United States Patent

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[15] **3,680,019**

[45] **July 25, 1972**

[54] HIGH-VOLTAGE FUSE HAVING A PLURALITY OF FUSE LINKS WOUND HELICALLY AROUND AN INSULATING MANDREL

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[22] Filed: **June 8, 1970**

[21] Appl. No.: **44,135**

[52] **U.S. Cl.**.....**337/161,** 337/166

[51] **Int. Cl.**.....**H01h 85/08,** H01h 85/10, H01h 85/12

[58] **Field of Search**.....337/158, 159, 160, 161, 162, 337/229, 231, 233, 276, 290, 293, 295, 296, 166, 292

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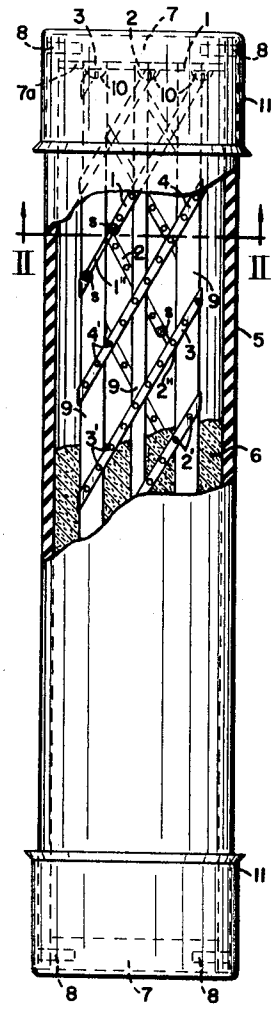
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[57] **ABSTRACT**

A high-voltage fuse having a mandrel supporting a plurality of ribbon fuse links wound substantially helically around the mandrel. Each fuse link has relatively short serially related neck portions, and each fuse link has a relatively long neck portion. The relatively long neck portions of the various fuse links are displaced in a direction longitudinally of the mandrel to substantially equalize heat generation by said neck portions along the mandrel.

3 Claims, 3 Drawing Figures



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SHEET 1 OF 2

FIG. 1

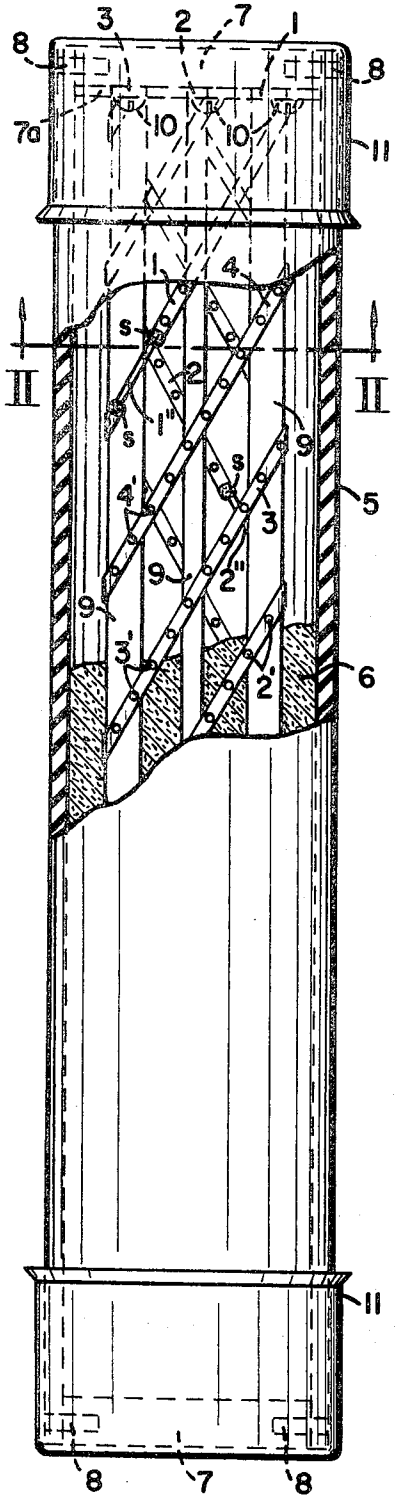
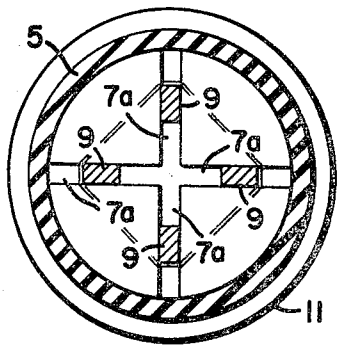


FIG. 2

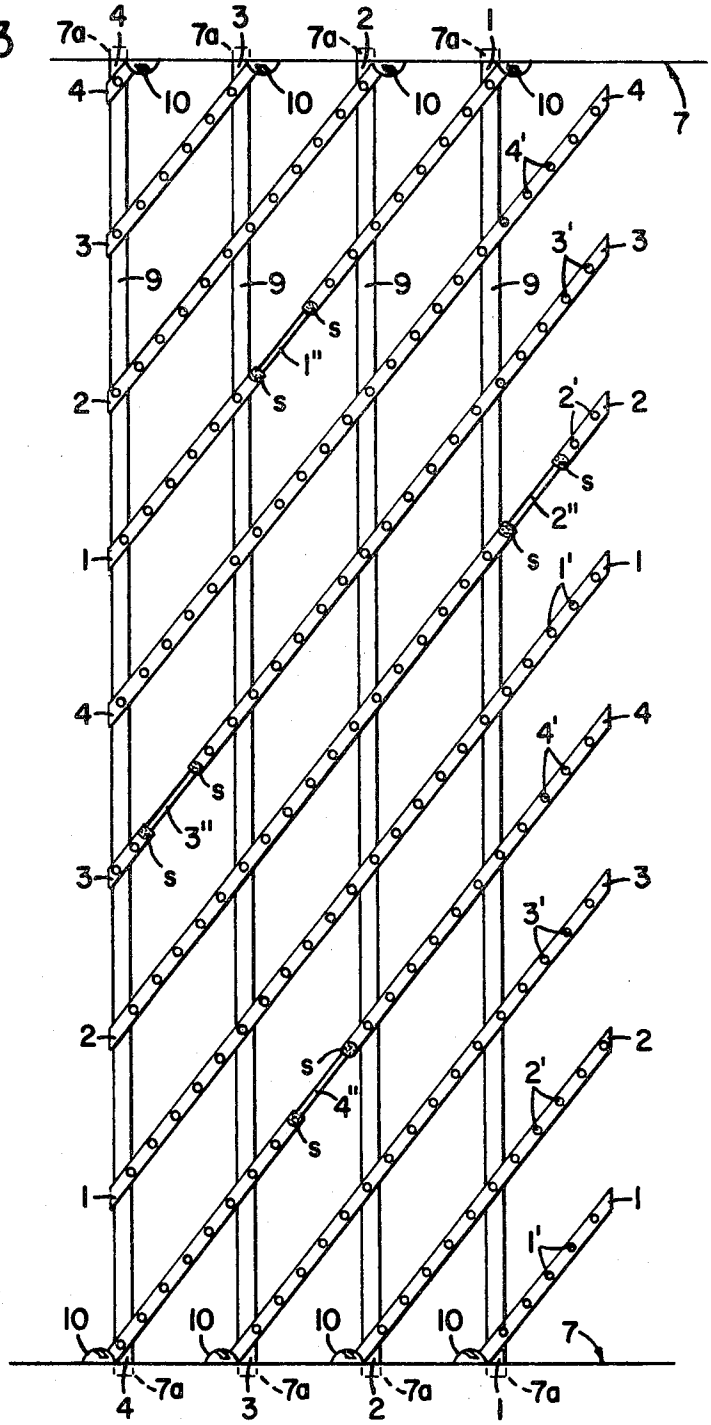


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FIG. 3



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HIGH-VOLTAGE FUSE HAVING A PLURALITY OF FUSE LINKS WOUND HELICALLY AROUND AN INSULATING MANDREL

BACKGROUND OF INVENTION

Ribbon fuse links for high-voltage fuses are provided with relatively short serially related neck portions and a relatively long neck portion. The former form series breaks upon fusion thereof caused by major fault currents, or short-circuit currents. The latter forms a single break upon occurrence of overload currents of inadmissible duration. This single break grows by backburn until the overloaded circuit is interrupted by arc elongation.

The heat generated by the relatively short, serially related neck portions of a fuse link of a high-voltage fuse is readily dissipated since it is substantially evenly generated all along the fuse structure whose length is significant as to heat transfer away from the fuse link. The relatively long necks provided for the interruption of overload currents of inadmissible duration are often a source of trouble because the amount of heat generated at these necks is relatively large, and because the heat generated at these necks is generated within a relatively limited space. Hence there is a tendency for the pulverulent arc-quenching filler surrounding the relatively long necks to assume a high temperature on occurrence of relatively small overloads of relatively long duration. Such a preheating of the arc-quenching filler tends to deprive the latter largely of its cooling and deionizing action. As a result, there is a tendency for high-voltage fuses to fail when attempting to interrupt relatively small but very protracted overload currents. Such excessive localized heat generation tends to cause damage to, or even charring of, the casing or fuse tube if made of an organic insulating material such as, for instance, glass-cloth melamine.

The above problem occurring in high-voltage fuses differs from that occurring in low voltage fuses inasmuch as the neck portions for interrupting overload currents must be much longer in high-voltage fuses than in low-voltage fuses, and thus generate relatively larger amounts of heat, and inasmuch as the heat generated in overload current interrupting neck portions of low-voltage fuse links can readily be dissipated by axial heat flow which cannot be done in regard to the much larger amounts of heat generated in the overload current interrupting neck portions of high-voltage fuse links.

When several overload-current-interrupting neck portions of high-voltage fuse links are vaporized in a pulverulent fulgurite-forming arc-quenching medium, particularly quartz sand, the resulting fulgurites often tend to merge into a more or less uniform fulgurite. Such contingency greatly reduces the rate of dielectric recovery of the several arc gaps and is, therefore, undesirable.

The present invention relates to a high-voltage fuse capable of successfully interrupting both major fault currents and relatively small protracted overload currents, and to achieve this end with one single pulverulent arc-quenching filler, namely quartz sand, rather than layers of different arc-quenching fillers having different thermal properties.

SUMMARY OF INVENTION

A high-voltage fuse embodying this invention includes a tubular casing of insulating material, and a pulverulent arc-quenching filler inside of said casing. A pair of electroconductive terminal elements closes the ends of the casing. A plurality of fuse links in excess of two is wound substantially helically and conductively interconnects said pair of terminal elements. The preponderant portion of the length of each of said plurality of fuse links has relatively short serially related necks and each of said plurality of fuse links further has a relatively long neck portion. Said relatively long neck portion of each of said plurality of fuse links is displaced in a direction longitudinally of said casing relative to said relatively long neck portion of all the other of said plurality of fuse links in such a way that a substantially even distribution of said relatively long neck portion of said plurality of fuse links along said casing is achieved. Said relatively long neck portion of some of said plurality of fuse links is also angularly displaced relatively to said relatively long neck portion of other of said plurality of fuse links.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a front view of a high-voltage fuse embodying this invention, a portion of its casing being broken away to show some of the constituent parts of the fuse arranged inside of the casing;

FIG. 2 is a section along II—II of FIG 1; and

FIG. 3 is a development of the fuse structure of FIG. 1 with its ribbon fuse links into the plane in which FIG. 3 is drawn.

DESCRIPTION OF PREFERRED EMBODIMENT

The high-voltage fuse shown in the drawings includes a tubular casing 5 of insulating material, e.g., melamine-glass-cloth. A pulverulent arc-quenching filler 6 is arranged inside of casing 5 and fills the latter. In FIG. 1 but a portion of the arc-quenching filler 6 has been shown to expose to view some parts which are normally immersed in, and covered by, the arc-quenching filler 6. Actually the entire space bounded by casing 5 is filled with the pulverulent arc-quenching filler 6, preferably quartz sand, except the spaces inside of casing 5 which are occupied by other parts, i.e., a mandrel structure and ribbon fuse links to be described below more in detail. The ends of casing 5 are closed by a pair of electroconductive terminal elements 7 which are in the form of metal plugs press-fitted into the ends of casing 5 and firmly maintained in position by steel pins 8 projecting radially through casing 5 into plugs 7. The axially inner end surfaces of terminal plugs 7 are provided with grooves 7*a*. As shown in FIG. 2 each terminal plug 7 is provided on the axially inner end surface thereof with a pair of grooves 7*a* which intersect at right angles. Both the upper terminal plug 7 and the lower terminal plug 7 are provided with identical systems of grooves 7*a*. Reference numeral 9 has been applied to indicate four elongated separate plates of insulating material engaging with the axially outer edge portions the grooves 7*a* in plug terminals 7. Plates 9 are preferably made of an inorganic insulating material which is non-tracking. The four plates 9 perform two functions. They form a spacing structure for spacing plugs 7 a required distance, and they form a fuse link-supporting mandrel embedded in filler 6 and supporting a plurality of ribbon fuse links 1,2,3,4. Fuse links 1,2,3,4 are wound substantially helically around the mandrel structure formed by elongated plates 9 and conductively interconnect terminal elements or terminal plugs 7. The radially outer lateral edges of the four plates 9 define a prism whose cross-sectional area is a square, and each ribbon fuse link 1,2,3,4 forms a helix arranged in the lateral surfaces of said prism. Each ribbon fuse link 1,2,3,4 has relatively short serially related neck portions, or portions of reduced cross-sectional area 1′,2′,3′,4′, which are formed by circular perforations in the aforementioned fuse links. Each of ribbon fuse links 1,2,3,4 is further provided with one relatively long neck portion, or portion of reduced cross-sectional area 1″,2″M″,4″. The four helical paths of fuse links 1,2,3,4 are angularly displaced 90°. The neck portions 1″,2″,3″,4″ are displaced in a direction longitudinally of casing 5 and longitudinally of fuse-link-supporting mandrel structure 9,9,9,9 in such a way as to be substantially evenly distributed along the casing 5 and along fuse-link-supporting mandrel structure 9,9,9,9. It will be noted that the latter is arranged in coaxial relation to casing 5. The formation of link-supporting mandrel structure 9,9,9,9 by a plurality of separate plates has the advantage of maximizing the space inside casing 5 available for filler 6.

Referring now more specifically to the diagram of FIG. 3, it is apparent from that figure that the neck portion 4″ of fuse link 4 is at the lowest level, closest to the lower terminal plug 7, that the neck portion 3″ of fuse link 3 is at a higher level than that of fuse link 4, that the neck portion 2″ of fuse link 2 is still at a higher level than the neck portion 3″ of fuse link 3,

and that the neck portion 1'' of fuse link 1 is at a higher level than any other neck portion 4'',3'',2'', i.e., neck portion 1'' is closest to the upper terminal element or terminal plug 7.

The number of fuse links may be larger than shown in FIGS. 1–3 and the number of levels in which the relatively long overcurrent interrupting necks are arranged may likewise be larger than shown in FIGS. 1–3, thus further dispersing the points of extreme heat generation and fulgurite formation incident to blowing of the fuse as a result of small protracted overloads.

Fuses embodying this invention include a minimum of three fuse links wound substantially helically around a mandrel structure with the relatively long neck portions thereof arranged at at least three points spaced in a direction longitudinally of casing 5 and mandrel structure 9,9,9,9, respectively.

The axially outer ends of ribbon fuse links 1,2,3,4 are clamped by the heads of screws 10 against the axially inner end surfaces of terminal plugs 7. The shanks (not shown) of these screws project at right angles into the axially inner end surfaces of terminal plugs 7.

In addition to the mechanical connection between fuse links 1,1,3,4 and terminal plugs 7 by screws 10 electrical low-voltage drop connections should be established between the axially outer ends of fuse links 1,2,3,4 and terminal plugs 7. This can readily be achieved by providing a drop of solder (not shown) adjacent each interface between the end of each fuse link 1,2,3,4 and terminal plugs 7.

The necks 1'',2'',3'',4'' of fuse links 1,2,3,4 may be formed by appropriately stamping or blanking the aforementioned fuse links by means of a saddle punch or the like punching tool. Preferably, however, necks 1'',2'',3'',4'' are formed by a pair of round silver wires which are laterally spaced and connected in parallel. The ends of such silver wires are spot-welded to ribbon fuse links 1,2,3,4 at points designated by the letter *s*. These points are thereafter covered with an overlay of a low fusing point link-severing metal, e.g., tin. On occurrence of small protracted overloads the tin overlays at points *s* reach their fusing point after predetermined periods of time. The fusing point of the link-severing overlays is considerably lower than the fusing point of the base metal of fuse links 1,2,3,4, which is generally silver. As a result of the fusion of the link-severing overlay a metal interdiffusion process occurs which results in the formation of metal alloys whose resistivity is high, consequent increased heat generation and ultimate formation of breaks at the points designated by the letter *s*.

Ferrules or terminal caps 11 mounted on casing 5 and conductively connected to terminal plugs 7 (by means not shown) make it possible to insert the fuse into a conventional high-voltage fuse holder.

Although this invention has been described in considerable detail, it is to be understood that such description of the invention is intended to be illustrative rather than limiting, as the invention may be variously embodied, and is to be interpreted as claimed.

I claim as my invention:

1. An electric high-voltage fuse including
   a. a tubular casing of insulating material;
   b. a pulverulent arc-quenching filler inside said casing;
   c. a pair of electroconductive terminal elements closing the ends of said casing; and
   d. a plurality of ribbon fuse links in excess of two wound substantially helically and conductively interconnecting said pair of terminal elements, the preponderant portion of the length of each of said plurality of fuse links having relatively short serially related necks and each of said plurality of fuse links further having a relatively long neck portion and said relatively long neck portion of each of said plurality of fuse links being displaced in a direction longitudinally of said casing relative to said relatively long neck portion of all the other of said plurality of fuse links in such a way that a substantially even distribution of said relatively long neck portion of said plurality of fuse links along said casing is achieved, and said relatively long neck portion of some of said plurality of fuse links being also angularly displaced relative to said relatively long neck portion of others of said plurality of fuse links.

2. An electric high-voltage fuse as specified in claim 1 including a casing of glass-cloth-melamine, at least three substantially helically wound fuse links with said relatively long neck portion thereof arranged at at least three points spaced in a direction longitudinally of said casing, each of said relatively long neck portions being formed by a plurality of parallel-connected current paths each provided with a link-severing overlay of a low fusing point metal.

3. A high-voltage fuse as specified in claim 2 wherein
   a. said pair of terminal elements is formed by a pair of terminal plugs press-fitted into the ends of said casing and having radially extending grooves in the axially inner end surfaces thereof; and wherein
   b. said fuse links are supported by a fuse-supporting mandrel structure, said fuse-link-supporting mandrel structure being formed by a plurality of elongated separate plates of insulating material engaging with the axially outer edge portions thereof said grooves in the axially inner end surfaces of said pair of terminal plugs and having radially outer edges engaged by said fuse links.

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