United States Patent

Deelman

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[54] **FUSES**

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[52] **U.S. Cl.** **337/185,** 337/239

[51] **Int. Cl.** **H01h 85/08,** H01h 85/36

[58] **Field of Search** 337/159, 165, 166, 182, 183, 337/185, 238, 239, 290, 297, 407

[56] **References Cited**

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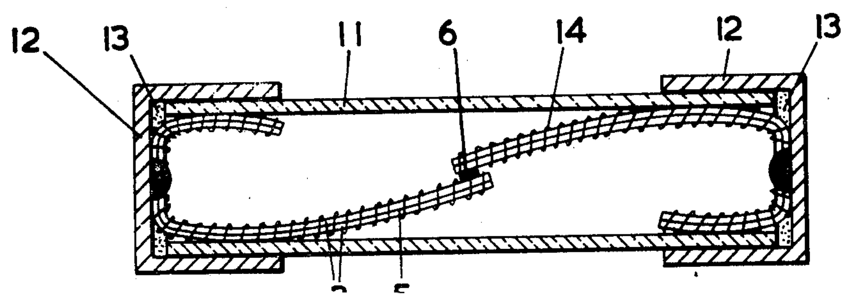
[57] **ABSTRACT**

A fuse in which two current conductors are connected by fusible pellet, the connection between the current conductors being broken by mechanical spring action at the exceeding of a current threshold for which the pellet melts. One or each current conductor is combined and attached to an associated biased resilient element, thus forming an interruption element with both excellent mechanical and electrical characteristics for providing the wanted interruption action.

2 Claims, 7 Drawing Figures



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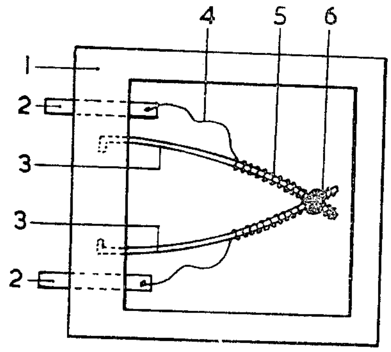


FIG. 1

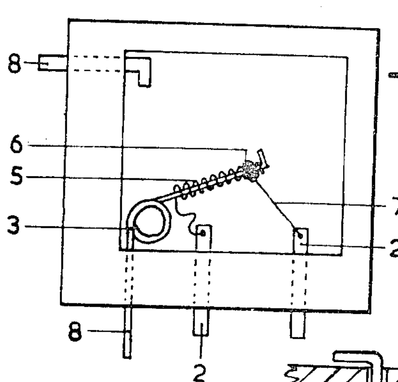


FIG. 2

FIG. 3

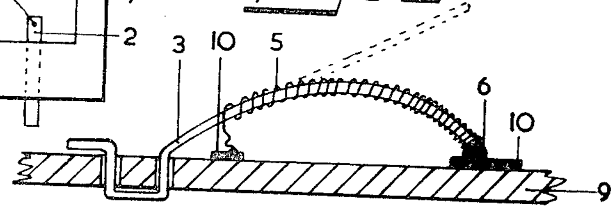
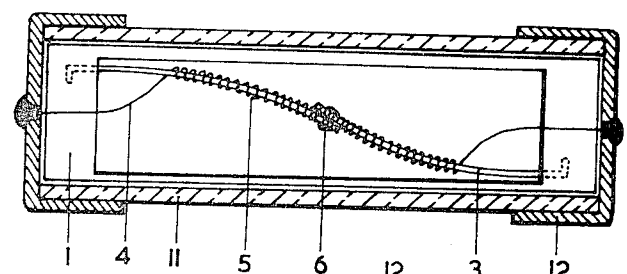


FIG. 4



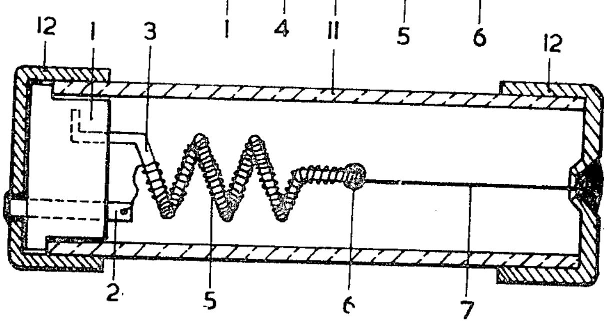


FIG. 5

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FIG. 6

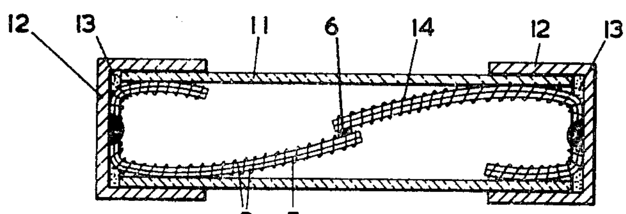
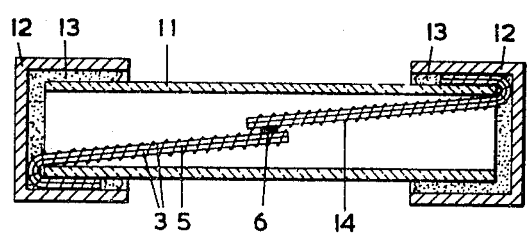


FIG. 7



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FUSES

This invention relates to a fuse comprising two current conductors connected by a fusible pellet, the connection being broken when a given threshold value of current flowing through the conductors is exceeded as a result of mechanical spring action when the pellet melts.

Such fuses are known in the art. In Bulletin des Schweizerischen Electrotechnischen Vereins, 1962, page 589 ff., there are described constructions of slow-blow fuses in which, in a glass tube, two small current-carrying tension springs are interconnected by a fusible pellet. When the pellet melts, at a given temperature, the current is cut off by the biased springs withdrawing to their equilibrium position.

Such fuses have some disadvantages, however. Since the pellet heating is caused by the generation of heat from the current in the springs, there is the danger that sudden overheating may result in a loss of resiliency, which may have disastrous effects on the apparatus protected by the fuse. This disadvantage is felt more strongly according as such fuses are designed for lower fusing currents. While winding of small tension springs is difficult enough in itself, the wires for such low-current fuses must also have a high specific resistance, the choice of materials is still further restricted by the requirement that the wires must be solderable with low-melting alloys. Materials which satisfy both requirements have the disadvantage, however, that they lose their resiliency at relatively low working temperatures.

The prior art has further proposed slow-blow fuses in which the current-carrying tension spring is electrically bridged with a flexible copper wire. Also, such springs are sometimes coated with tin or copper. These solutions of the problem of loss of resiliency referred to, however, are often not effective, cumbersome in the manufacture, and cause undue variety in the characteristics of such fuses. Another disadvantage of these fuses is that, particularly in constructions for low-fusing currents, heat losses occur in the current conductors, resulting in highly inefficient fuses with relatively large power dissipations. There is also a factor of uncertainty as far as the fusing range is concerned.

It is an object of the present invention to eliminate the disadvantages described above.

The invention accordingly provides a fuse comprising a casing with input and output means, and two current conductors with the one ends of said current conductors being connected by a fusible pellet and the other ends of said current conductors being connected to said input and output means respectively, at least one of said current conductors being disposed closely along and attached to a biased resilient element associated with it and following the geometrical configuration of said associated resilient element, the one end of the said resilient element being attached to the casing and the other end being in contact with the fusible pellet, so as to constitute an interruption element having both mechanical and electrical characteristics for breaking by mechanical spring action the electrical connection between said current conductors when a given threshold value of electrical current through said current conductors for melting said pellet is exceeded.

Accordingly, in the fuse according to the present invention, the functions of resilient elements and current-carrying elements are substantially separated and as a consequence, the choice of material for resiliency characteristics is no longer coupled to the choice of material for electrical characteristics. Such a separation is not new per se. In Dutch Patent Specification No. 24,318, there is described a fuse in which a fusible wire, which consists of two parts interconnected by a fusible pellet, is biased by a noncurrent-carrying compression spring. Since, however, in that case, the current conductors are spaced from the resilient element, there is still the disadvantage of insufficiently quick supply of heat from the conductors to the fusible pellet as a result of heat losses in the current conductors. On the other hand, in the fuse according to the present invention, we deliberately make use of the heat-accumulating properties of the resilient material by disposing the windings adjacent or closely around the resilient elements. By virtue of this arrangement, the resilient elements can serve as accumulators for the heat dissipated by the windings, so that more effective and quicker heating can take place at the pellet.

In the fuse according to the invention, the resilient elements may be secured in insulating material formed integrally with the casing of the fuse; the free ends of these resilient elements may be held together by a fusible pellet.

Preferably the resilient elements have a core of resilient material, which is a poor heat conductor and has a low specific heat, for example, stainless steel.

It is also possible to make use of a resilient element consisting of insulating material.

For low-current applications use can be made of a resilient element around which the current conductor has been disposed as a close thin current winding of a conducting metal. For the case the resilient element is formed of a metal core, such as stainless steel, said core may be surrounded by an insulating layer of for example enamel or synthetic resin material or the current winding may be coated with insulating material. The current windings may be produced by previously winding the resilient elements with a thin conductor, for example, an enameled wire, which may, for example, be made of a copper-nickel alloy of high specific resistance. The current windings may further be united with the resilient elements solidly by heat treatment, if necessary adding lacquer or adhesive. By further securing the free ends of the current windings to terminals of the casing of the fuse in such a manner that these terminals are electrically insulated from the supporting points of the resilient members, it is achieved in a simple manner that the resilient members do not take part in the current conduction of the fuse.

One advantage of the fuse according to the present invention is that there is a greater choice of materials and design, and methods of manufacture may be varied. Thus as stated before the resilient core need not be of conductive material in the form of a wire or strip, but may be made of insulating material, for example, of a glass fiber or strand of glass fibers. Furthermore, it is not necessary for the resilient core to be soldered to the alloy of the pellet. The latter may, for example connect two suitable points of the windings.

According to the invention windings may be built up from two or more thin conductors side by side, with the advantage of a greater flexibility and relatively low resistance. Instead of using a separate winding around a resilient core, we may also use an etch-printed conductor on an insulation of synthetic resin material surrounding the resilient core. In this manner the fuse according to the invention may, for example, be adapted for use in printed circuits.

For high-current applications, where shorter and thicker current conductors are needed, the current conductor instead of being wound around its associated resilient element can be disposed adjacent and parallel to the resilient element to constitute a useful current interruption element. For attachment of the conductor to the resilient element use can be made of a close thin winding around the so formed bundle. As is the case in the low-current application mentioned above there can be provided insulation between the resilient element and the current conductor. However in many cases such an insulation can be omitted. Thus it is possible for example to constitute a fuse with current interruption elements comprising a resilient element of stainless steel combined to a bundle with a good conducting metal wire, said bundle surrounded by coil of a thin metal wire, closely wound around said bundle.

So formed interruption elements have excellent characteristics for breaking the current connection above a predetermined threshold value of allowable electrical current.

The invention will be further described by way of example with reference to the accompanying drawings.

FIG. 1 shows a fuse according to the invention including two resilient elements on which current conductors are wound;

FIG. 2 shown a fuse with an indicator contact;

FIG. 3 shows a fuse according to the invention designed particularly for use with printed circuits;

FIG. 4 illustrates a fuse according to the invention in a form suitable for being built into a cylindrical tube of electrically insulating material; and

FIG. 5 illustrates a fuse according to the invention in which the resilient element takes the form of a helical tension spring, and

FIGS. 6 and 7 show high current fuses according to the invention in which are interruption elements consisting of a combined bundle of resilient and electrically good conducting metal wires surrounded by thin metal windings.

Referring to FIG. 1, there is shown a casing 1, in which are secured terminals 2 and resilient elements 3. The resilient elements are provided with current windings 5, the ends 4 of which are connected with the terminals 2. The fusible pellet 6, which provides a conductive connection between the windings 5, holds the resilient elements together. Depending on the magnitude of the current and the ambient temperature, blowing of the fuse will occur at the pellet 6. Sudden, very large currents however, will cause the current to be broken owing to the melting of the ends 4, which in such embodiments provides an additional protection.

In FIG. 2, there is shown a fuse according to the invention provided with an indicator contact, the conductive, resilient element 3 being kept under tension by a thin conductor 7, which connects the terminal 2 with the fusible pellet 6 at the end of the current winding. The winding 5 is insulated from the resilient element 3. When the pellet 6 melts, the spring 3 effects a conductive connection between the auxiliary contacts 8, which energizes an alarm system.

FIG. 3 shows a fuse according to the invention designed particularly for use with printed circuits. The resilient element 3, provided with a current winding 5, is clamped in a panel 9 provided with a printed circuit 10. The fusible pellet 6 connects the winding 5, which is so dimensioned that it has a resistance value suitable for the circuit, with the printed circuit 10 and also keeps the resilient element 3 under tension.

The fuse shown in FIG. 4 has a form particularly suitable for being built into a cylindrical tube of electrically insulating material. A casing 1 of, for example, heat-resistant synthetic resin material houses terminals and the resilient elements 3. The fusible pellet 6 connects the windings 5 and keeps the resilient elements 3 under tension. The casing is surrounded by a cylindrical tube 11, including metal caps 12 soldered to the terminals.

FIG. 5 shows a fuse according to the invention incorporating a resilient element 3 in the form of a helical tension spring surrounded by a winding 5. The tension spring is anchored in a casing 1 and is kept under tension by a conductor 7, which is conductively connected to the winding 5 by the fusible pellet 6. The fuse is accommodated in a tube 11 of electrically insulating material, provided with conductive caps 12.

FIGS. 6 and 7 relate especially to high-current fuses. In FIG. 6 there is shown a fuse comprising a glass tube 11, sealed by two conducting metal end caps 12, cemented to the glass tube by a cementing 13.

Enclosed in the glass tube there are two interruption elements each comprising two wires of stainless steel 3 and one wire of silver 5 combined to a bundle. Said bundle is surrounded by a thin silver winding 14 for attachment purposes.

The so formed interruption elements are clamped for biasing in the glass tube and contacted to the metal caps with their one ends, the other ends being contacted to each other by a fusible tin solder pellet 6. In this embodiment and insulation between steel wire and silver wire can be omitted as the main current will flow through the good conducting silver wire.

The fuse shown in FIG. 7 is of the same configuration as the foregoing except that the interruption elements are clenched between the caps and the glass tube for biasing the springs.

Of course the fuses shown are only exemplary embodiments shown for illustration purposes.

There are numerous variations possible which may fall under the scope of the invention. So it is for example possible to provide the interruption elements with a number of conducting wires 5 and a number of resilient wires 3. It is also possible to use for high-current purposes a fuse of the type shown in FIG. 5 with one helical-type interruption element constituted in accordance with the bundle principle mentioned above and comprising the first current conductor whereas the second current conductor is single silver wire.

Such a configuration gives a special protection for sudden very high-current pulses, for the current conductor 7 acts as a current-limiting element that will melt at very high and sustained overcurrents.

Embodiments with two opposite helical-spring-type interruption elements are also possible both in the design wherein the current conductor is wound around the resilient element as in the design wherein the current conductor is disposed along and parallel to the resilient element.

The fuses according to the invention show numerous advantageous aspects. By effecting, on the one hand, a separation between resilient elements and conductive elements, and on the other hand yet ensuring a mechanically coherent unit, the invention provides a reproducible fuse which permits an optimum choice of materials, both for resiliency characteristics and for electrical characteristics. Also it provides reliable current protection, and a compact and sturdy construction. Thus it is possible to construct sandfilled fuses with low heat dissipation. Furthermore the methods of manufacture are simple and suitable for production on a continuous basis. In addition, for the selection of the fusible pellet, one is not limited to a conductive soldered connection, but may, especially for low-current application, use nonconductive substances, for example, synthetic resins, having a desired melting point, and keeping thus the contact between the conductors closed.

In cases wherein a tin solder pellet is used, too much flowing of the tin solder along the contacted ends of the two current conductors is prevented because of the fact that the current conductors combined with the resilient elements are either formed as a coil either surrounded by a coil, thus limiting the tin flow in axial direction.

I claim:

1. A fuse comprising a casing with input and output means, and two current conductors with the one ends of said current conductors being connected by a fusible pellet and the other ends of said current conductors being connected to said input and output means respectively at least one of said current conductors being disposed adjacent and parallel to a biased resilient element associated with it and following the geometrical configuration of said associated resilient element, said one conductor being attached to the resilient element by a winding of thin metal wire closely wound around the assembly of the conductor and the resilient element, the one end of the said resilient element being attached to the casing and the other end being in contact with the fusible pellet, so as to constitute an interruption element having both mechanical and electrical characteristics for breaking by mechanical spring action the electrical connection between said current conductors when a given threshold value of electrical current through said current conductors for melting said pellet is exceeded.

2. A fuse comprising a casing with input and output means, and two current conductors with the one ends of said current conductors being connected by a fusible pellet and the other ends of said current conductors being connected to said input and output means respectively at least one of said current conductors being disposed closely along and attached to a biased resilient element associated with it and following the geometrical configuration of said associated resilient element, said resilient element comprising a bundle of at least two wires of a poor electrical conducting resilient metal, said bundle and said one conductor being surrounded by a coil of thin metal wire closely wound around said bundle and said one conductor, one end of the said resilient element being attached to the casing and the other end being in contact with the fusible pellet, so as to constitute an interruption element having both

mechanical and electrical characteristics for breaking by mechanical spring action the electrical connection between said current conductors when a given threshold value of electrical current through said current conductors for melting said pellet is exceeded.

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