July 2, 1968 F. J. KOZACKA 3,391,369

HIGH VOLTAGE FUSE

Filed Nov. 17, 1967 2 Sheets-Sheet 1

FIG. 1

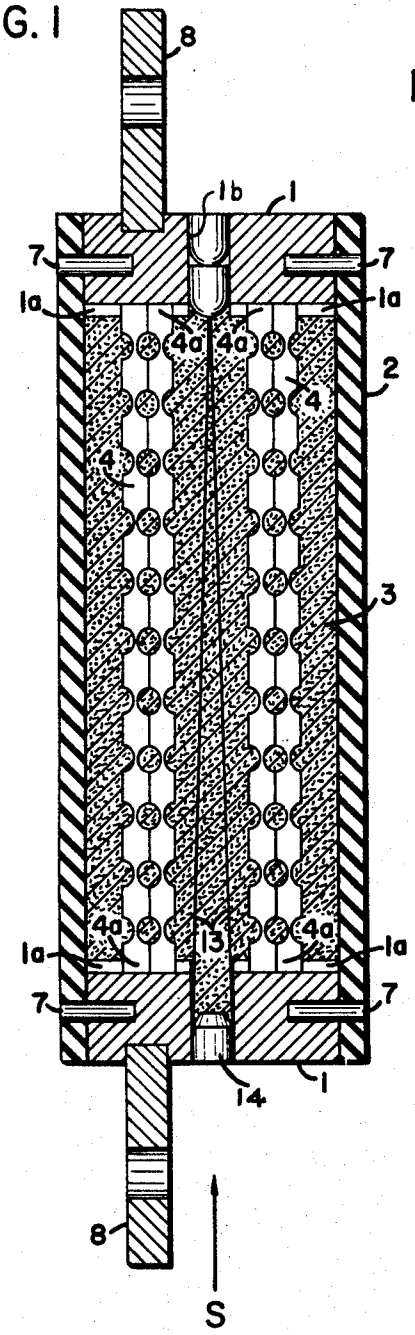


FIG. 2

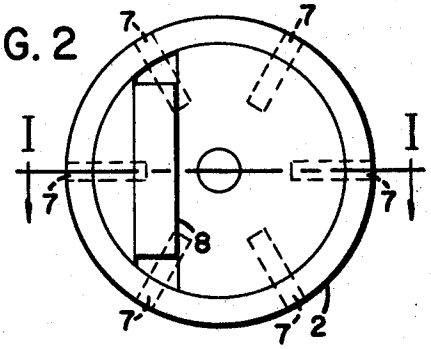
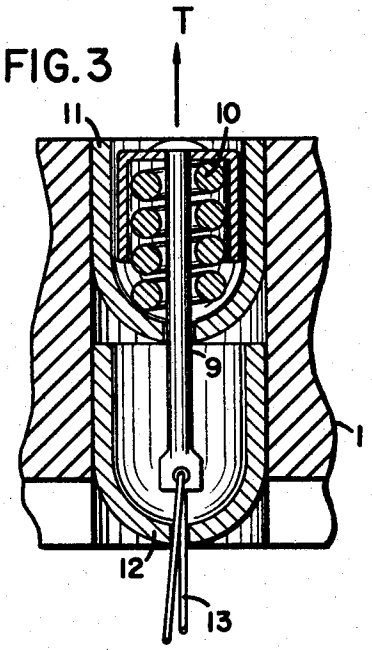


FIG. 3



INVENTOR:

FREDERICK J. KOZACKA

BY Irwin Kalyn ATTY.

July 2, 1968 F. J. KOZACKA 3,391,369

HIGH VOLTAGE FUSE

Filed Nov. 17, 1967 2 Sheets-Sheet 2

FIG. 4

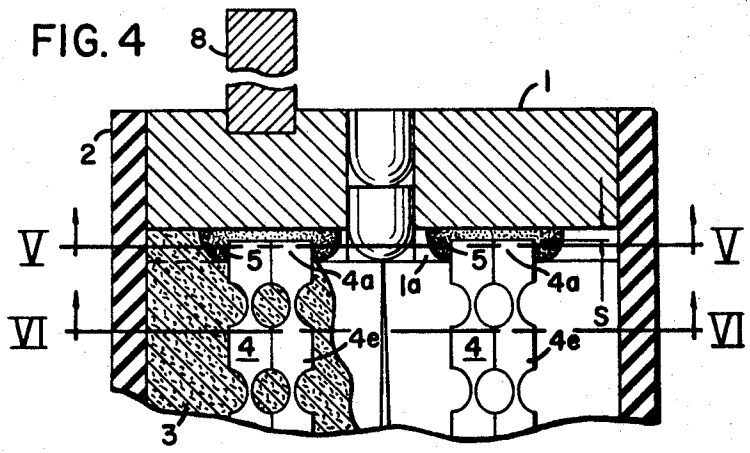


FIG. 5

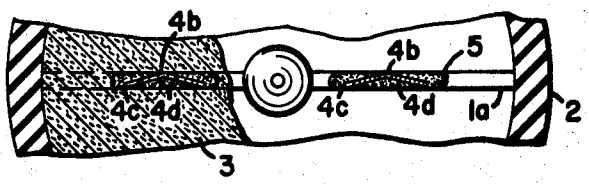


FIG. 6



FIG. 7

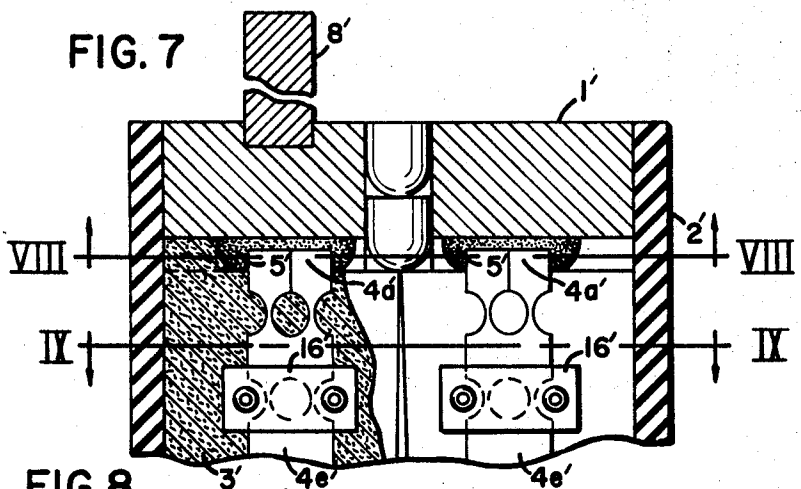


FIG. 8

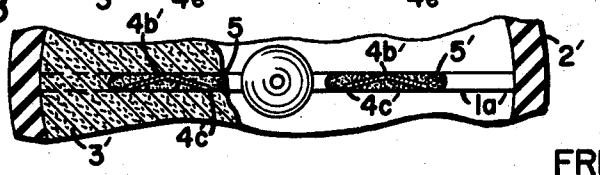
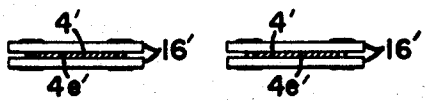


FIG. 9



INVENTOR:
FREDERICK J. KOZACKA
BY Irwin Salzer
ATTY.

United States Patent Office

3,391,369
Patented July 2, 1968

3,391,369

HIGH VOLTAGE FUSE

Frederick J. Kozacka, South Hampton, N.H., assignor to The Chase-Shawmut Company, Newbury, Mass.

Filed Nov. 17, 1967, Ser. No. 688,297
9 Claims. (Cl. 337—222)

ABSTRACT OF THE DISCLOSURE

A fuse wherein the ribbon type fuse link means have a high current-carrying capacity and are sufficiently long to generate the arc voltages required to effectively interrupt circuits having circuit voltages in excess of 600 volts, and more particularly to voltage of a few kilivolts. The ends of the the fuse link means engage grooves in terminal plugs in a novel fashion, greatly facilitating assembly of the relatively long ribbon fuse link means. The aforementioned ribbon fuse link means are fashioned in such a way as to have sufficient bending strength, and not to require a supporting mandrel, or similar supporting structure, widely used in fuses calling for fuse link means of considerable length.

The structure described below is provided with terminal elements which make it possible to apply the assembly process disclosed and claimed in United States Patent 2,740,187 to Philip C. Jacobs et al., Apr. 3, 1956, for Methods of Assembling Fuses, and to provide the fuse with a blown fuse indicator or other mechanical or electric means responsive to blowing of the fuse.

Background of invention

In low voltage applications, i.e. applications in circuits having circuit voltages of 600 volt, or less, fuses including a tubular casing of insulating material (preferably a synthetic-resin-glass-cloth laminate) closed on both ends by a pair of terminal plugs inserted into the axially outer ends of the casing have been very successful. In such fuses the axially inner end surfaces of the terminal plugs are provided with one groove, or a plurality of grooves, and the ends of the fuse link means are inserted into the groove, or grooves. Heretofore this design principle could not be applied successfully to fuses having voltages in the order of several kilovolts. One of the reasons underlying this fact is that prior art ribbon fuse links, if sufficiently long to be applied in fuses for relatively high circuit voltages, are too fragile to be handled safely, and more particularly to be safely inserted into the link-receiving grooves on the axially inner end surfaces of the terminal plugs. To be drastically current-limiting, fuse links for high-voltage fuses require a large number of serially related points of reduced cross-sectional area per unit of length, and these points must have a cross-sectional area which is considerably smaller than the cross-sectional area at points of the fuse link where the cross-sectional area is not reduced. These facts tend to limit the dimensional stability of long ribbon-type fuse links to such an extent as to make it extremely difficult to apply the grooved terminal plug design in high-voltage fuses.

The present invention overcomes these difficulties, and thus opens the successful grooved terminal plug design to the high-voltage fuse field.

Summary of invention

Fuses embodying this invention include a tubular casing of insulating material and a pair of terminal plugs inserted into the axially outer ends of the casing. Each of the terminal plugs has at least one groove on the axially inner end surface thereof, this groove being bounded by a pair of side walls and a bottom wall. The fuse further includes at least one elongated sheet metal ribbon fuse link inside said casing, submersed in a pulverulent arc-quenching filler and conductively interconnecting the aforementioned pair of terminal plugs. The fuse link has a pair of axially outer ends including a portion projecting into the aforementioned groove in each of said pair of terminal plugs. This portion of the fuse link is folded to form at least three edges extending in a direction longitudinally of the casing. At least two of said edges engage linearly frictionally one of said pair of side walls of said groove and at least one of said edges engages linearly frictionally the other of said pair of side walls of said groove.

Brief description of drawings

FIG. 1 is a longitudinal section of a fuse embodying the present invention taken along I—I of FIG. 2;

FIG. 2 is an end view of the structure of FIG. 1 seen in the direction of the arrow S of FIG. 1;

FIG. 3 shows a detail of FIG. 1 on a larger scale;

FIG. 4 shows another detail of FIG. 1 on a larger scale;

FIG. 5 is a section along V—V of FIG. 4;

FIG. 6 is a section along VI—VI of FIG. 4;

FIG. 7 is a modification of the detail of FIG. 5 shown in the same way as in FIG. 5;

FIG. 8 is a section along VIII—VIII of FIG. 7; and

FIG. 9 is a section along IX—IX of FIG. 7.

Description of preferred embodiments of invention

Referring to the drawings, numeral **1** has been applied to designate a pair of terminal plugs preferably of copper, inserted into the axially outer ends of casing **2**. Each terminal plug has at least one groove **1***a* on the axially inner end surface thereof. The embodiment of the invention shown in FIG. 1 includes two grooves **1***a* both coextensive with one diameter of one of the axially inner end surfaces of plugs **1**. Preferably the number of grooves is larger than two and the grooves are arranged along radii of the inner end surface of plugs **1** enclosing equal angles. Such an arrangement is shown, for instance, in United States Patent 2,658,974 to Frederick J. Kozacka, Nov. 10, 1953 for High Current Carrying Capacity Current-Limiting Fuses. Each groove **1***a* is channel-shaped, or substantially U-shaped, in cross-section thus being bounded by a pair of side walls and by a bottom wall. A pulverulent arc-quenching filler **3**, preferably quartz sand, is filled into casing **2**. Two elongated sheet metal ribbon fuse links **4** are arranged inside of casing **2**, submersed in filler **3**, and conductively interconnect terminal plugs **1**. Each fuse link **4** has a plurality of serially related points of reduced cross-sectional area. Each of these points of reduced cross-sectional area is formed by a circular perforation and two immediately adjacent semicircular lateral incisions. Each fuse link **4** has a pair of axially outer ends including a portion **4***a* projecting into groove **1***a* in each of the pair of terminal plugs **1**. Portion **4***a* of links **4** is folded to form at least three edges extending in a direction longitudinally of casing **1**. As best shown in FIGS. 4–6, at least two of

said three edges engage linearly frictionally one of the side walls of grooves 1*a*, and at least one of said three edges engages linearly frictionally the other of the side walls of grooves 1*a*. In FIG. 5 reference character 4*b* has been applied to indicate the edge in the center of fuse link 4 formed by folding the latter transversely and reference character 4*c* has been applied to indicate the two lateral edges of fuse link 4. As seen in FIG. 5 edge 4*b* engages linearly the upper side wall of grooves 1*a* and the pair of edges 4*c* engages linearly the lower side wall of grooves 1*a*. The axially outer edges of the portions 4*a* of the fuse link 4 projecting into grooves 1*a* are spaced from the bottom walls of grooves 1*a*. This spacing has been indicated in FIG. 4 by the reference character *s*. The portions 4*a* of fuse links 4 which project into grooves 1*a* define a single pair of wings 4*d* which enclose an obtuse angle, preferably in excess of 120 degrees. Since wings 4*d* are inherently resilient on account of the fact that the angle which they enclose can be enlarged by application of slight pressure, and reduced by reducing the pressure, wings 4*d* stay in position and are relatively firmly held therein even though grooves 1*a* are not filled with solder. While resiliently maintained in their positions fuse links 4 are conductively connected by solder joints 5 inside grooves 1*a* to terminal plugs 1. Tolerances of the spacing between the axially inner end surfaces of terminal plugs 1 are compensated by the spacing *s* existing between the axially outer ends of fuse links 4 and the bottom surfaces of grooves 1*a*. Fuse links 4 are held in position by edges 4*b*, 4*c* before solder joints 5 are formed, and while solder joints 5 are formed. This greatly eases the link-handling problem and tends to avoid stresses in the fragile reduced cross-section portions or necks of fuse links 4.

Fuse links 4 include two portions, namely the aforementioned portions 4*a* which project into grooves 1*a* and the portions 4*e* situated outside grooves 1*a*. The portions 4*e* of fuse links 4 extending between terminal plugs 1 outside grooves 1*a* are folded transversely to increase the bending strength or dimensional stability thereof. The angle enclosed between the portions 4*e* of fuse links 4 is slightly less than the angle enclosed between the portions 4*a* thereof. Before insertion of fuse links 4 into grooves 1*a* the angle enclosed between the two wings thereof is equal throughout the length of fuse links 4, but the portions 4*a* are flattened by insertion thereof into grooves 1*a* while the portions of links 4 outside of grooves 1*a* are hardly flattened adjacent plugs 1 and not flattened at all adjacent the centers of fuse links 4.

It will be apparent from the foregoing that the length of fuse links 4 is less than the spacing between the bottom walls of grooves 1*a*. As a result, the axially outer edges of fuse links 4 are spaced more or less from the bottom walls of grooves 1*a*. This effectively precludes stresses in the fuse links resulting from tolerances in the spacing of terminal plugs 1. On the other hand, the ends 4*a* of fuse links 4 are firmly yet resiliently clamped in position by their linear engagement with the side walls of grooves 1*a*. The width of grooves 1*a* must be sufficient to make it possible to readily receive the angularly shaped, or wing shaped, ends 4*a* of fuse links 4. To this end the width of grooves 1*a* must exceed the width of grooves in conventional terminal plugs not intended to establish linear frictional engagement between the side walls of the grooves and at least three longitudinal edges of the fuse link. In other words, the width of a terminal groove for a fuse embodying this invention must exceed the width of a terminal groove for a fuse according to the aforementioned United States Patent 2,658,974.

Fuse links 4 include a large number of serially related points of reduced cross-sectional area to generate a high arc voltage incident to blowing of the fuse. There are two axially outermost points of reduced cross-sectional area in each fuse link 4. The portions of fuse links 4 situated axially outwardly from the aforementioned axially outermost points of reduced cross-sectional area project into grooves 1*a* and the cross-section thereof define a larger angle than the angle defined by the portions 4*e* of links 4 situated axially inwardly from the axially outermost points of reduced cross-sectional area.

It is apparent from FIG. 1 that both terminal plugs 1 are firmly held in position by transverse steel pins 7 projecting through casing 2 into plugs 1. As shown in FIGS. 1 and 2 each plug 1 defines a central aperture 1*b* arranged in coaxial relation with casing 2. Aperture 1*b* is closed by aperture closing means which will be considered below more in detail. In order not to obstruct apertures 1*b* the blade contacts 8 of which each is integral with one of terminal plugs 1 are arranged in spaced relation from apertures 1*b*, or offset.

The above configuration of the terminal plugs 1 and blade contacts 8 has several important reasons. Apertures 1*b* may be used to insert a center past for spacing terminal plugs 1 during the process of assembly when fuse links 4 are fitted into their grooves 1*a*. When the subassembly including terminal plugs 1, fuse links 4 and the aforementioned center post has been inserted into casing 1, and affixed to the latter by steel pins 7, the aforementioned center post may be removed. Then casing 1 is filled with arc-quenching filler 3 through one of apertures 1*b*. A removal of the center post prior to filling of casing 1 with arc-quenching filler 3 is desirable because this makes it possible to maximize the content of the casing 2 with arc-quenching filler 3. It is further possible to use apertures 1*b* for installing a blown fuse indicator, or striker pin, i.e. a pin responsive to blowing of the fuse and then striking an external device, e.g. the latch of a disconnect switch, or for initiating operation of the external device. The offset of the blade contacts makes it possible to use the end surface of one of terminal plugs 1 as a support for an external device, e.g. an auxiliary electric switch operated by the striker pin and energizing an electric circuit to initiate an electric signal in response to blowing of the fuse.

FIG. 3 shows one of the terminal plugs 1 whose aperture 1*b* has been used to accommodate therein a blown fuse indicator mechanism. The latter includes a pin 9 biased by a helical spring 10 arranged in a cup 11 inside aperture 1*b* in the direction of arrow T. Cup 12 likewise inserted into aperture 1*b* precludes filler 3 from entering into aperture 1*b*. Cup 12 has a small hole at the apex thereof allowing the thin restraining wire 13 to be threaded through it, but not sufficiently large to allow the passage of particles of arc-quenching filler 3. Restraining wire 13 has one end attached to pin 9 and restrains pin 9 from moving in the direction of arrow T under the bias of spring 10 and another end inserted into the aperture 1*b* in the other terminal plug 1 and firmly held therein by a plug-shaped wedge member 14.

Restraining wire 13 is made of a high resistivity material and becomes current-carrying only upon interruption of the current paths formed by fuse links 4. Then restraining wire 14 melts, allowing pin 9 to pop out in the direction of arrow T.

In the modification of the structure of FIGS. 4–6 shown in FIGS. 7–9 the same reference characters as in FIGS. 4–6 with a prime added have been applied to indicate like parts. Hence FIGS. 7–9 require a detailed description only to the extent that the structure shown therein differs from that shown in FIGS. 4–6. Reference character 1′ has been applied to indicate one of a pair of terminal plugs closing the ends of a tubular casing 2′ of insulating material. Plugs 1′ of which but one is shown in FIG. 7 are provided with radially extending grooves 1*a*′ and central bores 1*b*′. Ribbon fuse links 4′ submersed in arc-quenching filler 3′ conductively interconnect terminal plugs 1′. The portion 4*a*′ of fuse links 4′ extending into grooves 1*a*′ are folded transversely to establish three groove-engaging edges 4*c*′, 4*b*′, 4*c*′. The portion of fuse link 4′ extending between the terminal plugs 1′ outside the grooves 1*a* thereof are not bent

transversely to any significant extent, but are preponderantly planar, and braced by insulating plate means **16'** affixed thereto impart to them the required mechanical strength, or dimensional stability. As shown in FIG. 9 plate means **16'** may sandwich fuse link **4'** between them and the former may be held together by staples or eyelets (not shown). Plate means **16'** may be used, in addition to their link-bracing function, for other purposes, e.g. to control the arc voltage generated in the fuse incident to blowing thereof as more fully explained in United States Patent 2,866,038 to Frederick J. Kozacka, Dec. 28, 1958, current limiting fuse with increased interrupting capacity; United States Patent 2,892,061 to Frederick J. Kozacka, June 23, 1959, fuses with fulgurite suppressing means and United States Patent 2,964,604 to Philip C. Jacobs, Jr., Dec. 13, 1960, current-limiting fuses having compound arc-voltage generating means.

While, in accordance with the patent statutes, I have disclosed the details of two preferred embodiments of my invention, it is to be understood that many of these details are merely illustrative and variations in their precise form will be possible, or necessary, depending upon the particular nature of application.

I desire, therefore, that my invention be limited only to the extent set forth in the appended claims and by the prior art.

I claim as my invention:

1. An electric fuse including in combination:

(a) a tubular casing of electric insulating material;

(b) a pulverulent arc-quenching filler inside said casing;

(c) a pair of terminal plugs inserted into the axially outer ends of said casing each having at least one groove on the axially inner end surface thereof, said groove being bounded by a pair of side walls and a bottom wall; and

(d) an elongated sheet metal ribbon fuse link inside said casing, submersed in said filler, conductively interconnecting said pair of terminal plugs, said fuse link having a pair of axially outer ends including a portion projecting into said groove in each of said pair of terminal plugs and being folded to form at least three edges extending in a direction longitudinally of said casing, at least wo of said edges linearly frictionally engaging one of said pair of side walls of said groove and at least one of said edges linearly frictionally engaging the other of said pair of side walls of said groove.

2. An electric fuse as specified in claim **1** wherein said portion of said axially outer ends of said fuse link projecting into said groove in each of said pair of terminal plugs is laterally bounded by a pair of lateral edges and is bent between said pair of lateral edges along a line parallel to said pair of lateral edges to define a single pair of wings enclosing an obtuse angle.

3. An electric fuse as specified in claim **1** wherein said portion of said axially outer ends of said fuse link projecting into said groove in each of said pair of terminal plugs is folded transversely to establish said three groove-engaging edges, and wherein the portion of said fuse link extending between said pair of terminal plugs outside said groove in each of said pair of terminal plugs is folded transversely to increase the bending strength thereof.

4. An electric fuse as specified in claim **3** wherein the angle defined by folded portions of said fuse link inside said groove in each of said pair of terminal plugs exceeds the angle defined by said transversely folded portion of said fuse link extending between said pair of terminal plugs outside said groove in each of said pair of terminal plugs.

5. An electric fuse as specified in claim **2** wherein said fuse link is folded transversely along the entire length thereof and defines a plurality of serially related points of reduced cross-sectional area, including a pair of axially outer points of reduced cross-sectional area each situated immediately adjacent to one of said pair of terminal plugs, and wherein the cross-section of the portion of said fuse link extending between said pair of terminal plugs outside said groove in each of said pair of terminal plugs defines a smaller angle than said obtuse angle enclosed by said pair of wings.

6. An electric fuse as specified in claim **1** wherein the length of said fuse link is less than the spacing between said bottom wall of said groove in one of said pair of terminal plugs and said bottom wall of said groove in the other of said pair of terminal plugs, wherein each of the axially outer edges of said fuse link is spaced from the bottom wall of said groove in one of said pair of terminal plugs immediately adjacent thereto, and wherein the space between each of the axially outer edges of said fuse link and the bottom wall of said groove in one of said pair of terminal plugs immediately adjacent thereto is filled with a body of solidified solder.

7. An electric fuse as specified in claim **1** wherein said portion of said axially outer ends of said fuse link projecting into said groove in each of said pair of terminal plugs is folded transversely to establish said three groove-engaging edges, and wherein the portion of said fuse link extending between said pair of terminal plugs outside said groove in each of said pair of terminal plugs is preponderantly planar and braced by insulating plate means affixed thereto.

8. An electric fuse including in combination:

(a) a tubular casing of an electric insulating material;

(b) a pulverulent arc-quenching filler inside said casing;

(c) a pair of terminal plugs inserted into the axially outer ends of said casing each having a plurality of grooves on the axially inner end surface thereof; and

(d) a plurality of elongated sheet metal ribbon fuse links inside said casing, submersed in said filler, conductively interconnecting said pair of terminal plugs, each of said plurality of fuse links being folded transversely along the entire length thereof and defining a plurality of serially related points of reduced cross-sectional area including a pair of axially outermost points of reduced cross-sectional area each situated immediately adjacent to one of said pair of terminal plugs, the ends of each of said plurality of fuse links situated axially outwardly from said axially outermost points of reduced cross-sectional area projecting into a pair of said plurality of grooves in said pair of terminal plugs, and the cross-section of the portion of each of said plurality of fuse links situated axially outwardly from said axially outermost points of reduced cross-sectional area defining larger angles than the cross-section of the portion of each of said plurality of fuse links situated axially inwardly from said axially outermost points of reduced cross-sectional area.

9. An electric fuse including in combination:

(a) a tubular casing of electric insulating material;

(b) a pulverulent arc-quenching filler inside said casing;

(c) ribbon fuse link means of sheet metal inside said casing submersed in said filler; and

(d) a pair of terminal plugs inserted into the axially outer ends of said casing and conductively interconnected by said fuse link means, each of said pair of said terminal plugs defining a central aperture arranged in coaxial relation to said casing, and closed by aperture closing means, said pair of terminal plugs being provided with grooves on the axially inner end surfaces thereof receiving the axially outer ends of said sheet metal ribbons, said axially outer ends of said sheet metal ribbons being folded transversely to establish a linear frictional engagement between said axially outer ends of said sheet metal ribbons and the lateral walls of said grooves; and

(e) a pair of blade contacts each integral with one of said pair of terminal plugs and arranged in spaced

relation from said central aperture to avoid obstruction by said pair of blade contacts of said aperture in each of said pair of terminal plugs.

References Cited

UNITED STATES PATENTS

2,148,803	2/1939	Bussmann	200—135
3,029,328	4/1962	Kozacka	200—120
3,143,615	8/1964	Kozacka	200—120
3,261,952	7/1966	Kozacka	200—131
3,341,674	9/1967	Jacobs	200—135 XR
2,794,096	5/1957	Kozacka	200—121 X
2,800,556	7/1957	Swain et al.	200—117 X

BERNARD A. GILHEANY, *Primary Examiner.*

H. B. GILSON, *Assistant Examiner.*