METHOD OF MANUFACTURING FUSES

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ABSTRACT

A method of manufacturing fuses in which a core wire composed of a non-conductive fibrous material is provided with a layer of thermosetting material. The thermosetting layer is set by heating, so that the core wire is rigidified. The core wire is subsequently wound with a very thin metal wire. The wound core is then cut into segments of predetermined dimensions. The segments are mounted in suitable containers, so that fuses are obtained.

13 Claims, 5 Drawing Figures
METHODE OF MANUFACTURING FUSES

The invention relates to a method of manufacturing fuses, particularly fuses for use at low current values, as well as to fuses manufactured by this method.

Modern electronic engineering has an increasing demand for high quality fuses for low current values, for instance for the protection of transistorized equipment. The most generally used type of fuse comprises a container tube in which a highly conductive fusible wire is stretched between two conductive terminals. These conventional fuses, however, have a number of drawbacks.

Since from the point of view of manufacture and use it is desirable to impart specific uniform dimensions to the fuses, the length of the fusible wire is substantially fixed. The current protection range of a conductive wire is known to be determined by parameters, such as the diameter, resistivity, length and melting point of the wire. In the case of a specific choice of material the current protection range is determined only by the diameter of the wire, since its length is substantially fixed. As only wires with a limited number of different diameters are commercially available, it is hardly possible to manufacture fuses for arbitrary current protection ranges.

Another drawback is that owing to the temperature increase due to the current flow the fusible wire will expand and sag. This sagging has an unfavourable effect on the fusing characteristic.

In general for a well defined current protection it is preferred to use a wire of a metal having a well defined melting point, which metal at elevated temperature is substantially inert to environmental affects. Such a material is e.g. silver. However, silver is less suitable for low current values, since these low current values require such a small diameter that the wire is substantially unmanageable. The relation between diameter and length of the wire should be such that the wire becomes too slack and tends to sag, which renders the fuse unreliable to a large extent. Moreover, the manufacture of fuses with very thin silver wires is practically impossible, since in mounting the silver wire in the container tube the wire tends to dissolve in the tin of the mounting places. Therefore, up to now fuses with silver wire have not been used in the case of current values less than 1A.

In practice the drawbacks linked up with silver are avoided by using metals of higher resistivity, so that wires of larger diameter can be used. A frequently used metal is e.g. nickel. However, these materials are not inert and upon use increasingly show corrosion effects when heated, as a result of which the material properties and, consequently, the melting point are no longer well defined, which reduces the reliability.

A possible solution for the above difficulties would be to replace the stretched wire by a winding disposed around an insulating core. In this manner the core can serve as a support so as to prevent sagging, which makes it possible to use the so desired silver wire even when very small diameters are required. However, the heat dissipating properties of such a core affect during use the heat properties of the winding. In order to meet this objection the core should be a good heat insulator and should be so thin that its heat dissipation can substantially be neglected. Suitable core materials are, for instance, extremely thin wire of glass or quartz fibres or a similar material. However, since these wires should have a very small diameter in the order of 5–10 microns, they are highly pliable and flexible, which makes it hardly possible to wind such wires with extremely fine metal wire, as during the winding process the lateral forces on the fibre material due to the winding operation may easily cause wire rupture.

It is an object of the invention to give a solution for the above problem by providing a method with which it is possible to dispose a wire winding of silver or any other desired material of extremely small diameter (in the order of 20–30 microns) around an extremely thin wire of fibre material. The method according to the invention is characterized in that a very thin wire of electrically non-conductive, heat-insulating and heat-resistive fibre material, which is provided with a thin layer of thermosetting material, is set or rigidified by heating, the set wire is wound with extremely thin metal wire, the wound wire is cut in defined segments and the segments are mounted in suitable containers.

By using the thermosetting effect of the coating on the fibre wire, the invention makes it possible to wind extremely thin cores, the heat dissipating properties of which are negligible, with micro-wire for obtaining a well defined fuse for low current values. The fuse manufactured by this method is characterized in that the current conductor consists of extremely fine wire having a well defined melting point and the core consists of set fibre material of such a thickness that its heat dissipating property is negligible. To this end the core material is preferably composed of glass fibre wire or quartz fibre wire, the thickness of the composing fibres being in the order of 5–10 microns. It is also possible to use fibres of synthetic material capable of standing high temperatures.

The fibres or fibre bundles may include in longitudinal direction metal wires or straps, which form an integral part with the core owing to the winding. The conductive function takes place owing to the winding material either or not in co-operation with the metal wires present possibly in longitudinal direction of the fibres. When applying the fuses according to the invention for higher current intensities it is preferable to pass part of the current through such metal wires and the remaining part of the current through the winding wires.

As observed in the above, the conductor material to be wound preferably consists of silver wire having a diameter in the order of 20–30 microns. If desired, a plurality of parallel metal wires can be used as a conductive winding.

Furthermore, owing to the increased mechanical solidity of the extremely thin fibre core, it has become possible to use other desired materials as current conductors. For example, a fine tin wire having a diameter in the order of 0.2–0.4 mm can be used as conductor material. Because of the high mechanical weakness of tin it was impossible to use tin in the conventional fuses for low current values.

By varying the number of windings it is possible to change the current protection range while using only one type of wire, so that the small number of different diameters commercially available forms no longer an impediment.

By varying the winding pattern it is possible to manufacture fuses of different characteristics, ranging from very fast to very slow fuses.
For instance in case of continuous production, it is possible to impart to the winding of metal wire a variable pitch in each fuse element in such a manner that each time the greatest heat development takes place in the centre of each element when in use.

By a suitable choice of winding wires and fibre core it has appeared to be possible to adjust the fusing characteristic over a very large range of nominal current intensities, from very low to very high values, while the same shape is retained. Both very fast and very slow-reacting fuses can be manufactured by means of the method according to the invention.

The above construction furthermore reduces the so-called critical length of the fuse element considerably. Thus it is possible to construct fuses with a very compact construction. Such a compactness is particularly important for panels having a printed circuitry. Thus, for instance, a fuse was constructed for 80 mA having a length of 3 mm by means of the method according to the invention.

Finally it has appeared that the switch-off power of a wound fuse is much better than that of a fuse having a straight fusible wire.

The advantages of the method and of the fuse according to the invention will be explained in greater detail with reference to the drawings.

FIG. 1 is a schematic side elevational view of a device suitable for winding a fibrous core yarn with metal wire.

FIG. 2 is a schematic representation in side elevational view of a device suitable for using the method according to the invention.

FIGS. 3–5 are representations in cross-section of fuses manufactured by means of the method according to the invention.

FIG. 1 shows a device which can be applied for the process of winding a conductive wire around a core formed by a glass fibre yarn. A spool 1 with mounting 2 having a brake device contains a supply of glass fibre yarn 4. The yarn is wound under tensile stress on spool 6. The spool 6 is driven by a motor 7 in such a way that the yarn passes through the winding device 8 at constant speed. The winding head 8 contains a supply bobbin 11 with the conductive metal wire 12. The hollow shaft 9 is rotated by a motor (not shown) coupled through a V-belt with wheel 10 in such a manner that the wheel 10 rotates at constant speed. The metal wire 12 is passed to the front side of the shaft 9 via a small guiding wheel 14, which is mounted on an arm located on the front side 13 of the bobbin 11. The metal wire is thus progressively wound around the glass fibre yarn. Depending on the speed adjustments of the yarn and the winding head the glass fibre yarn is thus provided with a winding of metal wire with a constant pitch.

The device described in the light of FIG. 1 can be applied conveniently for carrying out the method according to the invention. Reference is made in this connection to FIG. 2, in which drawing the same reference numerals show the same parts as in FIG. 1. From the spool 1 the glass fibre yarn is unwound under tensile stress and is passed between the rubber rolls 15 and 16, which are driven by a motor not shown. The rolls 15 and 16 contact each other and are urged against each other under such a pressure that the fibre yarn is unwound from the spool 1 without slippage owing to the effect of the roller. The glass fibre yarn 4 coming from the spool 1 is provided with a thermosetting material layer.

Between the spool 1 and the rolls 15 and 16 the yarn 4 is passed through a heating device, which heating device comprises a bored material block 17. A heating wire 18 is wound around the block 17. The heating wire 18 is connected to the terminals 19 and 20 of a suitable power supply not shown. If the fibre yarn 4 passes through the bore in the heated block 17, the thermosetting layer on the fibre yarn is set, so that a rigidified fibre core leaves the heating device. Subsequently the core is passed through the winding device 8 and is wound with a metal wire in the manner described above. The wound core is afterwards passed through a cutting device and is cut into segments by means of the blade 22 of the cutting device on the die 21. By effecting the cutting operation with certain intervals, segments of predetermined length are cut. The segments can subsequently be mounted in suitable containers to provide the fuses according to the invention.

It will be clear that an expert can contrive himself suitable ways to mount the segments in containers. Thus, for example, it is possible to apply at specific positions of the wound yarn an amount of solder prior to the cutting operation, in such a manner that after the suitably carried out cutting operation segments with soldered ends are obtained. It is also possible to mount a sealing wafer for a tubular insulating casing for the fuse to be manufactured at the end of the wound yarn 5 before cutting. After cutting it is only necessary to attach a casing to the sealing wafer and a different sealing wafer at the other end of the casing and of the yarn segment to complete the fuse. Automation of these methods can be effected conveniently by an expert.

Furthermore it will be clear that the above description of a device for applying the method according to the invention should by no means be considered limiting, but was only given by way of illustration. Other embodiments of such a device also come within the framework of the invention.

An example of fuses constructed in accordance with the invention is given in FIG. 3, in which 31 is a ferrule cemented to a cylindrical tube made of glass or any other suitable material and in whose axis the fuse element made of set or rigidified quartz fibres 34 with its conductive winding 33 is positioned by means of the eyelets 35. A solder alloy forms the conductive connection between the winding 34 of said fuse element and the ferrules 31.

Another suitable form that may be chosen in accordance with the invention is indicated in FIG. 4, in which a cylindrical tube 42 made from porcelain or any other suitable material is provided with end caps 41 made from copper or brass. The ends of the fuse elements with the conductive winding 44 around a set quartz fibre core 43 are bent around the edges of tube 42 in such a manner that the fuse element is in a diagonal position.

Another advantageous construction is given by way of example in FIG. 5. In accordance with the invention the fuse element is made of winding 54 with a concentration of its windings 56 in the middle of the element around a glass fibre core 53. The concentration of the windings in the centre reduces the heat dissipation in the fuse in a favourable way. The construction of the cylindrical tube 52 and end caps 51 is analogous to that of FIG. 4.

I claim:
1. A fuse for use at current values of one ampere and less comprising a tubular insulating casing, conductive terminal means mounted on each end of said casing and a fuse element mounted in said casing between said conductive terminal means, said fuse element including an electrically non-conductive, heat-insulating and heat-resistive wire core of fibres rigidified with set thermosetting material, wherein at least one current conductor of extremely fine wire is wound around said core.

2. A fuse according to claim 1 wherein said fine wire is silver having a diameter less than 30 microns.

3. A fuse according to claim 1 wherein said fine wire is tin having a diameter less than 0.4 millimeters.

4. A fuse according to claim 1 wherein said fine wire is silver having a diameter in the order of 20–30 microns.

5. A fuse according to claim 1 wherein said fine wire is tin having a diameter in the order of 0.2–0.4 millimeters.

6. A low-current value fuse comprising a casing, spaced-apart conductive terminal means mounted on the casing; and a fuse element mounted in the casing between the conductive terminal means, said fuse element including an elongated rigid core which is electrically non-conductive, heat-insulating and heat-resistant, said core being an extremely thin wire made of fibres having diameters of the order of 5–10 microns, said wire being rendered rigid by the presence of heat-setting thermosetting material in contact with said fibres, said fuse element further including at least one current conductor of extremely fine metal wire wound around said core.

7. A fuse according to claim 6 wherein said fine wire is silver having a diameter less than 30 microns.

8. A fuse according to claim 6 wherein said fine wire is tin having a diameter less than 0.4 millimeters.

9. A fuse according to claim 6 wherein said fine wire is silver having a diameter in the order of 20–30 microns.

10. A fuse according to claim 6 wherein said fine wire is tin having a diameter in the order of 0.2–0.4 millimeters.

11. A fuse according to claim 6 wherein said core consists of a fibre material chosen from the group consisting of glass fibres, quartz fibres and plastic fibres.

12. A fuse according to claim 1 wherein the number of windings per length unit of the very thin metal wire around the core in the centre of the element is larger than at the ends, so that during operation the greatest heat development occurs in the centre of the element.

13. A fuse according to claim 6 wherein the number of windings per length unit of the very thin metal wire around the core in the centre of the element is larger than at the ends, so that during operation the greatest heat development occurs in the centre of the element.

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