Oct. 14, 1969 P. EISLER 3,473,003

WALL COVERING MATERIAL FOR USE IN SPACE HEATING

Filed May 26, 1965 3 Sheets-Sheet 1

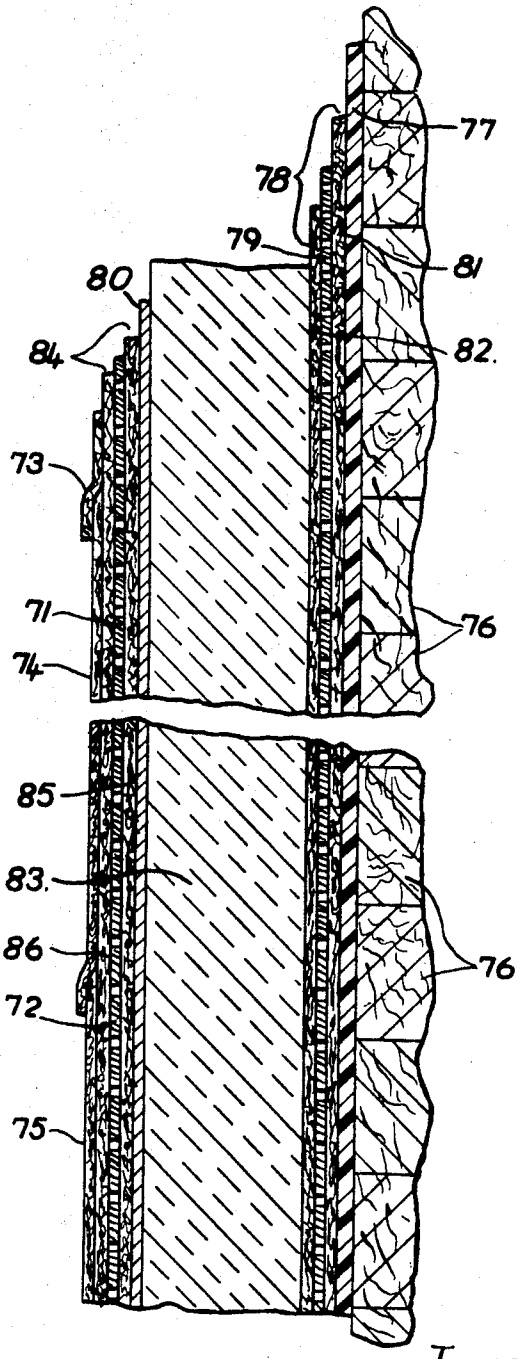


FIG. 1.

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Filed May 26, 1965 3 Sheets-Sheet 2

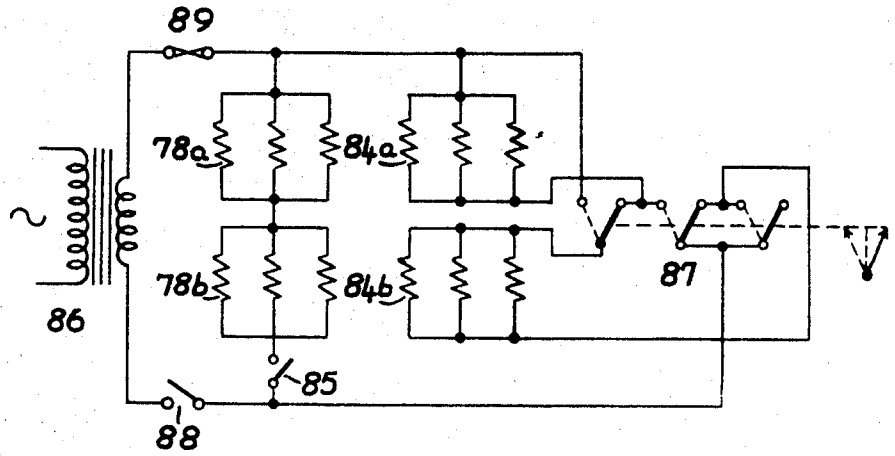


FIG. 2.

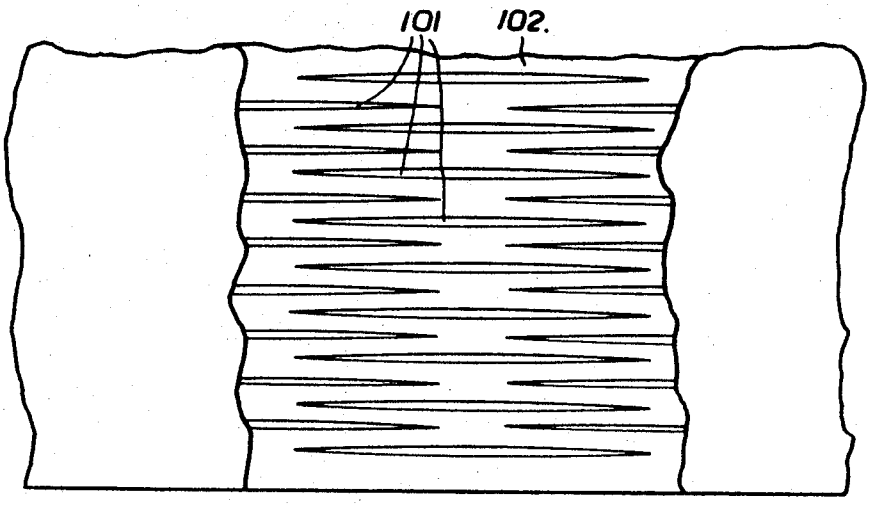


FIG. 7.

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WALL COVERING MATERIAL FOR USE IN SPACE HEATING

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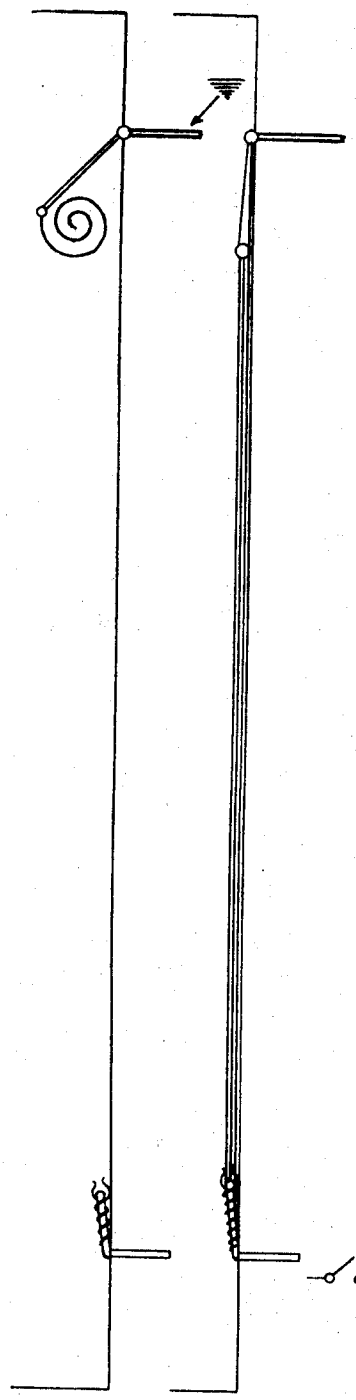
FIG. 3. FIG. 4.



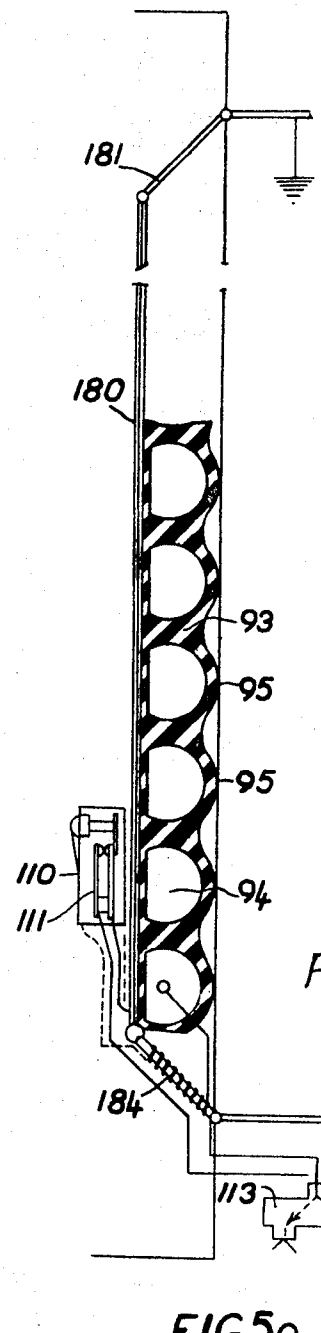
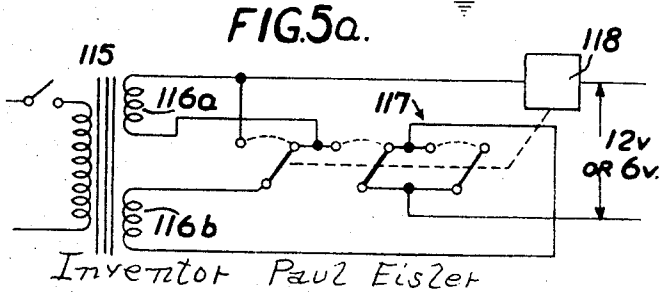



FIG. 6.

FIG. 5.

FIG. 5a.

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3,473,003

# WALL COVERING MATERIAL FOR USE IN SPACE HEATING

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Claims priority, application Great Britain, May 26, 1964, 21,688/64
Int. Cl. H05b 3/02, 3/26
U.S. Cl. 219—213 4 Claims

## ABSTRACT OF THE DISCLOSURE

A multi-layer wall covering material for use in space heating by means of an electric resistance heating film sandwiched between two other layers is a laminated structure (produced at latest when applied to a wall) comprising a three section structure. The first section incorporates the film sandwich, the second is an adhesive surface and the third section is on the space side of the first. The adhesive constituting the second section can be sufficiently weakened by an externally applied agent e.g. heat or a solvent to enable the third section to be stripped without damaging the first. The third section is penetrable by the agent, the first section is undamaged thereby; in the case of a solvent, it suffices for the layer of the third section adjacent to the second section to be impenetrable to the solvent. The material may include two surfaces weakenable by different agents. It may also incorporate two heating films, a heat reflective layer, various kinds of thermal insulation, be flexible so that it can be rolled up, or have an inflatable rear layer so that the spacing of the film from the wall can be varied.

This invention relates to a multi-layer covering material for use in space heating which includes an electric resistance heating film between at least two other layers. An electric resistance heating film is a thin structure which presents an electrically resistant path between terminal areas at which connection is made to it from a supply. The path desirably comprises a plurality of meander paths in parallel which can be produced by forming sequences of parallel slots in two relatively staggered sets in a thin conductive material such as a metal foil, or it may consist of a multitude of parallel paths in a sheet material, having a conductive coating, for example of carbon or graphite; usually the conductive material, which is desirably crimped, is held to a thin insulating layer or between two such layers and these may be provided with external metallic foil coverings so that the film is itself a multi-layer structure but for the purposes of the present invention the film may be regarded as one of the constituent layers of the multi-layer covering material. Examples of such heating films are described in my U.S. Patents Nos. 2,971,073, 3,020,378, 3,149,406, 3,283,284 and 3,317,657.

When such a film is used for space heating it usually has to be held to the surface of a wall in conjunction with other layers between at least two of which it may need to be laminated, so producing a multi-layer material, whether at the time of application to the wall or at some previous stage so that the multi-layer material would be prefabricated or partly prefabricated. For example there may need to be a layer of thermal insulation between the heating film and the mass of the wall and a decorative layer on the side of the heating film towards the space; it may also be necessary to include within the multi-layer material a thermal radiation reflecting layer. It also may be necessary from time to time to replace one of the layers, for example a decorative layer or the heating film, while the underlying layers may still be perfectly satisfactory if they can only be left undamaged.



According to the invention the adhesion between the various layers of a multi-layer material of the above character, that is to say a wall covering material for use in space heating which includes an electric resistance heating film between at least two other layers, the layers being laminated together at latest at the time of application to the wall, is of such a character as to permit delamination of at least one layer facing the space, while the adhesion between the layers to be left on the wall and their adhesion to the wall if they are actually secured to the wall remains resistant to the operations needed to effect said delamination.

The particular two layers between which the delamination can be effected in the above manner will be chosen according to the particular type of installation in which the multi-layer material is used. For example, a common requirement may be the possibility of stripping a decorative layer such as wallpaper so leaving all the underlying layers intact. In other cases it may be more important to be able to strip the heating film together with such layers as overlie it without damaging the underlying layers.

The zone of adhesion at which delamination is permitted may be formed by an adhesive which can be weakened by an agent which will penetrate the layers to be delaminated and is used in stripping said layers, while the underlying layer and its adhesion to the layers nearer the wall are resistant to said agent.

It might in some cases be desirable to enable delamination to be effected at two (or even more) inter-layer zones of adhesion within the total thickness of the multi-layer material, for example to enable either a decorative layer to be stripped from the underlying layers or the heating film with the decorative layer and any intermediate layers to be stripped, in which case the adhesion of the various layers to one another at the two zones in question could be of such character as to permit stripping at either of them, independently of the other or both together, by suitable choice of the adhesive and the agent used in stripping.

The invention will be further described with reference to to the accompanying diagrammatic drawings in which—

FIGURE 1 is a cross-section of a first example of embodiment of the invention;

FIGURE 2 is a circuit diagram illustrating one mode of control of the material shown in FIGURE 1;

FIGURES 3 and 4 are side views of another example of embodiment of the invention, respectively in a position out of use and a position in use;

FIGURES 5 and 6 are a side view with part broken away and a cross-section of a third example in two different positions of adjustment; and

FIGURE 7 is a face view with part broken away showing a typical example of a patterned foil used in the heating film.

Referring now to FIGURE 1, this illustrates a multi-layer material which incorporates two heating films and it is shown secured to a wall. Mounted directly on the wall **76** is a relatively thin thermal insulating layer **77**. Mounted on this layer is a heating film **78** comprising a patterned foil **79** sandwiched between two layers of insulating paper **81**, **82**. Mounted on the heating film **78** is a relatively thick thermal insulating layer **83** of a material which is easily dentable on which is mounted a layer **80** which is substantially more resistant to denting and protects the layer **83** from being dented. This layer **80** is desirably of material which is of substantially higher density than the layer **83** and has an extensibility less than the maxamum extensibility of a second heating film **84** and a decorative layer of wallpaper **73**, **74**, **75**, etc. The

film **84** is mounted on the layer **80** and comprises the patterned foils **71**, **72** etc. sandwiched between insulating papers **85**, **86**. The wallpaper is fixed over the heating film **84**, and is in widths **73**, **74**, **75** etc. which are disposed overlapping along the edges as at **70**, so that when heated the material can expand and can subsequently contract on cooling without visible gaps being produced between adjacent widths of wallpaper, such as might occur if the widths were hung abutted and spoil the appearance of the decorated wall.

The relatively thick insulating layer **83** may be formed of foamed or expanded synthetic resin materials or of corrugated paper, or any such material having a high air/solid ratio and thus forming a good insulator. The less easily dentable layer **80** may be of metallic foil. Such a foil can at the same time act as a thermally reflecting layer. In some cases such a layer may constitute the surface layer, i.e. the wallpaper might be omitted. In other cases the wallpaper itself may constitute a thermally reflecting layer, being for instance of a very light colour. Or again, if the patterned foils **71**, **72** etc. are of suitable character and the pattern itself does not result in large gaps in the foils, these can act as a thermally reflecting layer. A typical pattern such as shown in FIGURE 7, in which there are narrow lozenge-shaped slots **101** in a sheet of foil **102**, leaves a sufficient area of the foil unbroken for it to serve satisfactorily as a thermally reflecting layer in some cases. If other provision for a thermally reflecting layer is made, the less easily dentable layer **80** instead of being of metal foil, can be of a high density strong polymer foil, e.g. "Melinex" or a polyamide or even of a highly calendered paper.

The various layers of the material shown in FIGURE 1 are laminated together by adhesive. In a typical case the whole material is prefabricated before being mounted on the wall, this also being effected by the use of an adhesive. In other cases the material might be prefabricated, with the exception of the wallpaper which would be hung after the rest of the material has been secured to the wall. The invention provides that it should be possible to delaminate the multi-layer material at one of zones of adhesion. Typically this might be the zone between the wallpaper **73**, **74**, **75** etc. and the heating film **84**, or between the heating film **84** and the dent-resisting layer **80**. In the former case, the adhesive used between the wallpaper and the heating film could be an adhesive which is softenable by a solvent which can penetrate the wallpaper, while the surface layer of the heating film is insoluble in that solvent. Thus, if the wallpaper is penetrable by water, a water soluble adhesive may be used to fix the wallpaper to the water-insoluble surface of the heating film. A water soluble adhesive such as that known under the trade name "Polycell" may be used. The heating film of the invention is usually coated with a water-insoluble substance, for example a polyvinylactate based copolymer, at least on the surface which is arranged to face the wallpaper. Provided the heating film was not penetrable by water, a water-soluble adhesive could be used between it and the layer **80**, but if it is penetrable, a water-insoluble solvent would be necessary between the heating film and the layer **80**.

The adhesive used between the heating film **84** and the layer **80** could be one which softens at a temperature considerably higher than that developed by the heating film when it is in use, the adhesive used between the wallpaper and the heating film and between the layer **80** and the insulation **83** being of a character not affected by heat. Further back the adhesive would in any event be protected from heat by the insulation **83**. By the term "considerably higher temperature" is simply meant that the temperature is sufficiently higher that developed by the heating film, even when temporarily overloaded for instantaneous space heating purposes, to avoid any risk of detachment or undue weakening of the bond during use of the heating film.

If the wallpaper is penetrable by water and is secured by a water-soluble adhesive (e.g. "Polycell"), while the heating film **84** is secured to the layer **80** with a heat-softenable adhesive, (many suitable thermoplastic adhesives are commercially available, having a polyvinylacetate or other polymer base) by suitable choice of the agent used for instance damping by wetting (soaking) or using a heated roller, the wallpaper could be stripped from the heating film or the wallpaper and heating film together stripped from the layer **80**.

These are only examples, since it may be desired to provide for stripping at some other zone of adhesion within the thickness of the multi-layer material. In FIGURE 1 the thermal insulating layer **83** is shown much thicker than the layer **77**. Thus if the heating film **78** is brought into operation, heat will be much more rapidly transmitted towards the wall **76** than in the opposite direction towards the space. The film **78** thus serves as a wall heater, heat being stored in the wall. By suitable choice of the relative thickness and nature of the two thermal insulating layers the relationship between the heat dissipated in opposite directions from the film **78** can be predetermined.

The heating film **84** being backed by a thick layer of insulation **83** but on the other side only having the minor thermal insulation presented by the paper **86** and the wallpaper, when brought into use will dissipate the major part of its heat directly into the space as radiated heat.

The provision of two heating films in the multi-layer material enables heating to be effected according to various schemes to suit the type of installation in which the material is used and the temperature conditions met with. It will be desirable to provide for independent control of the two films and for the control to be adjusted differently in respect of at least one of the factors of timing, distribution of energy over the area bounding the enclosed space, the amount of energy and manner of dissipation.

FIGURE 2 illustrates one very simple scheme for achieving such independent control with a different range of adjustment for one of the films from that of the other.

Here the one heater comprises two sections **78*a***, **78*b*** permanently in series through an on and off switch **85** across the low voltage secondary winding of a transformer **86** supplied from conventional alternating current mains, while the other heater comprises two sections **84*a***, **84*b*** which can be connected in series or parallel across the secondary winding or be switched off altogether, by means of a switch **87**. With the switch **87** in the position shown in solid lines, the two sections are connected in series, when it is moved over to the left to the broken line position the two sections are connected in parallel, while in mid-position the two sections are disconnected altogether. In addition to the switches **85**, **87** there is a switch **88** which enables the supply to both heaters to be switched off, and a fuse **89** protecting the secondary circuit. It will be understood that the switches **85** and **87** will be controlled in accordance with the conditions, for example the switch **85** from the sensing device **17** of FIGURE 1 and the switch **87** by a combined manual and time mechanism.

It is not essential that the multi-layer material of the invention should be permanently fixed to a wall. Thus as shown in FIGURES 3 and 4, an extendable multi-layer material **180** according to the invention is provided, having a decorative covering layer to form a decorative scroll, blind or curtain, which is supported in its coiled form FIGURE 3, by an arm **181** attached to a wall **182** of the room to be heated. When it is desired to use the material to heat the room it is extended until it covers the wall **182**, as shown in FIGURE 4. Its free end is attached, by a spring clip **183**, to a second arm **184**. Electrical power is supplied to terminals attached to arms **181**, **184** and thus the heating film **180** incorporated in the material emits heat to warm the room. Power cannot be supplied to the film until the free end of the film is connected to spring clip **183**, and thus a safety device is incorporated

in the system since the full power cannot be supplied until the material **180** is fully extended.

The material **180** may incorporate two heating films as in FIGURE 1 or only a single such film and it may include an insulating layer between the heating film and the wall **182**.

With material used in this way it will usually be stripping of the decorative material which is provided for by the invention, so that the latter can be replaced from time to time without affecting the rest of the multi-layer material. Stripping can be effected and a new decorative layer applied with the material extended over the wall, notwithstanding that the material is not permanently fixed in this embodiment.

The multi-layer material may incorporate a thermal insulating layer, the heat transmittance of which is adjustable. Thus as shown in FIGURES 5 and 6 a thermal insulating layer **93** forms part of the multi-layer material and is constituted by an elastic material having inflatable internal cavities **94** distributed over it, the inflation of which can be varied to adjust the overall thickness and consequently the heat transmittance of the layer of insulation. Thus FIGURE 5 shows the cavities inflated much more than FIGURE 6. These figures also show the multi-layer material extendable over the wall and suspended as in FIGURES 3 and 4 but it could also be used in a permanently extended form, even with the layer **93** fixed to the wall at the small zones of contact indicated at **95** in FIGURE 5 so as to interfere as little as possible with the possibility of variable inflation of the cavities **92**.

This material may be controlled in accordance with the temperature at some point in the heater space, for example the surface temperature of the material. Thus as in FIGURE 5, a thermostat **110** which senses the surface temperature incorporates a switch **111** which is opened and closed as the temperature rises above or falls below a predetermined value and through a solenoid **112** regulates a valve **113** which connects the cavities **94** either to exhaust or to an air supply **114**, thus regulating the inflation of the cavities in accordance with the temperature.

This material can further be used for flooding a room with heat and subsequently reducing the heat supplied to the room by the heating film, say after an initial period of up to ten minutes. Thus as shown in FIGURE *5a*, the supply may be drawn from the conventional alternating current mains through a transformer **115** with a secondary winding in two sections **116***a*, **116***b* which by a switch **117** can be connected in series or parallel to provide a secondary voltage at 12 volts or 6 volts. During the initial period the supply is at 12 volts but at the end of the initial period, determined by an adjustable timing device such as a timing relay **118**, combined with a solenoid having its core mechanically linked to the switch **117**, the voltage to the material is reduced to 6 volts. Alternatively, with a constant power input to the heating film, the proportion of power radiated as heat into the room and conducted as heat into the wall may be readily varied by inflating and deflating layer **93**. Thus layer **93** could be inflated during the initial period, thereby increasing the proportion of heat radiated into the room and decreasing the proportion of heat conducted into the wall, and could then be deflated after the initial period, the timing device in this case serving to control the valve **113**.

The extendable multi-layer material of FIGURES 3 to 8 could be used as or on portable screens which may form temporary wall surfaces of a room and the inflatable material may be used as the main component of a heat-wall of an inflatable dome, igloo, tent or other structure held in erected position by inflation, while a strong textile or other fabric constitutes the outer component of the wall. Temporary partitions may be provided with collapsible heating layers and the partitions could then replace the wall in the arrangements of FIGURES 3 to 6.

The material of FIGURES 3 to 6 when extended over (or fixed to) the wall and with the heating film in use, as well as radiating heat into the space is also in direct heat exchange relationship with the neighbouring wall surface. When the inflation of the layer **93** is varied not only is the heat transmittance of the layer **93** thereby changed but the heating film is moved while it remains parallel to the neighbouring wall surface, and even if the heat transmittance of the layer **93** were changed only negligibly or not at all, the movement of the film could vary the relationship between heat dissipated in opposite directions by the film. Such a movement and variation in relationship of heat dissipated in opposite directions can also be achieved by omitting the cavities **92** and simply swinging the arms **184** to move the film towards or away from the wall.

In any of the above described embodiments, if the heating film embodies a metallic foil with the pattern of FIGURE 7, the foil itself will be vapour-impermeable. The patterned foil can be converted into a complete vapour barrier by closing the openings **101** by a vapour-impermeable flexible water-insoluble substance which is of relatively negligile electrical conductivity. The heating film will then serve to prevent surface and interstitial condensation both when the heating film is switched on and when it is switched off, even if the other layers of the material are not impermeable to vapour. While the substance may be inserted in the openings as an independent operation in the production of the film, it is much simpler to use the adhesive by the aid of which the three layers of the film are laminated together for the purpose. Thus the adhesive may be a thermoplastic based on polyvinyl-acetate, or it may be an elastomeric adhesive such as neoprene, and is squeezed into the openings **101** during the laminating process.

Any of the various layers of the multi-layer material may be of flame-proof or fire-proof material, thereby enhancing the fire resistant properties of the material.

The use of at least one terminal insulating layer as in all the above described embodiments, usually also assists sound insulation of the space, because the materials suitable for the purpose of thermal insulation are usually also efficient insulators for sound.

I claim:

**1.** A multi-layer wall covering material for use in space heating which includes an electric resistance heating film sandwiched between at least two other layers, the layers being laminated together at latest at the time of application to the wall comprising at least three sections, the first including the heating film and the two layers between which it is sandwiched, the second being a surface at which the first section normally adheres to the third section, the third section consisting of all the layers on the space side of the second section, the adhesion at the surface constituting the second section being weakenable by an externally applicable agent sufficiently to enable delamination to be effected thereat without damage to the first section, the first section being undamaged by said agent, and the third section being penetrable by said agent having more than one surface at which delamination is possible, the respective surfaces being formed by adhesive which can be weakened by different agents so that the surfaces at which delamination is effected can be selected by choice of the agent used.

**2.** A multi-layer wall covering material for use in space heating which includes an electric resistance heating film sandwiched between at least two other layers, the layers being laminated together at latest at the time of application to the wall comprising at least three sections, the first including the heating film and the two layers between which it is sandwiched, the second being a surface at which the first section normally adheres to the third section, the third section consisting of all the layers on the space side of the second section, the adhesion at the surface constituting the second section being weak-

enable by an externally applicable agent sufficiently to enable delamination to be affected thereat without damage to the first section, the first section being undamaged by said agent, and the third section being penetrable by said agent, the second section being constituted by an adhesive which is softenable by a solvent, the layers constituting the third section are penetrable by said solvent, and at least the layer of the first section next underlying the second section is insoluble in and impenetrable by the solvent.

3. A multi-layer wall covering material for use in space heating which includes an electric resistance heating film sandwiched between at least two other layers, the layers being laminated together at latest at the time of application to the wall comprising at least three sections, the first including the heating film and the two layers between which it is sandwiched, the second being a surface at which the first section normally adheres to the third section, the third section consisting of all the layers on the space side of the second section, the adhesion at the surface constituting the second section being weakenable by an externally applicable agent sufficiently to enable delamination to be effected thereat without damage to the first section, the first section being undamaged by said agent, and the third section being penetrable by said agent, the second section being constituted by an adhesive which is softenable by a solvent, the layers constituting the third section are penetrable by said solvent, and at least the layer of the first section next underlying the second section is insoluble in and impenetrable by the solvent, the adhesive being a water-sensitive adhesive and the third section is water-permeable.

4. A multi-layer wall covering material for use in space heating which includes an electric resistance heating film sandwiched between at least two other layers, the layers being laminated together at latest at the time of application to the wall comprising at least three sections, the first including the heating film and the two layers between which it is sandwiched, the second being a surface by which the first section normally adheres to the third section, the third section consisting of all the layers on the space side of the second section, the adhesion at the surface constituting the second section being weakenable by an externally applicable agent sufficiently to enable delamination to be affected thereat without damage to the first section, the first section being undamaged by said agent, and the third section being penetrable by said agent, two electrical resistance heating films, with thermal insulation between them, the two films being so arranged that they can be independently conrtolled for dissipating heat into the space under conditions which can be adjusted differently in respect to at least one of the factors of timing, distribution of energy over the area bounding the enclosed space, amount of energy and manner of dissipation and the two films being adapted to be connected in two different circuits the range of adjustment of one of which is in respect of at least one of the conditions which can differ is greater than the range of adjustment of the other.




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