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R. B. WHITE
FUSE CARTRIDGE
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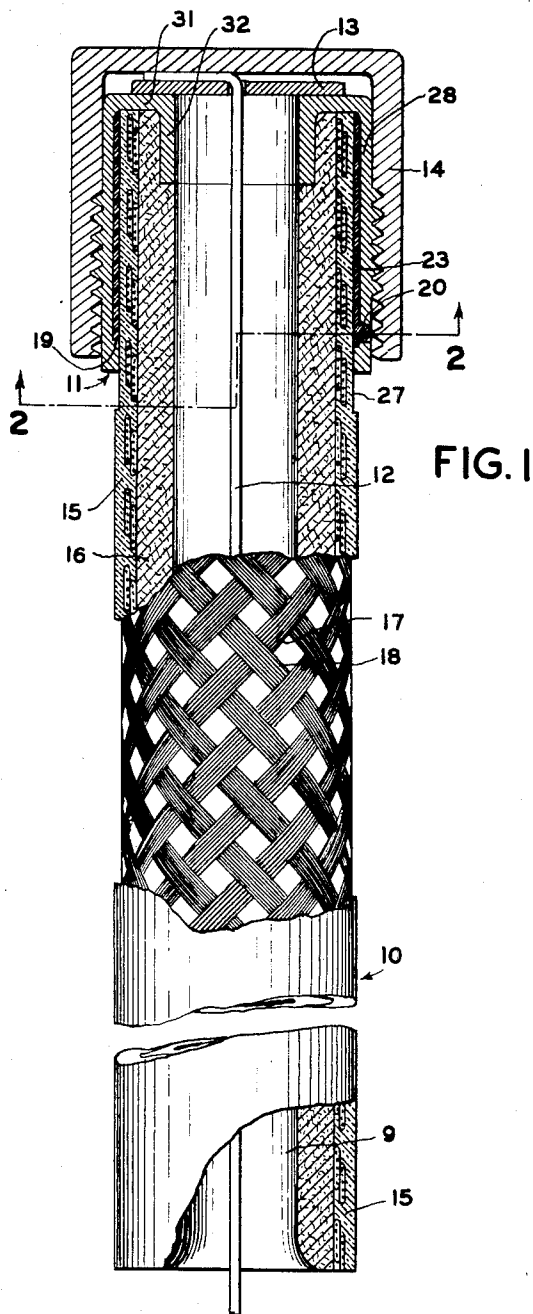


FIG. 1

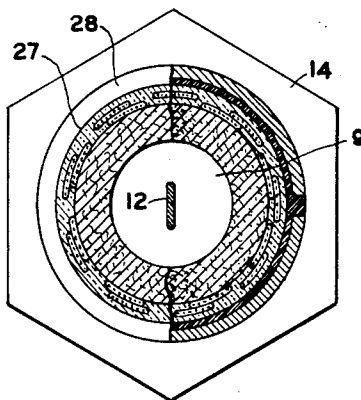


FIG. 2

INVENTOR.
ROGER B. WHITE
BY
Alfred C. Bork
ATTORNEY

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FUSE CARTRIDGE

Roger B. White, Cleveland, Ohio, assignor to The Glastic Corporation, Cleveland, Ohio, a corporation of Ohio

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4 Claims. (Cl. 200—131)

The present invention pertains to the art of electric fuses and, more particularly to an electric fuse body and metallic end cap therefor.

The invention is particularly applicable to the art of electric fuses wherein one end of the fuse body is open so that when the metallic fuse member inside the body separates, the arc formed heats the air and the expansion of this air blows the arc out of the lower end of the body to extinguish it and will be described with particular reference thereto, although it will be understood that the invention has broader applications.

In such fuses, the expansion of the air develops extraordinarily high values of pressure on the interior of the fuse body. If the fuse body is to be reused, its burst strength must be high enough to successfully resist these pressures.

Heretofore, it has been conventional to manufacture the fuse body out of an inner core of a vulcanized fiber tube reinforced by outer layers of conventional organic cloth or paper impregnated by a phenolic resin. The fiber core had the characteristic of retaining moisture, which moisture was vaporized in the heat of the arc and the pressures from this vaporization assisted in blowing the arc out of the lower end of the fuse body. The outer reinforcing layers provided resistance to weathering as well as the required burst strength.

As these fuses were required to handle more and more electrical power, the problem of increasing the burst strength of the fuse body without increasing its outer diameter, such as would result by employing more reinforcing layers, presented itself.

Experiments were run with a glass cloth impregnated with a polyester-type resin which, as known, must be cured under pressure in a mold if its maximum strength characteristics are to be developed. Manufacturing difficulties arose which made the use of glass cloth impractical. One of such difficulties was the problem of keeping the cloth held tight to the inner core while inserting it into the mold; another problem was that of eliminating porosity in the final molded product. Such porosity resulted in electrical failures of the fuse body.

The present invention contemplates a fuse body construction which overcomes all of the above-referred to difficulties and others and provides a maximum burst strength for a minimum outer diameter.

In accordance with the present invention, a fuse body is provided comprised of a hollow core and an outer reinforcing for said core comprised of at least two sets of glass fiber strands helically surrounding the core and impregnated with a hardened resin, each set of the glass fibers extending in a helical direction opposite to the other and having a pitch of between one to ten times the diameter of the core. Each of the sets may be composed of several parallel strands and each strand extends the entire length of the core. With such an arrangement, a lengthwise tension on the strands pulls all of the strands into close-fitting relationship with the core and the impregnating and molding operation is thus facilitated.

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With the above construction, a single layer of strands may be employed, but this presented the difficulty of fastening the metal cap to the fuse body. Thus, if the fuse body were threaded as has heretofore been the practice, then this threading operation would cut through the glass fibers and nullify the increase in bursting strength given by the glass fibers.

Various slip and tapered fits were tried with glue or cement to bond the surfaces together. Glues could be found which would bond to the metal of the cap or to the glass-reinforced polyester resin, but no glue could be found which would bond sufficiently well to both so as to develop a strength sufficient to resist the pressures developed within the fuse body under maximum current interruption conditions.

The present invention further contemplates an arrangement for fastening the metallic end cap to a fuse body which overcomes all the above referred to difficulties and others, which is strong, easily assembled and does not weaken the fuse body.

In accordance with the present invention, a fuse cartridge is provided comprised of a hollow tubular body having preferably an outer strength-providing surface of glass-fiber-reinforced polyester resin, a metallic end cap slip-fitted over one end of the tube and a cementitious-type material having a high bond strength to the glass-fiber-reinforced polyester resin and a high shear strength between the cap and the outer surface of the body, the arrangement of the body being such that forces tending to remove the cap from the body place the cementitious material under shear. Normally, the end cap will be recessed at one or more points spaced from its end providing one or more shoulders facing the end. The cementitious-type material will be in the space provided by the recess and the shoulders will bear against the material to place it in shear.

The cementitious material may, of course, be as desired providing it has the above stated requirements, but insofar as is known at the present time, the only material meeting such requirements is an "epoxy" resin.

The principal object of the invention is the provision of a new and improved fuse cartridge comprised of a hollow fuse body and a metallic end cap which has a minimum outer diameter and a maximum resistance against destruction from internal pressures.

Another object of the invention is the provision of a new and improved fuse body having an outer reinforcing layer of glass-fiber-reinforced polyester resin.

Another object of the invention is the provision of a new and improved arrangement of the glass fibers in such layer whereby the fuse body can be economically manufactured while holding the glass fibers in close proximity to the inner core.

Another object of the invention is the provision of a new and improved layout for the glass fibers reinforcing the core of a fuse body which provides a maximum strength at a minimum cost.

Another object of the invention is the provision of a new and improved arrangement whereby cementitious material may be employed to fasten a metallic end cap to a fuse body.

Another object of the invention is the provision of a new and improved arrangement for fastening a metallic cap onto a glass-fiber-reinforced polyester resin fuse body wherein the cement employed may be selected for its adhesion characteristics to the polyester resin only.

Another object of the invention is the provision of a new and improved fuse cartridge including, in combination: a metal cap and a hollow fuse body having improved means for preventing gases under pressure from working between the fuse cap and the tube.

Another object of the invention is the provision of a

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new and improved arrangement for securing a metal cap on a hollow fuse body wherein an epoxy resin adhesion material adheres to the polyester resin and the cap is so arranged that forces tending to remove same, place the resin material in shear.

The invention may take physical form in a number of different appearing parts and combinations of parts, a preferred embodiment of which will be described in detail in this specification and illustrated in the accompanying drawing which is a part hereof and wherein:

Figure 1 is a side view partly in section and partly in elevation of a fuse cartridge constructed in accordance with the present invention,

Figure 2 is a cross-sectional view of Figure 1 taken approximately on the line 2—2 thereof.

Referring now to the drawings wherein the showings are for the purposes of illustrating one form which the invention may take, and not for the purpose of limiting same, the figures show a fuse cartridge comprised of a long cylindrical fuse body 10 having a continuous interior passage 9 extending from one end to the other and an externally threaded metal cap 11 on one end thereof. A fuse wire 12 extends longitudinally through the passage 9 and is secured at one end to a washer 13 bearing against the left end of the cap 11. This washer is held in position by any suitable means such as the threaded can nut 14 fitted over and threaded onto the cap 11.

The body 10 is comprised of two concentric layers, an inner layer 15 formed of vulcanized fiber and an outer layer 16 of glass-fiber-reinforced polyester resin arranged in accordance with the present invention.

Thus, the outer layer 16 is comprised of sets 17, 18 of glass fibers extending generally helically of the core 15, the set 17 extending in one direction and the set 18 extending in the opposite direction. Each set 17 and 18 is preferably comprised of a plurality of strands, each strand extending parallel to the other strands of the set and being interwoven with the strands of the other set. In effect, the core 15 is enclosed in a braided sheath of a plurality of strands of glass fibers.

With this arrangement it will be noted that the core 15 can be inserted inside of the braided sheath and tension then placed on the ends of the strands which will pull all of the strands into tight fitting relationship with the outer surface of the core 15. This assembly may then be impregnated with a liquid thermosetting resin and the entire assembly placed into a heated mold until the polyester resin has completely cured.

With this arrangement, each strand of glass fibers contributes to both the longitudinal strength of the fuse body 10 as well as its circumferential strength. In this respect, it is to be noted that if the pitch of each strand is too low, then the required longitudinal strength is not developed. If the pitch is too long, the required circumferential strength is not developed. In accordance with the invention, the pitch of each strand should be at least equal to the diameter of the outer surface of the core 15 and not greater than ten times this diameter.

Preferably, each strand is composed of what has become known in the art as roving, which is composed of a large number of glass fibers generally not having any twist imparted thereto. It is possible to thus place in a single strand the maximum number of glass fibers while still retaining the maximum flexibility of each strand so that when the longitudinal forces are placed on the strands prior to molding, they will be drawn in snugly to the outer surface of the core 15.

With the arrangement shown, whenever the fuse wire 12 breaks an arc is formed. The heat of this arc causes ionization of the air in the tube and also vaporization of moisture in the core 15. The combination of the heated air and the vaporization of the moisture creates an explosive pressure within the fuse body which blows the arc outwardly through the lower or opposite end of the body 10 which, in the type of fuse shown, is open.

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The glass fibers bound together by the polyester resin uniformly resist the forces on the fuse body exerted by this explosive pressure. With the arrangement shown, maximum strength in the lay 16 is obtained with a minimum radial thickness.

Normally, the fuse body will be made in long lengths and then cut to size. Obviously, it could be made in the exact desired length. After being cut to length, the outer surface of the end of the tube to which the cap 11 will be fitted may be ground or otherwise finished into a smooth uninterrupted surface 17, the primary object of this operation being to exactly size the end of the fuse body 10, although possibly such grinding operation also exposes the glass fibers, roughens the surface of the polyester resin and makes possible an improved bond between the outer surface of the body 10 and an epoxy resin to be referred to hereinafter.

This pressure within the fuse body also tends to blow the cap 11 from the end of the fuse body. In the embodiment shown, and in accordance with the invention, the arrangement is such that these pressures can be successfully resisted.

The metal cap 11 is telescoped over the end of the body 10 and has a sleeve portion 28 which fits snugly over the surface 17. The interior of the portion 28 is recessed at a distance spaced from its upper end as viewed in Figure 1 to provide an internal shoulder 19 facing towards the upper end of the body 10. The space formed by the recess is filled with a cementitious material 23 which in the preferred embodiment is a hardened epoxy resin.

It is to be understood that the pressures developed on the inside of the body 10 when the fuse wire 12 parts or separates rise to extremely high values and that these pressures tend both to cause the body 10 to burst and the cap 11 to be forced axially off of the body 10. If the fuse cartridge is to be reused, it is imperative that these pressures be resisted without damage to the fuse body or to the fastening arrangement for the cap 11 on the body.

Thus, in experiments leading to the present invention, the characteristics of the cementitious material were found to be extremely important. No material could be found which had both high adhesive characteristics for both the polyester resin and metals. Thus, a cementitious material was selected which had extremely high adhesive characteristics to the polyester resin without regard to its adhesive characteristics for metal. In effect, the material becomes an integral part of the end of the fuse body.

The cap 11 is then constructed so that it depends upon some other characteristic of the cementitious material for resisting the pressures in the fuse body. Any axial forces on the cap 11 exert a shearing force on the cementitious material and its bond with the polyester resin. Thus, a cementitious material was selected which had not only the adhesive characteristics for the polyester resin above referred to, but also a high shear strength. Additionally, the axial length of the bond line between the material 23 and the outer surface of the body 10 should be substantial, as is shown in the drawings.

In the preferred embodiment, the cementitious material 23 is a liquid epoxy resin such as that manufactured by The Shell Chemical Corporation, Formula No. 828, which liquid resin has been allowed to harden.

Another characteristic which is to be noted of epoxy resins, which is very desirable, is that they have high shear strengths where the material has a substantial thickness as distinguished from other cementitious materials, glues or cement which only have high shear strengths in very thin thicknesses such as would result when the material is placed between two surfaces in pressure relationship.

In the preferred embodiment, the shoulder 19 has sharp corners and a surface perpendicular to the axis of the tube 10. A shoulder 19 may taper inwardly and toward the end of the tube 10 although this construction

is somewhat difficult to manufacture on conventional machinery. With the shoulder 19 either perpendicular or tapering inwardly as indicated, the amount of metal to the right of the shoulder 19 and its radial thickness may be held to a minimum. In this respect, it is to be noted that with the axial forces on the shoulder 19 with which the present invention deals, there is a tendency for the sleeve portion 28 to bend outwardly and allow the cap to be pulled off from the end of the body 10. In any event, there must be sufficient metal here to prevent this effect.

It is possible that if sufficient metal in the sleeve portion 28 is provided that the shoulder 19 could taper inwardly away from the tube end. The construction above described is preferable, however.

Only a single shoulder 19 has been shown as the means for placing the cementitious material 23 in shear. Obviously, more than one shoulder 19 could be provided or a single shoulder in the form of a helix having a circumferential extent of one or more turns might be employed.

The cap 11 also has an end portion 31 adapted to cover the end of the body 10 and a short tubular portion 32 extending internally of and concentrically within the sleeve portion 28 for a short distance. This portion 32 fits into a rabbet or recess formed on the inner left-hand end of the inner core 15. Its inner surface may or may not be flush as shown with the inner surface of the core 15. The axial length of the portion 32 and its outer diameter are all so proportioned that a snug interference fit preferably results between its surfaces and that of the recess in the end of the core 15. With the arrangement shown, the left-hand end of the body 10 may or may not butt against the surface of the end portion 31 although a tight fit is desirable.

This construction prevents the gases within the fuse body 10 from working between the inner surface of the cap 11 and the outer surface of the material 23. In this respect, it is to be noted that the pressures on the inside of the body 10 will tend to expand the tubular portion 32 against the inner surface of the core 15; in effect, providing a pressure seal.

The cementitious material 23 may be introduced into the space indicated in any desired manner, but preferably the portion 18 is provided with a small opening 20 close to the shoulder 19. A needle not shown is inserted into this opening 20 and the epoxy resin or other cementitious material employed is injected into the space indicated. The injection of this material is continued until the space is filled. This may generally be indicated by an extrusion of the resinous material between the right-hand end of the cap 11 and the surface 17.

It is also to be understood that the cementitious material may be introduced by other means such as positioning it on the inner surface of the portion 18 and then sliding the end of the tube 10 into the cap 11. The preferred arrangement discussed, however, has proven quite satisfactory in practice.

It will thus be seen that the embodiment of the invention described accomplishes all of the objectives heretofore set forth and others, and provides a fuse cartridge having a minimum external dimension and a maximum ability to withstand the explosive forces developed on the interior thereof whenever the fuse acts to relieve an overload in an electrical circuit.

Obviously, modifications and alterations will occur to others upon a reading and understanding of this specification and it is my intention to include all such modifications and alterations insofar as they come within the scope of the amended claims.

Having thus described my invention, I claim:

1. A fuse body comprising an elongated inner tube of electrical insulating material which, when heated, is capable of generating a high pressure vapor inside the tube, and an outer reinforcing layer of glass-fiber-reinforced polyester resin comprised of oppositely helically wound sets of glass fiber strands which extend tightly around the outside of said inner tube, said oppositely wound sets of strands being interwoven with each other to constitute a braided sheath capable of being tightened on the tube, after being placed thereon, by the application of lengthwise tension on the strands.

2. The fuse body of claim 1 wherein each of said sets of helically wound strands has a pitch length of between one and ten times the outside diameter of the inner tube to insure adequate longitudinal and circumferential strength of the fuse body.

3. A fuse body comprising an elongated inner tube of electrical insulating material which, when heated, is capable of generating a high pressure vapor inside the tube, and an outer reinforcing layer of glass-fiber-reinforced polyester resin comprised of helically wound glass fiber strands which extend tightly around the outside of said inner tube, each strand being composed of substantially untwisted glass fibers.

4. The fuse body of claim 3 wherein each helically wound strand has a pitch length of between one and ten times the outside diameter of the inner tube to provide adequate strength of the fuse body, both longitudinally and circumferentially.

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