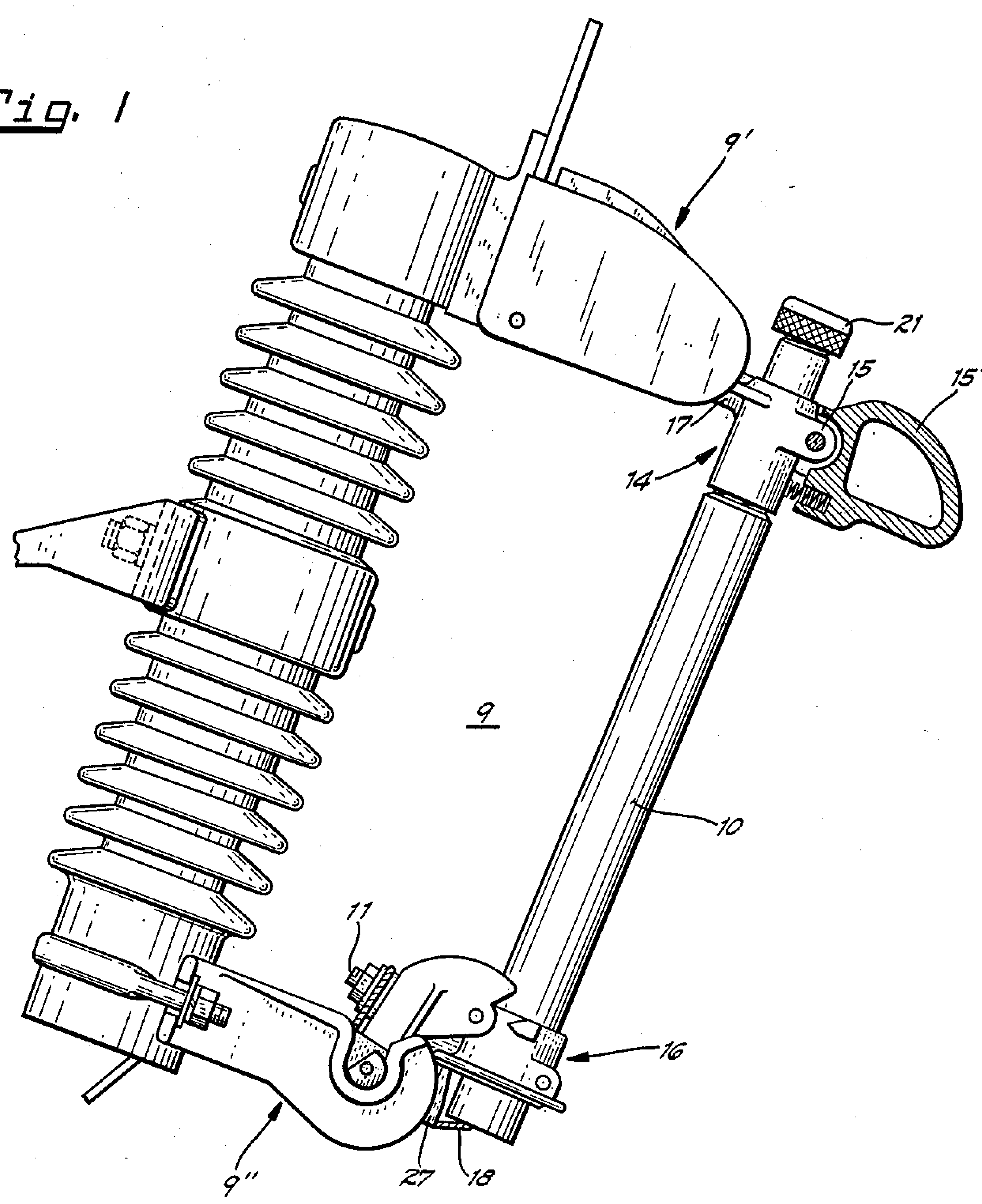
Aug. 27, 1963 R. J. BRONIKOWSKI 3,102,178

FUSE TUBE CONSTRUCTION

Filed June 29, 1960 2 Sheets-Sheet 1

Fig. 1



INVENTOR.

RAYMOND J. BRONIKOWSKI

BY

James T. Ryan

ATTORNEY

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Fig. 2

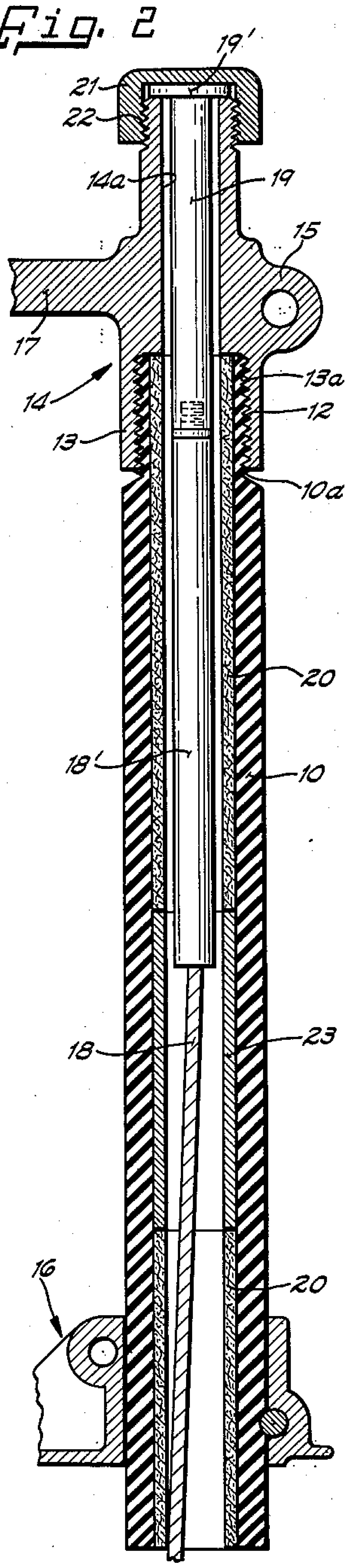


Fig. 3

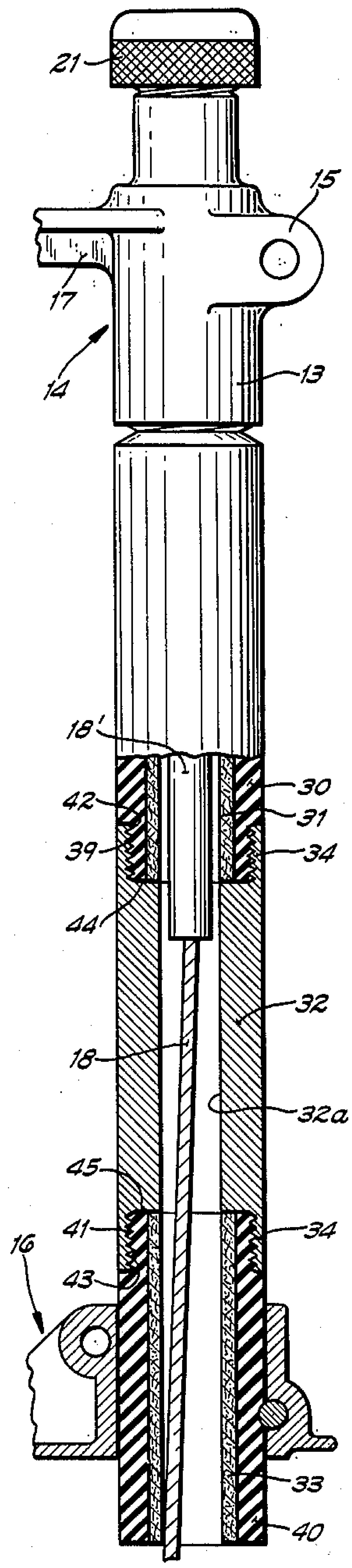
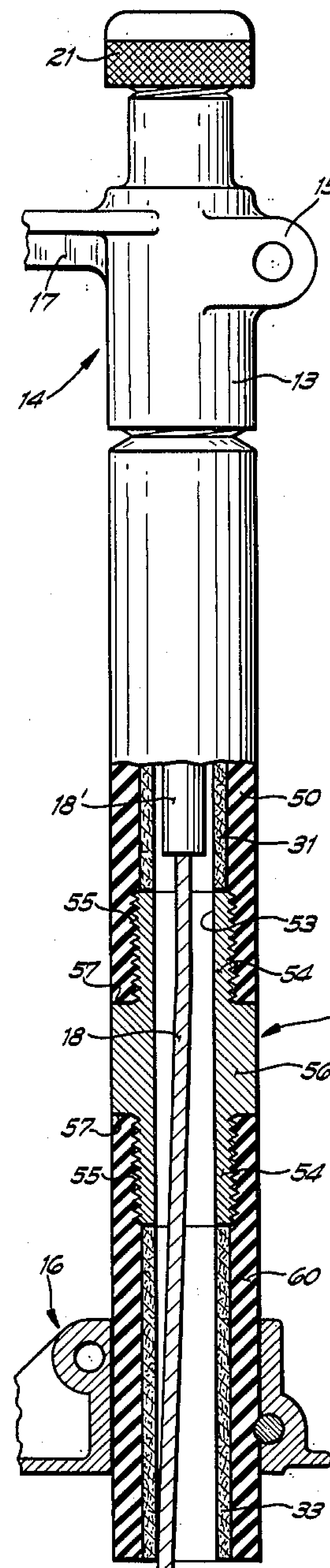


Fig. 4



INVENTOR.

RAYMOND J. BRONIKOWSKI

BY

James V. Ryan

ATTORNEY

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FUSE TUBE CONSTRUCTION

Raymond J. Bronikowski, South Milwaukee, Wis., assignor to McGraw-Edison Company, Milwaukee, Wis., a corporation of Delaware

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This invention relates, generally, to electrical circuit interrupting means and has particular relation to a fuse construction in which recoil during high current interruptions is substantially reduced without affecting the low current clearing ability of the fuse.

In interrupting high fault current conditions on an electric line, present day expulsion type fuse tubes rely on gases evolved from the fuse tube to extinguish the electrical arc resulting from the rupture of the fuse link. Since these gases are generated in a relatively confined space at a high rate they are under high pressure and this pressure aids in extinguishing the arc as well as expelling "ionized" gases from the confines of the fuse tube. This build up of pressure within the fuse tube and subsequent "venting" of gases, over a short period of time, leads to the development of high recoil forces on the fuse tube assembly. During individual cases of current interruption the recoil forces may reach such a value that portions of the interrupting device or the mounting bracket may be permanently deformed or otherwise damaged. Even if the recoil forces do not permanently deform portions of the interrupting device they may, in the case of a drop out fuse cutout, cause premature drop out of the fuse tube thereby burning the contact members. Excessive pressures within the fuse tube may also result in rupturing the fuse tube itself.

As distribution systems increase in size, the interrupting duty requirements of the interrupting devices also increase. Pressure build up in the fuse tube and recoil or thrust forces due to expulsion of gases from the fuse tube increase at least in proportion to the increase in current.

To reduce maximum pressure, prior art devices have frequently relied on increasing the inside bore of the fuse tube. This expedient served to increase the area within the tube and therefore to reduce the pressure of a given volume of evolved gas. However, the pressure decrease was far from dramatic since, as the cross-sectional area of the fuse tube bore increased as the square of the diameter, the surface of the gas evolving fiber exposed to the arc increased linearly with the diameter of the tube.

In increasing the inside bore of the fuse tube prior art constructions experienced additional difficulties in that the fuse tube did not consistently clear the circuit at the first current zero but carried over for additional half cycles of arcing. The additional force impulses caused by this prolonged arcing generally served to nullify the modest thrust reduction obtained from using a larger bore.

Another serious problem encountered in enlarging the fuse tube bore was that low current clearing ability was adversely affected by the enlarged bore. Low current clearing depends on the physical dimensions and properties of the link protector tube and fuse tube bore. Hence prior art devices in utilizing construction having a larger fuse tube bore ran into the difficulty that under certain transient conditions the link protector tube was alone unable to extinguish the arc and the fuse tube bore was too large to allow sufficient pressure build up to extinguish the arc at the particular current level. As a result the low current clearing ability of the fuse tube was seriously undermined by enlarging the bore to reduce thrust at high current values.

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It is academic that a low current arc that persists for several cycles can be extremely damaging to a given piece of equipment, as for example, a fault on the secondary of a transformer which if not cleared quickly, by the fuse cutout in series with the primary winding, will result in severe overheating and possible damage to the windings of the transformer.

I have found that by shielding portions of the gas evolving liner in a fuse tube from the arc that material reductions may be made in the internal gas pressure of the fuse tube without resorting to increasing the bore of the fuse tube and consequently impairing the low current clearing abilities of the fuse tube.

It is therefore an object of the invention to provide a fuse tube construction that will experience lesser pressure build up within the fuse tube during current interrupting operations.

Another object of this invention is to provide a fuse tube construction that will experience low thrust forces during high current interruption.

Another object of this invention is to provide a fuse tube construction that will experience low thurst forces during high current interruption while maintaining the low current interrupting capabilities of the fuse tube.

A further object of this invention is to provide a fuse construction that will shorten the arc during high current interruption and which will shield a portion of the gas evolving tubular liner from the arc during high current interruption.

A still further object of this invention is to provide a fuse construction having a lesser amount of gas evolving material in direct contact with the electrical arc without substantially altering the interrupting characteristics of the fuse tube.

Other objects and advantages of my invention will be apparent from the following description of the preferred embodiments of the invention taken in connection with the accompanying drawings in which:

FIGURE 1 is a view in elevation of a fuse cutout in which the invention may be utilized;

FIGURE 2 is a view in elevation of a longitudinal cross-section of a fuse tube embodying my invention;

FIGURE 3 is a view in elevation of a longitudinal cross-section of a fuse tube embodying a modified form of the invention; and

FIGURE 4 is a view in elevation of a longitudinal cross-section of a fuse tube embodying another modified form of the invention.

Referring now to FIGURE 1 of the invention, **9** designates a fuse cutout having a fuse tube or cartridge **10** which may have a liner of bone fibre and an outer, insulating covering of phenolic, glass reinforced-thermosetting resin or other similar material. The fuse cartridge **10** is supported between upper and lower fuse supports **9′** and **9″** respectively. Upper and lower spaced apart contacts **14**, **16** respectively are affixed to fuse tube **10** and in electrical engagement with stationary contacts (not shown) on the fuse supports **9′** and **9″**. A fuse link **18** extends throughout the fuse tube **10** and has the lower end thereof held tightly as by means **11**. It can thusly be seen that the fuse tube **10** and fuse link **18** serve to electrically bridge the space between upper and lower contacts **14**, **16**.

Referring now to FIG. 2 the upper end of the fuse tube **10** has screw threads **10*a*** on the outer periphery thereof which engage internal screw threads **12** on ferrule portion **13** of upper terminal contact member **14**. Ferrule portion **13** of member **14** has a longitudinally extending bore **13*a*** therethrough which is in axial alignment with and in communication with the interior of the fuse tube **10**. The bore **13*a*** of ferrule portion **13** is of a larger diameter than bore **14*a*** of member **14** so that the ferrule member 13 may embrace the upper extremities of the fuse tube 10.

Means 15 for mounting a pull ring assembly 15', and contact arm 17 may be integral with or otherwise affixed to terminal contact member 14. Lower contact terminal member 16 is affixed to the lower extremity of the fuse tube 10 and may be in embracing relation thereto.

A fuse link 18 having a ferrule adapter extension 19 and a link protector tube 18' therearound extends within bore 14*a*, bore 13*a* and fuse tube 10 and forms a current path between upper contact member 14 and lower contact member 16. The upper end of ferrule adapter 19 may be formed to a button head 19' so that it rests upon the upper margin of terminal member 14. While the ferrule adapter 19, which may be of brass, is shown extending into the upper area of fuse tube 10 it is to be understood that it may extend for a relatively great distance into fuse tube 10 or that it may extend for only a portion of the length of terminal member 14 or that it may not extend at all into fuse tube 10 but this is not shown. Closure means 21 engages screw threads 22 on the upper end of terminal member 14 and serves to close one end of the fuse tube.

A gas evolving fiber liner 20 extends from the top of the fuse tube 10 throughout most of the length of the tube. A portion of the liner 20 is cut away intermediate the ends of the fuse tube and conductive sleeve 23 replaces the so cutaway liner. The sleeve 23 is preferably of metal but may be of any other non-insulating, conductive material and may include insulating materials which will carbonize. While the conductive sleeve 23 is shown in FIGURE 2 as replacing a portion of the gas evolving liner 20 it might equally well be cemented to or otherwise affixed to a portion of the liner 20 thereby alleviating the necessity of cutting away a portion of the liner 20 or alleviating the necessity of providing a split (two piece) liner originally.

In FIGURE 3 a slightly modified construction is shown wherein conducting sleeve member 32 joins fuse tubes 30 and 40 having gas evolving liners 31 and 33 respectively, together. As before, the construction of FIGURE 3 includes an upper terminal member 14, lower contact terminal member 16, closure member 21, and fuse link 18.

The conductive sleeve member 32 has a bore 32*a* which communicates with the interior of fuse tubes 30 and 40 and which serves as a passageway for the fuse link 18. A peripheral portion 34 of the upper and lower extremities of sleeve member 32 extends in an axial direction beyond the remainder of the sleeve member. Screw threads 39, 41 on the upper and lower inner surfaces respectively of peripheral portions 34 engage screw threads 42, 43 on the ends of fuse tubes 30, 40 respectively. Internal shoulder portions 44, 45 of the sleeve member 32 serve as stops for the ends of the fuse tubes. Normally when the threaded extremities of the fuse tubes 30, 40 bottom respectively on shoulder portions 44, 45 of the sleeve member 32 the sleeve and fuse tubes 30, 40 will be properly affixed to one another and otherwise properly positioned with respect to one another. It can be seen that by using the conductive sleeve connector 32 that a substantial amount of gas evolving fiber is eliminated as compared to the heretofore described fuse tube constructions. Note also, that even though the amount of gas evolving fibre has been reduced that the confined area surrounding the fuse link has been virtually undiminished.

FIGURE 4 discloses a modification of FIGURE 1 similar in most respects to that of FIGURE 2.

A conductive sleeve member 52 has at each end axial extensions 53, 54 having screw threads 55 thereon. The annular portion 56 of the sleeve member 52 provides radial shoulder portions 57 adjacent extensions 53, 54 and each serves respectively as a stop for the lower end of fuse tube 50 and the upper end of fuse tube 60. In FIGURE 4 the sleeve 52 serves to shield a portion of the gas evolving tube from the fuse link 18 and to replace a portion of the gas evolving tube.

In both the modifications of FIGS. 3 and 4 electrical insulating material may be utilized to insulate the exterior portions of the sleeve member although this is not shown. It should also be understood that cement or similar expedients could be utilized in place of the screw connections to join the sleeve member and fuse tubes together.

The operation of all three embodiments is substantially similar and will now be explained.

During low overcurrents of up to approximately 400 amperes several cycles of current are generally required before the rupturable fuse link melts. Upon rupture of the fuse link 18 some amount of gas is generated by the link protector tube 18' as a result of the rise in temperature within the link protector tube due to arcing between ruptured ends of the fuse link. The gas so generated quickly permeates the confines of the protector tube and serves to extinguish the arc. The fuse link flip out lever 27 (FIG. 1) also serves to aid in extinction of the arc by separating the ruptured ends of the fuse link. Hence the arc is extinguished and the equipment to be protected is effectively isolated from the line. Note that subsequent to fuse link extraction the fuse tube will drop out thusly providing a large air gap.

In the case of fault currents in excess of 400 amps. the same sequence as in interruption of low currents will occur except that the gas generated by the protector tube 18' will be insufficient to extinguish the arc. As more and more gases are evolved pressure builds up within the link protector tube and it bursts and/or is expelled from the fuse tube. The arc is then exposed to portions of the gas evolving liner and gases are evolved at a rapid rate thusly increasing the pressure within the fuse tube. Venting at one end of the fuse tube then takes place propelling the ruptured fuse link ends apart as well as expelling ionized gases and relieving pressure within the tube. As current approaches zero the diameter of the arc diminishes and disappears as the zero point is reached.

The incorporation of a conductive sleeve serves to effectively limit the amount of gases generated in the tube and thereby reduces the thrust force and subsequent cutout recoil caused by gases under pressure being expelled from one end of the fuse tube. Note that while there is a reduced area of liner capable of evolving gases that the area available for gas expansion is relatively unaffected. Since control of the gases being evolved is effected through the use of a non-insulating (conductive) liner and not by an increase in the bore of the fuse tube the low current interrupting capabilities of the fuse tube remain intact. More particularly fault currents in the intermediate range (400–800 amps.) sufficient to cause rupture of the fuse link protector but not ordinarily sufficient to cause a substantial volume if gas to be evolved from the gas evolving liner will, in the instant device, cause a sufficient volume of gas to be evolved to extinguish the arc since there is no increase in the diameter of the fuse tube bore.

It is particularly to be noted that on high current faults subsequent to rupture of the fuse link that the length of the resultant arc increases. The arc originally exists between the ruptured ends of the fuse link but as the arc increases in length it is transferred from one end of the fuse link to the metal sleeve member. A second arc in series with the first arc is then created between the lower end of the metal sleeve member and a portion of the fuse leader below the sleeve. It can thusly be seen that whereas one elongated arc was present in prior art devices, that under high current condition the present device envisions two shorter arcs in series with one another. The total length of the shorter arcs will generally be less than the length of a single arc, given the same electrical conditions. Hence since a portion of the arc is eliminated by providing a current path through the metal sleeve insert the arc is effectively shortened and in being so shortened will tend to evolve a lesser volume of gases.

In addition the metal sleeve insert serves as a heat sink for cooling the two series arcs and in this respect the relatively cooler sleeve aids in de-ionizing the arc products at current zero.

It is most important that the metal sleeve insert not be in electrical contact with either of the terminal members and in fact best results are achieved when the sleeve is removed 1–3 inches from the open end of the fuse tube. This "floating" condition of the conductive sleeve is important since if the sleeve is in contact with, or even in close proximity to either of the electrodes, the low current clearing capabilities of the tube will be detrimentally affected.

It may thusly be seen that my invention results in substantially lesser arc lengths, better cooling, lesser volumes of evolved gases and therefore a much diminished thrust force. All this is achieved without detrimentally effecting the high or low current clearing ability of a fuse tube.

For example in utilizing my invention to interrupt current of 6000 amps., I have been able to reduce recoil forces from 900 pounds thrust to 650 pounds thrust, a reduction of 28% without detracting from the low current clearing ability of the fuse tube.

While three particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that various changes and modifications can be made therefrom without departing from the spirit of the invention and, therefore, it is intended that the appended claims cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. In a circuit interrupting device the combination of, a gas evolving expulsion fuse tube having a rupturable fuse link therewithin, upper and lower terminal means associated with said fuse tube and in electrical contact with said fuse link, closure means for one end of said fuse tube, whereby a recoil force is exerted upon said fuse tube as a result of the gas expelled from the open other end thereof when said fuse link ruptures, conductive sleeve means within said fuse tube and surrounding said fuse link, said conductive sleeve means being electrically isolated from said upper and lower terminal means, whereby subsequent to rupture of said fuse link said conductive sleeve means functions to shorten the length of the resulting arc and to decrease the area of said fuse tube available to evolve gases thereby decreasing said recoil force on said fuse tube.

2. In a circuit interrupting device, a gas evolving expulsion fuse tube having a rupturable fuse link therewithin, closure means for one end of said fuse tube, whereby gases expelled from the open other end of said fuse tube incident to rupture of said fuse link result in a reactive force thereon, and upper and lower terminal contact means associated with said fuse tube and in electrical contact with said fuse link, in combination with, electrically conductive sleeve means within a portion of said fuse tube in surrounding relation to a portion of said fuse link, said electrically conductive sleeve means being electrically separated from said upper and lower contact means and having a bore which is substantially equal in size to the bore of said fuse tube, said sleeve means decreasing the area of said fuse tube available to generate gases and shortening the arc formed upon rupture of said fuse link, whereby the energy in said arc and said reactive force are reduced.

3. In an expulsion fuse cutout of the drop out type the combination of first and second gas evolving fuse tube means in axial alignment with one another, electrically conductive sleeve means interposed between said first and second tube means and together therewith forming an expulsion type fuse tube, said conductive sleeve means having an internal diameter no greater than that of said fuse tube means and having an extended circumferential portion and an inner shoulder portion on each end, said shoulder portions of said conductive sleeve means serving as a stop for each of said fuse tubes and said extended portions embracing the outer periphery of each of said fuse tubes, upper and lower terminal contact means associated with said first and second fuse tubes respectively, a rupturable fuse link within said fuse tubes and said conductive sleeve means and electrically bridging said upper and lower terminal contact means and having a rupturable portion spaced axially of said fuse tube means from said conductive sleeve means, closure means for said first tube means, whereby a recoil force is exerted on said fuse cutout as a result of the gases expelled from said second fuse tube means when said fuse link ruptures, said conductive sleeve means decreasing the area of said expulsion type fuse tube available to generate gas and shortening the arc formed upon rupture of said fuse link and reducing said recoil force.

4. In a drop out type fuse cutout the combinaton of first and second gas evolving fuse tubes in axial alignment with one another, conductive sleeve means interposed between said first and second fuse tubes and together therewith forming an expulsion type fuse tube, said conductive sleeve means having an internal diameter no greater than that of said fuse tubes and having on both ends an outer circumferential shoulder portion and an inner portion that extends beyond said shoulder portion in an axial direction, said inner portions of said conductive sleeve means being receivable within the bore of said first and second fuse tubes and said shoulder portion serving to separate said first and second fuse tubes, upper and lower terminal contact means associated with said first and second fuse tubes respectively, a fuse link within said fuse tubes and said conductive sleeve means and normally electrically bridging said upper and lower terminal contact means and having a rupturable portion spaced axially of said fuse tubes from said conductive sleeve means, and closure means for said first fuse tube, whereby gas expelled from said second fuse tube incident to rupture of said fuse link results in a reactive force on said expulsion type fuse tube, said sleeve means reducing the area of said expulsion type fuse tube available to evolve gas and shortening the length of the arc formed upon rupture of said fuse link, whereby the arc energy and said reactive force are decreased.

5. In a fuse cutout, in combination, an expulsion fuse tube, gas evolving material on the internal periphery of said fuse tube, terminals on the ends of said fuse tube, a fuse link within said fuse tube connected to said terminals and having a rupturable portion, closure means for one end of said fuse tube, whereby the gas expelled from the open other end of said fuse tube upon rupture of said fuse link results in a recoil force on said fuse tube, an insulating protector tube surrounding said rupturable portion within said fuse tube, fuse link tensioning means for extracting a severed portion of said fuse link from said fuse tube after rupture of said rupturable portion, an electrically conductive sleeve having an inner diameter no greater than that of said fuse tube surrounding said fuse link within said fuse tube and being spaced axially of said fuse tube from said rupturable portion, said conductive sleeve being normally isolated electrically from said terminals and decreasing the area of said fuse tube available to evolve gas and shortening the arc formed upon rupture of said rupturable portion, whereby the energy of said arc is reduced and said recoil force is decreased.

6. In a circuit interrupting device, the combination of gas evolving expulsion fuse tubular means having a fuse link therewithin having a rupturable portion, closure means for one end of said tubular means, whereby the

gas expelled from the open other end of said tubular means upon rupture of said fuse link results in a recoil force on said tubular means, upper and lower terminal means associated with said tubular means and in electrical contact with the ends of said fuse link, conductive means within said tubular means surrounding said fuse link for shielding a portion of said tubular means from the arc created upon rupture of said fuse link, said conductive means being normally spaced axially of said tubular means from said rupturable portion and electrically isolated from said upper and lower terminal contacts, said conductive means shortening said arc and decreasing the area of said expulsion fuse tubular means available to evolve gas, whereby said recoil force is reduced.

7. In a circuit interrupting device the combination of a gas evolving expulsion fuse tube having a rupturable fuse link therewithin, terminal means on said fuse tube electrically connected to said fuse link, closure means for one end of said fuse tube, whereby gases expelled from the open other end of said fuse tube incident to rupture of said fuse link result in a recoil force on said fuse tube, electrically conductive means surrounding a portion of said fuse link for shielding a portion of said gas evolving fuse tube from the arc resulting between ruptured ends of said fuse link during circuit interruption and for shortening the length of said arc, said conductive means being electrically insulated from said terminal means, whereby said conductive means decreases the area of said fuse tube available to evolve gases and decreases the internal pressure within said fuse tube and said recoil force on said device without materially affecting the low current clearing capabilities of said fuse tube.

8. In a drop out fuse cutout the combination of, gas

evolving expulsion fuse tubular means having a fuse link therewithin, said fuse link having a rupturable portion intermediate the ends thereof, spaced apart terminal means affixed to said tubular means and electrically connected to said ends of said fuse link, closure means for one end of said tubular means, whereby gas expelled from the open other end of said tubular means incident to rupture of said fuse link results in a recoil force on said tubular means, electrically conductive sleeve means having an internal diameter no greater than that of said tubular means disposed within said tubular means and surrounding said fuse link and being spaced axially of said tubular means from said rupturable portion, said electrically conductive sleeve means being normally electrically isolated from said spaced apart terminal means, said electrically conductive sleeve means decreasing the area of said tubular means available to evolve gases and shortening the arc created upon rupture of said fuse link and a substantial portion of the voltage of said arc occurring between said conductive means and a severed portion of said fuse link adjacent said rupturable portion, thereby facilitating arc interruption and decreasing said recoil force.

References Cited in the file of this patent

UNITED STATES PATENTS

854,723	Dempster	May 28, 1907
2,337,872	Craig	Dec. 28, 1943
2,343,422	Rawlins	Mar. 7, 1944
2,878,341	Lange	Mar. 17, 1959
2,918,557	Link	Dec. 22, 1959