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Salzer

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[54] **ELECTRIC CARTRIDGE FUSE WITH BLOWN FUSE INDICATOR**

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[52] **U.S. Cl.** **337/244**, 337/206, 337/241

[51] **Int. Cl.** **H01h 85/30**

[58] **Field of Search** 337/206, 241, 244, 267

[56] **References Cited**

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Assistant Examiner—Fred E. Bell
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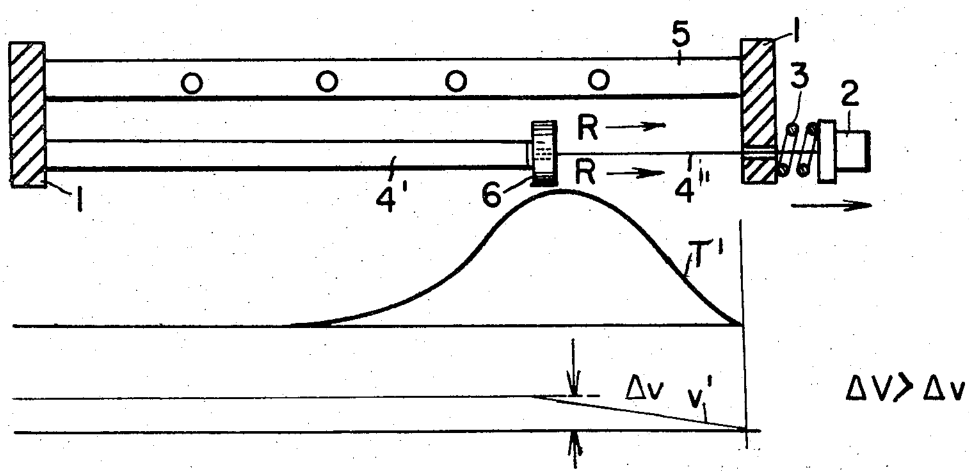
[57] **ABSTRACT**

An electric fuse having a spring-biased blown fuse indicator normally held in position by a fusible restraining means formed by a series arrangement of a ribbon of a low resistivity metal and a wire of a high resistivity, high tensile strength metal. A local enclosure of a gas evolving material is mounted on said wire, preferably immediately adjacent the point of junction of said ribbon and said wire.

11 Claims, 9 Drawing Figures



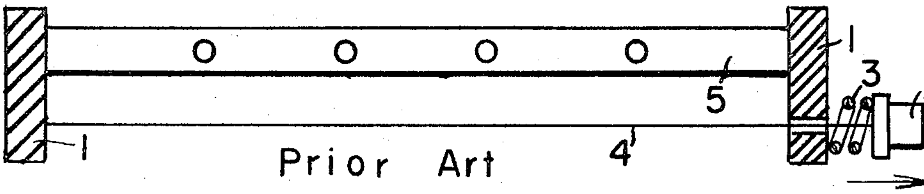


FIG. 1

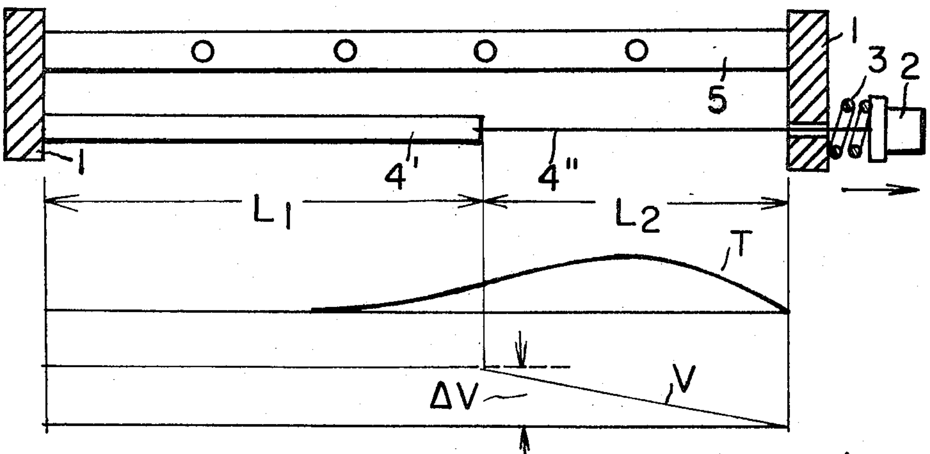


FIG. 2

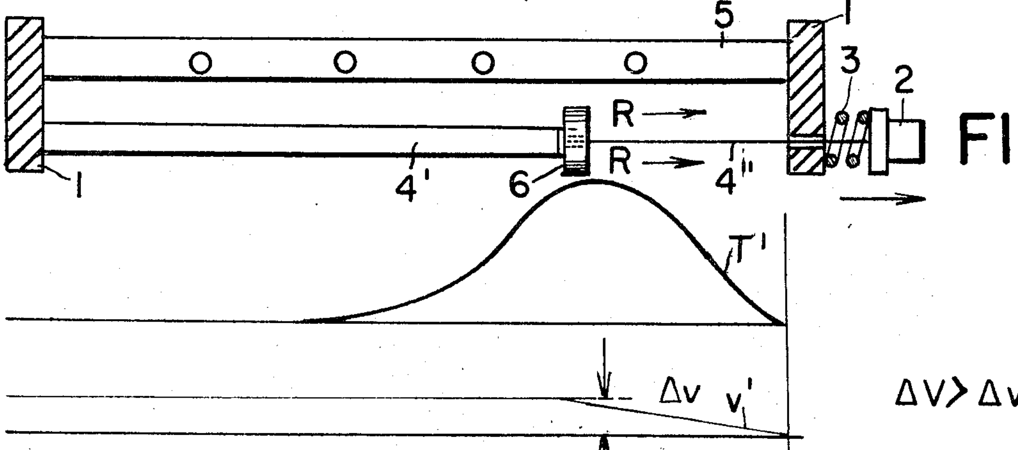


FIG. 3

FIG. 4a

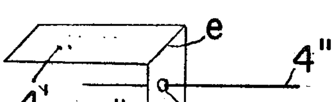


FIG. 4b

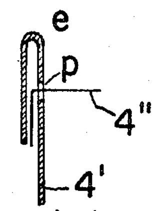


FIG. 4c

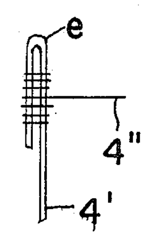
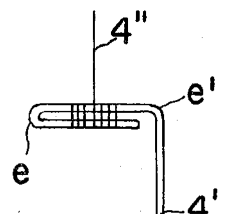


FIG. 4d



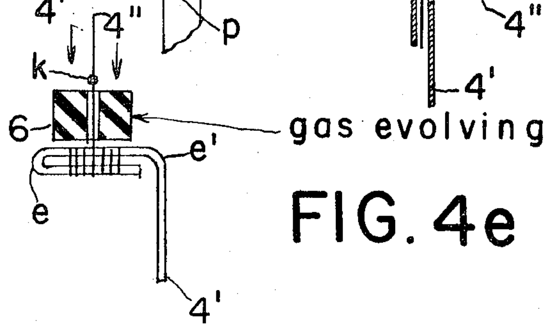
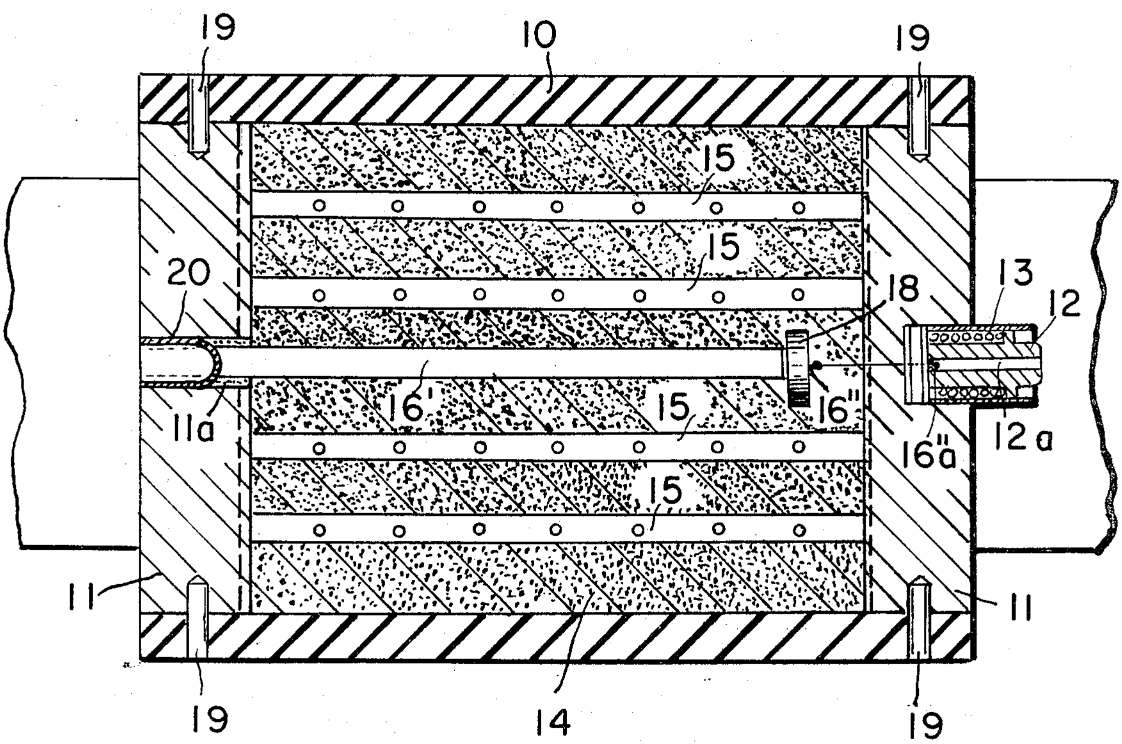


FIG. 4e

FIG. 5



ELECTRIC CARTRIDGE FUSE WITH BLOWN FUSE INDICATOR

BACKGROUND OF THE INVENTION

Blown fuse indicators are generally provided with a fusible restraining means for their spring-biased indicator pin. Normally the fusible restraining means is formed by a wire of a high resistivity, high tensile strength metal, e.g., stainless steel. A relatively high voltage, e.g., 10 volts, is required to cause fusion of a high resistivity, high tensile strength restraining wire within a reasonably short time. A reduction of the voltage required to cause fusion of the indicator-pin-restraining means, e.g., to 3 volts, can be achieved by using as restraining means a series arrangement of a ribbon of a low resistivity metal such as silver and of a wire of a high resistivity high tensile strength metal.

It is the prime object of this invention to provide fuses having restraining means for the blown fuse indicators thereof wherein the required fusion voltage is relatively low, but the arc voltage generated upon fusion of the restraining means is relatively high. Another object of this invention is to provide means for minimizing the tensile stresses to which the low resistivity metal ribbon of the pin-restraining means is subjected.

SUMMARY OF THE INVENTION

Fuses embodying this invention include a tubular casing of electric insulating material and a pair of electroconductive terminal elements closing the ends of the casing. A spring-biased pin responsive to blowing of the fuse is mounted on one of said pair of terminal elements. There is a pulverulent arc-quenching filler inside said casing. A first fusible element means in the form of a ribbon of a relatively low resistivity metal and having serially arranged points of reduced cross-sectional area interconnects said pair of terminal elements. Said pair of terminal elements is further interconnected by a second fusible element means normally restraining said pin against the spring-bias thereof. Said second fusible element means is in the form of a series arrangement of a ribbon of a low resistivity metal and a wire of a high resistivity, high tensile strength metal. Fuses embodying this invention further include a local enclosure of a gas evolving material mounted on and closely surrounding a limited portion of the length of said wire to reduce the heat flow from said limited portion of the length of said wire into said arc-quenching filler and exposing other portions of said wire to unrestricted heat flow into said arc-quenching filler.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic illustration of a conventional or prior art fuse having a spring biased blown fuse indicator;

FIG. 2 shows in the same fashion as FIG. 1 a modification of the structure of FIG. 1 requiring a smaller voltage than the structure of FIG. 1 for causing fusion of the restraining wire of the blown fuse indicator;

FIG. 3 shows a fuse embodying this invention in the same diagrammatic fashion as FIGS. 1 and 2;

FIGS. 4*a* to 4*e* show diagrammatically several consecutive steps in assembling the fuse structure of FIG. 3; and

FIG. 5 is a longitudinal more detailed section of a fuse embodying the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to FIG. 1, numeral 1 has been applied to indicate a pair of spaced electro-conductive terminal elements of an electric fuse. The parts have been shown but diagrammatically in FIG. 1. They may actually be formed by ferrules, or by plugs, closing the ends of a tubular casing of electric insulating material. One of terminal elements 1 is provided with a blown fuse indicator including a pin 2 and a pin-biasing spring 3. Normally pin 2 is restrained from moving from left to right under the action of spring 3 by a restraining wire 4 made of a high resistivity, high tensile strength metal, e.g., stainless steel. Wire 4 conductively interconnects terminal elements 1. Terminal elements 1 are also conductively interconnected by fusible element means in the form of a multiperforated ribbon 5 of a metal having a relatively low resistivity, e.g., silver. As long as the current path established by ribbon 5 is intact, high resistivity wire 4 is shunted out by ribbon 5. When the current path formed by ribbon 5 is interrupted, resistance wire 4 becomes current carrying. A certain voltage drop, e.g., 10 volts, is required to cause melting of wire 4 within a predetermined time Δt. Since the temperature peak occurs near the center of wire 4, fusion will be initiated at this point. When a break is formed in wire 4 it cannot restrain pin 2 any longer, and the latter will be moved from left to right under the action of helical spring 3, thus indicating blowing of the fuse.

The structure of FIG. 1 has two serious limitations. A relatively high voltage between terminals 1, i.e., between the ends of restraining wire 4 is required to cause rapid fusion thereof, i.e., fusion within the predetermined time Δt. One portion of wire 4 which is not vaporized by the arc kindled upon formation of a break in wire 4 must be pulled through the pulverulent arc-quenching filler, e.g., quartz sand, which normally surrounds ribbon 5 and wire 4 (and which has not been shown in FIG. 1). The undesirable friction between the aforementioned portion of wire 4 and the arc-quenching filler by which it is surrounded calls for a strong pin-biasing spring 3 which, in turn, calls for a restraining wire 4 capable of withstanding high stresses.

In FIG. 2 the same reference characters as in FIG. 1 have been applied to indicate like parts. Therefore the structure shown in FIG. 2 calls for description only inasmuch as it differs from the structure of FIG. 1. In the structure of FIG. 2 the restraining wire 4 of FIG. 1 has been substituted by a series arrangement of a ribbon 4′ having substantially equal cross-sectional along its entire length made of a low resistivity metal, e.g., silver, and a wire 4″ of a high resistivity, high tensile strength metal. The line T in FIG. 2 indicates diagrammatically the temperature distribution and the line V indicates diagrammatically the voltage drop along series conductors 4′,4″ required to establish a current which causes fusion of wire 4″ within a predetermined time Δt.

In FIG. 2 reference character L_1 has been applied to indicate the length of ribbon 4′ and reference character L_2 has been applied to indicate the length of wire 4″. The operation of the arrangement of FIG. 2 depends largely upon the ratio L_1/L_2. The larger this ratio, the smaller the voltage required to cause fusion of wire 4″ within a predetermined time Δt. On the other hand, the larger the ratio of L_1/L_2, the smaller the arc voltage tending to force the current through series conductors 4′, 4″ and the arc gap formed therein down to zero.

This is an undesirable performance characteristic of the structure of FIG. 2.

Another important aspect of the structure of FIG. 2 is this: The tensile force exerted by spring **3** upon the wire **4''** of a high tensile stress material is transmitted from wire **4''** to ribbon **4'** which must be of a low resistivity material which has inherently a relatively low tensile strength. Hence the cross-sectional area of ribbon **4'** must be determined by both low resistivity and high tensile strength requirements which cannot be met simultaneously in a perfect or very satisfactory way.

The structure of FIG. **3** embodying the present invention is not subject to the limitations of the structure of FIG. **2.** In FIG. **3** the same reference characters as in FIGS. **1** and **2** have been applied to indicate like parts. Therefore the structure shown in FIG. **3** calls for description only inasmuch as it differs from the structures of FIGS. **1** and **2.**

The structure of FIG. **3** differs from that of FIG. **2** by the addition of a part **6** of gas-evolving insulating material whose structural features will be described below in more detail. Part **6** is made of a gas evolving material having a smaller thermal conductivity than the pulverulent arc-quenching filler surrounding fusible elemets **5** and **4',4''**. As a result, the temperature distribution of the series connected fusible elements **4',4''** when carrying current has the shape of line T' whose peak is immediately adjacent the point of junction of elements **4'** and **4''**. Initial fusion will occur at the point where the temperature peak is situated. Since the presence of part **6** reduces heat losses, it reduces the current required to cause fusion of wire **4''** within the predetermined time Δ *t*, and to reduce the voltage drop along wire **4''** required to produce that current.

In other words, for a given ratio L_1/L_2, all other conditions remaining unchanged, wire **4''** fuses faster in the structure of FIG. **3** than in that of FIG. **2.** Thus the structure of FIG. **3** allows an increase of the ratio L_1/L_2, or a reduction of the voltage drop across wire **4''**, if equal fusing times Δ *t* of wire **4''** are considered for both the structures of FIGS. **3** and **2.**

Considering the structure of FIG. **2,** any increase of the ratio L_1/L_2 results in a reduction of the arc voltage generated upon fusion of wire **4''**.

The structure of FIG. **3** allows to compensate within wide limits for any reduction of arc voltage resulting from an increase of the ratio L_1/L_2. To be more specific, reductions of the arc-voltage resulting from reductions of the length of wire **4''** may be compensated by increases of arc voltage resulting from the evolution of arc-quenching gases from part **6** when the latter is subjected to the action of an arc kindled inside of, or immediately adjacent to it.

Part **6** may further be designed to transmit a significant portion of the tensile forces to which wire **4''** is subjected by spring **3** to the surrounding arc-quenching filler, thus greatly reducing the stress to which ribbon **4'** is subjected. The forces transmitted by part **6** to the surrounding arc-quenching filler have been indicated in FIG. **3** by a pair of arrows R. How this is achieved will be shown below in detail.

It may be added that the structure of FIG. **2** is a point of departure for arriving at the structure of FIG. **3.**

In the structure of FIG. **1** the voltage drop required to cause fusion of restraining wire **4** cannot be reduced because wire **4** must be made of a material combining high tensile strength and high resistivity, and metals having a smaller resistivity than conventional restraining wire materials have not sufficient tensile strength. Nor can the voltage drop along wire **4** of FIG. **1** be reduced by increasing the cross-sectional area thereof, one of the limitations precluding this way of reducing the voltage required to cause fusion of wire **4** within a predetermined interval of time Δ *t* being the low ionizing potential of vapors resulting from its vaporization.

Referring now to FIGS. **4***a* to **4***e*, FIG. **4***a* is an isometric view of the end of ribbon **4'** also shown in FIG. **3** adjacent its junction with wire **4''**. The latter is also shown in FIG. **4***a*. Ribbon **4'** is bent 90° and wire **4''** is threaded through a perforation *p* in ribbon **4'** adjacent an edge e formed by bending ribbon **4'**. This is the first step in arriving at the restraining means embodying this invention.

Thereafter, as shown in FIG. **4***b*, the end of wire **4''** threaded through perforation p is clamped between the portions of ribbon **4'** situated to opposite sides of edge *e*. To increase the clamping pressure upon the clamped end of wire **4''**, wire **4''** is wound repeatedly around the longitudinal edges of ribbon **4'**, as shown in FIG. **4***c*. The next step consists in forming a bend *e'* of 90° in ribbon **4** as shown in FIG. **4***d*. Then the free end of wire **4''** is threaded through a perforated disk or pellet **6** of gas evolving material, i.e., of a material evolving arc-quenching gases under the action of electric arcs. Disk or pellet **6** is preferably of a mixture of a melamine resin and inorganic substances. Pellet or disk **6** has a surface which abuts against a portion of ribbon **4'** bent transversely to the longitudinal direction thereof and thus fixedly positioned relative to ribbon **4'**. The diameter of disk or pellet **6** is relatively large, at least equal to the length thereof. A knot *k* formed in wire **4''** immediately adjacent to disk or pellet **6** precludes movements of disk or pellet **6** relative to ribbon **4'** in a direction away from ribbon **4'**. The free or upper end of wire **4''** shown in FIG. **4***e* is intended to be affixed to the spring-biased pin **2** of FIG. **3** and conductively connected to terminal element **1** immediately adjacent to pin **2,** and the free or lower end of ribbon **4'** shown in FIG. **4**e is intended to be affixed to and conductively connected with the other terminal element **1** of the fuse structure shown to the left of FIG. **3.**

It may be added that ribbon **4'** is not perforated except for its wire-receiving perforation *p*, i.e., the cross-sectional area of ribbon **4'** is uniform between the point of junction with wire **4''** and the point of connection with one of the terminal elements **1** of FIG. **3.**

Referring now to FIG. **5,** numeral **10** has been applied to indicate a tubular casing of electric insulating material closed at the ends thereof by a pair of electroconductive terminal elements **11** in the form of plugs. Steel pins **19** projecting transversely through casing **10** into terminal plugs **11** firmly affix the latter to casing **10.** Blown fuse indicator pin **12** is biased by helical spring **13** in the direction from left to right. Casing **1** is filled with a pulverulent arc-quenching filler **14,** preferably quartz sand. Terminal plugs **11** are conductively interconnected by first fusible element means in the form of multiperforated low resistivity ribbons **15,** silver being the preferred low resistivity metal for ribbons **15.** The fuse structure further includes second fusible element means **16',16''** in the form of a series arrangement of a ribbon **16'** of a low resistivity metal, preferably silver of uniform cross-section throughout its effective length and a wire **16''** of a high resistivity, high tensile strength metal. Fusible element means 16′,16″ conductively interconnect terminal plugs 11. Ribbon 16 enters recess 11a in left plug 11 and is clamped by a flexible metal cap 20 to left plug 11. Wire 16″ is affixed with one end to ribbon 16′ and with the other end to pin 12. To this end pin 12 is provided with an axial passageway 12a forming a shoulder at the left end thereof and wire 16″ forms a knot 16a″ which rests against said shoulder. Wire 16″ supports a disk or pellet 18 of a gas-evolving low thermal conductivity material close to its junction with ribbon 16′. Ribbon 16′ and wire 16″ are joined together in the way explained in regard to parts 4′ and 4″ in connection with FIGS. 4a–4e. Disk or pellet 18 transmits a significant portion of the force exerted by spring 13 upon wire 16″ to pulverulent arc-quenching filler 14, thus minimizing the tensile stress to which silver ribbon 16′ is subjected. The pellet or disk 18 of gas evolving material mounted on and closely surrounding a limited portion of wire 16″ reduces heat flow from said limited portion of wire 16″ into the surrounding pulverulent arc-quenching filler 14, but exposes other portions of wire 16″ to unrestricted heat flow into filler 14.

I claim as my invention:

1. An electric fuse including

a. a tubular casing of electric insulating material;

b. a pair of electroconductive terminal elements closing the ends of said casing;

c. a spring-biased pin responsive to blowing of the fuse mounted on one of said pair of terminal elements;

d. a pulverulent arc-quenching filler inside said casing;

e. first fusible element means in ribbon form of a relatively low resistivity metal and having serially arranged points of reduced cross-sectional area interconnecting said pair of terminal elements;

f. second fusible element means normally restraining said pin against the spring bias thereof, said second fusible element means being in the form of a series arrangement of a ribbon of a low resistivity metal and of a wire of a high resistivity, high tensile strength metal interconnecting said pair of terminal elements; and

g. a local enclosure of a gas-evolving material mounted on and closely surrounding a limited portion of the length of said wire to reduce heat flow from said limited portion of the length of said wire into said arc-quenching filler and exposing other portions of said wire to unrestricted heat flow into said arc-quenching filler.

2. An electric fuse as specified in claim 1 wherein said enclosure is mounted on said wire immediately adjacent to the point of junction of said ribbon of said second fusible element means and said wire thereof.

3. An electric fuse as specified in claim 2 wherein said ribbon of said second fusible element means includes a portion bent substantially transversely relative to the longitudinal direction thereof, wherein said portion is arranged immediately adjacent to said point of junction of said ribbon of said second fusible element means and of said wire thereof, and wherein said local enclosure of a gas-evolving material is arranged in abutting relation to said bent portion of said ribbon of said second fusible element means.

4. An electric fuse as specified in claim 3 wherein said enclosure is in the form of a pellet of a mixture of a melamine resin and inorganic substances having a central bore for the passage of said wire and having a surface in abutting relation with said portion of said ribbon of said second fusible element means being bent transversely relative to the longitudinal direction thereof.

5. An electric fuse as specified in claim 4 wherein the diameter of said pellet is at least equal to the length thereof.

6. An electric fuse including

a. a tubular casing of electric insulating material;

b. a pair of electroconductive terminal elements closing the ends of said casing;

c. a pin responsive to blowing of the fuse and a pin-biasing-spring mounted on one of said terminal elements;

d. a pulverulent arc-quenching filler inside said casing;

e. fusible element means inside said casing normally restraining said pin against the action of said pin-biasing spring, said fusible element means being in the form of a series arrangement of a ribbon of a low resistivity metal and of a wire of a high resistivity, high tensile strength metal interconnecting said pair of terminal elements; and

f. means of electric insulating material arranged immediately adjacent the point of junction of said ribbon and said wire of said fusible element means and extending substantially transversely to the longitudinal direction of said fusible element means and transferring a portion of the force exerted by said pin-biasing spring upon said wire from said wire to said arc- quenching filler and thus reducing the tensile force transmitted from said wire to said ribbon of said fusible element means to a substantially smaller tensile force than the tensile force to which said wire is subjected by said pin-biasing spring.

7. An electric fuse as specified in claim 6 wherein said means of electric insulating material is of an insulating material evolving arc-quenching gases under the action of electric arcs and defines a passageway, and wherein said wire of said fusible element means is threaded through said passageway.

8. An electric fuse as specified in claim 6 wherein said ribbon of said fusible element means includes a portion bent substantially transversely relative to the longitudinal direction thereof, wherein said wire of said fusible element means is provided with a knot arranged in spaced relation from said bent portion, and wherein said bent portion and said knot are arranged immediately adjacent the ends of said passageway to limit movement of said means of electric insulating material relative to said second fusible element means.

9. An electric fuse as specified in claim 8 wherein said means of electric insulating material is substantially in the shape of a disk having a predetermined diameter and a predetermined length and wherein said predetermined diameter exceeds said predetermined length.

10. An electric fuse including

a. a tubular casing of electric insulating material;

b. a pair of electroconductive terminal elements closing the ends of said casing;

c. a spring-biased pin responsive to blowing of the fuse mounted on one of said pair of terminal elements;

d. a pulverulent arc-quenching filler inside said casing;

e. fusible element means embedded in said filler normally restraining said pin against the spring bias thereof, said fusible element means being in the form of a series arrangement of low resistivity metal ribbon and a high resistivity high tensile strength wire interconnecting said pair of terminal elements, said wire having one end affixed to said pin; and

f. a local enclosure of gas evolving material mounted on and closely surrounding a limited portion of the length of said wire to reduce heat flow from said limited portion of the length of said wire into said arc-quenching filler and exposing substantially all of the rest of the length of said wire to unrestricted heat flow into said arc-quenching filler.

11. An electric fuse as specified in claim **1** wherein said enclosure is mounted on said wire immediately adjacent the point of junction of said ribbon and said wire and wherein said enclosure is adapted to transmit a substantial portion of said spring bias from said wire to said pulverulent arc-quenching filler so as to substantially relieve said metal ribbon from said spring bias.

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