March 11, 1958 F. J. KOZACKA 2,826,660

CURRENT-LIMITING FUSES WITH FUSE LINKS ARRANGED IN RADIAL PLANES

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Fig. 1.

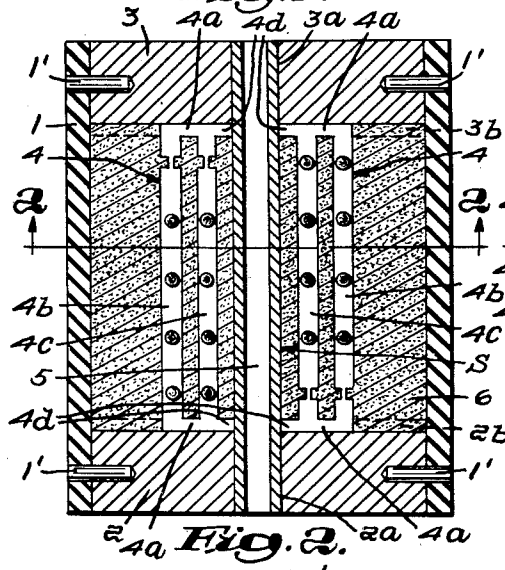


Fig. 3.

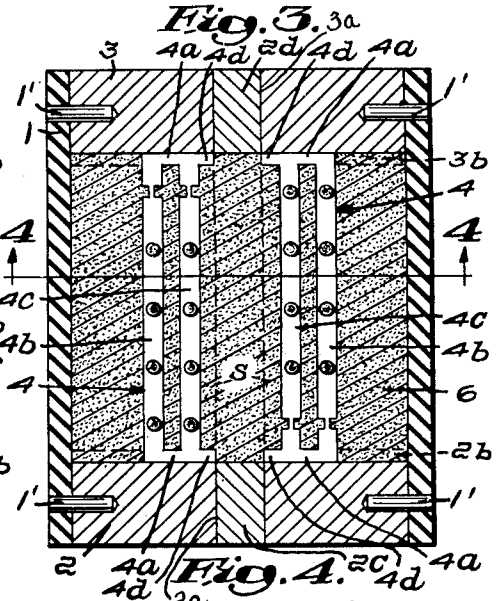


Fig. 2.

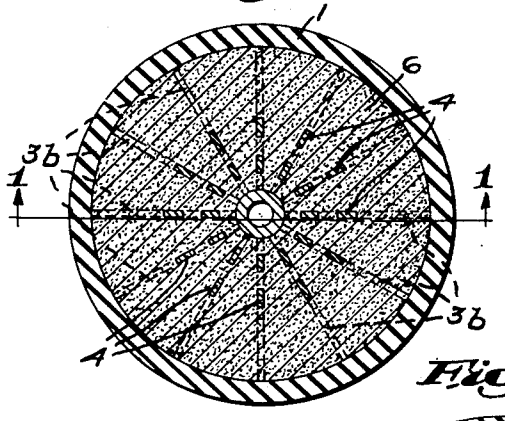


Fig. 4.

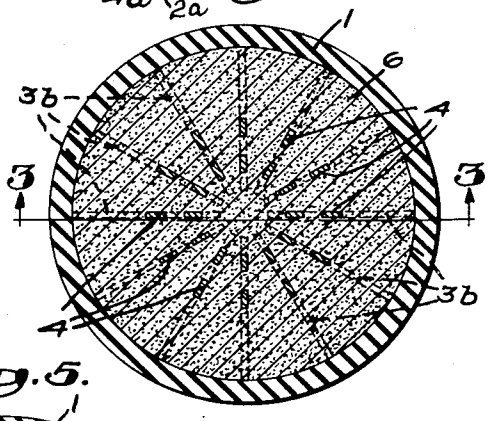
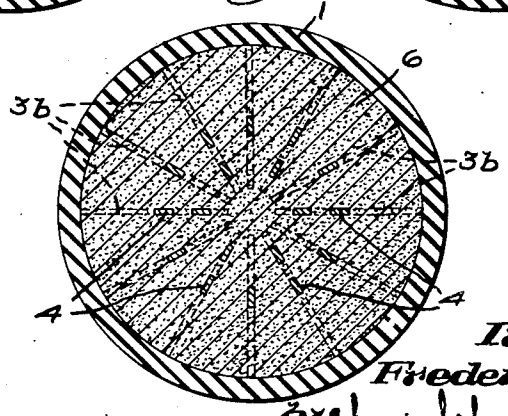


Fig. 5.



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CURRENT-LIMITING FUSES WITH FUSE LINKS ARRANGED IN RADIAL PLANES

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7 Claims. (Cl. 200—120)

This invention refers to current-limiting fuses, i. e. fuses capable of limiting major fault currents to peak values substantially below the peak value which the fault current would reach without the current-limiting action of the current-limiting fuse.

More particularly this invention refers to a type of current-limiting fuses comprising a tubular casing of insulating material, a pair of metal plugs inserted into said casing and closing the ends thereof, a system of radial grooves on the juxtaposed surfaces of said pair of plugs, and a system of ribbon-type fuse links arranged in radial planes and inserted with the ends thereof into said system of grooves. Current-limiting fuses of this type are distinguished by their great mechanical strength and by the fact that they can be manufactured in very compact sizes, i. e. in this type of fuses the ratio of current-carrying capacity to the internal volume of the casing, and the ratio of interrupting capacity to the internal volume of the casing, may be relatively large.

I have observed on blowing of such fuses that a portion of the arc quenching pulverulent filler is not, or not sufficiently, used for heat absorption, while other portions of the filler are overheated, and therefore tend to cool down at a slower rate than desirable in the interest of the best possible operation of the fuse.

It is, therefore, one object of this invention to provide current-limiting fuses of the aforementioned type wherein heat generation at the various loci of the fuse structure is controlled in such a way as to achieve a more efficient action of the pulverulent arc quenching medium.

Laminates of glass-cloth and a synthetic resin are particularly well adapted in many respects for casings of current-limiting fuses, yet casings made of such materials may be charred during the interrupting process and may then release large amounts of gases.

It is, therefore, another object of the invention to provide current-limiting fuses wherein the arcing zone is located in such a way as to preclude impairment of a casing of a glass-cloth-synthetic-resin laminate by the heat generated during the interrupting process.

Another object of the invention is to provide current-limiting fuses of the aforementioned type wherein the fulgurite resulting from fusion of the pulverulent arc quenching filler under the heat of the arc extends from the immediate region of the axis of the casing radially outwardly toward the inner surface of the casing, and wherein the fulgurite is sufficiently spaced from the inner surface of the casing even though the design of the fuse is very compact, and considerably more compact than any comparable prior art fuse I am familiar with.

A further object of the invention is to so arrange the fuse links in current-limiting fuses of the aforementioned type that the arcs formed on blowing are blasted by magnetic action into sound pulverulent arc quenching medium and that virtually all the arc quenching medium within the casing of the fuse is utilized as energy absorber.

Other objects and advantages of the invention will, in part, be obvious and in part appear hereinafter.

For a more complete understanding of the invention reference may be had to the following detailed description thereof taken in connection with the accompanying drawing, in which:

Fig. 1 is substantially a longitudinal section along 1—1 of Fig. 2 of a fuse embodying my invention;

Fig. 2 shows a cross-section of the fuse taken along 2—2 of Fig. 1;

Fig. 3 shows a modification of the structure shown in Fig. 1 and is substantially a longitudinal section along 3—3 of Fig. 4;

Fig. 4 shows a cross-section taken along 4—4 of Fig. 3; and

Fig. 5 is a cross-section similar to Figs. 2 and 4 of still another modification of my invention.

Referring now to the drawing, and more particularly to Figs. 1 and 2 thereof, reference numeral 1 has been applied to indicate a tubular casing of an insulating material, preferably a synthetic-resin-glass-cloth laminate. Cylindrical metal plugs 2 and 3 are inserted under pressure into casing 1 and close the ends thereof. Pins 1' secure casing 1 to plugs 2 and 3. Plugs 2 and 3 are provided with a pair of center-post-holes 2*a* and 3*a* defining a space S coaxial with metal plugs 2 and 3. A swstem of radial grooves 2*b* and 3*b*, respectively, is provided on each of the juxtaposed surfaces of metal plugs 2 and 3. The angle enclosed between adjacent grooves is of considerable importance, as will more fully be explained below. In the particular embodiment of the invention shown in Figs. 1 and 2 this angle is 30 degrees. Each of said systems of grooves 2*b*, 3*b* is engaged by one single link-forming stamping generally indicated by reference numeral 4. Each stamping 4 comprises a pair of groove-engaging terminal bars 4*a* and a plurality of terminal-bar-interconnecting multiperforated ribbons 4*b*, 4*c* extending at right angles to terminal bars 4*a*. Terminal bars 4*a* project radially inwardly toward the center-post-hole-defined space S, and beyond the plurality of multiperforated ribbons 4*b*, 4*c*. In the embodiment of the invention shown in Figs. 1 and 2 the space S is occupied by the center post 5 fitted under pressure into the holes 2*a* and 3*a* in plugs 2 and 3. Reference numeral 4*d* has been applied to indicate the radially inner tab-like ends of terminal bars 4*a* in abutting relation with center post 5. The tab-like ends or tabs 4*d* form spacers, or abutments, defining exactly the position of stampings 4, and of all the constituent parts thereof, inside of casing 1, and more particularly with respect to the systems of grooves 2*b*, 3*b*. The terminal-bar-interconnecting multiperforated ribbons 4*b* form a radially outer shell, and the terminal-bar-interconnecting multiperforated ribbons 4*c* form a radially inner shell, of fusible conductors or fuse links. The spacing between the center-post-hole-defined space S, or the center post 5 proper, on the one hand, and said inner shell formed by links 4*c* is in the order of the width of one of the ribbons or fuse links 4*b*, 4*c*, whereas the spacing between the outer shell formed by fuse links 4*b* and casing 1 is a multiple of the width of one of the fusible ribbons or fuse links 4*b*, 4*c*. Casing 1 is filled with a pulverulent arc quenching filler 6, preferably quartz sand from which metallic impurities have been carefully removed, and all stampings 4 are submersed in filler 6.

Plugs 2 and 3 may be provided with any desired kind of connector enabling insertion of the fuse shown into a suitable fuse holder such as, for instance, blade contacts, plug contacts, or the like. Since the particular type of connectors used has no bearing upon the present invention, such connectors have been omitted in the drawing.

In Figs. 3 and 4 the same reference numerals as in

Figs. 1 and 2 have been applied to indicate like parts; therefore Figs. 3 and 4 require a detailed description only to the extent to which these figures differ from Figs. 1 and 2. Figs. 3 and 4 refer to a fuse manufactured in accordance with the teachings set forth in United States Patent 2,740,187 to P. C. Jacobs, Jr. et al., Methods of Assembling Fuses, April 3, 1956, and for a detailed description of this method reference may be had to that patent. Briefly, plugs 2 and 3 are first provided with coaxial center-post-holes 2*a* and 3*a*, and then arranged in spaced relation with said holes 2*a* and 3*a* in registry. Then a spacer—not shown in the drawing—is inserted into holes 2*a* and 3*a* to maintain plugs 2, 3 in spaced relation. Thereafter stampings 4 are inserted into the systems of grooves 2*b*, 3*b*, thus conductively interconnecting plugs 2 and 3. To minimize the internal resistance of the fuse structure terminal bars 4*a* are connected by soft solder to terminal-bar-receiving grooves 2*b*, 3*b*. Thereafter casing 1 is pressure-mounted upon both plugs 2 and 3, thus forming a spacer between plugs 2 and 3 and enabling removal of the temporary spacer or center post which has been inserted in holes 2*a*, 3*a*. Prior to removal of the temporary center post casing 1 and plugs 2, 3 are firmly attached to each other as by transverse steel pins 1'. As shown in Fig. 3, the holes 2*a*, 3*a* are ultimately closed by small plugs or sub-plugs 2*c*, 2*d* upon filling of casing 1 with a pulverulent arc-quenching filler 6, such as quartz sand. During the assembly of the fuse stampings 4 are being pushed radially inwardly until their tabs 4*d* engage the temporary center post, which operation defines their exact position within casing 1 relative to plugs 2 and 3. As a result, the distance between the center-post-hole-defined space S and the radially inner edges of the system of links 4*b*, 4*c* can be maintained rigorously uniform and substantially equal to the width of one of fuse links 4*b*, 4*c* which is particularly desirable.

Assuming each ribbon-type link 4*b*, 4*c* to be substantially identical, this is conducive to sequential blowing of links 4*b* and 4*c*, the current density in the former being for magnetic reasons considerably higher than in the latter. In view of the large spacing between the outer link shell formed by links 4*b* and casing 1 the products of arcing are free to sweep radially outwardly and to form a fulgurite without any danger of scorching the heat sensitive synthetic-resin-glass-cloth-laminate casing or causing the latter to evolve vapors and fumes and to dangerously increase the pressure prevailing inside casing 1. The distance between the inner edges of the inner shell of fuse links 4*c* depends upon the diameter of holes 2*a*, 3*a* and the length of tabs 4*d*; however the diameter of holes 2*a*, 3*a*, the spacer tabs 4*d* provide for a sufficiently large central quartz sand core in the center region of the fuse and, on the other hand, preclude that this mass of quartz sand be larger than required for absorbing the heat generated when fuse links 4*c* vaporize subsequent to vaporization of fuse links 4*b*. I found the amount of quartz sand needed inside the radially inner shell formed by links 4*c* to be very small. This is due to the fact that the products of arcing are magnetically biased radially outwardly.

As a result of numerous tests with various arrangements of fuse links inside of casings, I found the radial arrangement of the links, i. e. the arrangement of stampings 4 in radial, relatively narrowly spaced planes, to be of considerable importance. This seems to be due to the fact that narrow spacing of fuse links is conducive to heat exchange during blowing, causing all the links to fuse, to burn back and to thus contribute to the interruption of the circuit. There is a tendency for some of a plurality of fuse links arranged in parallel in a circuit not to burn back upon formation of an initial break on one or more of said plurality of links, the fuse links to fuse first being shunted by the fuse links to fuse last. In the past, this tendency could only be overcome by integrating all the fuse links into a unitary substantially tubular structure forming one or more shells arranged in coaxial relation inside of the casing. Such tubular link structures, while not subject to the drawback of incomplete back-burning, are subject to the drawback of requiring relatively large amounts of metal, which is undesirable. In the arrangements shown in Figs. 1 to 4, narrowness of spacing between individual links is conducive to heat exchange during the blowing period and this, in turn, establishes a tendency of back-burning of all the links, thus causing all the links to contribute equally to the interruption of the circuit without requiring a larger amount of metal than the bare minimum that is needed to comply with predetermined current carrying requirements.

I have found that fusion and back-burning of the fuse links 4*c* which constitute the radially inner shell tends to result in a relatively dense fulgurite indicative of high specific energy absorption, i. e. high energy absorption per unit of volume. Nevertheless the link geometry has no tendency to fail because of full participation of all the links in the interrupting duty and equal distribution of arc energy within the active zone of the fuse.

The tendency of the inner shell of fuse links to be subject to a more severe interrupting duty than the outer shell of fuse links can be decreased, if necessary, by providing in the outer shell a number of fuse links having a larger total cross-sectional area than the total cross-sectional area of the fuse links 4*c* which form the inner shell. Fig. 5 has been drawn on the assumption that all fuse links have exactly the same geometry, i. e. equal length, width, number of perforations, etc., and that the inner shell of fuse links includes a smaller number of fuse links than the outer shell.

While I have shown the radial length of tabs 4*d* to be equal to the width of fuse links 4*b*, 4*c*, the radial length of tabs 4*d* may be a little larger if the current density in the inner shell is particularly high. In that case the radial length of tabs 4*d* and the distance between space S and the inner shell of links may be in the order of 1 to 2 times the width of links 4*b*, 4*c*.

It will be understood that although but three embodiments of the invention have been illustrated and described in detail, the invention is not limited thereto. It will be also understood that the embodiments illustrated may be modified without departing from the spirit and scope of the invention as set forth in the accompanying claims.

It is claimed:

1. A current-limiting fuse comprising, a substantially tubular casing of insulating material, a pair of metal plugs inserted into said casing and closing the ends thereof, a pair of center-post-holes in said pair of plugs defining a space coaxial with said pair of plugs, systems of radial grooves on the juxtaposed surfaces of said pair of plugs, a system of ribbon-type fuse links arranged in radial planes and inserted with the ends thereof into said systems of grooves, the distance between the inner surface of said casing and the radially outer edges of said system of fuse links being in the order of a multiple of the width of one of said system of links, the distance between said center-post-hole defined space and the radially inner edges of said system of fuse links being in the order of the width of one of said system of fuse links, and a system of spacers forming an integral part of said system of fuse links, said system of spacers being adapted to maintain a predetermined fixed spacing between said center-post-hole defined space and said system of fuse links.

2. A current-limiting fuse comprising, a substantially tubular casing of a laminate of glass-cloth and a synthetic resin, a pair of metal plugs closing the ends of said casing, a pair of center-post-holes in said pair of plugs defining a cylindrical space coaxial with said casing and said pair of plugs, systems of radial grooves on the juxtaposed surfaces of said pair of plugs, a system of ribbon-type fuse links arranged in radial planes and in-

serted with the ends thereof into said systems of grooves, said system of links defining a pair of coaxial spaced surfaces enveloping said center-post-hole-defined space, the distance between said cylindrical space and the radially inner of said pair of surfaces being in the order of the width of one of said system of links, and the distance between the inner surface of said casing and the radially outer of said pair of surfaces being a multiple of said first mentioned distance, and a system of spacing tabs forming an integral part of said system of links extending radially inwardly from said system of links.

3. A current-limiting fuse comprising, a substantially tubular casing of insulating material, a pair of metal plugs inserted into said casing and closing the ends thereof, a center-post spacing said pair of plugs, systems of radial grooves on the juxtaposed surfaces of said pair of plugs, a system of ribbon-type fuse links arranged in radial planes and inserted with the ends thereof into said systems of grooves, and a system of spacers forming an integral part of said system of links arranged in abutting relation to said center-post.

4. A current-limiting fuse comprising, a substantially tubular casing of a laminate of glass cloth and a synthetic resin, a pair of metal plugs closing the ends of said casing, systems of radial grooves on juxtaposed surfaces of said pair of plugs, a system of ribbon-type fuse links arranged in radial planes and inserted with the ends thereof into said systems of grooves, said system of links comprising a system of spacing tabs extending radially inwardly from the radially inner edges of said system of links, and the length in radial direction of each said tab of said system of tabs being substantially less than the distance between the inner surface of said casing and the radially outer edges of said system of links.

5. A current-limiting fuse comprising, a substantially tubular casing of a laminate of glass-cloth and a synthetic resin, a pair of metal plugs inserted into said casing and closing the ends thereof, a pair of center-post-holes in said pair of plugs defining a space coaxial with said casing and with said pair of plugs, systems of radial grooves on the juxtaposed surfaces of said pair of plugs, a plurality of ribbon-type fuse links arranged in radial planes and inserted with the ends thereof into said systems of grooves, said plurality of fuse links defining a

radially outer shell and a radially inner shell both coaxial with respect to said center-post-hole-defined space, the spacing between said space and said inner shell being one to two times the width of one of said plurality of links, the spacing between said outer shell and said casing being a multiple of said first mentioned spacing, and a system of spacing tabs forming an integral part of said plurality of fuse links extending radially inwardly from said plurality of fuse links toward said center-post-hole-defined space.

6. A current-limiting fuse comprising, a tubular casing of insulating material, a pair of metal plugs inserted into said casing and closing the ends thereof, systems of radial grooves on the juxtaposed surfaces of said pair of plugs, a plurality of ribbon-type fuse links arranged in radial planes and inserted with the ends thereof into said system of grooves, said plurality of fuse links defining a radially outer shell and a radially inner shell, and the total cross-sectional area of said fuse links in said outer shell being larger than the total cross-sectional area of said fuse links in said inner shell.

7. A current-limiting fuse comprising, a tubular casing of insulating material, a pair of metal plugs inserted into said casing and closing the ends thereof, a pair of center-post-holes each in one of said pair of plugs, said pair of center-post-holes defining a space coaxial with said pair of plugs, systems of radial grooves on the juxtaposed surfaces of said pair of plugs, a system of link-forming flat stampings arranged in radial planes and inserted with the ends thereof into said systems of grooves, each groove of said systems of grooves being engaged by one single link-forming stamping comprising a pair of groove-engaging terminal bars and a plurality of terminal-bar-interconnecting ribbons extending at right angles to said pair of terminal-bars, said pair of terminal-bars projecting radially inwardly toward said center-post-hole-defined space and beyond said plurality of ribbons.

References Cited in the file of this patent

UNITED STATES PATENTS

2,658,974	Kozacka	Nov. 10, 1953
2,740,187	Jacobs et al.	Apr. 3, 1956