

[54] **HEATER**

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[51] Int. Cl. **H05b 1/00**

[58] Field of Search.....219/213, 345, 528, 538, 544, 219/549; 264/105; 18/DIG. 25; 252/502, 511; 165/49

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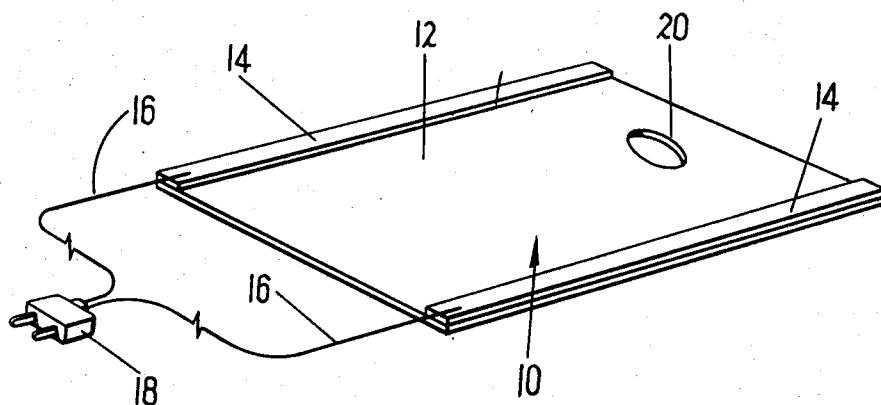
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[57] **ABSTRACT**

A heater, that is adapted to be integrally formed as part of a structure to provide heating along or over a surface of the structure, comprises a plurality of layers including at least a resistive layer of a plastic filled with metallic or non-organic particles or powders, a thermally insulating dielectric layer adjacent one side of the resistive layer, and a thermally conductive dielectric layer adjacent another side of the resistive layer. A source of electrical energy is coupled to the resistive layer to cause heating thereof. The thermally insulating layer directs generated heat toward the thermally conductive layer to cause heating over a surface of the structure.

13 Claims, 8 Drawing Figures



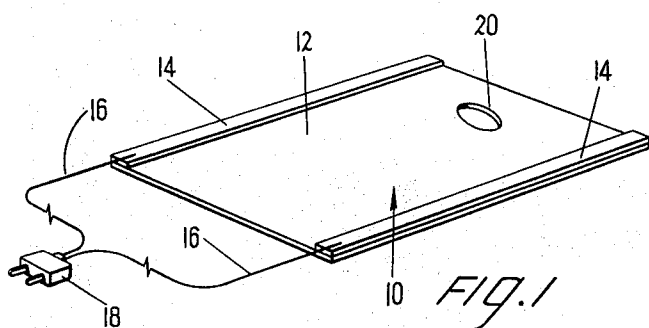


FIG. 1

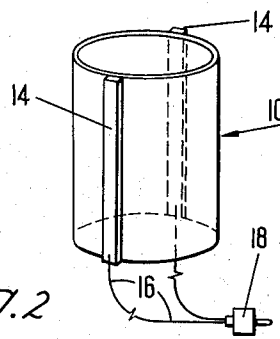


FIG. 2

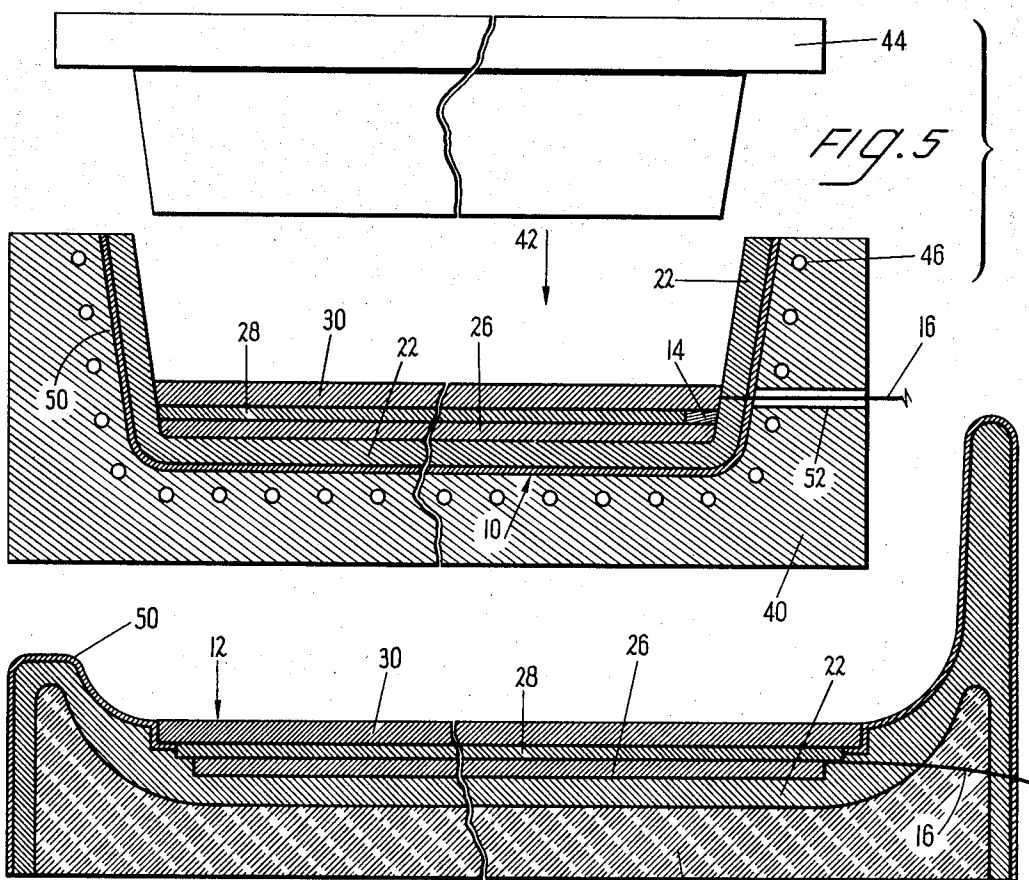


FIG. 5

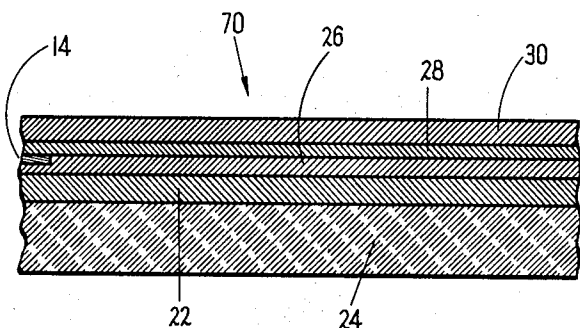


FIG. 3

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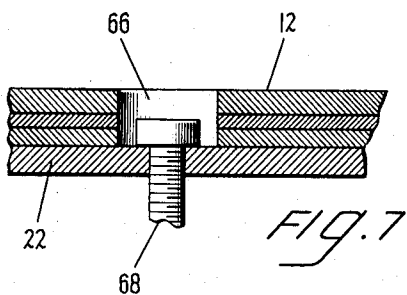
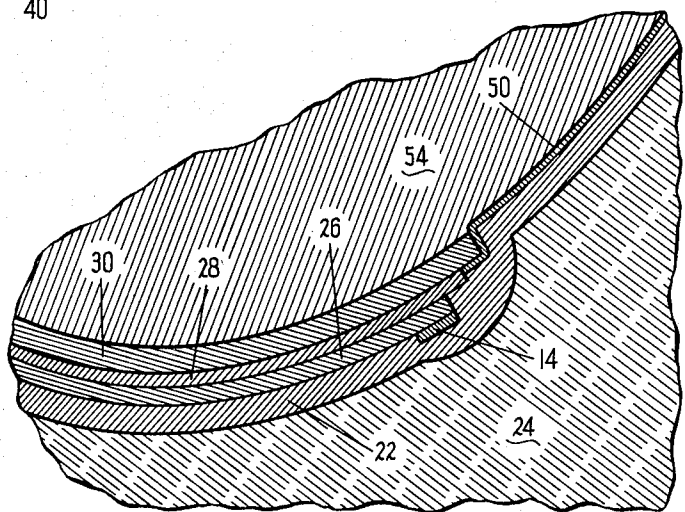
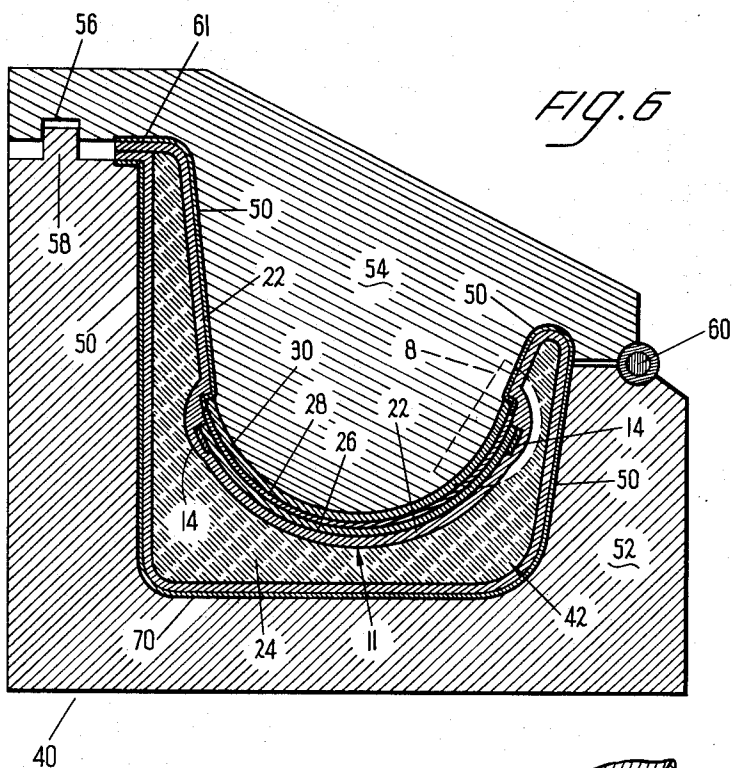


FIG. 8

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HEATER

BACKGROUND OF THE INVENTION

The present invention relates to a heating element that is incorporated within a structure to provide heating along a surface thereof, and a method for integrally forming the heating element and structure, preferably in a one-step operation.

Various types of heating devices are presently available for causing a heating along one or more surfaces of the devices. One such device comprises a basic support structure including a wound resistive wire through which an electrical current passes to cause heating over surfaces of the structure. One drawback associated with this type of heating device is that it is quite difficult to provide even heating especially when the structure has irregular shape because it is difficult to place the wires in the desired locations. Also, if the wire breaks or opens at any point along its length, complete heating is interrupted as no currents can flow through the wire. Still another drawback associated with this type of an arrangement is that the fabrication of the completed device is time consuming and costly. This was due, at least in part, to the need for winding the wires and placing them correctly.

Accordingly, one important object of the present invention is to provide an improved heating device, preferably forming an integral part with a support structure.

Another object of the present invention is to provide a structure including a heating layer that provides heating over one or more surfaces of the structure.

A further object of the present invention is to provide a heater structure according to the preceding object that provides uniform heating over a surface of the structure, even though the structure including the heated surface has non-continuous portions.

Still another object of the present invention is to provide a heating element incorporated into a structure, that may be fabricated with the structure in a one-step process, and that may be readily configured into different structural shapes.

SUMMARY OF THE INVENTION

To accomplish these and other objects the heater of the present invention comprises a thermally insulative base which preferably forms the basic support structure of the heater. A resistive heating layer may then be deposited over the base layer, and is preferably composed of a resin plastic filled with metallic, organic or non-organic particles or powders. A source of electrical energy is conductively coupled to the heating layer to provide heating thereof. A thermally conductive, electrically insulative layer covers the heating layer and includes at least one outer surface toward which heat is transmitted from the heating layer when the electrical source is supplying current to the heating layer.

In accordance with another method of the invention, the base layer may comprise the core or filler material for the heater structure. An uncured premixed foam is used as the filler and expands during the fabrication process to provide an integral structure including a heating device.

According to the method of the invention, the different layers that comprise the heating element may be fabricated by a film deposition technique, by spraying

or by other like methods. A mold is usually provided and a first thermally insulative layer may be sprayed, for example, into the mold to form a base. A supporting layer may then be deposited over the base layer followed by a resistive heating layer. Connections are provided through the mold to connect to conductive bus bars which in turn are connected to the heating layer. Finally, a thermally conductive, electrically insulative layer covers the top of the resistive heating layer and provides for external heat conduction and electrical insulation between the heating layer and an outer surface of the structure. With such an arrangement the curing of the various layers comprising the structure can be accomplished in a single operation.

Numerous other objects and features of the invention should now become apparent upon a reading of the following detailed description in conjunction with the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a flat heater according to the invention;

FIG. 2 is a perspective view of a heater structure arranged in a cylindrical form;

FIG. 3 is an enlarged fragmentary cross-sectional view of an integrated heating element and structure;

FIG. 4 is a cross-sectional view similar to FIG. 3 of a finished integrated heater structure;

FIG. 5 is a cross-sectional view of an integrated heater structure fabricated using a mold;

FIG. 6 is a cross-sectional view of one embodiment of the invention wherein a heating device is formed integrally with a gutter structure;

FIG. 7 is a cross-sectional view of a heater structure showing a means for penetrating the structure to fasten it to another structure; and

FIG. 8 is an enlarged fragmentary view of the portion of the structure of FIG. 6 in the region of the bus bar.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. 1 there is shown a unitary heater structure 10. Structure 10 is relatively flat and includes an upper surface 12 over which heating occurs. A pair of bus bars 14 are arranged in parallel on either side of structure 10. Each of the bus bars 14 is fabricated of a low resistance material and has electrical lines 16 connected at one end thereof. The electrical lines 16 connect to a conventional plug 18 which may be inserted in a conventional 120 volt alternating current socket. Alternatively, plug 18 could connect to a direct current supply to provide current to bus bars 14 and heating structure 10. In FIG. 1 only the exposed portion of bus bars 14 is shown. FIG. 3 indicates the position internal of the heating structure to which bus bars 14 connect.

FIG. 1 also shows an opening 20 which passes through the heating structure 10. Passage 20 may be provided so that the finished structure with integrated heater can be attached to another object without impeding heating by the heating element. This passage does not interrupt the uniform heating of the remainder of surface 12.

Referring to FIG. 2 there is shown a heating structure 10 that is cylindrical in shape and includes two bus bars 14 spaced parallel to each other. This structure 10

shown in FIG. 2 also includes wires 16 which couple the bus bars 14 to a plug 18 which may in turn be connected to a conventional AC socket. With the embodiment of FIG. 2 heating surfaces could be provided on both the inner and outer surface of structure 10.

A fragmentary cross-sectional view through the integrated heater/structure 70 is shown in FIG. 3. Heater/structure 70 comprises a plurality of separate laminate layers each of which may be prefabricated of a plastic film having predetermined properties. One such material may, for example, have metallic particles interspersed in the plastic to form a resistive film. Alternatively, each layer could be fabricated by spraying on an appropriate composite plastic layer. The structure includes a supporting layer 22 which for some applications may be relatively rigid so that the structure does not bend. Usually, layer 22 is the primary substructure with which the heater is integrated. When sufficient space is available and additional thermal insulation is desirous, a thermally insulative layer 24 is disposed next to layer 22. Layer 22 directs heat flow toward the surface 12 of structure 70. If a heating element similar to that shown in FIG. 2 were being fabricated and the heating surface were to be the outer surface, layer 24 could fill the entire inner portion defined by cylindrical structure 10.

The heating layer 26 is disposed above substructure layer 22 and may be a plastic resin filled with metallic or carbon particles or powders to achieve a resistive material having sufficient resistance to provide adequate heating properties. Bus bar 14 is shown connected to layer 26. The rest of bus bar 14 extends above surface 12 as indicated in FIG. 1, or alternatively may extend out to the side.

A thermally conductive, electrically insulative layer 28 is disposed above layer 26 and is adapted to thermally conduct the heat energy generated from layer 26 toward surface 12. Layers 22 and 28 provide electrical insulation on either side of layer 26 to prevent current leakage to the surface of the structure, and confine current flow to layer 26. In a preferred embodiment of the invention the layer 28 is constructed relatively thin so that heat flow from layer 26 is not impeded. Layer 28 may be much thinner than layer 26.

A layer of surface material 30 may also be provided above layer 28. This layer 30 may comprise a plastic resin filled with metallic particles to achieve a thermally conductive outer layer that acts as an excellent heat sink. Thus the top surface 12 of layer 30 should have good specific heat characteristics to provide for even distribution of heat thereby minimizing hot spots. Also, layer 30, especially adjacent surface 12, should be durable and resist wear. The resin in this are should therefore contain more metallic reinforcing particles or wear-resistant additives. For example, in fabricating heated stair treads a primarily sand base could be used. For some applications a layer 30 used for heat sink purposes may be omitted as the heating layer 26 provides sufficiently even heating in itself across surface 12.

The cross-sectional view of FIG. 4 is similar to that shown in FIG. 3. The integrated heater/structure 70 may be used as a shelf for warming foods for example. In this embodiment the heating layer 26 does not extend to the edge of the structure but terminates farther in from the edge of the structure than surface layers 28

and 30. The dielectric layer 28 extends over layer 26 and terminates short of or at the edge of layer 30. Layer 26 is thus enclosed by layers 22 and 28 so as to electrically isolate it. Electrical connection is provided by lines 16 which connect from the bus bar to an external current source. The article could be fabricated in a female mold with the sequential application of layers 30, 28, 22 and 24. A gel coat for the basic structure may be applied between the application layers 30 and 28.

A spraying technique may be used for depositing the different plastic reinforced layers. Alternatively, the embodiment of FIG. 5 uses a mold with a matching die to form a heating surface on the inside of structure 70 rather than on the outside.

FIG. 5 shows a mold 40 having a cavity 42 therein. A mating mold member 44 fits within cavity 42 and is used in the latter stages of fabrication to provide a tight mold. The mold 40 also includes a plurality of passages 46 through which either a heating or cooling fluid may pass. During the curing of the structure a heating or cooling fluid would pass through these passages 46 to control the curing cycle. The different layers that comprise the heating structure 10 may be applied by such methods as casting, spraying, stenciling, brushing, or rolling on the appropriate plastic reinforced materials.

A gel coat 50 is usually first sprayed onto the inner surface of mold 40. A reinforced plastic substructure 22 may then be deposited or sprayed onto the gel coat 50. Alternatively, this substructure 22 could be prefabricated and merely placed within the cavity 42. The heating layer 26 which is a composite of a plastic and resistive reinforcing particles is then deposited over layer 22 and forms the basic heating layer for the structure. Next, a dielectric layer 28 is formed above layer 26. Layer 28 is electrically insulating and thermally conductive so that the heat generated from layer 26 is conducted by layer 28 towards layer 30. Layer 30 may also be sprayed or rolled onto layer 28 and may be of the same material as shown in the embodiment of FIG. 3.

The mold 40 is also provided with a passage 52 through which a pair of wires 16 extend from external of the cavity 40 to bus bar 14. FIG. 5 shows only one of the bus bars 14. A hole is also formed within layer 22 where the wire extends from the bus bar to the passage 52. Alternatively, an electrical connector could be integrated in the substructure 26, and passage 52 would not be required.

Finally, the mold member 44 is placed in cavity 42 and the curing of the integral structure takes place at an appropriate temperature, depending upon the particular materials employed.

Referring now to FIG. 6, a gutter is shown as the integrated heater/structure 70, and includes a heater device 11 for causing heating over the inner arcuate surfaces of the structure.

In FIG. 6 the mold 40 generally includes a first mold member 52 and a second mold member 54 adapted to cooperate to form a mold cavity 42 of generally U-shape. The mold members 52 and 54 are typically constructed of a relatively strong and heat conductive material such as a metal. Mold member 54 includes a recess 56 which meets with locating pin 58 of member 52. Members 52 and 54 are pivoted at pivot point 60 so

that the structure 10 can be subsequently removed from the mold 40 after curing. The mold members 52 and 54 may also be provided with passages similar to those shown in FIG. 5 for controlling the curing cycle of the composite sandwich construction structure.

The heater element generally depicted at 11 is fabricated on a portion of the convex inner surface of mold member 54 starting with layers 30, 28 and 26 (FIG. 6). FIG. 8 shows the placement of bus bar 14 which connects externally to an electric source. A gel coat 50 is applied to the inner cavity defining surfaces of mold members 52 and 54. A resin impregnated layer of fibreglas for layer 22 is then placed over the heating element on mold member 54 (which is then swung open) and draped into the cavity over member 52.

A premixed foam may be used to form the insulating layer 24. This premixed foam would be placed within the cavity 42 before the mold members 52 and 54 are secured together, or it could be injected through a passage (not shown) after the members are secured together. There are various types of premixed foams that are adapted for use with the method of the present invention. For structures requiring support strength a rigid type of foam is preferred. Some such foams which have been found to be suitable are polyurethane, polyester, polystyrene and polyvinylchloride. The quantity of the premixed foam that is to be used in the cavity 42 is a function of the desired forming pressure and the density of the finally expanded foam. FIG. 6 shows the foam in its expanded state filling the majority of the cavity 42.

The expanding foam shapes the integrated structure 70 into the final configuration and curing of the composite system is accomplished. The excessive material 61 of layer 22 is retained for use in actual installation or attachment of the gutter to the building.

The method of the present invention may also be employed to provide a heating surface for existing structures. In this case, a rigid insulation material, that is conventionally available is used in lieu of the layer 24 depicted in FIG. 3. This rigid insulation material may be placed on an existing floor, for example, and a dielectric material similar to layer 22 of FIG. 3 placed over this material to electrically and thermally insulate the material from the heating layer. The rest of the structure comprising the heater may be identical to the layers shown in FIG. 3. A longer cure cycle, related to room temperature may be necessary when the heater is being adapted to an existing structure. The entire floor of a room, for example, may be resurfaced with heating elements only in selected areas as required to meet predetermined heating needs.

After the fabrication of a heater structure in accordance with this invention, it is anticipated that for some applications, it may be necessary to penetrate the structure as indicated in FIG. 1. A dielectric material is then used to line the penetrating passage thus preserving the electrical isolation of the heating layer from any conductive or partially conductive layer or material. For some applications, requiring mechanical or structural strength a dielectric collar could be inserted in the penetrating passage. Surface integrity can be provided by fastening the structure with a bolt 68 or the like that extends to a height below the surface 12. A potting

material 66 can then fill the rest of the passage and provide a smooth top heating surface 12. FIG. 7 shows bolt 68 as a fastening means that extends through layer 22 and has a potting compound 66 surrounding its top end.

Having described certain embodiment of and techniques for practicing the invention, modifications of and departures from the illustrated embodiments should become apparent to one skilled in the art, all of which are contemplated as falling within the spirit and scope of the present invention.

What is claimed is:

1. A heater device comprising a base material that is thermally and electrically insulative, a resistive heating layer of a plastic having a myriad of electrically conductive particles interspersed therethrough and covering said base material, conductive means for coupling electrical energy to said resistive heating layer, and a heat distributing layer adjacent said heating layer that is thermally conductive and electrically insulative and includes at least one exposed surface toward which heat may be transmitted from said heating layer when electrical energy has caused heating of said heating layer, wherein said heat distributing layer comprises a plurality of separate layers including a heat sink layer insulated from said heating layer, wherein said heat sink layer is a plastic having a myriad of electrically conductive particles interspersed therethrough to provide even heating throughout said heat sink layer.

2. A heater device as set forth in claim 1 wherein said base material comprises an expandable foam filler.

3. A heater device as set forth in claim 1 wherein said base material comprises a rigid dielectric support layer.

4. A heater device as set forth in claim 1 wherein said heating layer comprises carbon.

5. A heater device as set forth in claim 1 comprising a source of electrical energy external of said device, and wherein said conductive means couples between said source and said resistive heating layer.

6. A heater device as set forth in claim 1 wherein said heat distributing layer has an exposed surface that is wear-resistant.

7. A heater device as set forth in claim 6 wherein said heat distributing layer has an exposed surface area that is treated to improve the emissivity for radiation transfer of heat.

8. A heater device as set forth in claim 1 for use as a floor heater for a room.

9. A heater device as set forth in claim 1 wherein the electrically conductive particles of said heat sink layer are metallic.

10. A heater device as set forth in claim 9 wherein the electrically conductive particles of said resistive heating layer are metallic.

11. A heater device as set forth in claim 1 wherein the electrically conductive particles of said heat sink layer are composed of an organic material.

12. A heater device as set forth in claim 1 wherein the electrically conductive particles of said heat sink layer are composed of an inorganic material.

13. A heater device as set forth in claim 1 comprising a thermal and electrical insulating layer adjacent said base material and remote from said heat sink layer.

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