METHOD OF MAKING ELECTRICAL HEATING UNITS

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ABSTRACT
A method of making an electrical heating unit which includes the steps of shaping a strip of electrical resistance wire into a pattern for the heating element of the unit, contacting one of the planar surface of the shaped strip against a masking member shaped in a pattern corresponding to that of the shaped strip, flowing an insulating and hardenable material over the remaining exposed part of the strip to encapsulate the exposed part and then hardening the material, and removing the masking from in contact with the strip to expose the unencapsulated surface of the strip.

7 Claims, 5 Drawing Figures
Fig. 3

Fig. 4

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Background of the Invention

Many electrical heating units in use today comprise a strip or ribbon of a sinuate, serpentine or undulated length of electrical resistance wire shaped into a pattern desired for the heating element of the respective heating unit, such strip or ribbon being supported on a card of suitable thermal resistant and electrically insulating material, or on a support member of a similar material having grooves or channels preshaped in said desired pattern for receiving said undulated strip of wire. In such heating units the strip or ribbon of wire must, of course, be retained or fastened on said card or in said channels or grooves such as by stapling or other similar retaining means and, therefore, the making or manufacture of such types of heating units is time consuming and relatively expensive since the staples or other retaining means must usually be manually applied to the strips or ribbons of wire for their retention on or in their respective support members. Accordingly, the present invention was developed to provide an economical method of making electrical heating units of the type described.

SUMMARY OF THE INVENTION

In accomplishing the object of the invention a strip or ribbon of a sinuate, serpentine or undulated length of electrical resistance wire is formed or shaped into an areal or planar pattern for the desired heating unit and such shaped strip or ribbon is disposed against a masking member which is shaped in a planar configuration corresponding to the planar or areal pattern of the shaped strip or ribbon but whose dimensions across the widths of the shaped masking member are equal to or slightly less than the lengths of the straight wire between the undulations or curves at the opposite edges of the sinuate or serpentine strip or ribbon of wire. In other words, the masking member is shaped so that it may be disposed against one of the areal or planar surfaces of said shaped strip or ribbon of wire and, thereby, mask such surface leaving only the curves or undulations at the opposite edges of the strip of wire exposed. The strip or ribbon of wire so masked is then placed in the interior or cavity of a container or mold member which preferably corresponds in shape to the outer expanse or reaches of said shaped strip or ribbon of wire but whose said cavity or hollow has dimensions somewhat larger than said outer reaches or expanse. The bottom of said container or mold member is preferably made of a foraminous plate, screen or meshwork which is suitably held on or in the container or mold member adjacent the bottom of the wall defining the peripheral limits of the cavity therein, and said masked strip or ribbon of wire is placed in the mold member with said masking member contacting said foraminous plate, meshwork, or screen, that is, with said strip or ribbon of wire spaced from said plate, screen or meshwork by the thickness of the masking member. A flowable or pourable mixture or slurry of a thermal resistant, electrically insulating and air dryable or thermosetting material is then poured into the container or mold member to cover the strip or ribbon of wire and its masking member with a thickness or depth of such material desired for the partial enclosure or encapsulation of the finished heating unit. The liquid portion of said slurry or mixture is permitted to drain through said plate, screen or meshwork, or preferably is drawn therethrough by vacuum applied to the bottom of the container. The slurry or mixture of the assembly, comprising the strip or ribbon of undulated wire, its masking member and said slurry or flowable mixture, is then permitted to air dry, harden or set, or is baked for thermosetting purposes. Following said drying, hardening or setting of said mixture or slurry, the assembly is removed from said container or mold member and said masking member is then removed from the hardened or thermoset material to expose the previously masked surface of the strip or ribbon of wire and thereby provide the completed heating unit.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 comprises a top plan view of a strip or ribbon of undulated or sinuously bent electrical resistance wire which is shown as shaped or formed into a spiral areal or planar configuration or pattern for use in making a heating unit in accordance with the method of the invention;

FIG. 2 comprises a top plan view of a masking member of a selected thickness and having a planar configuration corresponding to said areal or planar configuration or pattern of the shaped or formed strip or ribbon of wire shown in FIG. 1;

FIG. 3 is a top plan view of the strip or ribbon of wire and the masking member of FIGS. 1 and 2, respectively, and disposed in the hollow or cavity of a container or mold member adjacent the bottom thereof during practice of the invention;

FIG. 4 comprises an elevational view of the container or mold member of FIG. 3 with a small part of the peripheral wall of the mold member broken away to illustrate the bottom of the mold member with the strip or ribbon of wire and the masking member disposed adjacent such bottom as illustrated in FIG. 3; and

FIG. 5 comprises an isometric view on an enlarged scale of one type of a finished electrical heating unit made in accordance with or by the method of the invention disclosed, and with a small part of a thermal resistant and electrically insulating material of the unit being broken away to further illustrate portions of such unit.

Similar reference characters refer to similar parts in each of the figures of the drawings.

PREFERRED EMBODIMENT OF THE INVENTION

Referring to the drawings in detail, there is shown in FIG. 1 a length, strip or ribbon 11 of serpentinely or sinuously bent or undulated electrical resistance wire 12 which, for purposes of one example only of the practice of the inventive method disclosed, is illustrated or shown as formed or shaped into a circularly spiral areal or planar configuration or pattern for the making of a circular heating unit of a well known type, that is to say, a heating unit having the peripheral shape of many heating units in use today. As best illustrated in FIG. 5, first ends of electrically conductive terminal strips such as 11a and 11b are electrically connected, as by soldering or welding, to first and second ends of wire strip or ribbon 11.
A masking member 13 such as shown in FIG. 2 is provided, such member being preferably made of a relatively rigid material, such as aluminum or black iron for example, and such masking member, by way of example only, having a thickness on the order of one eighth of an inch. Member 13 has a planar or areal circularly spiral configuration or pattern corresponding to that of the length, ribbon or strip 11 of undulated wire 12. However, the width of masking member 13, taken thereacross at any selected location or locations along its spiraled length, is somewhat less than the width of spiraled strip 11 of wire 12 taken thereacross at a location or locations corresponding to said selected location or locations along said spiraled length of member 13. In other words, the widths of masking member 13 along its spiraled length are such that the lower or bottom planar or areal surface of spiraled strip 11 or ribbon of wire 12 (viewing FIG. 1) can be disposed adjacent or against the upper or top planar or areal surface of masking member 13 (viewing FIG. 2) so that only the lengths of the straight sections of wire extending between the undulations along the opposite edges of spiraled strip or ribbon 11 are contacted by the masking member, that is, so that each undulation or curved section of the sinuously or serpentinously bent wire 12 is exposed, or is not contacted or masked by masking member 13. For convenience or ease of positioning, and the maintenance of such positioning, of wire strip or ribbon 11 on masking member 13 in the orientation described above, a plurality of small diameter, generally cylindrical, and relatively short projections such as 14 and extending upwardly from and generally normal to said upper or top surface of masking member 13 may be provided on such member in a somewhat staggered orientation along opposite edges of the spiraled length of the masking member. Moreover, the provision of the projections such as 14 is not critical but other means such as a suitable adhesive or cement may be used for said positioning and/or said maintenance of such positioning.

The strip or ribbon such as 11 of undulated wire such as 12 is disposed adjacent masking member 13 as discussed above, and such assembly is then placed in the hollow or cavity 16a of a container or mold member such as 16 shown in FIGS. 3 and 4. The hollow or cavity such as 16a of mold member 16 preferably generally conforms in configuration to the outer peripheral expanse or reaches of spirally shaped or formed wire strip or ribbon 11 and masking member 13, but is of a somewhat larger diameter than the greatest distance across said reaches or expanse of the spiral of the wire strip such as 11. The assembly, comprising wire strip or ribbon 11 and masking member 13, is placed in said cavity 16a of mold member 16 so that the lower surface of masking member 13 is, as illustrated in FIG. 4, disposed against or in contact with the bottom 17 of the mold member with the geometrical center point of the inner curve of the spiral of wire strip 11 generally coinciding with the center of bottom 17 of mold member 16 as illustrated in FIG. 3. Bottom 17 of mold member 16 preferably comprises a foraminous plate, screen or meshwork which is held in or adjacent to the lower part of cavity 16a of member 16, the limits of such cavity being otherwise defined by the inner surface of the peripheral wall of the mold member.

Following the above discussed placing and positioning of the assembly, comprising wire strip or ribbon 11 and masking member 13, in cavity 16a of mold member 16, a quantity of a slurry or suspension 21 (FIG. 4) of a pourable or flowable mixture of a thermal resistant, electrically insulating, and dryable, hardenable or thermosetting material is poured or flowed into cavity 16a of mold member 16 as from one end of a suitable pipe or conduit 20 whose second end is connected to a source or supply of said slurry, suspension or mixture of the encapsulation material. Said assembly is covered or encapsulated to a desired height or depth of said material while leaving the free ends of the previously mentioned terminal strips 11a and 11b exposed as illustrated in FIG. 5. The excess fluid or liquid of said mixture or slurry is permitted to drain through the foraminous plate, screen or meshwork bottom 17 of mold member 16, or is preferably drawn through such bottom by applying vacuum thereto in any of the manners well known in the art. Said pourable or flowable mixture or slurry of thermal resistant and electrically insulating material may, for example, comprise a mixture of an alumino-silicate fiber such as bulk FIBERFRAX which is manufactured and sold by the Refractories and Electronics Division of The Carbournondum Company, Niagara Falls, New York, and a water-diluted solution of HS-40 type LUDOX as a binder for the alumino-silicate fiber, such binder being manufactured and sold by E. I. duPont de Nemours and Company, Incorporated, Wilmington Delaware. However, slurries or mixtures of many other types of thermal resistant and electrically insulating and hardenable material combined with a suitable binder may be used for said pourable or flowable mixture used in the practice of the inventive method disclosed herein.

Subsequent to the flowing of said slurry or mixture of the thermal resistant, electrically insulating, and dryable or hardenable material into cavity 16a of container or mold member 16, and the drainage or removal of the excess fluid or liquid of the slurry or mixture from such container or mold member as discussed above, said material is permitted to sufficiently harden or set so that it provides an encapsulation such as 18 (FIG. 5) which will retain its formed shape when removed from mold member 16. If a thermosetting encapsulation material is used, the mold member such as 16 and its contained slurry or mixture is subjected to a suitable heat cycle for setting or mixture of such encapsulation material.

When the encapsulation or covering material has set or become hardened to a sufficient degree, the assembly comprising wire strip or ribbon 11, masking member 13 and the now hardened or set encapsulation material 18, is removed from mold cavity 16a of the container or mold member 16, said assembly is inverted, and masking member 13 is then removed or extracted from the encapsulation material 18 to expose the surface of wire strip or ribbon 11 previously contacted or masked by such masking member. Thus, an electrical heating unit such as 19 shown in FIG. 5 is provided, such heating unit including the undulated electrical resistance strip or ribbon of wire such as 11 which is the heating element of the heating unit and whose undulations or curved sections thereof remain embedded in the encapsulation material such as 18 for retention or support of the heating element in the en-
capsulation material. The electrical terminal strips 11a and 11b, whose first ends are electrically connected to the ends of wire strip or ribbon 11 forming the resistance heating element of the heating unit such as 19, extend downwardly through the encapsulation material 18 and out of the bottom thereof so that electrical connections may be made to the second or otherwise free ends of the terminal strips for energization of the heating element or wire strip or ribbon 11 in the manner well known in the art.

It is pointed out that an electrical heating unit made by the method of the present invention need not necessarily comprise a heating element which is formed or shaped so as to have a circularly spiral areal or planar configuration or pattern, or so as to have any overall generally circular configuration such as shown in FIG. 5, but strips or ribbons of electrical resistance wire shaped or formed into many planar or areal shapes other than circularly spiral can be used for making heating units in accordance with the method of the present invention. For example, a heating element for an electrical heating unit may comprise a strip or ribbon of undulated, or sinuously or serpentinebly bent electrical resistance wire which is rebent, shaped or formed into a generally rectangular pattern or configuration which generally corresponds to a rectangular area such as 40 shown in FIG. 8 of U.S. Pat. No. 3,534,783 issued Oct. 20, 1970 to Everett F. Kelm for Electrical Heating Elements. If a strip or ribbon of undulated electrical resistance wire is so rebent shaped or formed into such a rectangular pattern or configuration for the purpose of making a heating unit in accordance with the method of the present invention, the masking member employed in practicing the invention is, of course, provided with a corresponding rectangular pattern, or planar or areal configuration. This will be readily apparent to those skilled in the art from the previous example of the practice of the inventive method disclosed, taken in conjunction with FIGS. 1 through 5 of the present application.

It is further pointed out that the container or mold member such as 16 used in practicing the method herein disclosed may sometimes be expediently or conveniently provided with a screen, peripheral meshwork or otherwise foraminous peripheral sidewall or sidewalls rather than a solid sidewall such as shown in FIGS. 3 and 4 as defining the limits of the cavity such as 16a in the container or mold member such as 16. This would, of course, depend to a substantial extent on the consistency of the slurry or mixture of the flowable or pourable thermal resistant and electrically insulating material used for the encapsulation or support body such as 18 of the heating element of the heating unit such as 19 as shown in FIG. 5 of the drawings.

Although there is herein shown and described in any substantial detail only a single example of the practice of the method comprising the invention, it will be understood that various changes and modifications may be made or used within the purview of the appended claims without departing from the spirit and scope thereof.

We claim:

1. A method of making an electrical heating unit such method comprising,
   A. providing a strip of undulated electrical resistance wire;
   B. shaping said strip of wire into a planar or areal configuration or pattern desired for a heating element for said heating unit;
   C. disposing in contact with one of the planar surfaces of said shaped strip of wire a planar surface of a masking member, such surface having a configuration or pattern corresponding to said one planar surface of said strip of wire but of lesser dimensions in width than the width of such wire strip;
   D. disposing the assembly, comprising said wire strip and said masking member, adjacent the bottom of a mold member having a cavity corresponding in planar configuration to the outer reaches of said shaped wire strip but of somewhat larger dimensions than said outer reaches, said assembly being so disposed with said masking member contacting said bottom of said mold member;
   E. flowing a mixture of an insulating and hardenable material into said mold member to encapsulate and cover said assembly to a depth for a desired insulating support for said heating unit;
   F. drying and hardening said mixture of insulating material;
   G. removing said encapsulated assembly from said mold member following the hardening of said encapsulating material; and
   H. removing said masking member from said encapsulated assembly to thereby expose the portion of said one planar surface of said shaped strip of wire contacted by the masking member while leaving the undulations along the edges of such wire strip embedded in said encapsulating and insulating material, whereby said electrical heating unit results.

2. The method in accordance with claim 1 and in which the ends of said strip of undulated electrical resistance wire are electrically connected with first ends of conductive terminal strips which extend upwardly from such strip of wire while such strip is in said mold member and are of a length such that the second ends of the terminal strips are exposed following said flowing of said insulating material into the mold member.

3. The method in accordance with claim 1 and in which said bottom of said mold member comprises a screen or meshwork for drainage of the liquid portions of said mixture from the mold member.

4. The method in accordance with claim 1 and in which said mixture comprises a thermosetting material.

5. The method in accordance with claim 2 and in which said bottom of said mold member comprises a screen or meshwork for drainage of the liquid portions of said mixture from the mold member.

6. The method in accordance with claim 2 and in which said mixture comprises a thermosetting material.

7. The method in accordance with claim 3 and in which said mixture comprises a thermosetting material.