH THERE IS AN INTERCONNECTION BETWEEN A ROD-LIKE TERMINAL AND SURROUNDING METALLIC TUBE BY A FLEXIBLE CONDUCTOR IN AN IMPROVED MANNER

Original Filed June 30, 1960 2 Sheets-Sheet 1

Fig. 1

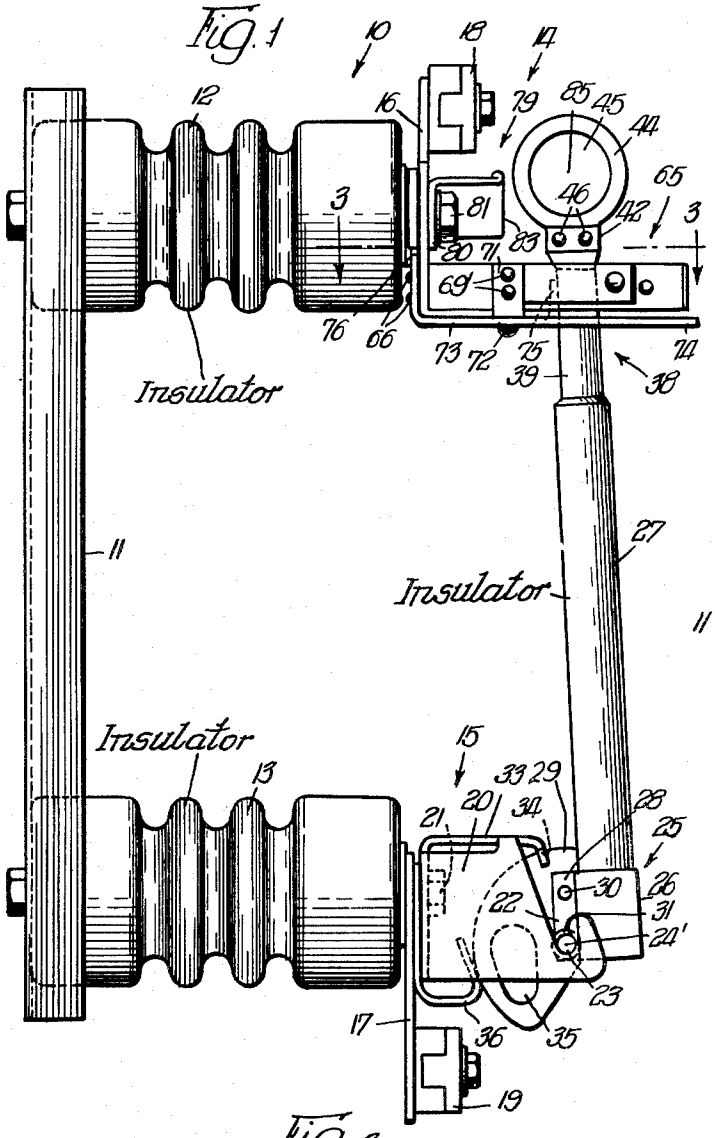


Fig. 2

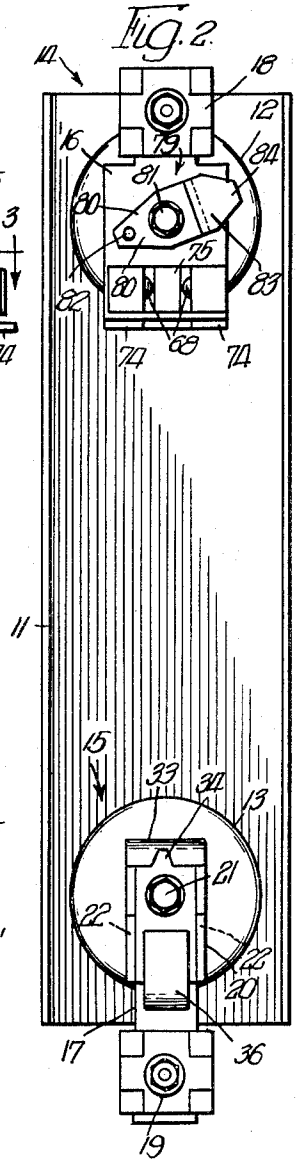
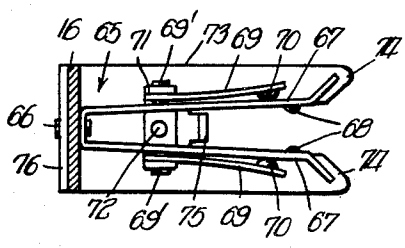


Fig. 3



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Fig. 6

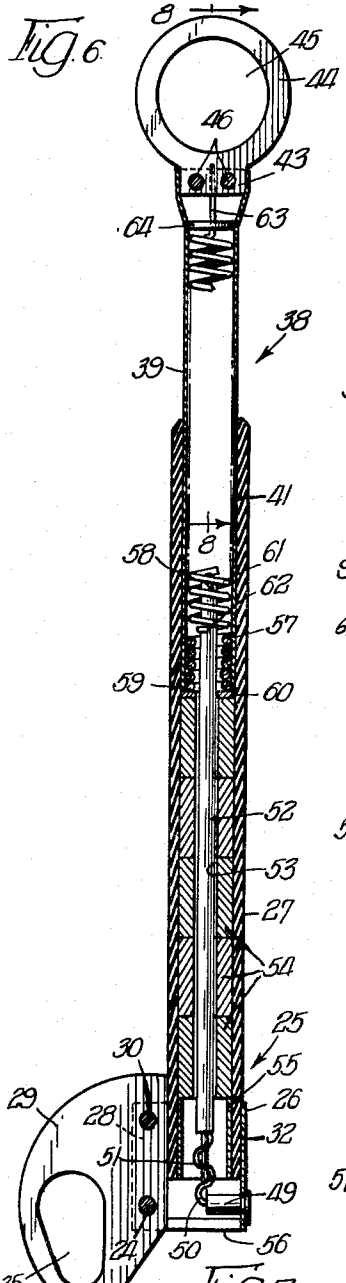


Fig. 9

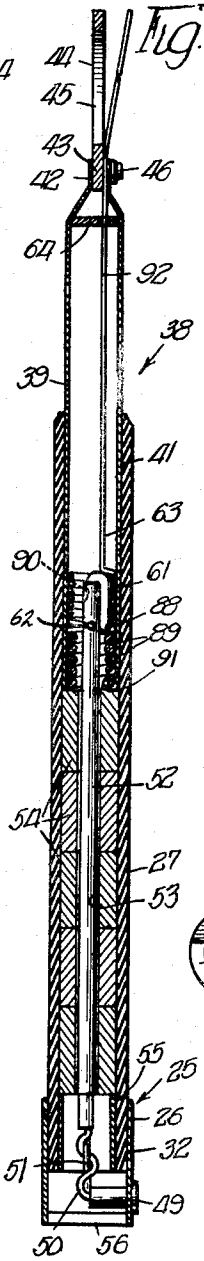


Fig. 8

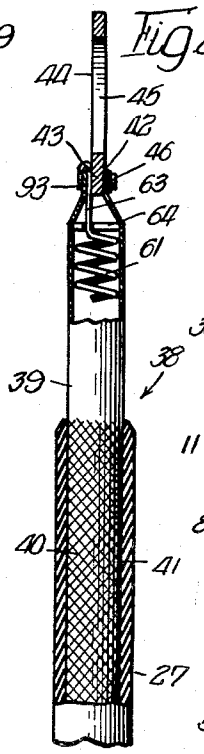


Fig. 10

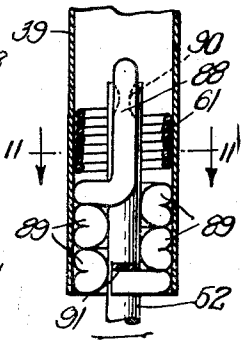


Fig. 11

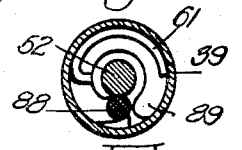


Fig. 4

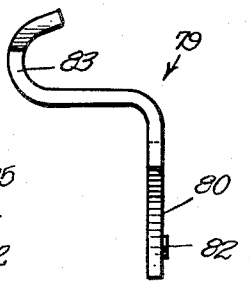


Fig. 5

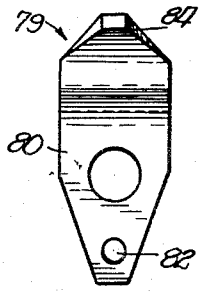
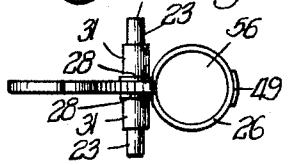


Fig. 7



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FUSE CONSTRUCTION IN WHICH THERE IS AN INTERCONNECTION BETWEEN A ROD-LIKE TERMINAL AND SURROUNDING METALLIC TUBE BY A FLEXIBLE CONDUCTOR IN AN IMPROVED MANNER

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Original application June 30, 1960, Ser. No. 39,886, now Patent No. 3,094,597, dated June 18, 1963. Divided and this application Dec. 18, 1962, Ser. No. 245,546

7 Claims. (Cl. 200—117)

This application is a division of application Serial No. 39,886, filed June 30, 1960, Patent No. 3,094,597, issued June 18, 1963.

This invention relates, generally, to fuses for use in electric distribution circuits operating at moderate voltages of the order of 7.5 to 15 kv. It relates particularly to the construction of such fuses for operation by an auxiliary circuit interrupter carried by a live line stick, such as that shown in U.S. Patent No. 2,816,981, issued December 17, 1957, and especially where the fuses are positioned below shoulder height as contrasted with being mounted overhead on a pole or cross arm.

Among the objects of this invention are: To provide a fuse construction, arranged to receive the separable contacting conducting parts of an auxiliary circuit interrupter, that is simple and efficient in operation and can be readily and economically manufactured and installed; to mount the fuse tube of the fuse construction on a lower line terminal member to pivot about an axis at right angles to the plane containing a pull ring at the upper end of the fuse tube; to mount the pull ring in the upper end of a metallic tube which is telescoped within the upper end of the fuse tube and forms its upper terminal or contacts; to knurl or otherwise roughen the outer surface of the metallic tube and secure it in place in the fuse tube by cement; to cement a ferrule to the lower end of the fuse tube and to apply the ferrule under tension to reinforce the holding action of the cement; to provide an arcuate contact plate on the lower end of the fuse tube in the plane of the pull ring for engaging contact means on the lower line terminal and to resist the upward recoil when the fuse blows; to guide the arcuate contact plate in the lower contact assembly on the lower line terminal laterally and longitudinally in the movement of the fuse tube to closed position to direct the terminal or contact at the upper end into engagement with contact means on the upper line terminal; and to interconnect a rod-like terminal and surrounding metallic tube by a flexible conductor in a new and improved manner.

For a more complete understanding of the nature and scope of this invention reference can be had to the following detailed description, taken together with the accompanying drawings, in which:

FIG. 1 is a view in side elevation of a fuse construction in which the present invention is embodied.

FIG. 2 is a view in front elevation of the construction shown in FIG. 1, the fuse and parts connected thereto being omitted.

FIG. 3 is a horizontal sectional view taken generally along the line 3—3 of FIG. 1.

FIG. 4 is a top plan view of a hook member which is mounted on the upper line terminal member.

FIG. 5 is a rear elevational view of the hook member shown in FIG. 4.

FIG. 6 is a vertical longitudinal sectional view through the fuse which is mounted on the base and insulated supports shown in FIG. 2.

FIG. 7 is a bottom plan view of the fuse shown in FIG. 6.

FIG. 8 is a vertical sectional view taken generally along the line 8—8 of FIG. 6 and showing certain details of the construction of the fuse at the upper end.

FIG. 9 is a view, similar to FIG. 6, and showing a modified and preferred arrangement for the flexible conductor.

FIG. 10 is a view, at an enlarged scale, showing in more detail the modified arrangement of the flexible conductor, shown in FIG. 9.

FIG. 11 is a sectional view taken generally along the line 11—11 of the construction shown in FIG. 10.

Referring now particularly to FIGS. 1 and 2 of the drawings, it will be observed that the reference character 10 designates, generally, a fuse construction which is typical of the construction that can be used for electric power distribution circuits operating at voltages of the order of 7.5 to 15 kv. The fuse construction 10 includes a metallic channel base 11 provided with upper and lower insulators 12 and 13 in spaced relation thereon. The insulators 12 and 13 carry, respectively, upper and lower line terminal members 14 and 15 to which are secured upper and lower terminal plates 16 and 17. Line conductor clamps 18 and 19 are secured to the upper and lower terminal plates 16 and 17 to permit the connection of line conductors thereto in accordance with conventional practice. The fuse construction 10 is intended for mounting below shoulder height and is particularly adapted for use in connection with underground electric power distribution systems now becoming popular for residential use where a complete subdivision layout is made and utilities are installed prior to the erection of any buildings.

The lower line terminal member or assembly 15 includes a generally U-shaped metallic housing 20, preferably formed of sheet steel, and secured by a bolt 21 to the lower insulator 13. The bolt 21 extends through the base of the housing 20 and also through the lower terminal plate 17. The arms of the U-shaped metallic housing 20 are provided with upwardly and rearwardly opening slots 22 for receiving trunnions 23 which are located at the ends of the shaft 24 on a lower fuse tube terminal that is indicated, generally at 25. The lower fuse tube terminal 25 includes a lower fuse tube ferrule 26 which surrounds the lower end of a fuse tube of insulation. For example, the fuse tube 27 can have a fiber lining and an outer layer formed of a phenolic condensation product for weather resisting characteristics. Also the fuse tube 27 may be formed of fiber glass reinforced by epoxy resin. Flanges 28 extend rearwardly from and are formed integrally with the lower ferrule 26 and they overlie opposite sides of an arcuate contact plate 29 that preferably is formed of good conducting material such as brass. The flanges 28 are secured in tight contact engagement with opposite sides of the arcuate contact plate 29 by a copper rivet 30 and also by annular shoulder members 31 which are pressed on the trunnions 23 from opposite sides, the shaft 24 having the trunnions 23 and the annular shoulder members 31 being formed preferably of steel.

The lower fuse tube terminal 25 is assembled on the fuse tube 27 and is securely held in place thereon by first providing a layer of epoxy cement 32 between the lower end of the fuse tube 27 and the ferrule 26. Then the flanges 28 are drawn up tight against the juxtaposed sides of the contact plate 29 by the application of the rivet 30 and the pressing of the shoulder members 31 onto the trunnions 23 of the shaft 24. This places the ferrule 26 under tension while the cement 32 is uncured and the tension remains during curing and after the cement has cured and finally set.

With a view to guiding the fuse tube 27 into the closed circuit position, a tongue 33 is formed integrally with

the U-shaped metallic housing 20 and it has a notch 34 in the forward end, shown in FIG. 2, for receiving the curved surface of the arcuate contact plate 29. It will be observed that the contact plate 29 has a cylindrical surface the center of which is the axis of rotation of the trunnions 23 which is indicated at 24'. As the fuse tube 27 is swung toward the closed position with the trunnions 23 in the slots 22, the cylindrical surface of the contact plate 29 is juxtaposed to the bottom of the notch 34 and the sides of it in cooperation with the sides of the contact plate 29 provide the desired guiding action. An elongated slot 35 is formed in the contact plate 29 to receive the prong of a live line stick.

A contact spring finger 36 bears against the peripheral surface of the contact plate 29 and provides contact engagement therewith. The contact spring finger 36 provides an outward thrust against the contact plate 29 and holds the trunnions 23 in the bottoms of the slots 22. The trunnions 23 are also held in the lower ends of the slots 22 by the tongue 33 since the contact plate 29 interfits with the notch therein and the peripheral surface of the former is juxtaposed to the bottom of the latter. It will be noted that the contact spring finger 36 has an arm which extends between the lower terminal plate 17 and the base of the U-shaped metallic housing 20 and that it is securely held in place by the bolt 21.

The details of construction of the upper fuse tube terminal, shown generally at 38, at the upper end of the fuse tube 27 are shown more clearly in FIG. 6 of the drawings. It will be observed that the upper fuse tube terminal 38 includes a conducting ferrule in the form of a metallic tube 39 which preferably is formed of good conducting material such as copper. The lower end of the metallic tube 39 is telescoped within the fuse tube 27 and it has a knurled or roughened surface 40, shown in FIG. 8, for receiving cement 41, preferably an epoxy cement, which serves to secure the knurled lower end of the metallic tube 39 to the inner surface of the fuse tube 27.

The upper end of the metallic tube 39 is flattened at 42 for receiving a depending flange 43 of a pull ring 44 that may be formed of sheet steel. The pull ring 44 has a relatively large opening 45 for receiving one of the separable contacting conducting parts of the auxiliary circuit interrupter above referred to. Rivets 46 extend through the upper end of the metallic tube 39 and through the flange 43. This provides a rigid construction. It will be noted that the pull ring 44 is flat and that it is located in a plane which extends at right angles to the pivot axis 24' through the trunnions 23. Also, it will be noted that the arcuate contact plate 29 is in this same plane.

The lower fuse tube terminal 25 is connected to the upper fuse tube terminal 38 by fusible means located within the fuse tube 28. The fusible means includes a terminal stud 49 which extends radially inwardly from the lower end of the lower ferrule 26. Secured to the terminal stud 49 are a fusible element 50, formed preferably of silver, and a strain element 51, preferably formed of high strength wire having a relatively high resistance. The other ends of the fusible and strain elements 50 and 51 are secured in the lower end of a movable rod-like terminal 52 which extends upwardly through a bore 53 in cakes 54 of arc extinguishing material such as boric acid. Surrounding the major portions of the fusible and strain elements 50 and 51 is a metallic tube 55 which constitutes an arc guard for the lower end of the fuse tube 27. The metallic tube 55 also defines an arcing chamber in which the arc is drawn initially on blowing of the fusible and strain elements 50 and 51. A closure disc 56, formed of rubber or the like, interfits with the lower end of the lower ferrule 26 and closes off the same. Upon blowing of the fusible and strain elements 50 and 51, the pressure developed usually is sufficiently great to expel the closure disc 56 and open the arcing chamber defined by the metallic tube 55 to the atmosphere.

At its upper end the rod-like terminal 52 is connected by a flexible conductor or cable 57 to the metallic tube 39. The upper end of the rod-like terminal 52 is connected at 58 to one end of the flexible conductor 57 while the other end of the latter is connected to the lower end of the metallic tube 39 at 59. The flexible cable 57 is disposed in a spiral coil around the upper end of the rod-like terminal 52 and the lowermost coil bears against a washer 60 which forms a stop for the cakes 54 of arc extinguishing material when they are assembled in the fuse tube 27.

The rod-like terminal 52 is biased upwardly by a coil tension spring 61. The lower end of the spring 61 is connected at 62 to the rod-like terminal 52 near its upper end while the upper end 63 of the spring 61 extends through a stop washer 64 and between one of the side walls of the upper flattened end 42 of the metallic tube 39 where it is anchored when the rivets 46 are placed in position. The stop washer 64 is in the path of upward movement of the rod-like terminal 52 and receives the impact thereof when it moves upwardly under the influence of the spring 61 and the blast action resulting from the blowing of the fusible and strain elements 50 and 51, particularly when the relatively heavy fault is interrupted. The stress incident to such impact is distributed by the stop washer 64 over the entire upper end of the metallic tube 39 and reduces the likelihood that the upper end of the rod-like terminal 52 will shear the rivets 46, dislodge the pull ring 44 and open up the upper end of the metallic tube 39.

The metallic tube 39, which forms a part of the upper fuse tube terminal 38, is arranged to engage a U-shaped contact clip or upper contact assembly, shown generally at 65 in FIG. 3 of the drawings. The contact clip 65 is secured by rivets 66 to the upper terminal plate 16. It extends forwardly therefrom and has flexible resilient contact arms 67 for receiving the metallic tube 39 therebetween to provide a good contact engagement therewith. For this purpose the contact clip 65 is formed of good conducting material such as copper or Phosphorbronze. Shoulders 68 extending inwardly from the contact arms 67 cooperate with the metallic tube 39 to hold the upper fuse tube terminal 38 and thereby the fuse tube 27 in the closed position while permitting withdrawal thereof on the application of sufficient force to the pull ring 44. Spring fingers 69, provided with shoulders 70, bear against the outer sides of the contact arms 67 and urge them into good contact engagement with opposite sides of the metallic tube 39. The spring fingers 69 are secured by rivets 69' to the upstanding ends of a U-shaped clip 71 that is secured by a rivet 72 to a guide plate 73 that may be formed of sheet steel. The guide plate 73 has outwardly extending spaced apart arms 74 that serve to guide the metallic tube 39 into contact engagement between the arms 67 of the contact clip 65. A stop lug 75, upstanding from the central portion of the guide plate 73, serves to limit the movement of the upper fuse tube terminal 38 toward the upper line terminal member 14 as shown in FIG. 1. A flange 76 extends upwardly from the left end of the guide plate 73 where it is held securely to the rear side of the upper terminal plate 16 by rivets 66 which mount the contact clip 65 on the front side.

Provision is made for receiving the other separable contacting conducting part of the auxiliary circuit interrupter on the upper line terminal member 14. For this purpose a hook member, shown generally at 79, is employed. The details of construction of the hook member 79 are shown more clearly in FIGS. 4 and 5 of the drawings. It will be observed that the hook member 79 includes a shank 80 which is arranged to overlie and bear flatwise against the front side of the upper terminal plate 16. It is held in place by a bolt 81 which also

holds the upper terminal plate 16 in position on the outer end of the upper insulator 12. A centering boss 82 projects rearwardly from the shank 80 for interfitting with a suitable opening in the front side of the upper terminal plate 16 to hold the hook member 79 against rotation about the bolt 81. The hook member 79 has a hook portion 83 which is curved away from the pull ring 44. The hook portion 83 has a beveled nose 84 to facilitate the application of the other separable contacting conducting part of the auxiliary circuit interrupter.

Attention is directed to the location of the hook portion 83 with respect to the center 85 of the opening 45 in the pull ring 44. The hook portion 83 is located slightly below the center 85 and it extends upwardly at a slight angle. The purpose of this arrangement is to facilitate the application of the auxiliary circuit interrupter, above referred to, particularly where insulating barriers extend vertically and closely adjacent to opposite sides of the fuse construction 10 to segregate it from adjacent like fuse constructions. Thus, on application of the auxiliary circuit interrupter, the contacting conducting part engaging the pull ring 44 can have an upwardly and outwardly directed force applied thereto for swinging the fuse tube 27 and particularly the upper fuse tube terminal 38 thereof out of contact engagement with the upper line terminal member 14 to shift the circuit to the auxiliary circuit interrupter where it is finally opened without arcing between the upper line terminal member 14 and the upper fuse tube terminal 38.

The fuse tube 27 is applied to the lower line terminal member 15 by inserting the prong of a live line stick in the slot 35 formed in the arcuate contact plate 39. The prong is located in the smaller end of the slot 35 with the fuse tube 27 depending therefrom. The trunnions 23 are placed in the slots 22 with the fuse tube 27 in the pendant position. Then the prong of the switch stick is inserted in the pull ring 44 and the fuse tube 27 together with the associated parts is swung about the axis 24' of the trunnions 23 to the position shown in FIG. 1. It is guided into this position, in part, through the interaction between the sides of the notch 34 in the tongue 33 with the sides of the contact plate 29 and finally through the guiding action exerted by the arms 74 of the guide plate 73 on the opposite sides of the metallic tube 39. The closing movement is arrested when the metallic tube 39 engages the stop lug 75. The shoulders 68 tend to limit the outward movement of the fuse tube 27 as described above. For opening the fuse construction 10, the separable contacting parts of the auxiliary circuit interrupter are applied to the hook portion 83 of the hook member 79 and to the pull ring 44. Then a pull upwardly and outwardly on the live line stick carrying the auxiliary circuit interrupter causes the contacting conducting part interfitting with the pull ring 44 to separate from the contacting conducting part held stationary by the hook portion 83 of the hook member 79. As a result the fuse tube 27 is rotated about the pivot axis 24' through the trunnions 23 to the open position in the manner described.

FIGS. 9, 10 and 11 show a modified and preferred arrangement for applying the flexible conductor. As there shown, a flexible conductor 88 interconnects the upper end of the rod-like terminal 52 with the lower end of the metallic tube 39. Instead of coiling the flexible conductor 88 around the upper end of the rod-like terminal 52, as shown in FIG. 6 and described hereinbefore, the flexible conductor 88 is formed with reverse turns, as indicated at 89, which extend around the rod-like terminal 52 for nearly its entire circumference. Then, when the rod-like terminal 52 is withdrawn by the coil tension spring 62 on blowing of the fusible and strain elements 50 and 51 at maximum current interrupting rating, the overlying parts of the flexible conductor 88, instead of wrapping around the rod-like terminal 52 which may cause a snubbing effect and interfere with its movement, straighten out and extend generally parallel to it in the withdrawn position without opposing or interfering with the movement of the rod-like terminal 52. Because of the arrangement of the flexible conductor 88 in reverse turns 89, the magnetic effect, particularly at high current flow, is to cause these turns to straighten out and extend along the retracted rod-like terminal instead of tending to collapse as is the case for the spirally arranged flexible cable 57 as shown in FIG. 6. The upper end of the rod-like terminal 52 is hollow and is swaged at 90 onto one end of the flexible cable 57. The other end of the flexible cable 57 extends around a tab 91 struck from the lower end of the metallic tube 39 and is soldered thereto.

FIG. 9 also shows how the coil tension spring 61 is tensioned. It will be noted that initially the upper end 63 of the coil tension spring 61 has an extension 92 which is long enough to project out of the upper end of the metallic tube 39. On assembly, the extension 92 is drawn upwardly through the metallic tube 39 to tension the spring 61, as shown in FIGS. 6 and 8 of the drawings, against the underside of the stop washer 64. Then the rivets 66 are applied and a portion of the extension 92 is turned over, as indicated at 93 in FIG. 8, and the balance of the extension is cut off and discarded.

It will be understood that a disconnecting switch blade can be substituted for the fuse tube 27 and associated parts where only a disconnecting function is to be performed and no fuse action is required. Such a switch blade has trunnions, similar to the trunnions 23, for mounting on the lower line terminal member and a section, corresponding to the metallic tube 39, for cooperation with the contact arm 67 of the contact clip 65. A pull ring, similar to the pull ring 44, is provided for the same purposes. This disconnecting switch blade can be opened by the auxiliary circuit interrupter in the manner described for the fuse construction 10.

What is claimed as new is:

1. In a fuse construction, in combination, an insulating fuse tube, a first terminal at one end of said fuse tube, a metallic tube extending at one end into the other end of said fuse tube and forming a second terminal for said fuse tube, a rod-like terminal at one end projecting into said one end of said metallic tube and movable further into the same, fusible means interconnecting the other end of said rod-like terminal and said first terminal, a coil tension spring in said metallic tube anchored at one end to said one end of said rod-like terminal and at the other end to the other end of said metallic tube and biasing said rod-like terminal thereinto, and a flexible conductor within said metallic tube interconnecting said one end of said rod-like terminal and said one end of said metallic tube and of a length sufficient to maintain the interconnection on movement of the former into the latter for a substantial distance without interference with such movement.

2. In a fuse construction, in combination, an insulating fuse tube, a first terminal at one end of said fuse tube, a metallic tube extending at one end into the other end of said fuse tube and forming a second terminal for said fuse tube, a rod-like terminal at one end projecting into said one end of said metallic tube and movable further into the same, fusible means interconnecting the other end of said rod-like terminal and said first terminal, a coil tension spring in said metallic tube anchored at one end to said one end of said rod-like terminal and at the other end to the other end of said metallic tube and biasing said rod-like terminal thereinto, and a flexible conductor interconnecting said one end of said rod-like terminal and said one end of said metallic tube and of a length sufficient to maintain the interconnection on movement of the former into the latter for a substantial distance, said flexible conductor being positioned within said metallic tube and coiled around said rod-like terminal in tandem with said spring.

3. In a fuse construction, in combination, a metallic tube, a rod-like terminal at one end projecting into one end of said metallic tube and movable further into the same, a coil tension spring in said metallic tube anchored at one end to said one end of said rod-like terminal and at the other end to the other end of said metallic tube and biasing said rod-like terminal thereinto, and a flexible conductor interconnecting said one end of said rod-like terminal and said one end of said metallic tube and of a length sufficient to maintain the interconnection on movement of the former into the latter for a substantial distance, said flexible conductor being disposed around said rod-like terminal in a series of reverse turns.

4. In a fuse construction, in combination, an insulating fuse tube, a first terminal at one end of said fuse tube, a metallic tube extending at one end into the other end of said fuse tube and forming a second terminal for said fuse tube, a rod-like terminal at one end projecting into said one end of said metallic tube and movable further into the same, fusible means interconnecting the other end of said rod-like terminal and said first terminal, a coil tension spring in said metallic tube anchored at one end to said one end of said rod-like terminal and at the other end to the other end of said metallic tube and biasing said rod-like terminal thereinto, and a flexible conductor interconnecting said one end of said rod-like terminal and said one end of said metallic tube and of a length sufficient to maintain the interconnection on movement of the former into the latter for a substantial distance, said flexible conductor being positioned within said metallic tube physically in series with said coil tension spring and between it and said first terminal.

5. In a fuse construction, in combination, an insulating fuse tube, a first terminal at one end of said fuse tube, a metallic tube extending at one end into the other end of said fuse tube and forming a second terminal for said fuse tube, a rod-like terminal at one end projecting into said one end of said metallic tube and movable further into the same, fusible means interconnecting the other end of said rod-like terminal and said first terminal, a coil tension spring in said metallic tube anchored at one end to said one end of said rod-like terminal and at the other end to the other end of said metallic tube and biasing said rod-like terminal thereinto, and a flexible conductor interconnecting said one end of said rod-like terminal and said one end of said metallic tube and of a length sufficient to maintain the interconnection on movement of the former into the latter for a substantial distance, said flexible conductor being coiled around said rod-like terminal and positioned within said metallic tube, the turns of said coiled flexible conductor being located

in endwise relation to the turns of said coil tension spring.

6. In a fuse construction, in combination, a metallic tube, a rod-like terminal at one end projecting into one end of said metallic tube and movable further into the same, a coil tension spring in said metallic tube anchored at one end to said one end of said rod-like terminal and at the other end to the other end of said metallic tube and biasing said rod-like terminal thereinto, and a flexible conductor interconnecting said one end of said rod-like terminal and said one end of said metallic tube and of a length sufficient to maintain the interconnection on movement of the former into the latter for a substantial distance, said flexible conductor being disposed around said rod-like terminal in a series of reverse turns and positioned within said metallic tube in series with said coil tension spring.

7. In a fuse construction, in combination, an insulating fuse tube, a first terminal at one end of said fuse tube, a metallic tube extending at one end into the other end of said fuse tube and forming a second terminal for said fuse tube, a rod-like terminal at one end projecting into said one end of said metallic tube and movable further into the same, fusible means interconnecting the other end of said rod-like terminal and said first terminal, a coil tension spring in said metallic tube anchored at one end to said one end of said rod-like terminal and at the other end to the other end of said metallic tube and biasing said rod-like terminal thereto, the convolutions of said spring having their outer surfaces juxtaposed to the inner surface of said tube, and a flexible conductor interconnecting said one end of said rod-like terminal and said one end of said metallic tube and of a length sufficient to maintain the interconnection on movement of the former into the latter for a substantial distance, said flexible conductor for the principal portion of its length being located in endwise relation to said spring and between it and said first terminal.

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