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(71) Applicant: **Bel-Fuse, Inc.**
Jersey City, New Jersey 07302 (US)

(72) Inventor: **Bernstein, Elliot**
Glen Cove, New York 11542 (US)

(74) Representative:
Steil, Christian, Dipl.-Ing. et al
Witte, Weller, Gahlert,
Otten & Steil,
Patentanwälte,
Rotebühlstrasse 121
70178 Stuttgart (DE)

(54) Conductive epoxy fuse and method of making

(57) A fuse (10) includes a hollow insulating body (11) having opposed ends. A fusible element (12) is positioned within the insulating body (11) such that the ends of the fusible element (12) extend from and overlie the ends of the insulating body (11). Conductive end caps (14) are inserted onto the ends of the insulating body (11). The end caps (14) are connected to the insulating body (11) and to the respective ends of the fusible element (12) by a conductive epoxy (15) wherein the conductive component comprises a noble metal, such as silver.

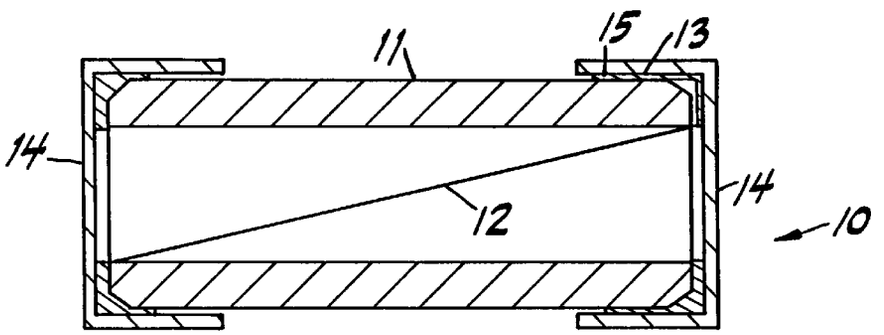

FIG. 1

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Description

BACKGROUND OF THE INVENTION

This invention relates to fuses and, in particular, to miniature fuses.

Conventional miniature fuses are assembled by feeding a fusible element through a hollow insulating body and soldering end caps to the body/fusible element assembly. The solder performs the function of making an electrical connection of the element to the end caps and a mechanical connection of the end caps to the insulating body.

Control of the soldering operation is most critical since variations in time, temperature and pressure, both individually and in combination, can cause a multitude of quality problems. Among them - solder splashes, solder blowouts, cold solder joints, flux stains, etc. These potential problems add substantially to the cost of manufacture by requiring both heavy investment in assembly equipment and costly inspection procedures. Additionally, manufacturing costs are increased because of high shrinkage rates.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a fuse and a method of making the same which solves the foregoing problem.

Another object of the present invention is to provide a fuse and a method of making the same which avoids the use of solder.

The foregoing and other objects of the invention are achieved by a fuse which includes a hollow insulating body having opposed ends. A fusible element having opposed ends is disposed within the insulating body such that the opposed ends of the fusible element extend from and overlie the opposed ends of the insulating body. First and second conductive end caps enclose the respective opposed ends of the insulating body and the fusible element. Each of the end caps is connected to respective ends of the insulating body and the fusible element by a conductive epoxy wherein the conductive component comprises a noble metal.

Using a noble metal as the conductive component of the conductive epoxy avoids any problems with oxide build up which could adversely affect the conductivity of the fuse. More specifically, oxides of noble metals are conductive and, accordingly, even if oxide formation occurs, such oxide formation will not adversely affect the conductivity of the fuse.

In a preferred embodiment, the fusible element (or at least the exposed surfaces thereof) is also made of a noble metal and, advantageously, the same noble metal as the conductive component of the conductive epoxy.

In accordance with one aspect of the invention, in making the fuse, respective quantities of conductive epoxy are deposited into the end caps prior to assembling of the end caps onto the insulating body.

In accordance with another aspect of the invention, in making the fuse, respective quantities of conductive epoxy are applied to the opposing ends of the insulating body prior to assembling the end caps onto the insulating body.

In accordance with still another aspect of the invention, in making the fuse, after assembly of the caps to the insulating body, the respective ends of the fuse are heated to cure the epoxy. Preferably, the ends of the fuse are heated simultaneously, i.e., the heating takes place after the fuse has been completely assembled.

Other aspects and advantages of the invention will become apparent from the following more detailed description, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a longitudinal cross sectional view of a fuse illustrating certain principles of the present invention.

Figure 2 is an exploded perspective view of the elements constituting the fuse of Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings and, in particular, to Figures 1 and 2, there is shown an embodiment of a fuse 10 illustrating certain principles of the present invention. The fuse 10 includes a hollow insulating body 11 which, in the embodiment shown, is substantially rectangular in shape. This shape is typical of fuses which are surface mounted, along with other components, on a printed wiring board. However, the insulating body 11 may assume any other appropriate shape, such as, for example, cylindrical as is common for socket mounted fuses used in many electronic assemblies.

A fusible element 12 is positioned within the hollow insulated body 11 and extends from one end to the other end. The composition and structure of fusible element 12 is such that it fuses or melts when the current therethrough exceeds a predetermined amount. At the ends of the insulated body 11, the ends 13, 13 of the fusible element 12 are partially wrapped around and overlie the insulating body. Typically, the fusible element 12 is in the form of a flat or circular wire although other shapes may be employed.

A pair of end caps 14, 14 in the same shape as the insulating body 11 are provided, the end caps 14, 14 being designed to closely fit over the ends of the insulating body 11. Each of the end caps 14, 14 is made of metal so as to provide conductivity from one end cap 14 through the fusible element 12 to the other end cap 14.

Prior to mounting the end caps 14, 14 to the insulating body 11, a conductive epoxy 15 is deposited in the

end caps 14, 14. Alternatively, the ends of the insulating body may be coated with epoxy 15 by a suitable process, such as by dipping the ends into epoxy. Thereafter, the end caps 14, 14 are press fitted onto the insulating body 11 and the epoxy 15 is cured by heating it for a sufficient time. The epoxy is such that it cures at a temperature below the melting temperature of the fusible element 12. The conductive metal in the epoxy 15 forms a reliable electrical connection between the end caps 14, 14 and the insulating body 11, while at the same time the bonding capability of the epoxy 14 completes and assures a reliable mechanical connection of the end caps 14, 14 to the fusible element 12 and to the insulating body 11.

In accordance with the present invention, the conductive component of the conductive epoxy 15 is a noble metal to avoid any problems with oxide build-up. For the same reason, it is preferable to also form the fusible element 12 or at least its external surfaces of a noble metal. Advantageously, the conductive metal in the epoxy 15 is silver and the fusible element 12 is also formed of or plated with silver.

In an illustrative example, the end caps 14, 14 are made of silver plated brass; the fusible element 12 is made of silver plated copper; the insulating body 11 is made of ceramic; and the epoxy 15 includes silver flake.

Although the present invention has been described in relation to particular embodiments thereof, many other variations and modifications and other uses will become apparent to those skilled in the art. It is preferred, therefore, that the present invention not be limited by the specific disclosure herein, but only by the appended claims.

Claims

1. A fuse (10) characterized by:

   a hollow insulating body (11) having opposed ends;
   a fusible element (12) having opposed ends, the fusible element (12) being disposed within the insulating body (11) such that the opposed ends of the fusible element (12) extend from and overlie the opposed ends of the insulating body (11); and
   first and second conductive end caps (14) enclosing the respective opposed ends of the insulating body (11) and the fusible element (12), each of the first and second end caps (14) being connected to the respective opposed ends of the insulating body (11) and of the fusible element (12) by a conductive epoxy (15) wherein the conductive component comprises a noble metal.

2. The fuse of claim 1, characterized in that the fusible element (12) has outer surfaces and the outer surfaces are comprised of a noble metal.

3. The fuse of claim 2, characterized in that the outer surfaces of the fusible element (12) and the conductive component of the conductive epoxy (15) are comprised of the same noble metal.

4. The fuse of claim 3, characterized in that the noble metal is silver.

5. A method of manufacturing a fuse (10), characterized by the steps of:

   (a) providing a hollow insulating body (11) having opposed first and second ends, a fusible element (12) having opposed first and second ends, and first and second end caps (14);

   (b) positioning the fusible element (12) within the hollow insulating body (11) such that the first and second ends of the fusible element (12) extend respectively from the first and second end of the insulating body (11) and overlie the insulating body (11);

   (c) assembling the first end cap (14) and a first quantity of a conductive epoxy (15) with the first end of the insulating body (11), the first quantity of conductive epoxy (15) interconnecting the first end cap (14), the first end of the insulating body (11) and first end of the fusible element (12);

   (d) heating the interconnected first end cap (14), first end of the insulating body (11) and first end of the fusible element (12) to cure the epoxy of the first quantity of conductive epoxy (15);

   (e) assembling the second end cap (14) and a second quantity of a conductive epoxy (15) with the second end of the insulating body (11), the second quantity of conductive epoxy (15) interconnecting the second end cap (14), the second end of the insulating body (11) and the second end of the fusible element (12); and

   (f) heating the interconnected second end cap (14), second end of the insulating body (11) and second end of the fusible element (12) to cure the epoxy of the second quantity of conductive epoxy (15).

6. The method of claim 5, characterized in that step (c) includes depositing the first quantity of conductive epoxy (15) in the first end cap (14) prior to assembling the first end cap (14) to the first end of the insulating body (11), and step (e) includes

depositing the second quantity of conductive epoxy (15) in the second end cap (14) prior to assembling the second end cap (14) to the second end of the insulating body (11).

7. The method of claim 5, characterized in that step (c) includes applying the first quantity of conductive epoxy (15) to the first end of the insulating body (11) prior to assembling the first end cap (14) to the first end of the insulating body (11), and step (e) includes applying the second quantity of conductive epoxy (15) to the second end of the insulating body (11) prior to assembling the second end cap (14) to the second end of the insulating body (11).

8. The method of any of claims 5 to 7, characterized in that the fusible element (12) has outer surfaces and the outer surfaces are comprised of a noble metal.

9. The method of claim 8, characterized in that the outer surfaces of the fusible element (12) and the conductive component of the conductive epoxy (15) are comprised of the same noble metal, the nobel metal being preferably silver.

10. The method of any of claims 5 to 9, characterized in that steps (d) and (f) are performed simultaneously.

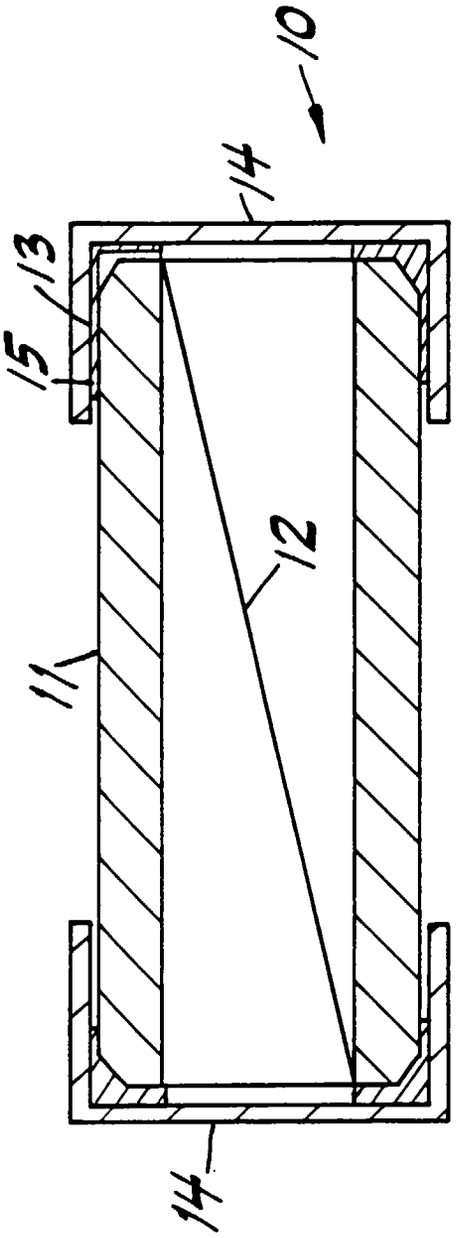

FIG. 1

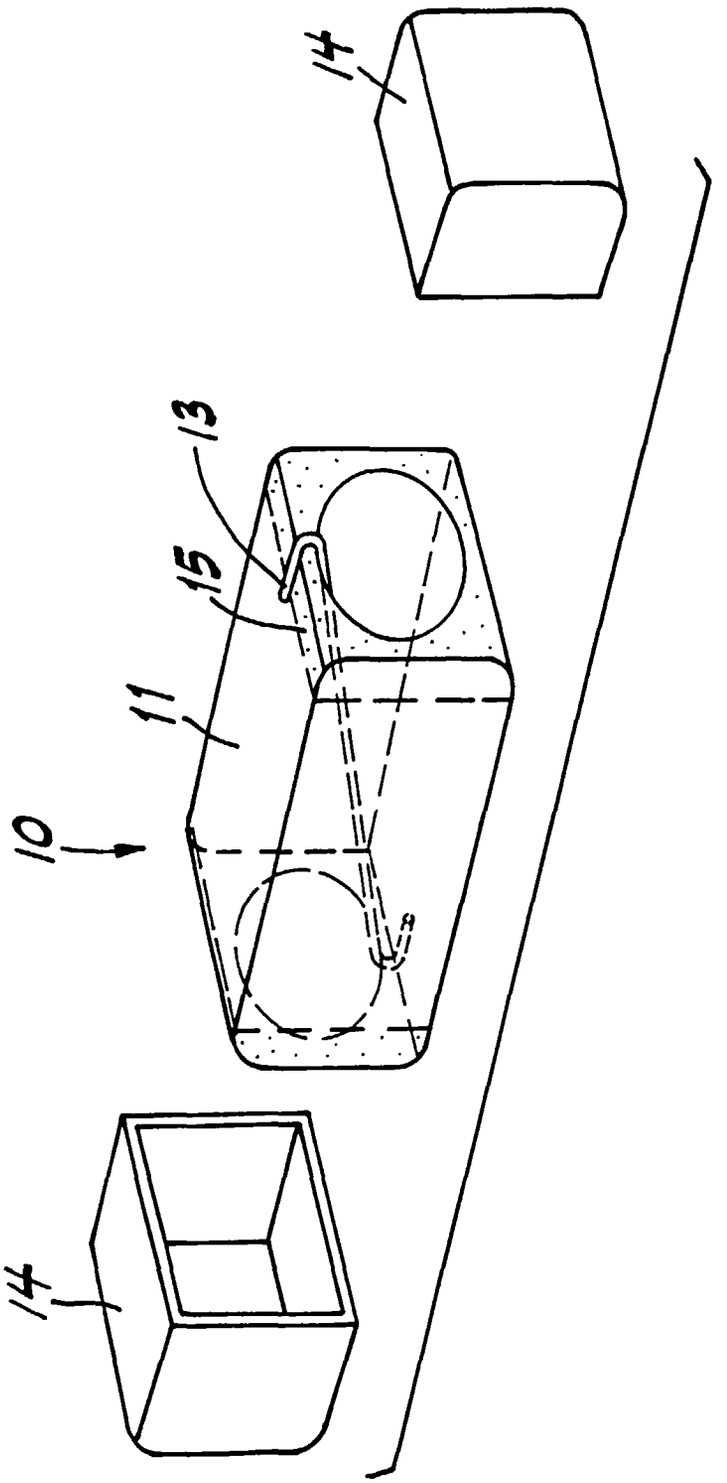

FIG. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 97 11 1494

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	US 3 374 330 A (CAMERON FRANK L) * the whole document *	1 2-8	H01H85/041 H01H85/157
Y	WO 91 14279 A (MORRILL GLASSTEK INC) * page 14, line 9 - line 26 *	2-4,8	
Y A	US 5 214 406 A (REESE LLOYD W ET AL) * column 5, line 24 - line 59 *	5-7 1	
X Y	US 3 505 630 A (MERRILL PHILLIP EDWARD ET AL) * column 3, line 29 - line 49; claim 3 *	1 2-4,8	
Y	EP 0 199 401 A (VERMIJ LEENDERT) * page 6, line 9 - line 15 *	2-4,8	
A	GB 2 278 743 A (SOC CORP) * abstract *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 November 1997	Desmet, W

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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