MIDGET POWER FUSE HAVING COPPER-CLAD SUPPORT FOR FUSIBLE ELEMENT

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This invention is concerned with, and relates to, electric fuses, and more particularly very small power fuses, often referred to and known as midget fuses.

A typical patent is the United States Patent 2,895,031, also known as the Midget Power Fuse Having Copper-Clad Support for Fusible Element, filed Feb. 15, 1965, and issued July 14, 1951 to Fusible Protective Devices discloses a fuse structure which is inherently very compact, but whose compactness is subject to certain limitations.

It is one object of this invention to provide electric fuses which are based on the same or similar design principles as the above patent to Kozracka, but not subject to the same limitations as the latter.

When it is desired to reduce the size of the structure of U.S. Patent 2,895,031, the inner diameter of the fuse tube must be made as small as possible and substantially equal to the width of the metal-clad insulating strip supporting the fusible element or elements in wire-form. This results in a reduction of the size and the effectiveness of the body or bodies of synthetic resin encapsulating the fusible element or elements. It further results in a decrease of the quantity of the encapsulant arc-quenching medium available inside of the fuse tube, and more particularly available immediately adjacent to the arc path. These two limitations give rise to a tendency of flash-over between two copper layers situated on opposite sides of the insulating strip supporting the fusible element or elements in wire-form. This danger of flash-over is particularly significant incident to interruption of relatively large fault currents, when the narrow gap between the metal layers of the insulating strip is ionized, or contaminated, by hot arc products.

As long as the size of the bodies of synthetic resin encapsulating the fusible elements of fuses according to U.S. Patent 2,895,031 as well as the mass of the arc-quenching medium immediately adjacent the arc path are relatively large, there is no significant tendency of flash-over between the metal layers by which the insulating strip is covered; but these prerequisites of safe operation are not present if extreme miniaturization of the fuse structure is desired, or required.

It is, therefore, another object of this invention to provide electric fuses based on the teachings of U.S. Patent 2,895,031, but not subject to the danger of flash-over even if designed so compactly as to preclude the provision of relatively large bodies of synthetic resin encapsulating the fusible element and to preclude the presence of a significant mass of the arc-quenching medium immediately adjacent to the fusible elements or arc path.

Further objects and advantages of the invention will become apparent as the following description proceeds, and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to, and forming part of, this specification.

For a better understanding of this invention reference may be had to the accompanying drawings in which

FIG. 1 is a longitudinal section of a portion of a fuse according to U.S. Patent 2,895,031.

FIG. 2 is a section of the structure of FIG. 1 taken along 2—2 of FIG. 1.

FIG. 3 is a longitudinal section of a portion of a fuse embodying the present invention;

FIG. 4 is a section along 4—4 of FIG. 3;

FIG. 5 is a longitudinal section of a complete fuse embodying this invention; and

FIG. 6 is an end view of the structure of FIG. 5 seen in the direction of the arrow R of FIG. 5.

Referring now to the drawings, and more particularly to FIGS. 1 and 2 thereof, reference numeral 1 has been applied to indicate a copper-clad strip of insulating material and reference numeral 2 has been applied to indicate the copper layers on both sides of insulating strip 1.

Bore 3 extends transversely through strip 1 and copper layers 2. A fusible element 4 in wire-form, preferably of silver, projects through bore 3 and has ends conductively-connected—by spot welding—to copper layers 2.

Wire 3 is encapsulated in synthetic resin and reference numeral 5 has been applied to indicate the outline of a body of synthetic resin encapsulating wire 4. The body of synthetic resin is surrounded by a pulverbulent arc-quenching filler 6, e.g. quartz sand, enclosed in a tubular casing 7.

If the structure of FIGS. 1 and 2 is to be housed in a very small fuse tube or casing, the width of the body of synthetic resin must be dramatically reduced. In the limit case the width W of the body of synthetic resin is equal to the width w of strip 1 and of copper layers 2, and the smallest distance between parts at different voltage levels then becomes b. This results in a strong tendency of flash-over greatly reducing the value of the structure as a means for circuit protection. Even if the width W is slightly in excess of the width w, the danger of flash-over still prevails.

This danger is eliminated in the structure of FIGS. 3 and 4. The structure of FIGS. 3 and 4 includes a strip 1' of copper-clad insulating material provided with a transverse bore 3'. Both sides of strip 1' are covered by layers 2' of sheet copper bonded to, and integral with, insulating strip 1'. Fusible element 4' in the form of a silver wire projects through bore 3' and has ends situated outside of bore 3' spot welded to layers 2'. Copper layers 2' have edges 2'a' adjacent bore 3' spaced from bore 3' in a direction longitudinally of strip 1'. Reference character s has been applied to indicate the spacing between the edges 2'a of copper layers 2' and bore 3'. It is apparent from FIG. 3 that copper layers 2' are coextensive with strip 1, except in the region of bore 3'. The stops or edges 2'a' of copper layers 2' are spaced sufficiently from bore 3' in a direction longitudinally of strip 1' to preclude flash-over between copper layers 2' in the presence of a predetermined voltage difference between layers 2'. In FIG. 3 reference character B has been applied to indicate the shortest distance between points of the fuse structure at different voltage levels. It is apparent that B+b, Fusible element 4' is encapsulated in a body of synthetic resin to which the reference character s' has been applied. This body of synthetic resin is surrounded by a pulverbulent arc-quenching filler 6' housed in tubular casing 7' of insulating material.

FIGS. 5 and 6 show a fuse including a duplication of the basic structure of FIGS. 3 and 4 and adapted to form two series breaks and capable of being applied in A-C circuits having a circuit voltage up to 300 volts. The fuse shown in FIGS. 5 and 6 comprises a tubular casing 7' of insulating material, e.g. vulcanized fiber, closed on the ends thereof by terminal elements in the form of caps 8'. Each cap 8' is provided with a circular recess 8'a and the bottom of each recess has a rectangular cut-off 8'b. A strip 1' of copper-clad insulating material is arranged inside of casing 7'. Insulating strip 1' substantially the same width as the inner diameter of casing 7', i.e., the width of strip 1' is but slightly less than the inner diameter of casing 7'. Insulating strip 1' has substantially the same length as casing 7'. In the particular embodiment of the invention shown, the length of
3. Strip 1' exceeds slightly that of casing 7' and the ends of strip 1' project through the rectangular cut-outs 8'b' into the circular recesses 8'a' of caps 8'. Strips 1' has two transverse bores 3' each having a smaller spacing x from the adjacent end of strip 1' than its spacing X from the center of strip 1'. Strip 1' is surrounded by an arc-extinguishing filler 6' of quartz sand. Reference numeral 4' has been applied to indicate a pair of fusible elements in wire-form each projecting through one of bores 3'. Both the axially inner ends and the axially outer ends of fusible elements 4' are situated outside of bores 3'. Insulating strip 1' is covered on one side thereof by the axially inner copper layer 2' and on the other side thereof by a pair of axially outer copper layers 2' all of which are bonded to, and integral with, strip 1'. The axially inner copper layer 2' has a shorter length than the spacing between bores 3', and the axially outer copper layers 2' have a shorter length than the spacing between each of the bores 3' and the end of strip 1' immediately adjacent thereto. The axially inner copper layer 2' is conductively connected to the axially inner ends of fusible elements 4' as, for instance, by spot welding. Similarly the axially inner ends of the axially outer copper layers 2' are conductively connected to the axially outer ends of fusible elements 4'. The axially outer ends of the axially outer copper layers 2' project through the rectangular cut-outs 8'b' in caps 8' into recesses 8'a' and are conductively connected to caps 8' by solidified drops of soft solder. Reference numeral 5' has been applied to indicate the outline of bodies of synthetic resin as, for instance, bodies of epoxy resin, encapsulating fusible elements 4' and separating the latter from the quartz sand filler 6'. It is apparent—particularly from FIG. 4—that the thickness of the layers of synthetic resin encapsulating fusible elements 4' is extremely thin adjacent the longitudinal edges of strip 1'. This is a result of the miniaturization of the fuse structure, i.e. a result of housing strip 1' with its copper layers 2' in a housing 7' having an inner diameter substantially equal to, and only slightly more than, the width of strip 1'. The danger of a flash-over between the upper and lower copper layers 2' incident to interruption of a faulted circuit resulting from the reduced thickness of the body of synthetic resin encapsulating fusible elements 4' is effectively avoided by increasing the spacing B between the juxtaposed edges of the axially inner copper layer 2' and the axially outer copper layers 2' in a direction longitudinally of strip 1', as best shown in FIG. 3. The exact value required in any particular case for the aforementioned spacing B can readily empirically be determined. It depends primarily upon the voltage of the circuit in which the fuse is intended to be used, and also to some extent on the current-carrying capacity of fusible elements 4', and also on the effectiveness of the barrier of synthetic resin enveloping the longitudinal edges of strip-shaped sandwich 2', 1', 2'. The presence of this barrier, even though thin, is generally indicated. It is a safety feature and its presence is optional rather than mandatory.

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

I claim as my invention:
1. A midget electric fuse capable of withstanding a predetermined voltage across the gap formed upon fusion of the fusible element thereof, said fuse comprising in combination:
   (a) a tubular casing of insulating material having a predetermined inner diameter;
   (b) a pair of terminal elements closing the ends of said casing;
   (c) a strip of insulating material arranged inside said casing, said strip having substantially the same width as said predetermined inner diameter of said casing and substantially the same length as said casing, said strip having a bore extending transversely across said strip in wire-form projecting through said bores and having ends situated outside said bores; and
   (d) a fusible element in wire-form projecting through said bores and having ends situated outside said bores;
   (e) a pair of copper layers arranged on opposite sides of said strip, integral with said strip, each conductively connected to one of the ends of said fusible element and to one of said pair of terminal elements, said pair of copper layers being coextensive with said strip except in the region of said bores, and the juxtaposed edges of said pair of copper layers being spaced sufficiently far from said bores in a direction longitudinally of said strip to preclude flash-over between said pair of copper layers in the presence of said predetermined voltage across said pair of copper layers.

2. A midget electric fuse for a predetermined rated voltage comprising in combination:
   (a) a tubular casing of insulating material having a predetermined inner diameter;
   (b) a pair of terminal caps each closing one of the ends of said casing;
   (c) a strip of copper-clad insulating material having substantially the same width as said predetermined inner diameter of said casing and having substantially the same length as said casing, said strip having a pair of bores each having a smaller spacing from the adjacent end of said strip than from the center of said strip; and
   (f) said strip of copper-clad insulating material including an axially inner copper layer arranged on one side of said strip, having a shorter length than the spacing between said pair of bores and being conductively connected to said axially inner ends of said pair of fusible elements, and said strip of copper-clad insulating material further including a pair of axially outer copper layers arranged on the other side of said strip and having a shorter length than the spacing between one of said pair of bores and one end of said strip immediately adjacent thereto, the axially inner ends of said pair of axially outer copper layers being conductively connected to said axially outer ends of said pair of fusible elements, and the axially outer end of each of said pair of axially outer copper layers being conductively connected to one of said pair of terminal caps, the juxtaposed edges of said axially inner copper layer and of said axially outer pair of copper layers immediately adjacent said pair of bores being spaced sufficiently from said pair of bores in a direction longitudinally of said strip to preclude flash-over between said pair of copper layers in the presence of said rated voltage across said pair of terminal caps.

No references cited.

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