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Wiebe

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[54] **ELECTRIC FUSE THERMOPLASTIC ENCAPSULANT**

[76] Inventor: **Gerald Wiebe**, 18W 077 Williamburg Ln., Villa Park, Ill. 60181

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[52] **U.S. Cl.** **337/241,** 337/231, 337/245, 337/246, 337/248, 337/251

[51] **Int. Cl.** **H01h 83/30,** H01h 85/14

[58] **Field of Search** 337/228, 231, 232, 234, 337/236, 238, 206, 241, 245, 246, 248, 251, 252, 253, 265, 332, 376, 416, 417, 297; 317/260

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Primary Examiner—A. T. Grimley

[57] **ABSTRACT**

An electric fuse including a solid, unitary transparent plastic body having embedded therein a metal fusible link in the form of an elongate wire-like element. The plastic body is in intimate contact with the fusible link to not only provide mechanical support therefor, but also to provide for enhanced heat transfer between the fusible link and fuse body. Opposite ends of the link extend outwardly beyond the ends of the plastic body and are formed into a coiled configuration which is initially spaced slightly from the adjacent body end. A cup-shaped metal end cap is received over each end of the plastic body, and the coiled ends of the fusible link are compressed between an end of the plastic body and an end wall of the end caps, so that the fusible link is in positive electrical and heat-conductive relationship with the end caps. To improve the electrical and heat-conductive relationship between the end caps and the ends of the fusible link, and ends of the fusible link and/or the end caps are coated with a suitable conductive material. The end caps provide heat sinking for not only the fusible link, but also for the plastic body.

The fuse is formed by placing an elongate metal wire in the cavity of a mold, with the end portions of the wire projecting beyond the cavity, and injecting a transparent, fluid plastic material into the cavity to completely surround and encase the wire and subsequently form a fuse body upon hardening. The outwardly projecting ends of the wire are then bent into a coiled configuration spaced slightly outwardly from the ends of the fuse body, and cup-shaped metal end caps are shifted axially of the fuse body to compress the coiled ends of the fusible link between the end caps and the fuse body after a conductive substance is applied to the ends of the fusible link and/or end caps.

20 Claims, 12 Drawing Figures

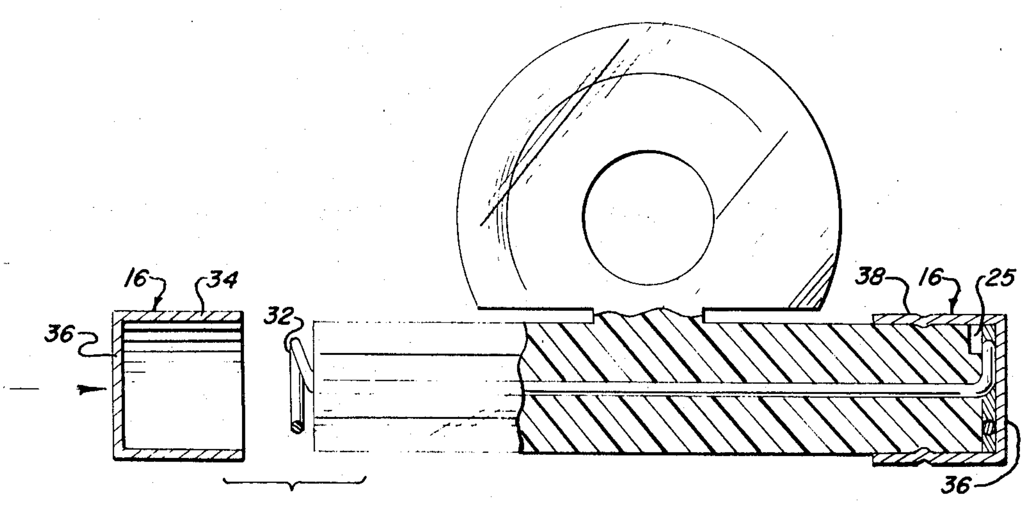
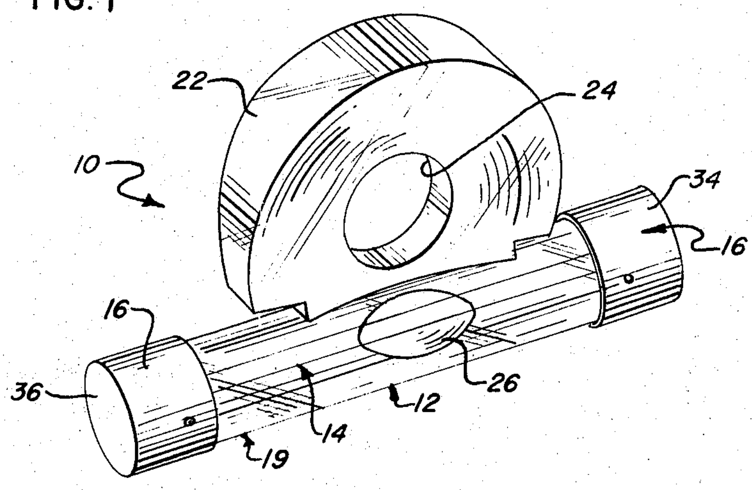


FIG. 1



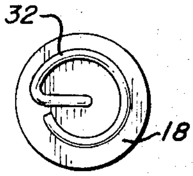


FIG. 5

FIG. 2

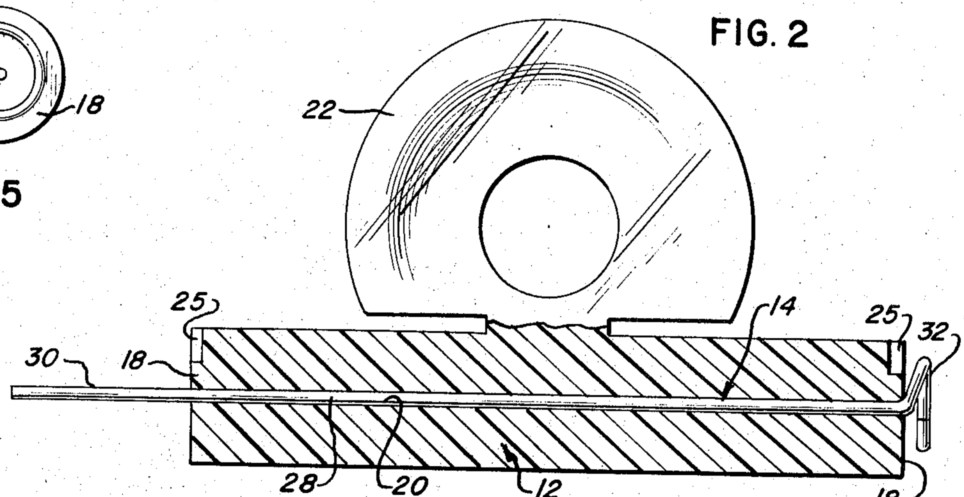


FIG. 4

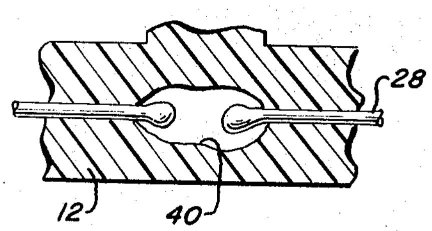


FIG. 3

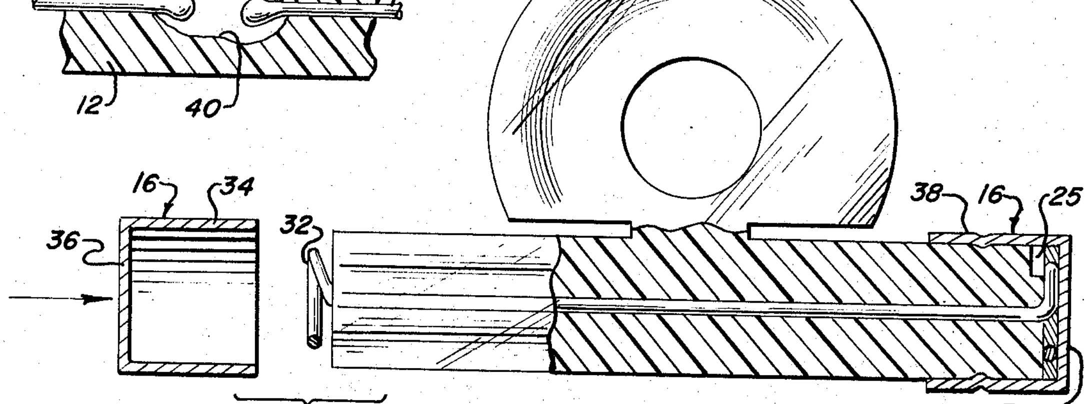


FIG. 6

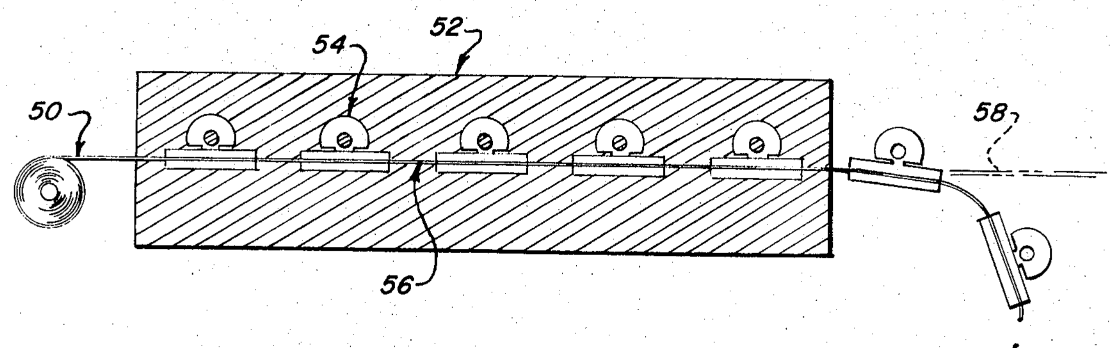


FIG. 7

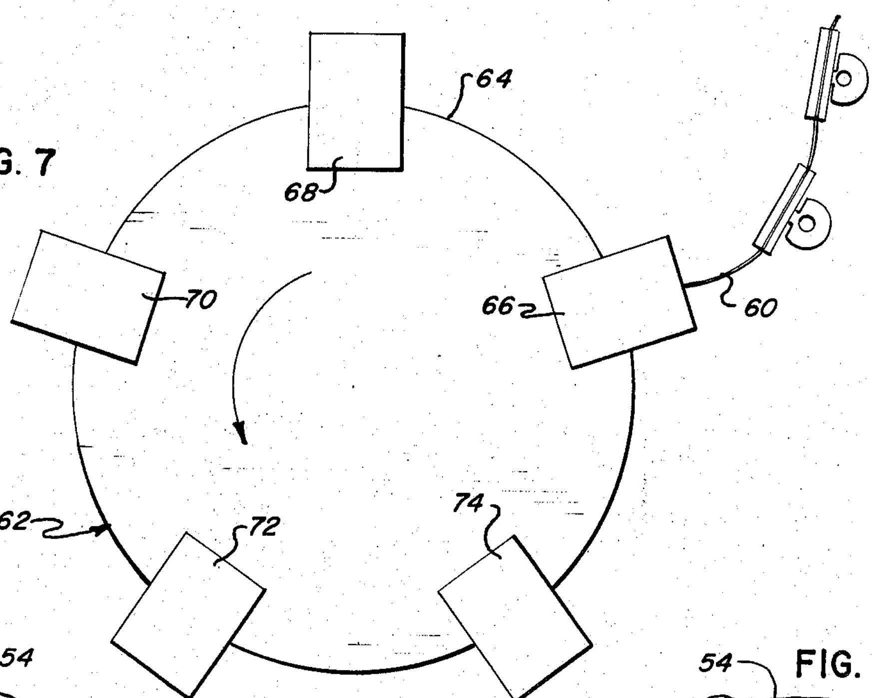


FIG. 12

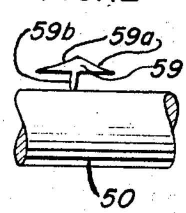


FIG. 11

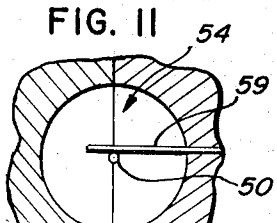


FIG. 9

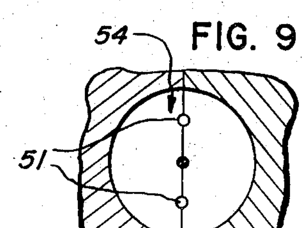


FIG. 10

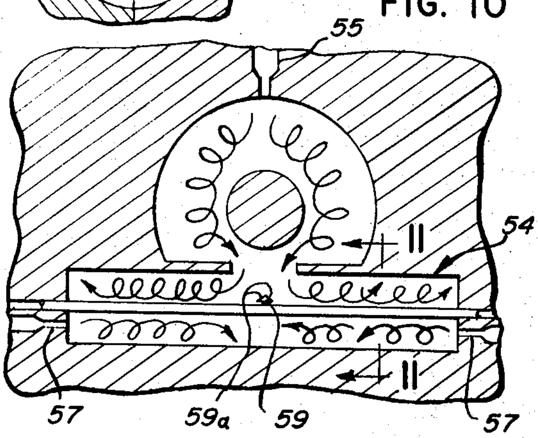
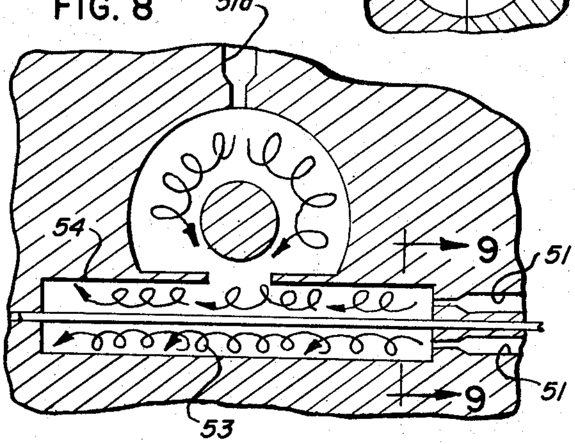


FIG. 8



ELECTRIC FUSE THERMOPLASTIC ENCAPSULANT

BACKGROUND OF THE INVENTION

The present invention relates in general to electrical fuses, and more particularly to automotive and appliance type protective fuses which heretofore have conventionally consisted of a hollow glass tube, metal end caps closing each end of the tube, and a fusible link within the tube and having its end portions secured to the end caps. For so-called "normal blow" fuses, i.e., those fuses that will disrupt an electric circuit when the current in the circuit exceeds a predetermined level after a given relatively short period of time, the fusible link has conventionally been in the form of a flattened metal element having a mid-portion of reduced width. For so-called "slow blow" fuses, i.e., those fuses that will disrupt an electric circuit when the current in the circuit exceeds a predetermined level after a given relatively long period of time, the fusible links have taken on a more complicated configuration, to prevent the fuse from blowing when there is an unsustained current surge above the rating of the fuse.

Commercially available slow blow fuses are substantially more expensive than normal blow fuses, normally costing on the order of three times as much, or more. As a consequence, in automotive circuits normal blow fuses are conventionally used because of economy, but in many circuits (especially motors) where current surges are common, slow blow fuses should be used, but are not. Instead, to economize a normal blow fuse will be used which will sustain the current surge, and this results in over fusing of the circuit to a dangerous extent.

Fuses of the above-described type have met with widespread commercial success, and, in general, have functioned satisfactorily for the intended purpose. However, in spite of their apparent simplicity, fuses of the above-described type are extremely difficult to manufacture economically. One of the major problems is in the assembly of the end caps to the fuse body, since the tubular configuration makes it difficult to get an effective seal or connection between the end caps and the fuse body. This problem is complicated by the fact that the fuse bodies are conventionally formed of glass, which is so fragile as to preclude the mechanical deformation of the end cap, such as in a crimping operation. Consequently, it has been necessary to adhesively bond the end caps to the fuse body, and while the adhesive technology is highly advanced, difficulty is encountered in consistently obtaining a seal which is sufficiently strong to meet the strict standards established by such groups as Underwriters' Laboratories, Inc. and the Society of Automotive Engineers.

Another difficult problem that is encountered in the manufacture of conventional fuses as described above is in joining the ends of the fusible link to the end caps in a manner which will result in a positive and reliable electrical connection therebetween. This problem results, at least partially, from the tubular shape of the fuse body which precludes the use of normal soldering or brazing techniques. Also, because of the tubular configuration of the fuse body, the fusible link is unsupported throughout its length and this necessitates the use of a self-supporting material, which often places undue stress on the connections with the end caps.

The necessity of having to form the fusible link of a material that is self-supporting has other inherent disadvantages. For example, soft and readily workable alloys with low melting points cannot be used, since such materials do not have sufficient structural integrity to be self-supporting. Also, such materials cannot be readily soldered and will not make reliable contact with the end caps. Furthermore, in order to insure proper positioning of the fusible link within the tubular body, the ends of the link must be widened to about the inner diameter of the end caps, which results in extra material and cost for a given current carrying capacity.

Fuses of the above-described type are also not completely satisfactory in use, because of the unreliable connections between the end caps and the fuse body and between the end caps and the fusible links. These problems are particularly acute in environments where a substantial amount of vibration is encountered. Such fuses are also characterized by an excessive voltage drop thereacross.

Still another problem that is encountered with conventional type fuses having glass bodies is the fragile nature thereof, which complicates not only the manufacture of the fuse, but also the subsequent handling thereof, since special packaging techniques are required, such as the use of metal containers, close packing, etc. Such conventional fuses are also completely cylindrical in external configuration, so as to be somewhat difficult to install and replace, particularly in a fuse holder that is located in a remote area. The fragile nature of the glass body of conventional fuses also makes it necessary to place the coding information that is a requisite for fuses of this type on the end caps, which is often not only difficult to read, but which also requires an additional manufacturing step that adds to the overall cost of the fuse.

SUMMARY OF THE INVENTION

The present invention provides an extremely simplified fuse structure, and method of forming the same, so that the fuse inherently has slow blowing characteristics that make it suitable for use in electrical circuits wherein current surges are commonly encountered, as well as in normal circuits wherein current surges are uncommon and it is only desired to provide protection against a sustained overload. Because of the uniquely simple design of the fuse structure, the slow blowing feature can be provided at or below the costs usually expected for a normal blow fuse. As a result, it is no longer necessary to follow the dangerous prior art expedient of over fusing with a larger normal blow fuse in a situation where a slow blow fuse should be used.

The fuse of the present invention includes a simplified fusible link which preferably takes the form of a wire that is circular in cross section. The wire is preferably, although not necessarily, formed of a low-melting point metal alloy, which is embedded in place in a generally cylindrical plastic body. The plastic body provides intimate surface-to-surface contact with the fusible link, so as to provide enhanced heat transfer from the fusible link and to provide a substantial amount of thermal inertia to give the fuse its desirable slow blowing characteristics. Because the plastic body completely surrounds and supports the fusible link, a relatively soft material may be used, if desired, which normally would not have sufficient inherent strength to be self-supporting. The plastic body preferably, although not necessarily, has a lower melting point than the fusible link, so that the material adjacent the fusible link will at least be softened during normal use. As a result, when overload conditions exist, the fusible link will readily melt and separate to positively disrupt the circuit in which the fuse is placed. The plastic body is a sufficiently good conductor of heat, that even though the portion of the body adjacent the fusible link may become softened, the remainder of the fuse body retains its structural integrity.

The fuse body is formed of a transparent, preferable thermoplastic material, so that a blown fuse can be readily seen. An optical configuration can be molded into the fuse body to increase the visibility of the fusible link, and this is particularly important when the fusible link is in the form of a relatively small diameter wire or filament.

The ends of the fusible link are bent into a coiled configuration which are initially spaced slightly outwardly from the ends of the solid fuse body, so that when cup-shaped end caps are positioned on the fuse body, the coiled fusible link ends are compressed between the opposed end surfaces of the fuse body and the end walls of the end caps. This provides a positive electrical connection between the fusible link, which may be supplemented, if desired, by coating the ends of the fusible link and/or the interior of the end caps with a suitable conductive material, such as a flux, solder paint or other conductive paint.

The internal diameter of the sidewall of the end caps is sized so as to be positioned in close, tight fitting engagement with the mating portions of the fuse body. The end caps, which may be applied simultaneously by shifting them axially of the fuse body, are preferably heated to slightly expand the sidewall thereof to facilitate placement of the end caps on the fuse body. After cooling, the end caps are mechanically deformed, as by crimping, to positively grip the sidewall of the fuse body.

The fuse construction of the present invention lends itself to manufacture by a high speed molding process. Specifically, an elongate wire is positioned in a plurality of cavities of a multiple cavity mold, or molds, and a fluid plastic material is simultaneously injected into the cavities. After the material hardens, the resulting composite structures are removed from the cavities, and the wire severed between each of the plastic body portions. The portions of the wire projecting beyond the plastic bodies are then coiled and the end caps applied, as described above. One of the advantages of the process of the present invention is that the same equipment and process steps can be used to provide fuses having different characteristics, and different ratings. To this end, all that need be done is to change the material of the plastic body and/or the fusible link, and by proper material selection and matching of properties, fuses having the desired rating and performance characteristics will be produced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a fuse formed in accordance with the teachings of the present invention;

FIG. 2 is a front elevational view, partially in cross section, showing the fuse in an intermediate stage of manufacture;

FIG. 3 is a view similar to FIG. 2, and showing the fuse in a still further stage of manufacture;

FIG. 4 is a fragmentary cross-sectional view of the mid-portion of a blown out fuse;

FIG. 5 is an end view of the right-hand of the fuse body shown in FIG. 2;

FIGS. 6 and 7 are schematic views of apparatus used to manufacture the fuse, and which facilitate an understanding of the process of the present invention;

FIGS. 8 and 10 are central cross-sectional views through one cavity of molds that have particular utility in manufacturing fuses in which the fusible link is in the form of a fine filament;

FIGS. 9 and 11 are cross-sectional views taken generally along lines 10—10 of FIG. 8 and 11—11 of FIG. 10, respectively; and

FIG. 12 is an enlarged fragmentary view illustrating the relationship between the fusible link and link holding pin of the embodiment of FIGS. 10 and 11.

DETAILED DESCRIPTION

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail a preferred embodiment of the invention, and modifications thereof with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiments illustrated. The scope of the invention will be pointed out in the appended claims.

Referring now to the drawings, the fuse of the present invention is shown in its entirety at **10** in FIG. **1**, and includes a body **12**, a fusible link **14**, and end caps **16**.

In the illustrated embodiment, body **12** is a solid, unitary generally cylindrically shaped member having flat, parallel opposite end surfaces **18**. As will be evident from the following description, body **12** is preferably formed by a molding process, with the fusible link **14** having previously been placed in the cavity of the mold, so as to be positioned in a passage **20** disposed centrally of the body **12** and opening at each end surface **18**. Body **12** is preferably formed from a clear plastic material, such as the thermoplastic polycarbonate resin sold by General Electric Co. under the trademark LEXAN. Other clear, tough, heat resistant, dimensionally stable, non-conductive plastic materials may also be used, such as high impact polystyrene, cellulose propionate, cellulose acetate-butyrate, etc. While thermoplastic materials are preferred, the present invention also contemplates that certain thermosetting materials may be used. The particular plastic material that is utilized is selected so that its properties, in combination with the properties of the fusible link, give the resulting fuse the desired rating and performance characteristics.

While body **12** is generally cylindrically shaped, as previously described, a gripping handle **22** is preferably formed integrally with the body, to facilitate insertion and removal of the fuse in a fuse holding clip structure, not shown. Handle **22** may be provided with an opening **24**, so that the fuse may be readily carried (or displayed) on a key chain, or the like. The generally cylindrical configuration is preferred, although it is contemplated that the fuse body may be other than circular in cross-section, e.g., oval, square, hexagonal, etc. In all fuse bodies it is desired that at least the end portions thereof be circular in cross-section, so as to readily accept conventional end caps, as will hereinafter appear.

Coding information **19**, or other suitable indicia, may be formed in the sidewall of the fuse body **12** at the time of molding. Body **12** may also be provided with an optical configuration **26** in the mid-portion of the sidewall thereof to define a magnifying lens making the mid-portion of the fusible link readily visible, even when the fusible link is an extremely fine wire. The ends of body **12** may also be provided with a shallow, radially extending slot **25**, to cooperate with a spinning tool, as will hereafter appear. Indicia **19**, handle **22**, slots **25** and lens portion **26** can be formed at the same time body **12** is molded around fusible link **14**, so these desirable features can be given to the fuse with no increase in manufacturing cost.

Fusible link **14** is in the form of an elongate wire, which in the illustrated embodiment is circular in cross section and centered relative to body **12**, as previously mentioned. The external surface of the major portion **28** of the fusible link, which is embedded in situ in body **12** by virtue of the molding operation, is in intimate surface-to-surface contact with the inner surface of passage **20** in the fuse body. This latter relationship provides one of the major areas of distinction over known types of prior art fuses, since the surface-to-surface contact provides an improved vehicle for getting heat out of the fusible link of the fuse. Because of the improved heat transfer, the wire may have an unexpectedly small size in comparison to its current carrying capacity, which results in a significant economic benefit in material cost savings. For example, a 0.030 inch wire which will only carry 5 amperes in air will carry **10** amperes in the fuse of the present invention.

Wire **14** is preferably, although not necessarily, a low-melting point alloy, such as for example, an alloy consisting essentially of from about 95 percent tin to about 5 percent lead. Relatively large diameter wires of this alloy have been tested and found to be extremely satisfactory, and the wires have varied from about 0.010 to about 0.050 inches, depending on the current rating of the fuse. While low-melting point alloys are preferred, the present invention also contemplates that the fusible link may be formed of copper, steel, or aluminum, although with such metals, a very fine filament must be used. While wire **14** has been illustrated as being circular in cross section throughout its length, for certain applications it may be desirable to give the wire a different configuration, as by flattening the midportion thereof, as will be understood by those skilled in the art. In addition to flattening, the present invention contemplates that other operations, such as trimming, punching, stretching, etc. may be performed on the fusible link. Of course, if the wire is given a special configuration, this must be done prior to the molding operation.

Low-melting point alloys of the above-described type, in combination with a plastic body approximately 7/32 inch in diameter, have been found to be particularly well suited for the purposes of the present invention. When a fusible link of the above-described size and composition is formed in situ in a plastic body of the above-described size and composition, a substantially uniform mass of plastic is provided outwardly of wire portion **28**, which provides for substantial thermal inertia. This factor, when coupled with the substantial surface-to-surface contact between the fusible link and the plastic body, gives the fuse its desirable slow blowing characteristics.

As will hereinafter appear during manufacture, a single elongate wire preferably extends between a plurality of cavities of a multi-cavity mold, or a plurality of such molds. A plastic material of the above-described type is then simultaneously injected into each of the cavities while the wire is simultaneously retained in centered relationship with respect to the cavities, to form the fuse bodies **12**. Subsequent to the molding operation, the outwardly projecting portions of the wire **14**, which formerly were positioned between the mold cavities, are severed to provide wire end portions **30** (FIG. **2**). End portions **30** are then bent into a configuration to provide for improved electrical and thermal conduction between the fusible link and end caps **16**.

Referring particularly to FIGS. **2** and **5**, it will be noted that end portions **30** are bent, or otherwise shaped, into a substantially coiled configuration **32** that is initially spaced from the adjacent body end wall **18**, as is evident from the right-hand side of FIG. **2** and left-hand side of FIG. **3**. While a single loop **32** has been shown, it will be appreciated that the end portion **30** could also be bent into a helical configuration.

End caps **16** are assembled to the fuse body subsequent to the above-described step of shaping the ends **30** of the fusible link. End caps **16** are cup-shaped elements that include a cylindrical sidewall **34** and an end wall **36** transverse thereto. End caps **16** are sized so as to comply with previously existing standards, such as those established by the Society of Automotive Engineers. As is well known, end caps **16** may be formed of brass, or a brass alloy, and may be plated to prevent oxidation. The end caps **16** are assembled to the outer end portions of the fuse body **12** by shifting the end caps axially of the fuse body, and the end caps **16** are preferably simultaneously placed on the fuse body **12**. The inner diameter of sidewall **34** of the end caps **16** is preferably about the same size as the outer diameter of the end portions of the fuse body **12**, so as to be positively retained thereon. To facilitate assembly, the end caps **16** are preferably heated prior to placement on the fuse body, with the subsequent shrinkage of the end caps **16** upon cooling causing them to strongly grip the fuse body. The hot end caps also tend to melt the portions of the plastic body in contact therewith, so that the end caps adhere to the ends of the fuse body.

During the assembly of the end caps, the end walls **36** are moved into engagement with the coiled portion **32** of the fusible link **14** to compress it against surface **18**, and because of the inherent resilience of the fusible link, the end portion **32** thereof is urged outwardly into engagement with the end wall **36** of the end caps to provide a positive current transmitting connection therebetween. If desired, the ends **32** of the fusible link may be treated with a flux, or other suitable material, such as a solder paint, or other conductive paint, prior to placement of the end caps **16** on the fuse body. Instead of, or in addition to, coating the ends of the wire, the interior of the end caps may be coated. Heat may be applied to the end caps **16** after placement upon the fuse body, to create an effective bond between the end walls **36** and the coiled end portion **32** of the fusible link. Because of the deformability of the plastic body **12**, the end caps **16** may also be mechanically deformed, as by crimping as shown at **38** in FIG. **3,** to insure that the end caps **16** will not be removed from the fuse body.

When a sustained current above the design level of the fuse flows therethrough, the fusible link **14** is heated above its melting point, and the fuse body **12** is unable to dissipate the heat sufficiently rapidly, the fusible link will melt and pull apart as shown in FIG. **4.** The plastic material around the fusible link is at least softened, and often melted, to enable the melting fusible link to easily pull apart. This results in an immediate disruption of the electric circuit, and the absence of current flow causes the fusible link and the surrounding plastic material to cool rapidly. The separated ends of the fusible link are positively held in spaced relationship within a cavity **40** (FIG. **4**) in the fuse body by the remaining still solid portion thereof. This prevents arcing even in environments where severe vibrational conditions are present.

The process of the present invention will be best understood by considering FIGS. **6–10.** With reference to FIG. **6,** the material for fusible links **14** may be provided from a coil of wire as shown at **50,** which is initially fed into a multi-cavity molding machine **52** so as to be positioned between the mold halves and centered relative to the cavities **54,** which have the configuration of the previously described fuse body **12.** Heated and softened plastic material is then forced through a nozzle, and through the sprues and runners (not shown) of the molding machine into the cavities **54.**

For fuses wherein the fusible link is in the form of a fine diameter wire, e.g., 0.020 inches or less, it is desired to substantially equalize the fluid pressure of the plastic material on the wire **50** to prevent the wire from bending and to make sure that the wire is substantially centered relative to the fuse body. To this end, the mold **52** may be gated as shown in FIG. **8** to provide gate passages **51** on diametrically opposed sides of wire **50** and spaced equally outwardly therefrom. The plastic material that is simultaneously injected into the cavity **54** through each gate **51** flows in a tumbling manner, as shown at **53,** to apply substantially equal pressure to all sides of the wire **50,** and thereby retain it centered within the cavity **54.** If equal amounts of plastic material are injected through each gate **51,** a slightly unequal pressure will be applied to the mid-portion of the wire adjacent the narrow portion of the cavity leading to the cavity portion which forms the fuse handle, and this force may be counterbalanced by injecting a suitable amount of plastic material through a gate opening **51**a, as shown in FIG. **8.**

Alternatively, for fuses having such fine wire fusible links, the mold may be gated as shown in FIG. **9** to provide a gate passage **55** in the central part of the portion of the cavity that provides the handle **22,** and gate passages **57** in each end of the cavity on the side of wire **50** opposite from the cavity portion for handle **22.** Approximately 60 percent of the material is injected through gate **55,** while approximately 20 percent of the material is simultaneously injected through each passage **57.** One of the halves of mold **52** is provided with a pin **59** that is located in alignment with the narrow portion of the cavity **54** which forms the stem of handle **22,** as is clear from FIG. **10.** Pin **59** preferably has inclined or concave faces **59**a facing toward the material flowing from passage **55** through the aforementioned narrow portion of the cavity. Pin **59** is normally positioned in abutting engagement with wire **50,** so as to prevent the wire from being deflected toward the narrow portion of the cavity by material flowing inwardly from gates **57.** The material that is injected into the cavity **54** through gate **55** divides around the pin that is provided in the mold **52** to form opening **24,** and the material recombines in the narrow portion of the cavity prior to engagement with pin **59,** which again divides the material and deflects it outwardly toward the ends of the portion of the cavity that forms the fuse body. This divided material combines with the material flowing inwardly through gates **57,** so that the ends of the body portion of the cavity are filled before the mid-portion of the cavity adjacent pin **59** is filled. Pin **59** preferably is provided with one of more narrow projections **59**b (FIG. **12**) and the material deflected outwardly by surfaces **59**a creates a suction behind pin **59** so that the wire is retained against projection **59**b. It has been found that this gating arrangement substantially equalizes the pressure on wire **50,** and effectively prevents it from deflecting in the mold cavity.

After the plastic material hardens, the halves of the mold are separated and the fuse bodies are ejected from the movable half of the mold. It should be noted that at this stage of manufacture, the fuse bodies are interconnected by wire lengths extending therebetween. The resulting composite structure can then be transported to a storage station, as shown by the broken line **58** in FIG. **6,** or pass directly to a further processing area, as shown by the full line **60** in FIGS. **6** and **7.**

In any event, after the composite structure has been completed, it is transported to an apparatus **62** illustrated in FIG. **7** which completes the fuse structure. In the illustrated embodiment, apparatus **62** takes the form of a rotatably mounted turntable **64** which serially transports the incipient fuses to five working stations **66, 68, 70, 72** and **74.** The turntable **64** has a predetermined dwell at each working station, and it has been found that each of the hereinafter described operations can take place in three seconds, so that the entire operation of apparatus **62** can be completed within 15 seconds.

At working station **66,** the composite structures coming from molding apparatus **52,** or from storage, are grabbed, and the exposed wire portion **56** between adjacent fuse bodies **12** is severed medially thereof. The turntable **64** then indexes the resulting structure to work station **68** where a turning tool engages slot **25,** and the projecting wire portions **30** are given the coiled configuration **32.** The flux material is also applied to the wire ends at station **68.** The turntable **64** then indexes the product to work station **70,** where preheated end caps are simultaneously pressed on opposite ends of the fuse body **12** and crimped. The product is then indexed to work station **72** where heat is applied to the end caps to melt the flux and achieve the positive electrical connection between the ends of the fusible link and the end wall of the end caps. During this heating operation, cooling air may be applied to the plastic body. The product is then indexed to working station **74,** where testing current is applied to the finished product, and where a suitable mechanism will eject the finished products and separate those products which have been unsatisfactorily produced from those which have been satisfactorily made.

From the above it is believed clear that the fuse of the present invention, and the method of producing it, result in a low cost product having improved performance characteristics. In this regard, the plastic body with the fusible element embedded therein provides a tough and durable structure, which can be readily packaged in plastic or cardboard containers. The current rating and performance characteristics can be readily varied with no increase in cost (except for possible differences in material costs) by merely varying the material of the plastic body and/or the material of the fusible element. The surface-to-surface contact between the fusible link and the plastic body provides for heat transfer by conduction, and the mass of plastic material positioned around the fusible link provides substantial thermal inertia which gives the fuse the desirable slow blowing characteristics.

It has been found that fuses of the present invention have a significantly lower (on the order of 10–15 percent) voltage drop thereacross than commercially available comparably rated fuses. Furthermore, the tendency of metal to migrate toward the current source, which is an inherent problem in all fuses and which can control the usable life thereof when the fuse is not subjected to overload conditions, is reduced by the fuse of the present invention, since the fuse operates at a lower temperature than conventional commercially available fuses.

What is claimed is:

1. An electric fuse comprising: a solid unitary body of thermoplastic material defining a body sidewall and oppositely facing body ends; a low melting point metal fusible link embedded in situ in said body, said link being in the form of an elongate wire-like element having its midportion within said body and opposite end portions each extending outwardly beyond one end of said body, said wire-like element having a diameter in excess of about .010 inches, the external surface of the portion of said element within said body being in intimate contact with said plastic material, said end portions being positioned at an angle with respect to the length of said element so as to be disposed adjacent the respective body ends in direct contact therewith; and a metal end cap positioned over each end portion of said body, said end caps each being a cup-like member including a sidewall compressively embracing the sidewall of the body adjacent one end thereof and an end wall adjacent an end of the body and compressing therebetween the end portion of the fusible link, the internal surface of the sidewall of said end caps being smooth to permit said end caps to be assembled to said body by axial relative movement therebetween and said internal surfaces being in intimate surface to surface contact with the adjacent external surface of the fuse body.

2. A fuse as set forth in claim **1** wherein said body ends are perpendicular to said body sidewall and parallel with the end wall of the adjacent end cap.

3. A fuse as set forth in claim **1** wherein said fusible link is centered relative to said body.

4. A fuse as set forth in claim **1** wherein said fusible link is of circular cross-sectional configuration.

5. A fuse as set forth in claim **4** wherein said fusible link has a uniform cross-sectional configuration throughout its length.

6. A fuse as set forth in claim **4** wherein the ends of said fusible link are formed into a coiled configuration.

7. A fuse as set forth in claim **6** wherein said fusible link is formed of a material having a degree of inherent resiliency, whereby said end portions are urged against the end walls of said caps.

8. A fuse as set forth in claim **1** wherein a mass of said plastic material extends outwardly from the sidewall of said body.

9. A fuse as set forth in claim **8** wherein said mass is shaped into the form of a gripping handle.

10. A fuse as set forth in claim **9** wherein said gripping handle has an aperture therein.

11. A fuse as set forth in claim **1** wherein identifying indicia are formed integrally with said body.

12. A fuse as set forth in claim **1** wherein at least one portion of each end cap is deformed inwardly into an adjacent portion of the fuse body.

13. An electric fuse comprising: a solid, unitary transparent body of thermoplastic material defining a generally cylindrical body sidewall and oppositely facing generally planar body ends disposed perpendicularly with respect to the body sidewall; a low melting point metal alloy fusible link embedded in situ in the center of said body, said link being in the form of an elongate wire-like element having its midportion within said body and opposite end portions each extending outwardly beyond one end of said body, said wire-like element having a diameter in excess of about .010 inches, the external surface of the portion of said element within said body being in intimate contact with said plastic material, said outwardly extending end portions being formed into a coiled configuration so as to be initially disposed adjacent to and in spaced relationship with the respective body ends; a metal end cap positioned over each end portion of said body, said end caps each being a cup-like member including a generally cylindrical sidewall compressively embracing the sidewall of the body adjacent one end thereof and an end wall parallel with and adjacent to an end of the body and spaced therefrom by a distance substantially corresponding to the thickness of said element to positively compress the end portion of the fusible link directly against the ends of the body and the end walls of the end caps, the internal surface of the sidewall of said end caps being smooth to permit said end caps to be assembled to said body by axial relative movement therebetween and said internal surfaces being in intimate surface to surface contact with the adjacent external surface of the fuse body; and means for preventing axial movement between said end caps and said body, and including means bonding the end portions of the fusible link to the end wall of an end cap.

14. A fuse as set forth in claim **13** wherein said fusible link is formed of a material having a degree of inherent resiliency, whereby said end portions are urged against the end walls of said caps.

15. A fuse as set forth in claim **13** wherein said means for preventing axial movement between said end caps and said body further includes at least one inwardly offset portion of the sidewall of each end cap which engages within an adjacent recess in the sidewall of the fuse body.

16. A fuse as set forth in claim **13** including a conductive material interposed between each end of the body and the end wall of each end cap.

17. An electric fuse comprising: a solid, unitary body of plastic material defining a body sidewall and oppositely facing body ends, each body end being provided with a shallow radially extending slot; a metal fusible link embedded in situ in said body, said link being in the form of an elongate wire-like element having opposite end portions each extending outwardly beyond one end of said body, the external surface of the portion of said element within said body being in intimate contact with said plastic material, said end portions being positioned at an angle with respect to the length of said element so as to be disposed adjacent the respective body ends; and a metal end cap positioned over each end portion of said body, said end caps each being a cup-like member including a sidewall embracing the sidewall of the body adjacent one end thereof and an end wall adjacent an end of the body and compressing therebetween the end portion of the fusible link.

18. An electric fuse comprising: a solid, unitary body of transparent plastic material defining a body sidewall and oppositely facing body ends; a metal fusible link embedded in situ in said body, said link being in the form of an elongate wire-like element having opposite end portions each extending outwardly beyond one end of said body, the external surface of the portion of said element within said body being in intimate contact with said plastic material, said end portions being positioned at an angle with respect to the length of said element so as to be disposed adjacent the respective body ends; means providing an optical configuration in the mid-portion of the sidewall of the fuse body for magnifying the image of the fusible link at the mid-portion of the fuse body; and a metal end cap positioned over each end portion of said body, said end caps each being a cup-like member including a sidewall embracing the sidewall of the body adjacent one end thereof and an end wall adjacent an end of the body and compressing therebetween the end portion of the fusible link.

19. A fuse as set forth in claim **18** wherein said optical configuration is provided by a lens portion formed integrally with said body sidewall.

20. An electric fuse comprising: a solid, unitary transparent body of thermoplastic material defining a body sidewall and oppositely facing body ends; a low melting point metal alloy fusible link embedded in situ in said body, said link being in the form of an elongate wire-like element having its midportion within said body and opposite end portions each extending outwardly beyond one end of said body, said wire-like element having a diameter in excess of about .010 inches, the external surface of the portion of said element within said body being in intimate contact with said plastic material, said end portions being positioned at an angle with respect to the length of said element so as to be disposed adjacent the respective body ends in direct contact therewith; a metal end cap positioned over each end portion of said body, said end caps each being a cup-like member including a sidewall embracing the sidewall of the body adjacent one end thereof and an end wall adjacent an end of the body and compressing therebetween the end portion of the fusible link; and means bonding the end portions of the fusible link to the end wall of an end cap, the internal surface of the sidewall of said end caps being smooth to permit said end caps to be assembled to said body by axial relative movement therebetween and said internal surfaces being in intimate surface to surface contact with the adjacent external surface of the fuse body.

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