Fig. 3

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(54) Title: ARMOUR ED RESISTOR OF AN ELECTRIC HOUSEHOLD APPLIANCE AND A METHOD FOR MANUFACTURING THEREOF

(57) Abstract: Armoured resistor of an electric household appliance comprising a tube-shaped casing (1) defining a longitudinal development (X) and at least one end, an outer tip (2) at least partially emerging from the interior of said at least one end, an inner tip (4) on the tube-shaped casing, a thermal fuse electrically connecting the outer tip (2) with the inner tip (4); the inner tip is adapted to be connected to a resistive wire; the inside of the tube-shaped casing (1) is filled with insulating powder to insulate the tube-shaped casing (1) from the inner electric components; the tube-shaped casing (1) comprises a narrowing zone (11) at the inner tip (4).
AROMOURED RESISTOR OF AN ELECTRIC HOUSEHOLD APPLIANCE AND A METHOD FOR MANUFACTURING THEREOF

Field of the invention
The present invention relates to an armoured resistor of an electric household appliance and a method for the manufacture thereof.

Prior art
Armoured electric resistors are used in electric household appliances which come into contact with water, such as washing machines, dishwashers, etc. Such armoured resistors incorporate within themselves security systems which, in the event of malfunction of the apparatus or of any component thereof, eliminate the risk of fires started by said resistor.

Thermal fuses that are capable of interrupting the resistor's power supply when said resistor exceeds a predetermined temperature in particular are incorporated.

A resistive wire is inserted into the substantially tube-shaped casing and isolated therefrom by means of powdered magnesium oxide.

A metal tip partially projects at each end of tube-shaped casing, which tip is duly electrically insulated from the tube-shaped casing by means of suitable insulating sheaths, both tips are intended to be connected to a source of electricity.

A thermal fuse is present in at least one of said ends.

Therefore the magnesium oxide electrically insulates the resistive wire from the metal casing, but is responsible for transporting the heat generated by the resistive wire towards the outside, for heating water.

The dimensions of the thermal fuse must take account of the following conflicting requirements:

- to intervene rapidly in the event of an absence of water to be heated, to prevent the plastic, which is very close to the resistor, from catching fire.
- To limit the intervention of the thermal fuse following a variation in the heat-exchange characteristics towards the water due to accumulation of limestone and lint, such as in the case of a washing machine, and food residues in the case of dishwashers.

Therefore, there is a requirement both for the thermodynamic system to be rapid for large reductions in the dispersion of heat, on account of the absence of water,
and also for the thermal fuse not to intervene prematurely on account of slight variations in dispersion, for example due to accumulation of sediments. On the other hand, the known art teaches the subjection of resistors filled with magnesium oxide to what is known as a rolling process, which leads to a 2%-20% reduction in the diameter of the casing. However, rolling is a procedure according to which the tube-shaped casing undergoes a process of narrowing by passing between rollers which, little by little, reduce its diameter in accordance with a cross-section, uniformly along the entire longitudinal development of the casing. This process is rendered necessary by the fact that when the magnesium oxide is inserted into the casing, it tends not to compact, incorporating air which, as is known, is a good thermal insulator. The magnesium oxide is therefore compacted by rolling, improving the thermal conductivity of the layer of magnesium oxide which envelops the resistive wire. Such a rolling process has nothing in common with the process of narrowing presented in US2846537. The hexagonal cross-section narrowing presented in US2846537 is localised at the bead, in order to ensure that the bead fits perfectly, preventing the insulating material from being able to escape from the armouring. In case of non-circular cross-section, the same result is obtained with uniform pressure along the whole length of the casing.

According to the prior art, uniform reductions of the casing cross-section are within the range from 2% to 20% of the original cross-section. However, this range cannot be exceeded with such a process, because this leads to excessive work-hardening of the casing. As a result, this breaks during bending of the resistor.

**Summary of the invention**

About aim of the present invention is to provide an armoured resistor for an electric household appliance, having improved thermal fuse behaviour in respect of the accumulation of sediments on the resistor without prejudicing the security thereof.

The aim of the present invention is an armoured resistor for an electric household appliance according to claim 1.
Such narrowing, localised at the inner tip, is limited to a portion of the longitudinal development of the casing and not to the entire length, as in the rolling process. Advantageously, thanks to the present invention, an increase in the thermal conductivity of the magnesium oxide at the level of a proximal zone of the thermal fuse, which increase is obtained due to narrowing at least at one portion of the inner tip, enormously improves fuse behaviour, by determining a synergistic effect between the behaviour of the fuse and the presence of the localised narrowing. This effect has been demonstrated by numerous different laboratory tests.

A further aim of the invention is to provide a method for a manufacturing an armoured resistor of an electric household appliance which enables an armoured resistor to be obtained having improved thermal fuse behaviour in respect of the accumulation of sediments on the resistor, without prejudicing the security thereof. Such narrowing locally modifies the thermal conductivity of the magnesium oxide. This translates into improved local heat dispersion during normal operation of the resistor, that is, when it is submerged in water. At the same time, the conduction of heat produced by the resistive wire towards the thermal fuse is not reduced in the disadvantageous case of dry operation of the armoured resistor; in brief, the narrowing does not modify the speed of intervention of the thermal fuse, as a result of which the resistor security in the event of operation under conditions of abnormal overheating (for example in the absence of water) is not prejudiced.

Furthermore, thanks to the present invention, the mechanical characteristics of the resistor are not prejudiced during the process of bending thereof.

Another subject of the invention is a method of manufacturing an armoured resistor of an electric household appliance.

As will be illustrated in what follows, the method of manufacturing the present invention may also be applied to pre-existing armoured resistors or those anyhow manufactured according to alternative methods.

The dependent claims describe preferred embodiments of the invention, forming an integral part of the present description.
Brief description of the drawings

Further characteristics and advantages of the invention will be more evident in the light of the detailed description of preferred, though not exclusive, embodiments of an armoured resistor of an electric household appliance, which resistor is illustrated by way of a non-limiting example, with the aid of the drawings attached, wherein:

Fig. 1 represents a portion of one end of an armoured resistor, prior to rolling,
Fig. 2 represents the same part as in Fig. 1, after the rolling process,
Fig. 3 shows the same portion of the preceding figures according to the present invention.

The same numbers and the same letters used for reference in the figures indicate the same members or components.

Detailed description of a preferred embodiment of the invention

With reference to the drawings, figure 1 shows a portion of one end of any armoured resistor prior to rolling. Numeral 1 indicates the outer casing, 2 the tip, 3 box, as well as 31 the space between the box 3 and the casing 1 and a so-called inner tip 4 the purpose of which tip is to connect the thermal fuse 6 to the resistive wire, not represented here since it may be of any type. The point of connection between the inner tip 4 and the resistive wire may also be of any kind. Use of the attribute tube-shaped here does not imply that any cross-section should be circular. It may be of any shape, but preferably circular.

Fig. 2 shows the same portion of Fig. 1 following the process of reducing the cross-section of the casing, for example by rolling. It can be seen that the space 31, also called "air", has disappeared. In other words, the box adheres perfectly to the casing and vice versa.

It is also understood that the box 3 is made so as to deform and adhere perfectly to the casing during any process of reduction of the cross-section of the casing. By "cross" is meant perpendicularly relative to the axial development X of the casing.

In general, but not necessarily, the inner tip 4 is of a shape which tends to taper at the inner end 41 directed towards the inside of the casing, that is, to the right with reference to the drawings.
In accordance with the present invention, the armoured resistor comprises a
localised narrowing of the casing 1 along a length corresponding to the inner tip.
For example, astride the inner end 41 of the inner tip 4.
Therefore, during dry operation of the resistor, the heat is no longer adequately
dissipated in the environment and establishes alternative routes. That is, as well
as propagating through the inner tip 4 which is in direct contact with the resistive
wire, the heat also dissipates via the magnesium oxide or an equivalent insulating
powder which exhibits improved thermal conductivity within the zone of narrowing,
precisely because it is narrower, until it reaches the thermal fuse, which intervenes
more promptly.
On account of the above, the thermal fuse may be dimensioned in such a way that
slight increases in temperature due to possible accumulation of sediments on the
casing may be overlooked.
The narrowing has limited axial extension, that is, along the X-development of the
armoured resistor, which preferably does not exceed the length of the inner tip.
Furthermore, this narrowing preferably does not involve the part of the casing in
contact with the box 3.
According to a preferred variant of the invention, the longitudinal development of
the narrowing may vary. A preferred length of this development may be within the
range from at least 0.5 to 4 times the average outer diameter of the casing.
By average outer diameter is meant a average diameter calculated within a zone
different from that affected by the narrowing.
Thus, if the average outer diameter is 10 mm, the zone of narrowing 11 may
extend axially for 5 to 40 mm and beyond.
Furthermore, it is preferable for the narrowing to be such as to present a diameter
within the range from 70% and 98% of the average outer diameter, that is,
calculated within a zone outside the narrowing.
This narrowing 11 may be given to the casing 1 at any point in the manufacture of
the resistor or after manufacture thereof.
This narrowing may be provided in many ways. For example, by means of planar
or radially circular pressing, also called sectoral pressing, or by coining.
The radially circular pressing/re-pressing reduces the diameter of the zone involved via a plurality of sectors which radially compress the zone in question, maintaining a substantially circular geometry of the portion affected by the narrowing. The total extent of narrowing may be obtained by means of further operations, successively repeated.

Even though coining is a procedure which reduces the axial ends in an extremely localised manner, within a few hundredths of a millimetre to 1 or 2 mm, the possibility of this process too being validly usable is not excluded. It is worth highlighting that the above-mentioned narrowing ratios refer to a preferably uniform narrowing both along the X axis of development of the casing, and along a cross-section of the zone affected by the narrowing. However, this does not detract from the fact that the narrowing may not be relative to these two directions, for example giving rise to another cross-section, or to two or more consecutive narrowings, etc.

The process of manufacturing the armoured resistor may provide for a prior or subsequent step of reducing the average outer diameter of the tube-shaped casing 1, that is, of the portions of the tube-shaped casing 1 remaining relative to said zone(s) of narrowing 11. Preferred reductions in percentage are of the order of 0% to 20%.

The advantages deriving from application of the present invention are clearly that better behaviour of the thermal fuse and of general operation are achieved without prejudicing its mechanic behaviour during bending of said resistor. If the armoured resistor comprises a fuse at both ends, the narrowing may be located at one or both inner tips 4.

The members and the characteristics illustrated in the various preferred embodiments may be combined with one another without exceeding the scope of the protection of the present application.
CLAIMS

1. Armoured resistor of an electric household appliance comprising a tube-shaped casing (1) defining a longitudinal development (X) and at least one end, an outer tip (2) at least partially emerging from the interior of said at least one end, at least one inner tip (4) of the tube-shaped casing, a thermal fuse (6) electrically connecting the outer tip (2) to the inner tip (4), the inner tip (4) being adapted to be connected to a resistive wire, an inner part of the tube-shaped casing (1) being filled with insulating powder to insulate the tube-shaped casing (1) from the inner electric components,

characterized in that said tube-shaped casing (1) comprises a narrowing zone (11) at least at one portion of said at least one inner tip (4).

2. A resistor according to claim 1, wherein said narrowing zone (11) has a length, according to said longitudinal development (X), from at least 0.5 to 4 times the average outer diameter of the tube-shaped casing (1).

3. A resistor according to claim 1 or 2, wherein said narrowing zone (11) has an average diameter from 70% to 98% of the remaining average outer diameter of the tube-shaped casing (1).

4. A method of manufacturing an encased resistor of an electric household appliance comprising a tube-shaped casing (1) defining a longitudinal development (X) and at least one end, an outer tip (2) at least partially emerging from said at least one end, at least one inner tip (4) of the tube-shaped casing, a thermal fuse (6) electrically connecting the outer tip (2) to the inner tip (4), the inner tip (4) being adapted to be connected to a resistive wire, an inner part of the tube-shaped casing (1) being filled with insulating powder to insulate the tube-shaped casing (1) from the inner electric components,

the method comprising at least one step of introducing at least one narrowing zone (11) in at least one portion of said at least one inner tip (4).

5. A method according to claim 4, wherein said step comprises at least a pressing process.

6. A method according to claim 4, wherein said step comprises at least a circular, radial pressing process.

7. A method according to claim 4, wherein said step comprises at least a coining
process.

8. A method according to claim 5 or 6 or 7, wherein said narrowing zone (11) has a length, according to said longitudinal development (X), from at least 0.5 to 4 times the remaining average outer diameter of the tube-shaped casing (1).

9. A method according to one of the claims from 5 to 8, wherein said narrowing zone (11) has an outer average diameter from 70% to 98% of the remaining outer diameter.

10. A method according to one of the claims from 5 to 9, comprising a step, before or after the introduction of the narrowing zone (11), wherein the outer average diameter of the tube-shaped casing (1) is reduced in percentage from 0% to 20%. 
INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2012/052894

A. CLASSIFICATION OF SUBJECT MATTER

INV. H05B3/52
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>EP 0 086 465 Al (ELPAG AG CHUR [CH]) 24 August 1983 (1983-08-24) figures 1,2,7</td>
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* Further documents are listed in the continuation of Box C. X See patent family annex.

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