United States Patent

[11] **3,594,545**

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[21] Appl. No. **845,836**
[22] Filed **July 29, 1969**
[45] Patented **July 20, 1971**

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[54] **RADIANT HEAT PANEL**
10 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **219/345,** 219/213, 219/528
[51] **Int. Cl.** **H05b 1/00,** H05b 3/34
[50] **Field of Search** 219/345, 213, 528, 543, 549

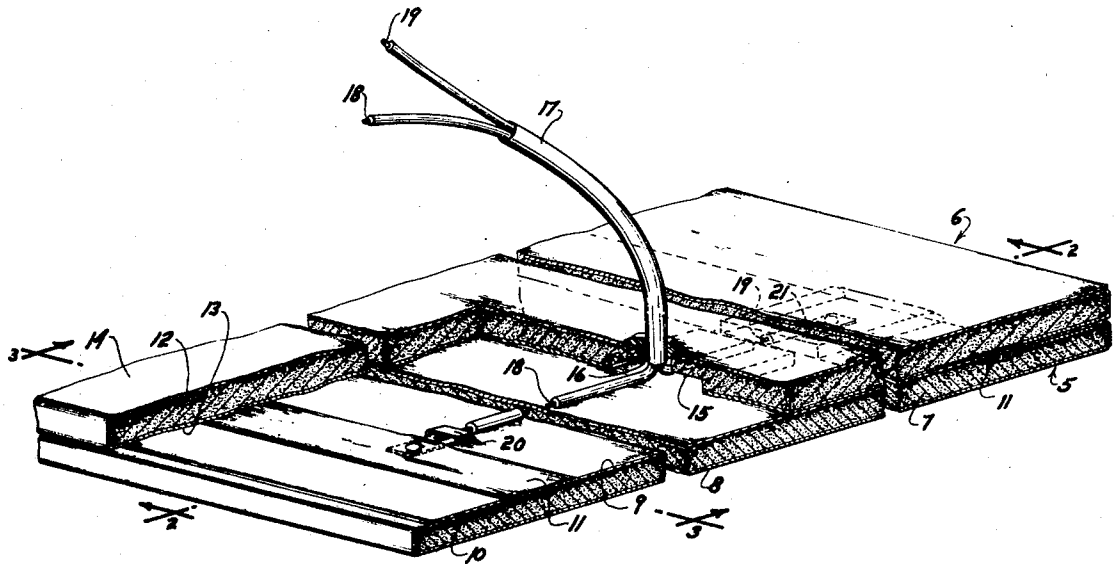
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ABSTRACT: A radiant heat panel comprising two plasterboards in face-to-face relation, one board having an electrically conductive paper sheet adhesively secured thereto, and current supply means including spaced contact strips laminated with the conductive paper sheet, and power connections attached to the contact strips and lying between the planes of the opposite faces of the other of the two plasterboards of which the panel is formed.



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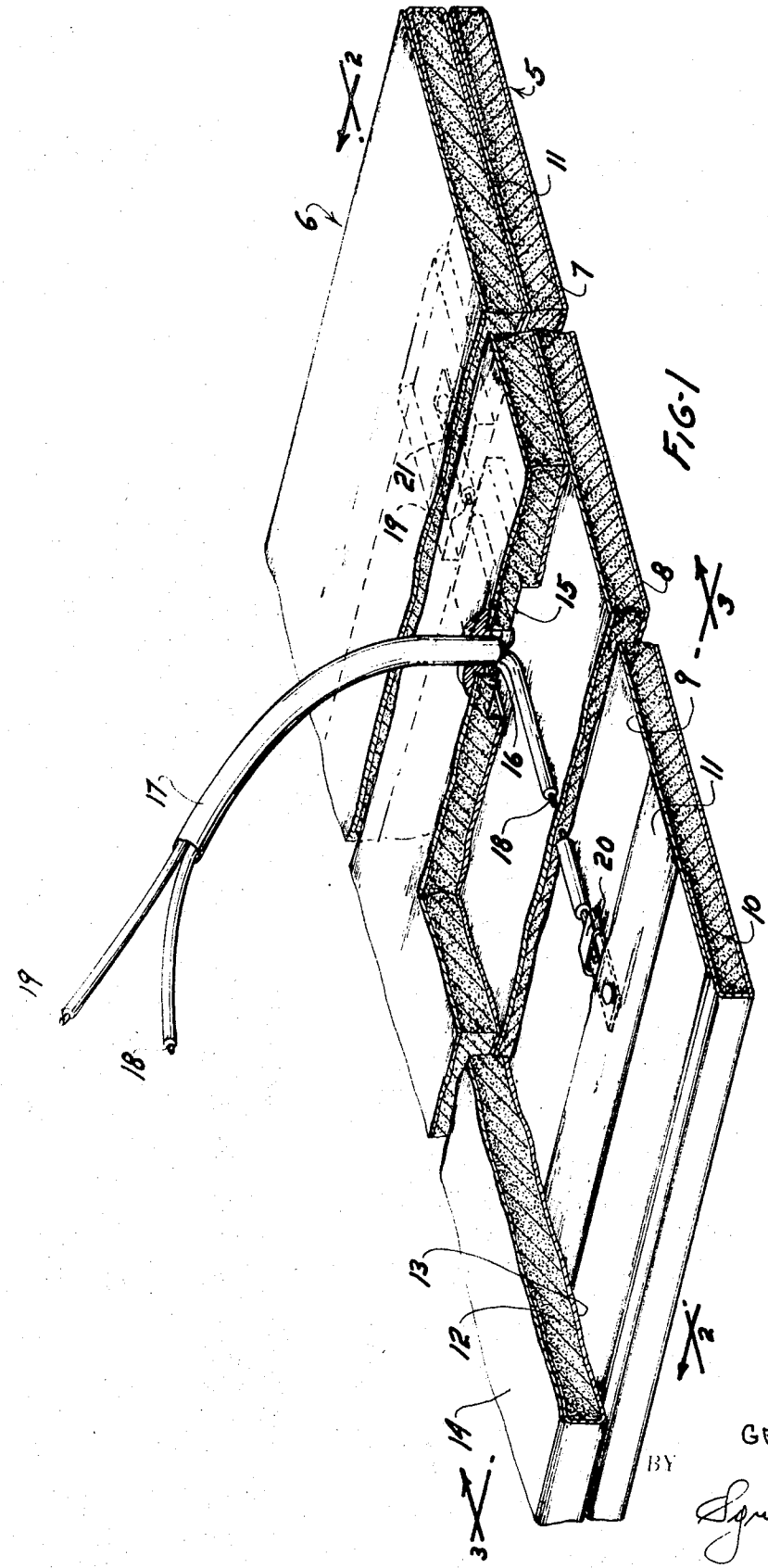


FIG. 1

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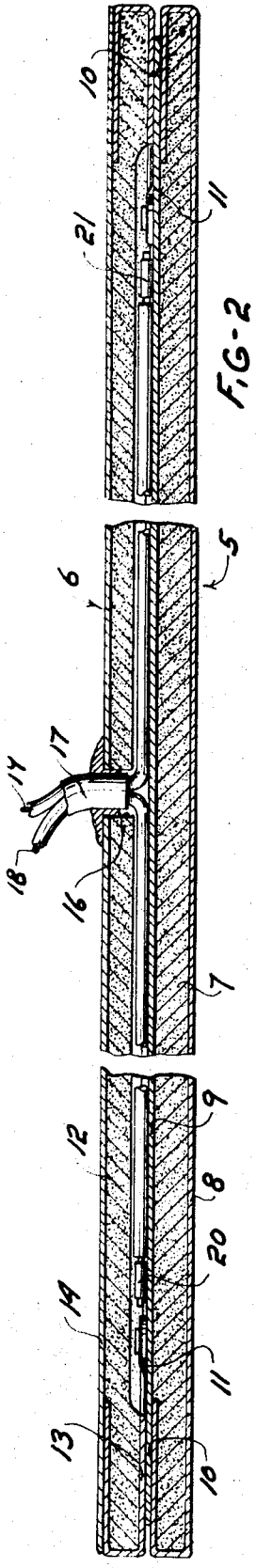


FIG-2

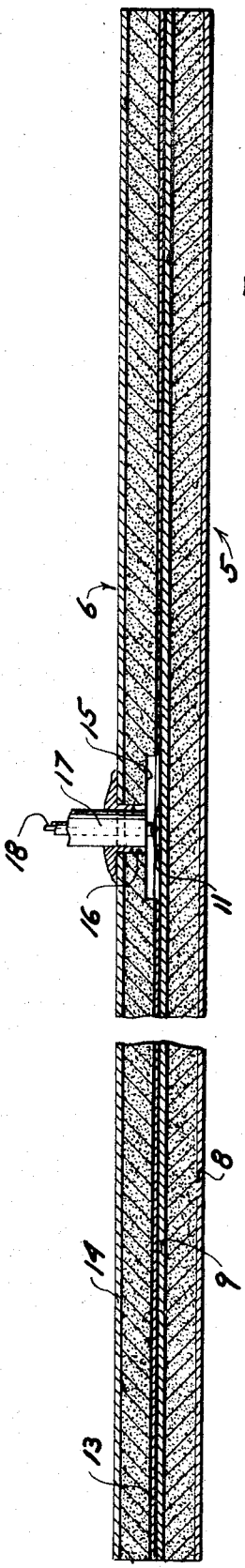
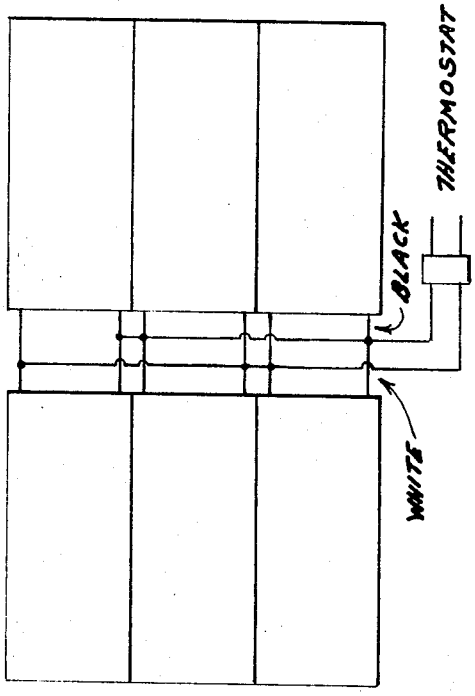


FIG-3

FIG-4



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RADIANT HEAT PANEL

This invention relates to radiant heating and especially to a novel form of radiant heat panel adapted for installation upon walls or ceilings, especially the latter, and preferably comprising a sandwich formed of a pair of plasterboards, with an electrically conductive paper sheet therebetween.

Various types of electrical radiant heat panels have been proposed and used to a limited extent heretofore. For example, various prior panels have utilized resistance wires or elements extended upon or within a panelboard, for instance in a serpentine path. Panels in this form have various disadvantages including the fact that it is not practical to trim the panels or otherwise cut them to fit the area to be covered in a wall or ceiling. Such cutting or trimming will of course sever the heating wires and thus destroy the electrical system of the panel. Moreover, with heating wires extended in a serpentine path over the area of the panel, the areas in which the panel may be nailed to supporting joists or studs is relatively limited. Panels in which numerous grooves have been cut to accept the serpentine heating wires are also of necessity considerably weakened.

In accordance with another type of prior art panel, a board or paper has been coated with an electrically conductive coating, applied in liquid form and then dried. Where such an element is prepared in the form of a coated paper, the paper is then laminated to a board and ultimately installed, or is adhesively applied to a board previously applied to a wall or ceiling. This type of panel made by applying a conductive coating is subject to certain serious disadvantages arising from the fact that a coating operation produces a conductive layer which is quite thin, for instance of the order of 0.002 inch. With coating materials containing powdered carbon or other conductive constituents, it is difficult to carry on the coating operation in a manner avoiding irregularities in thickness of the coating. For instance in the coating operation, lumps of the conductive material frequently are deposited in localized areas. Since the coating itself is quite thin, the local irregularities, resulting from lumps or the like are of thickness running up to several times the thickness of the coating itself. In other words, the thickness of the irregularities frequently present very large percentage increases in thickness of the coating, and this introduces large irregularities in the conductivity of the coating in different areas thereof.

Where the coating results in unintentional increase in thickness as compared with the average coating thickness, the areas of such increased thickness form "hot spots" because of the high increase of conductivity in those areas. This irregularity in the conductivity in different areas of a conductive coating applied in liquid form and then dried is a serious disadvantage with the type of radiant heating panel relying upon a coating operation to introduce the conductive layer into the product.

In addition to the foregoing disadvantage resulting from "hot spots," the form of heating element made by applying and then drying a coating is also disadvantageous because it requires highly specialized or unique manufacturing equipment.

It is an objective of the present invention to overcome various of the difficulties and disadvantages of prior art electrical radiant heat panels, and this is achieved according to the invention by using as the heating element of the panel a conductive paper sheet of substantial thickness, for instance upwards of about 0.010 inch. In a typical embodiment according to the present invention the conductive paper comprises cellulosic fibers, powdered carbon and a butadiene styrene binder. With a conductive paper having a thickness of the order of magnitude indicated, it is practical to maintain the thickness of the paper within tolerance limits representing a percentage variation from the average thickness which is much smaller than in the case of a conductive layer provided by a coating operation. Indeed, even if localized lumping or other irregularities occur in the paper, the percentage deviation from the mean

paper thickness is only a minor fraction of that ordinarily encountered in the case of a conductive layer provided by a coating operation.

In addition to the foregoing, the arrangement of the invention overcomes various of the disadvantages pointed out with reference to the type of radiant heat panel incorporating resistance wires. In contrast to the form of panel incorporating resistance wires, the panel of the present invention may be trimmed or cut, at least at one end, in order to fit the space to be covered. Also, as compared with panels incorporating heating wires, the panel of the present invention having a conductive paper sheet extended over the area of the panel is not weakened but, indeed, is strengthened by virtue of being a laminate as opposed to a single board, and it is only in very limited areas in which the panel incorporating the paper may not be penetrated by nails used for mounting the panel.

The laminated panel of the present invention not only has high strength and toughness, but in addition it is capable of being installed with much the same ease as regular wallboard.

It is a still further objective of the invention to provide an improved gypsum core formulation for use in a radiant heat panel and to provide an arrangement of electrical power supply means to the conductive paper of the panel, incorporated in the panel in a manner minimizing weakening of the panel and maximizing convenience in making the electrical connections.

The invention also has in view minimizing the total number of operations required to produce the radiant heat panel, and with this objective in view, the preferred practice of the invention contemplates production of a plasterboard of which the facing sheet at one face thereof is formed of the electrically conductive paper, so that the paper is directly bonded to the gypsum and constitutes a integral part of the plasterboard.

How the foregoing and other objects and advantages are attained will appear more fully from the following description referring to the accompanying drawings, in which:

FIG. 1 is an isometric view of a portion of a panel constructed according to the invention, with parts broken away and shown in section in order to more clearly disclose various features of the panel;

FIG. 2 is a transverse sectional view through the panel, taken generally as indicated by the section line 2–2 on FIG. 1;

FIG. 3 is a view similar to FIG. 2 but taken generally on the section line 3–3 on FIG. 1; and

FIG. 4 is a diagrammatic small scale plan view of a group of panels and the preferred arrangement of electrical connections to be used.

Although the terms "face" and "back" have frequently been used in the plasterboard industry to respectively identify the exposed and back sides of plasterboard as installed on a wall or ceiling, unless otherwise specifically indicated, the term "face" is used herein in a generic sense, i.e., to refer to either side of the board.

The panel of the present invention is made up of two plasterboards which are preferably adhesively secured to each other in face-to-face relation. These two boards are generally indicated in the figures at 5 and 6.

The board 5 comprises a gypsum core 7 having paper facing sheets at opposite faces thereof as indicated at 8 and 9. The sheet 8 may comprise normal plasterboard facing paper, but the sheet 9 preferably comprises electrically conductive paper which is directly laminated or bonded to the gypsum and which thus serves not only as a structural part of the board 5, but also as the heating element of the panel. As seen in the drawings, the paper sheet 8 extends around the edges of the core 7 and the edge portions of the conductive sheet 9 overlap the edge portions of the sheet 8 along the upper side of the board 5 as indicated at 10. The conductive sheet 9, however, is preferably terminated short of the side edges of the board, leaving a clearance space which will avoid contact of the edge of the conductive sheet of one panel with the edge of a conductive sheet of an adjacent panel when the panels are installed in edge-to-edge relation.

Contact strips or electrodes **11**, made for instance of copper, are applied to the conductive sheet **9**, desirably being secured thereto by an electrically conductive adhesive, for instance a solution of a synthetic rubber and resin mixture containing powdered carbon or some other conductive material. Such an adhesive is available from the Armstrong Cork Company under the designation 012551 Adhesive. These contact strips are positioned in spaced relation, desirably being extended lengthwise of the panels, for instance at a distance about one inch from the side edges. Electrical connections of the power supply means are to be connected with the contact strips in the manner which will be explained more fully herebelow.

Turning now to the construction of the second of the two plasterboards, i.e., the board indicated generally at **6**, it is pointed out that this board also comprises a gypsum core **12** having paper facing sheets at both sides, indicated at **13** and **14**. This board may comprise a standard form of board available from a plasterboard production line, which board is then subjected to certain machining operations. Thus, in one face of this board a channel indicated at **15** is cut out, this channel being extended transversely of the long dimension of the panel and desirably in a position near one end of the panel, for instance 6 inch. In addition an aperture **16** is drilled through the board in registry with the groove **15** and desirably in a position offset from the center of the board toward one side edge, for instance 4 inches off center.

The power supply system includes a two wire pigtail or lead **17** extended through the aperture **16** and having the two connecting wires **18** and **19** extended to terminal clips **20** and **21** which are fastened to the electrodes or strips **11**.

The power supply wires **18** and **19** are of course insulated from each other and are desirably encased in an insulating sheath in order to make up the two wire cable **17**. The insulation for the individual wires **18** and **19** is advantageously of different color, for instance black and white, and the manner of connection of these wires to the conductive strips **11** is desirably arranged in the same manner for each panel, in relation to the 4 inches offcenter location of the pigtail provided because of the offcenter drilling of the aperture **16** in the board. This uniformity of wiring from panel to panel assists in ensuring the desired pattern of connection of the power supply wires to the powerline, in a multipanel installation, as will be explained more fully herebelow.

In selecting the thickness of the individual plasterboards of which the panel is made up, several factors are kept in mind. First, it is noted that there are several standard thicknesses of plasterboards as presently manufactured, i.e., boards of ¼-inch, ⅜-inch, ½-inch and ⅝-inch thickness. It is preferred to make up the panel or sandwich of two plasterboards whose combined thickness will equal that of a board of one of the standard thicknesses, for instance ½ inch or ⅝ inch. When made up in this way, areas of a wall or ceiling which are not to be covered with the radiant heat paneling may readily be filled in and covered with a board of the standard thickness equal to the thickness of the radiant heat panel.

In the preferred radiant heat panel the thickness of the board presented inwardly to the room should be less than the thickness of the board presented outwardly, since this enhances inward "heat flow" into the room, while diminishing outward heat flow away from the room. Moreover, it is also preferred to utilize a thicker board at the outer side of the sandwich in order to more readily accommodate the channel (such as indicated at **15** in the drawings) provided for the electrical supply connections.

With the foregoing in mind, the preferred thicknesses of the plasterboards used to make up the radiant heat panels are the ¼-inch thickness for the inner board and the ⅜-inch thickness for the outer board, thereby making up a total of ⅝ inch which is the same as the standard ⅝-inch plasterboard.

Although the plasterboards used in accordance with the present invention may be of conventional composition and construction, it is preferred to employ plasterboards in which the gypsum is formulated to have a calcination temperature higher than that of ordinary plasterboards. Various ways are known for increasing the calcination temperature, for instance by the addition to the gypsum of boric acid. By employing a gypsum formulation having an elevated calcination temperature, the life of the panel will be increased.

Although electrically conductive paper made of various fibers and formulated in various ways may be employed, as above indicated it is preferred that the paper be at least 0.010 inch, and preferably at least 0.015 inch in thickness, for instance in the range of from about 0.020 inch to about 0.040 inch. The upper limit of thickness is not critical but, of course, very thick paper is not needed and would unnecessarily add to the expense. The minimum thickness of the paper, however, is of special importance because thickness variations represent only a very small percentage of the total paper thickness and therefore have very little influence upon the conductivity of the paper. This is of importance for reasons already explained, including the substantial elimination of hot spots of the kind encountered in certain prior types of radiant heat panels where the conductive layer is relatively thin, as occurs for example, by a coating operation.

The minimum thickness of the paper indicated is also desirable from the standpoint of the strength of the paper, thereby enabling use of the paper in the plasterboard-making equipment when it is desired to bond the conductive paper directly to the gypsum of the board core. Still further, a conductive paper of the thickness indicated will contribute strength to the panel.

Effective conductive papers for the purposes of the present invention are papers manufactured by Armstrong Cork Company and identified as Paper No. 260 and Paper No. 1140, being sold under the trade name "Temsheet." Paper of this kind of 0.030 inch thickness is advantageously used. It is formulated of cellulosic fibers and comprises powdered carbon as the conductive material dispersed throughout the thickness of the paper, and still further includes a butadiene styrene binder.

In FIG. **4** there is diagrammatically illustrated a pattern for electrically connecting a plurality of panels to a power source. Here it will be seen that six panels are illustrated in part, and it will appear that the powerline is so connected with the black and white supply wires of the individual panels that the adjacent longitudinal edges of the panels are connected to the same side of the powerline. Additionally the adjacent ends of panels are also so positioned so that if the conductive sheets of adjacent panels contact each other end for end, the conductive strips of the two panels will likewise be connected to the same side of the powerline. This will avoid arcing or short circuiting either at the longitudinal edges of the panels or at the ends of the panels.

It is to be noted that the panels constructed according to the present invention may readily be cut off at any desired length without interferring with the electrical connection system, and this is of very substantial advantage as compared with prior art panels in which heating wires are employed, because, with heating wires it is not possible to cut off a portion of the panel without destroying the electrical system.

It is contemplated according to the invention that the panels be made in standard wallboard sizes, for instance 4 feet × 8 feet, and it is also contemplated that the panels will be made in certain other lengths, such for example as 4 feet, 6 feet, 10 feet and 12 feet. In all cases the pigtail or power connection leads would of course be provided on the panel adjacent to one end thereof.

Still further panels are preferably made in which the overall width of the plasterboards is 4 feet but in which only about half the width of the panel is provided with the conductive paper sheet. With panels of this type, they may be trimmed not only by cutting off an end portion but also by cutting off a side edge portion.

When employing paper of the kind above described, it is contemplated to utilize the standard 240 v. current supply,

and with typical panels the wattage will be of the order of 60 watts per linear foot of the panel length, or 30 watts per linear foot in the case of the panels with a 2-foot wide conductive paper.

It will be understood that with variation in the paper employed, so that the conductivity thereof is different, the power consumption will of course also be different, and these variations may be resorted to to meet different installation conditions.

With regard to the heating panel as described above it should be noted that while the various parts of the panel, including the two plasterboards, the conductive paper and the electrical connections, could be installed separately, it is preferred that the several components of the panel be preassembled in the relation illustrated in the drawings and described above. Most advantageously, the several components of the board are adhesively secured to each other before installation.

Although the conductive paper can be adhesively applied over a standard facing sheet provided on a plasterboard, it is preferred to use the conductive sheet as one of the facing sheets employed in the manufacture of the board itself, in which case the conductive sheet serves not only as the heating element but also as a structural part of the board to which it is applied. Moreover, it is preferred to apply or bond the conductive paper to one side of the core of the thinner or inner plasterboard of the assembly, as this maintains the conductive sheet as close as possible to the surface of the assembly or sandwich from which it is desired to radiate the heat into the room.

The construction of the panel of the invention is of advantage in providing a very strong panel, this objective being achieved in part by the attachment of the conductive sheet to one of the two plasterboards used while, at the same time, arranging the power supply means including supply connections **18** and **19** in a manner lying between the planes of the two surfaces of the other board incorporated in the panel. In this way, the strength of the panel carrying the conductive sheet is not impaired. Moreover, the adhesive bonding of the two panel boards together results in mutual contribution of the strength of each to the other.

I claim:

1. A ceiling or wall panel comprising two plasterboards in face-to-face relation and each comprising a gypsum core, an electrically conductive paper sheet between said boards and secured to one of them, and electric current supply means associated with the conductive sheet comprising conductive strips secured to the conductive sheet along lines spaced from each other, the electrical current supply means further including power connections lying in large part between the opposite faces of the other plasterboard, the power connections being connected with said conductive strips and having power input leads extended through the outer face of said other plasterboard.

2. A panel as defined in claim **1** in which the two plasterboards are adhesively secured to each other.

3. A ceiling or wall panel comprising two plasterboards in face-to-face relation and each comprising a gypsum core, an electrically conductive paper sheet between said boards and secured to one of them, and a pair of electrical power connections at least one of which is extended in the region between said spaced conductive strips and lies in large part between the opposite faces of the other plasterboard, the power connections being connected with said conductive strips and having power input leads extended through the outer face of said other plasterboard in positions adjacent to each other.

4. A ceiling or wall panel comprising two plasterboards in face-to-face relation and each comprising a gypsum core, an electrically conductive paper sheet between said boards and secured to one of them, spaced electrically conductive strips secured to the conductive sheet, and a pair of electrical power connections at least one of which is extended in the region between said spaced conductive strips, the other plasterboard having a channel formed in its surface facing said one plasterboard accommodating the electrical power connection in said region, and the power connections being connected with said conductive strips and having power input leads extended through the outer face of said other plasterboard.

5. A ceiling or wall panel comprising first and second plasterboards secured together in face-to-face relation, each board comprising a gypsum core and paper facing sheets at both faces thereof, the facing sheet on the side of the first board facing the second board comprising an electrically conductive paper sheet directly bonded to the gypsum core, and electrical connections associated with the conductive sheet comprising conductive strips secured to the conductive sheet along lines spaced from each other.

6. A panel as defined in claim **5** in which said connections are accommodated at least in large part between the opposite faces of said second plasterboard.

7. A ceiling or wall panel comprising an assembly of two plasterboards in face-to-face relation and each comprising a gypsum core, the board at the side of the assembly to be presented inwardly being thinner than the board at the side of the assembly to be presented outwardly, an electrically conductive paper sheet between said boards and secured to one of them, and electric current supply means associated with the conductive sheet comprising conductive strips secured to the conductive sheet along lines spaced from each other, the electrical current supply means further including power connections lying in large part between the opposite faces of the thicker plasterboard, the power connections being connected with said conductive strips and having power input leads extended through the outer face of said thicker plasterboard.

8. A panel as defined in claim **7** in which the conductive paper sheet is secured to the thinner plasterboard.

9. A panel as defined in claim **7** in which the conductive paper sheet is directly bonded to the gypsum core of the thinner plasterboard.

10. A ceiling or wall panel comprising an assembly of two plasterboards in face-to-face relation and each comprising a gypsum core, the board at the side of the assembly to be presented inwardly being of standard ¼-inch thickness and the board at the side of the assembly to be presented outwardly being of standard ⅜-inch thickness, an electrically conductive paper sheet between said boards, and electric current supply means associated with the conductive sheet comprising conductive strips secured to the conductive sheet along lines spaced from each other, the electrical current supply means further including power connections lying in large part between the opposite faces of the assembly.