May 1, 1962 A. C. BOGGS 3,031,739

ELECTRIC HEATING UNITS AND METHOD OF MAKING THE SAME

Filed June 2, 1958

2 Sheets-Sheet 1

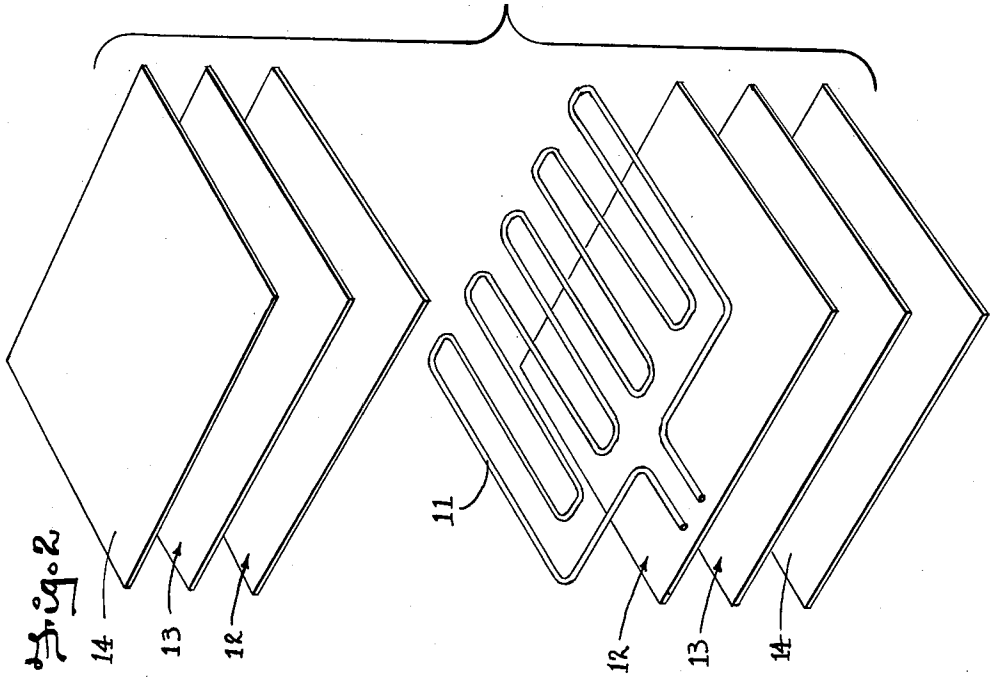

Fig. 2

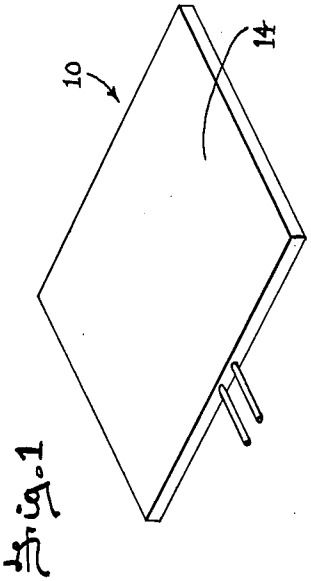

Fig. 1

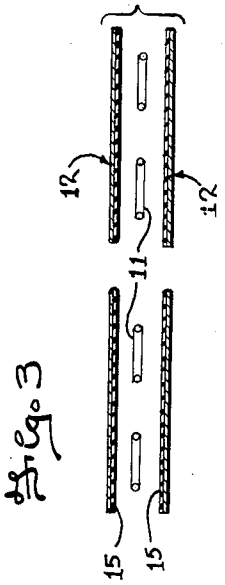

Fig. 3

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2 Sheets-Sheet 2

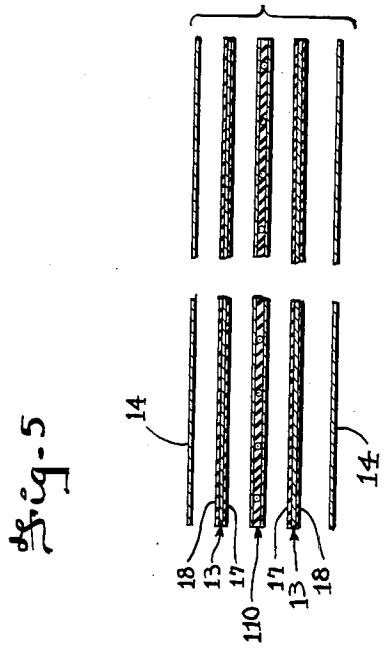

Fig. 5

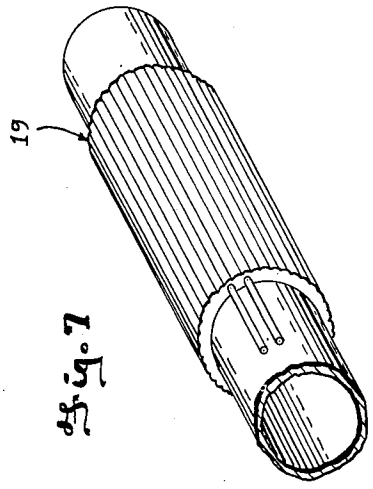

Fig. 7

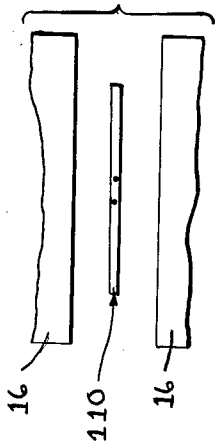

Fig. 4

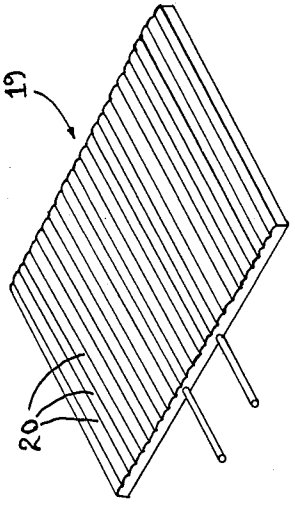

Fig. 6

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ELECTRIC HEATING UNITS AND METHOD OF MAKING THE SAME

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5 Claims. (Cl. 29—155.63)

The present invention relates to electric heating units and to methods of manufacturing the same, more particularly to electric resistance heating units of the metallic sheathed type, and the principal object of the invention is to provide new and improved heating units of such character and new and improved methods of manufacture thereof.

Heating units of the type wherein a resistor conductor element is disposed between two sheets of uncured resinous material such as rubber which is then subjected to a curing operation to permanently bond the rubber sheets and the interpositioned resistor element together have long been known. Heating units of this type may be used for a variety of purposes where relatively low heat output is required and where a highly flexible unit is desired.

Unfortunately, because of the fact that rubber-like materials are rather poor conductors of heat, heat distribution across the surface of the heating unit is rather uneven. This results in relatively high surface temperatures of the unit at places adjacent the embedded resistor conductor and in relatively low surface temperatures of the unit at places but slightly spaced from the embedded resistor.

The present invention, by providing the heating unit with heat conductive surfaces, achieves a much more even heat distribution because the heat is rapidly conducted away from the places of high concentration to places of low concentration. Since the heat is rapidly conducted away from the places of high heat concentration (those places immediately adjacent the embedded resistor conductor), the heat output of the unit can be increased without exceeding the maximum permissible temperature to which the rubber-like material may be subjected without deterioration. Other advantages will readily become apparent from a study of the following description and from the drawing appended hereto.

In the drawing accompanying this specification and forming a part of this application there is shown, for purpose of illustration, an embodiment which the invention may assume, and in the drawing.

FIGURE 1 is a perspective view of a preferred embodiment of an electric resistance heating unit constructed in accordance with the present invention,

FIGURE 2 is an exploded perspective view of the heating unit illustrating the various parts of which it is composed,

FIGURE 3 is an enlarged broken sectional view illustrating an early stage in the manufacture of the heating unit,

FIGURE 4 is a reduced size elevational view of a subsequent stage of manufacture,

FIGURE 5 is a view similar to FIGURE 3 but illustrating a still later stage of manufacture,

FIGURE 6 is a view similar to FIGURE 1 but of another embodiment of the invention, and

FIGURE 7 is a perspective view of the embodiment seen in FIGURE 6 in use in heating a non-planar body.

The embodiment of the heating unit seen in FIGURE 1 is shown to be flat so that it may subsequently be applied to a generally flat surface to be heated. It is to be understood, however, that the invention is not limited to flat heating units but that curved or bent heating units may as readily be constructed. Moreover, because certain heating unit embodiments of the present invention have considerable flexibility, such units may, although initially flat, be readily bent or curved to closely fit non-planar bodies to be heated.

The completed heating unit **10** shown in FIGURE 1 is built up, as will hereinafter be disclosed, of a plurality of parts shown in FIGURE 2. These parts at the present time preferably comprise a resistor conductor wire **11** which is formed to provide any desired heating pattern, two sheets of glass fiber cloth **12** and **13** disposed on each side of the patterned resistor wire, and thin metal sheets **14** on the outside faces of sheets **13**. As will be seen, these parts are adapted to be bonded together in superimposed relation to provide the structurally integral unitary assembly illustrated in FIGURE 1.

In the present embodiment, sheets **12**, **13** and **14** are of a size sufficient to extend beyond the pattern provided by the resistor wire **11** so as to totally enclose the latter. Respective terminal ends of the resistor, of course, extend beyond the margins of the sheets as shown to provide for making the necessary electrical connection thereto. If desired, the terminal ends of the resistor may be connected to suitable lead wires whose ends adjacent the resistor will extend between respective sheets.

Referring to FIGURE 3, the facing surfaces of glass fiber sheets **12**, **12** are coated with a resinous, uncured rubber-like material **15** which, in the present embodiment, is preferably uncured silicone rubber because of the latter's ability to withstand much higher temperatures than natural rubber or other materials of this general type.

With the patterned resistor conductor disposed between the two sheets **12**, the sub-assembly **110** thus formed will be placed between a pair of suitable heated platens **16**, **16** (see FIGURE 4) which will be forced together to embed the resistor conductor in the silicone rubber coatings **15**. As presently contemplated, the platens **16** will be held together for a time sufficient to cure the silicone rubber thus bonding the sheets **12** and the resistor into a structurally integral unit.

Following the above curing operation, the glass fiber cloth sheets **13**, each having an uncured silicone rubber coating **17**, **18** on respective sides, will be placed on respective sides of the sub-assembly **110** with coatings **17** innermost and coatings **18** outermost. The thin metallic sheets **14**, such as aluminum foil or the like, will then be positioned against coatings **18** and the assembly once again placed between the heated platens **16** and pressed therebetween to cure the coatings **17**, **18**. In order to insure good adherence of the metal sheets to coatings **18**, each metal sheet will preferably have its appropriate facing side coated with a suitable bonding primer prior to its assembly with sheets **13**. Following this final curing operation, the now completed, metal encased flat heating unit may be removed and placed in service.

It should be pointed out that while it is preferable at the present time to build up the thickness of the unit and therefore its electrical insulation in two stages as above described, under different conditions the unit might be built up and cured in but one stage. This might be done, for example, by eliminating the sheets **12** and possibly increasing the thickness of sheet **13** to obtain the necessary dielectric strength thereof.

Normally, the heating unit constructed as hereinabove described will be clamped or otherwise secured to a generally flat surface of a body to be heated. It is, moreover, not limited to use on flat surfaces since, because of its flexibility, it may be secured to curved or other non-planar surfaces. While the above described unit has a certain amount of flexibility, any attempt to bend it about too small a radiused surface will cause so much tensile stress in that sheet **14** spaced furthest from such

surface that this outermost sheet will be torn. Accordingly, to obviate this difficulty and permit the unit to be bent about relatively sharp radii, the following construction is employed.

Referring to FIGURE 6, the heating unit 19 therein shown may be similar to that heretofore described and may be made in the same manner with but one exception. Such exception is that at least one of the outer foil sheets (herein shown to be the top sheet) will be formed with a plurality of closely spaced ribs or corrugations 20. This may conveniently be done by providing the working surface of one of the platens in which the final cure of the unit is made with a plurality of corrugations instead of the smooth surface heretofore described. With one of the platen surfaces corrugated, it will be evident that corresponding corrugations will be impressed into the adjoining foil sheet when the unit is pressed between the platens for curing.

As seen in FIGURE 7 wherein the heating unit 19 has been bent about a tubular body which is to be heated thereby, it is important that the corrugated sheet be outermost and that the corrugations 20 extend at right angles to the direction the unit is to be bent. Stated another way, the unit is to be bent longitudinally and not transversely of the corrugations. It is to be understood that when a corrugated unit is bent as above described, the corrugations provide an accordion-like surface which readily unfolds as the outer sheet is stretched thus rendering the unit more flexible and preventing tearing of such sheet.

Although not shown, both of the sheets 14 may, if desired, be provided with corrugations (which will all extend in the same direction, of course) to even further increase the flexibility of the unit.

In view of the foregoing it will be apparent to those skilled in the art that I have accomplished at least the principal object of my invention and it will also be apparent to those skilled in the art that the embodiments herein described may be variously changed and modified, without departing from the spirit of the invention, and that the invention is capable of uses and has advantages not herein specifically described, hence it will be appreciated that the herein disclosed embodiments are illustrative only, and that my invention is not limited thereto.

I claim:

1. In the art of heating a body by the application of heat to a cylindrical surface thereof, the method which comprises pressing together to provide an integral structure an electrical resistance conductor member having a flat heating pattern and a flat metallic sheet which is separated from said conductor member by a layer of flexible dielectric material, forming a plurality of closely spaced corrugations in said metallic sheet as the latter and said conductor are pressed together, and bending the structure to a cylindrical formation about an axis extending in the same direction as the corrugations in said metallic sheet to cylindrical conformity with the said surface of the body to be heated.

2. In the art of heating a body by the application of heat to a cylindrical surface thereof, the method which comprises forming an elongated electrical resistance conductor member to a flat heating pattern, interposing flexible dielectric material flatwise against and between the juxtaposed sides of said patterned conductor member and a thin flat metallic sheet, pressing said conductor member, said die-electric material and said metallic sheet together to provide an integral structure and simultaneously forming a plurality of closely spaced corrugations in said metallic sheet, and bending the structure to a cylindrical formation about an axis extending in the same direction as the corrugations in said metallic sheet and to cylindrical conformity with the said surface of the body to be heated.

3. In the art of heating a body by the application of heat to a cylindrical surface thereof, the method which comprises forming an electrical resistance conductor member to provide a flat heating pattern, interposing uncured resinous material in a substantially flat layer between the juxtaposed sides of said patterned conductor member and a thin flat metallic sheet, pressing said conductor member, said uncured material and said metallic sheet together while applying heat to cure said material and provide an integral structure and simultaneously during the curing operation forming a plurality of closely spaced corrugations in said metallic sheet, and bending the structure to a cylindrical formation about an axis extending in the same direction as the corrugations in said metallic sheet and to cylindrical conformity with the said surface of the body to be heated.

4. The method of making an electric heating unit which comprises positioning a resistor conductor member having a flat heating pattern between two flat layers of uncured resinous material, side pressing said material layers together to embded said conductor member therein while applying heat to cure said material about said member and form therewith an intgeral assembly, positioning said integral assembly against a thin flat metallic sheet which is separated from said assembly by a layer of uncured resinous material, and pressing said assembly and said metallic sheet together between dies while applying heat to said dies to cure said uncured material and to bond said assembly and said metallic sheet together, the die pressing against said metallic sheet having a corrugated surface to simultaneously press said metallic sheet to corrugated formation.

5. In the art of heating a body by the application of heat to a cylindrical surface thereof, the method which comprises positioning a resistor conductor member having a predetermined flat heating pattern between two flat layers of uncured resinous material, pressing said material layers together to embed said conductor member therein while applying heat to cure said material about said member and form therewith an integral assembly, positioning said integral assembly against a thin flat metallic sheet which is separated from said assembly by a layer of uncured resinous material, pressing said assembly and said metallic sheet together between dies while applying heat to said dies to cure said uncured material and to bond said assembly and said metallic sheet together to provide a unitary structure, the die pressing against said metallic sheet having a corrugated surface to simultaneously press said metallic sheet to corrugated formation, and bending the structure to cylindrical formation about an axis extending in the same direction as the corrugations in said metallic sheet to cylindrical conformity with the said surface of the body to be heated.

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