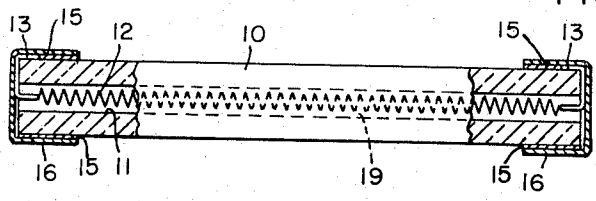
March 19, 1968 F. L. CAMERON 3,374,330

CURRENT LIMITING FUSE

Filed April 19, 1966

FIG. 1.



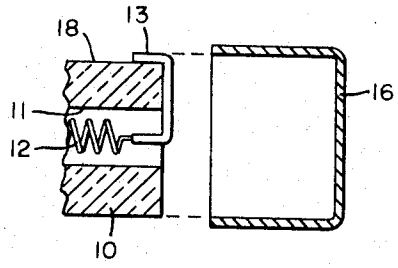
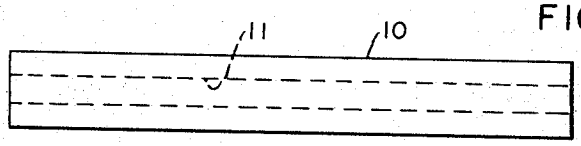


FIG. 2.

FIG. 3A.



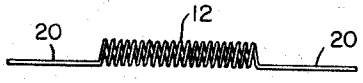


FIG. 3B.

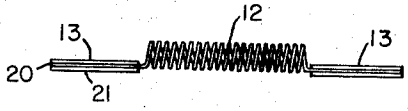


FIG. 3C.

WITNESSES

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3,374,330

CURRENT LIMITING FUSE

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ABSTRACT OF THE DISCLOSURE

A fuse which may be easily and quickly assembled without the necessity of soldered connections includes a spirally wound fuse element passing through a fuse tube, the element having end portions of enlarged diameter formed by crimping copper straps to the ends of the fuse element, which are bent around the ends and outside wall of the fuse tube, the enlarged ends of the fuse element and the portions of the outside wall of the fuse tube adjacent the ends thereof being coated with an epoxy resin containing a large number of conductive particles, such as silver, to form a conductive cement. The ferrules are then forced down over the ends of the fuse tube and the enlarged ends of the fuse element including the crimped straps, the conductive cement resin cementing the ferrules to the fuse tube and cementing the fuse element ends to the ferrules while providing electrical connections between the ends of the fuse element and the ferrules. The enlarged diameters of the ends of the fuse element increases the surface area in contact with the conductive cement thereby forming a better electrical connection. The increased surface area in contact with the cement also insures a better bond. The cement quickly sets at room temperature. The crimped copper straps extend far enough into the bore in the fuse tube to prevent an arc burning back to the ferrules.

This invention relates to improvements in fuses, and more particularly to an improved current limiting fuse which may be easily and quickly assembled, and employing a conductive cement which both holds the ferrule to the fuse tube and provides an electrical connection between the fuse element and the ferrule.

The use of cement to secure a ferrule to a fuse tube is old in the art. However, usually the cements employed have required a considerable setting or curing time at a temperature above room temperature and even though cement was so employed, it was necessary to provide a soldered connection between the fuse element and the ferrule.

I have discovered that certain conductive epoxy cements have characteristics which permit their use in fuse construction so that they will both seal the ferrule to the fuse tube, where the fuse tube is made of suitable material, and will also provide an improved electrically conductive connection between the end of the fuse element and the ferrule, thereby obviating the necessity for a soldered connection. Furthermore, I have discovered that certain of these materials or cements have characteristics so that they will quickly set or be cured at room temperature and do not require long periods to harden, and do not require elevation above room temperature.

Accordingly, a primary object of my invention is to provide a new and improved fuse.

Another object of my invention is to provide a new and improved fuse which may be easily and quickly assembled without the necessity of soldered connections.

A further object is to provide a new and improved fuse employing a conductive cement to both secure the ferrule to the end of the fuse tube and to provide an electrical connection between the end of the fuse element and the ferrule.

These and other objects will become more readily apparent after a study of the following specification when read in connection with the accompanying drawings, in which:

FIG. 1 is a view of a fuse constructed according to my invention, the view being partially in section and partially side-elevational;

FIG. 2 is a detailed view of the end construction of the fuse; and

FIGS. 3A, 3B and 3C are views of certain of the elements of the fuse showing steps in the construction thereof.

Particular reference is made now to FIG. 1. A fuse tube **10**, which may be composed of ceramic, has a central bore or aperture **11** in which is disposed a current limiting fusible element **12** which may be in the form of an axially stretched coil, or spiral wound, having end extensions **20**. The enlarged or somewhat heavy end **13** of the fuse element **12**, FIG. 2, formed by folding a copper strap **21** around each fuse element end **20** and crimping the strap to the end of the fuse element, as shown in FIG. 3C, is bent at a 90° angle with respect to the axis of the bore **11**, and thereafter bent at another 90° angle so that the end of the fuse wire or fuse element lies snugly along the outside wall surface **18** of the fuse tube **10**. Coatings of a conductive cement **15** are shown, FIG. 1, covering portions of the outside wall of the fuse tube near the ends thereof and covering the ends **13** of the fuse element **12**, and ferrules **16** are shown disposed on the ends of the fuse tube, with a layer of conductive cement between the inner surface of the cylindrical wall of each ferrule and the adjacent outside wall of the fuse tube, the conductive cement also making good electrical connection with fuse ends **13**.

One conductive cement suitable for use in the construction of the fuse of FIGS. 1 and 2 is a product known in the trade as "Hysol K20." More generically, a suitable conductive cement consists of an epoxy resin to which has been added a suitable and sufficient quantity of conductive particles, for example silver dust, thoroughly mixed and distributed throughout the resin and providing electrical conductivity for the resin, which conductivity is maintained and exists after the cement dries.

Particular reference is made now to FIGS. 3B and 3C. The fuse element **12** may be wound tight around a mandrel of suitable diameter, leaving extended ends **20**. In FIG. 3C, it is seen that after the fuse element has been removed from the mandrel, the diameter of the spiral wound fuse element portion may be increased somewhat. Thereafter the ends **13** including the crimped copper straps **21** are bent as shown in FIG. 2. In FIG. 3A there is shown an elevational view of the fuse tube **10** before assembly, the fuse tube having a bore **11** extending therethrough.

If desired, in assembling the fuse shown in FIG. 1, after one ferrule has been attached, the bore **11** may be filled with a non-conductive material or filling medium **19** such as sand, and the ferrule at the other end thereafter affixed to the fuse tube.

It is seen, FIGS. 1 and 2, that each crimped copper strap around the extended end of the fuse element extends a substantial distance into the bore of the fuse tube, so that if the sand in the fuse tube settles or the tube, so that if the sand in the fuse tube settles or the tube is not completely filled with sand, an arc formed when the fuse element blows will not burn back to the ferrule.

Furthermore, the enlarged diameters of the ends of the fuse element increase the surface areas thereof in contact with the conductive cement, forming substantially perfect electrical connections and reducing the resistance, so that there is substantially no excessive heating in a confined small area under the side of the ferrule, which

excessive heat, if it existed, might damage the fuse tube and result in breaking the seal between the fuse tube and the ferrule, which seal is desirable to hermetically seal the fuse structure and prevent the absorption of moisture by the sand.

Still further, the enlarged cross section of the end of the fuse element in contact with the cement gives a more effective bond which would not otherwise be obtained.

The aforedescribed fuse construction meets the requirements for high voltage, low ampere rating fuses of high interrupting capacity where requirements place a premium on physical size. This is frequently the case. Not only must such fuses require a minimum of space, but manufacturing costs as well must be small. A typical rating of a fuse constructed according to my invention would be a rating of one quarter or one half ampere, 5500 volts and with an interrupting rating of 500 mv. a. As previously stated, this fuse utilizes a unique low cost construction and with the same basic design can be given either a one quarter or one half ampere rating depending upon the filling fuse medium used. This fuse is considerably smaller in size than our present 5 kv. one-half ampere fuse, being 5½ inches long and ⅞ inch in diameter as opposed to a length of a prior art fuse of 9½ inches and a diameter of 1⅝ inches for substantially the same rating.

The aforedescribed unique and novel means of assembly avoids the use of solder, and utilizes a high strength conductive epoxy cement to both assemble and seal the fuse as well as assuring a good electrical connection between the fuse element and the ferrule.

The term "ferrule" as employed herein means any electrical terminal means.

Whereas I have shown and described my invention with respect to an embodiment thereof which gives satisfactory results, it will be understood that changes may be made and equivalents substituted without departing from the spirit and scope of the invention, and that the aforedescribed description is illustrative only and is not to be interpreted in a limiting sense.

I claim as my invention:

1. As an article of manufacture, a fuse comprising a hollow fuse tube composed of insulating material, a fuse element disposed inside the bore of the fuse tube and extending between the ends thereof, the end portions of the fuse element being of increased diameter, the end portions of increased diameter of the fuse element being bent over the ends of the fuse tube and extending along the outside wall of the fuse tube at least a predetermined distance, coatings of a conductive cement disposed on the outside wall of the fuse tube at both ends thereof and making electrical connection with the adjacent end portions of increased diameter respectively of the fuse element, the increased diameter of the end portions increasing the surface areas thereof in contact with the cement thereby insuring a more effective bond, the increased surface areas in contact with the conductive cement improving the electrical connections therewith, and ferrules disposed over the ends of the fuse tube, each ferrule being composed of conductive material and making good electrical connection with the conductive cement, and thereby making good electrical connection with the adjacent end of the fuse element.

2. A fuse according to claim 1 in which the conductive cement is composed of an epoxy resin having a quantity of particles of conductive material disposed therein and distributed throughout to give the cement an electrically conductive characteristic.

3. A fuse according to claim 2 in which the conductive cement is an epoxy resin having silver dust disposed therein.

4. A fuse according to claim 1 including in addition a filler of non-conductive material filling the space in the bore in the fuse tube not occupied by the fuse element.

5. A fuse according to claim 1 in which the fuse tube is composed of a ceramic.

6. A fuse according to claim 4 in which the filler material is sand.

7. A fuse according to claim 1 including conductive straps crimped to the end portions of the fuse element to provide end portions of increased diameter.

8. A fuse according to claim 1 in which the end portions of increased diameter of the fuse element extend a substantial distance into the bore of the fuse tube to prevent an arc formed when the fuse blows from burning back to a ferrule.

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