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Eisler

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[54] **COMBINED DEMISTING AND DEFROSTING HEATING PANEL FOR WINDOWS AND OTHER TRANSPARENT AREAS**

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July 18, 1970 Great Britain.....34,971/70

[52] **U.S. Cl.** .....**219/203**, 52/171, 161/406, 174/117 A, 219/522, 219/526, 219/549, 338/212

[51] **Int. Cl.**.....**H05b 3/10**

[58] **Field of Search**.....219/203, 219, 345, 219/520, 522, 526, 541, 536, 543, 544, 546–549; 52/171, 203; 338/306–314, 210–212; 161/406; 174/68.5, 117 A, 117 F

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Attorney—H. Geoffrey Lynfield and Lester Horwitz

[57] **ABSTRACT**

Heater panel for application of heat to a transparent area, demisting and de-icing of vehicle rear windows. A panel form, adherent to the transparent area, has a transparent base of plastics material onto which there is made adherent a series of spaced parallel electrical solid conductor elements in meander form. The conductor elements are covered with an adhesive for ensuring sticking of them to the transparent area and to assist direct heat conduction to the transparent area. For variable rates of heating selective switching of series or parallel arrangements of the conductor elements is possible.

12 Claims, 3 Drawing Figures

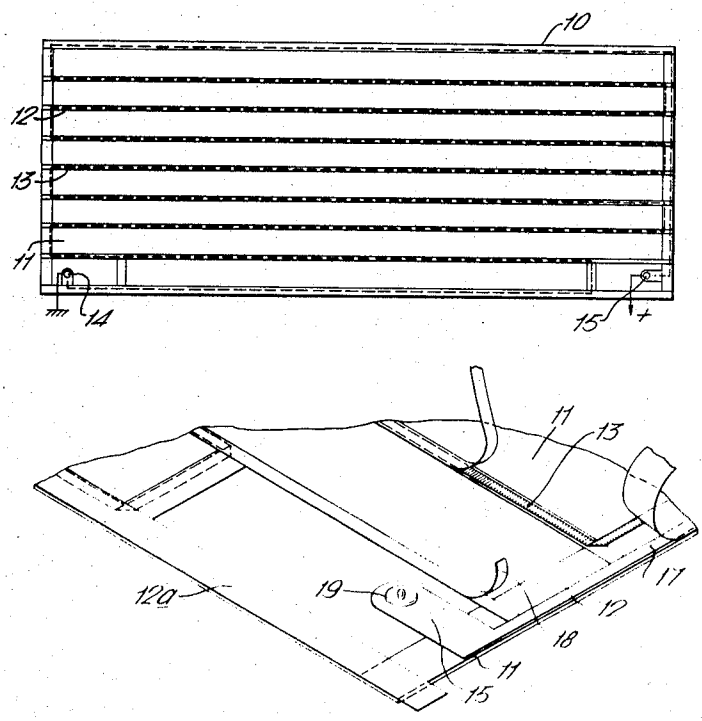


FIG. 1.

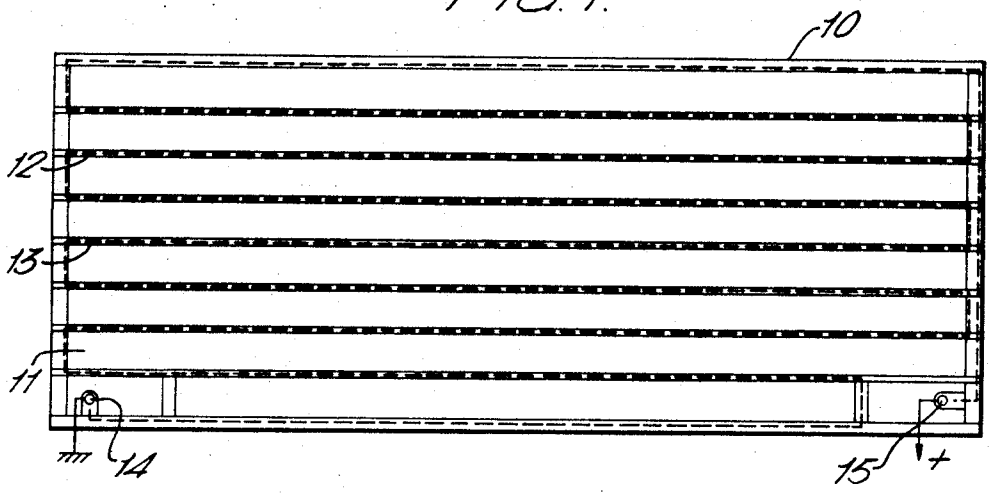
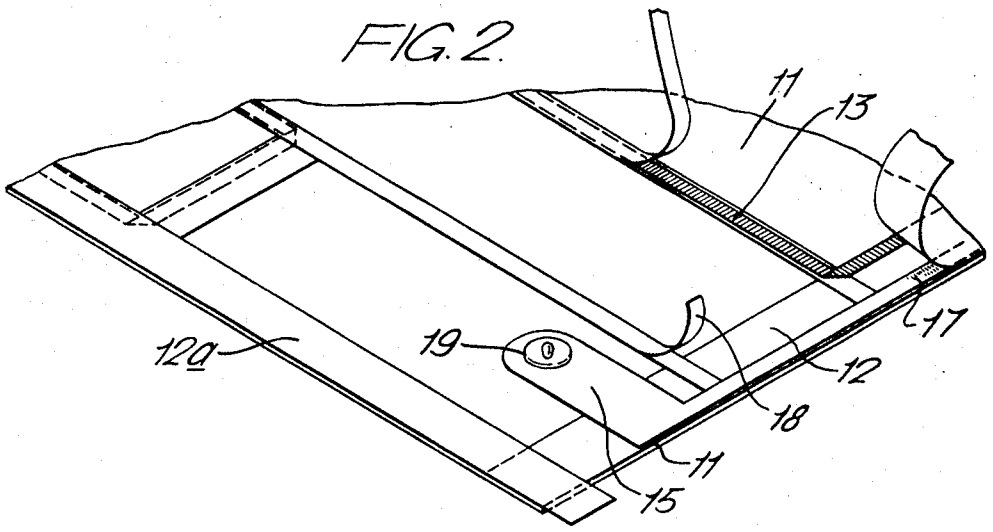


FIG. 2.



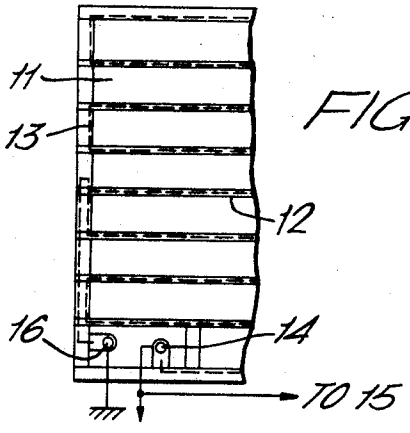


FIG. 3.

COMBINED DEMISTING AND DEFROSTING HEATING PANEL FOR WINDOWS AND OTHER TRANSPARENT AREAS

The present invention relates to panel heaters for the heating of transparent areas such as windows in cars, boats or other vehicles which have a power source of low voltage to supply the heating current.

A previously proposed panel heater for use in the heating of the rear window of a car comprises a film of polyester on the surface of which conductive lines are printed or painted, the borders of the film being treated with adhesive for fixing to the car rear window. In this known construction due to the limit set by the temperature endurance of the polyester film and due to the conductive lines which consist of conductive powder and an organic binder there is a limit to the permissable heating currents and values of heating current as required for de-icing are to be avoided. With a gap of air between the conductive lines and the glass of the window there is inefficiency of transmission of heat through the airgap to the glass of the window and distortions may arise by accidental contact of the conductive lines with the car window.

According to the present invention there is provided a combined demisting and defrosting heating panel for windows and other transparent areas comprising a thin, transparent, flexible, plastic base panel, a series of narrow, parallel, longitudinal solid metal heating elements forming a meander pattern mounted on said base panel and sufficiently distanced from each other to permit substantially uninterrupted vision, the parallel heating elements forming at least one electric circuit for heating the transparent area and adapted to be connected to a supply of current and adhesive means applied over and completely covering at least said heating elements so that the transparent panel can be stuck directly to the inside of the window so as to permit heat to be conducted directly from the heating elements to the window.

The parallel solid heating elements are preferably in the form of metal foil strips forming either one or two electrical circuits which permit a current to pass through all foil strips forming a circuit in series, while, in case of two circuits, the circuits themselves can be connected in series or parallel or switched on separately. The parallel horizontal heating elements or foil strips of a circuit cohere together in a meander pattern, preferably by being part of bent, continuous single conductor or foil strip which is folded, least said heating elements so or otherwise shaped into a 180° turn from one horizontal line into the next. The conductor or strip ends in terminals preferably at the lower corners of the panel. The terminals are preferably formed by a short copper-, brass- or other well conductive metal foil strip being welded to the circuit forming metal conductor or foil strip. The well conductive foil strip may carry a press button or tab. The circuit forming solid metal conductor is usually a thin aluminum alloy-, or a steel foil strip of approximately 0.1 inch width or less and may be crimped. A preferred production method for this strip is to slit from a thin wide foil, say approximately of 0.002 inch thickness, strips of say ⅛ inch width and fold the edges of these narrow strips up and back onto the strip so that they form new reinforced edges and narrow the strip down to 0.1 inch or less.

(See British Patent No. 1,020,311). The folding stage may be followed by a crimping stage.

The solid conductor or foil strip may be coated with an adhesive in order to adhere it to the polyester film forming the transparent base panel (and subsequently to the glass of the car rear window). The adhesive, at least for the latter task, is preferably a pressure sensitive adhesive which complicates application to the conductor or foil and then of the foil to the polyester film. These difficulties however can be overcome by special application devices in the factory producing the base panels, but the difficulty the motorist has to apply this panel to the inside of the usually curved glass of the rear window of the car cannot be solved satisfactorily without forcing him to use special gadgets, which is objectionable. In order to ensure firm adhesion, the thickness of the adhesive cannot be negligibly small and must be precisely controlled so that under the relatively heavy application pressure it does not ooze out and make an unsightly smear next to the foil line. The present invention solves this problem as hereinafter described.

A difference between the panels of the present invention and those in use at present lies in the nature of the narrow electrically conductive strips and the heat transfer to the glass of the window. By the present invention the conductors may be solid metallic foil strips or round wires and provision is made for these conductors to stick to the glass and thus transfer their heat by thermal conduction to the glass.

Panels as previously used on the other hand, have conductive lines printed or painted on the polyester film and the wide borders of the panel are treated to be adhesively fixed to the glass of the car's rear window. The conductive lines are not stuck to the glass and there is thus a thin airgap between them and the glass at least over most of their length.

For de-icing purposes this conventional design imposes a limit to the heating current which can be passed through the lines. This limit is set by the temperature endurance of the polyester film and by the nature of the conductive line, often consisting of conductive powder and an organic binder. Consequently the de-icing performance of the convention panel is rather poor, because of the limit of heat it is capable of generating and the inefficiency of transmitting this insufficient heat through an airgap to the glass.

It has already been pointed out that conductive heating elements or foil strip firmly stuck to the glass uses the efficient and quick conductive transfer of heat to the glass. What has not been pointed out is the fact that the intimate heat conductive adhesion of the conductor or foil to the window which under de-icing conditions is naturally cold keeps the temperature rise of the conductor down in spite of the relatively high wattage generated. This "cooling" effect on the conductor or foil while it is heating the cold glass of the window is a feature of a panel according to the present invention.

It has also be pointed out further above that the conductor or foil strip may have folded edges which reinforce the strip of metal. They may be compared to seams in a textile strip. Furthermore this reduces the danger of fatigue cracks which usually start at indents or other irregularities of the slit edge.

The foil may be crimped and this allows it to expand and contract on getting hot or cold without itself suffering unduly under stress and strain, nor itself subjecting

its bond to the glass and to the polyester film to such forces.

The problem of sticking the solid metal conductor or foil strip, may be overcome by use of double-sided self adhesive tape. This tape must be a little wider than the conductor or foil strip for most lines while it can and should be much wider on the four sides of the panel where it forms the panel borders. This tape is commercially available in width from ⅛ inch upwards in the form of a tissue paper or polyester film coated on both sides with a pressure sensitive adhesive and covered with a release paper. For applications to special windows much narrower adhesive tapes and foil strips can be produced, but for car rear windows an adhesive tape of ⅛ inch (0.125 inch) width and a foil strip of 0.1 inch width are a suitable combination. For the borders of the panel the adhesive tape may be ⅜ inch or ½ inch wide. The preferred adhesive is crosslinking and becomes stronger by the heating and is not affected by water nor by ultra-violet radiation. The production of the panel proceeds by first applying the two ½ inch and say seven ⅛ inch wide double coated tapes on the whole web of polyester film in the longitudinal web direction which will be the horizontal direction. Then the web movement is reversed, stopped, and the vertical ½ inch double coated tapes are applied. Next the release paper is stripped and the 0.1 inch wide metal conductor or foil is guided from its reel onto the center of the sticky ⅛ inch wide tape lines, folded, taken along the vertical ½ inch tape, folded again to go back within the next ⅛ inch wide horizontal tape until the whole pattern is completed, including the foil path within the ½ inch horizontal border tapes. Both ends of the conductor or foil are soldered or welded to copper or brass foil strips carrying a convenient terminal such as a tab or press stud which is led through a hole in the polyester film and fixed to the film mechanically for instance by a double coated adhesive patch.

Next a second layer of double coated self-adhesive tape is placed in exact register over the first layer of tape which is stuck to the polyester film and carries the 0.1 inch wide foil strip within its width. Thus the narrow foil strip is sandwiched between the two slightly wider tapes which extend over its edges and enclose it. The foil strip is consequently protected against corrosion, during storage or while on the window. The release paper stays on until the panel is to be mounted on the rear window of the car.

The curvature of the rear window of the car can be taken up by the thin polyester film. In order to ease the placing of the panel, it may have a masking tape along its bottom border which is lightly fixed on the window by way of a try-out for the correct position. When the position is judged satisfactory then the release paper is stripped and the panel is stuck to the glass horizontal line by line, beginning with the bottom line and pressing from center outwards. This results in cleanly and firmly adherent foil strips without smear. Only the thickness of a tissue remains between the foil and the glass. A near perfect heat conduction takes place.

The polyester film between the tape lines remains spaced from the glass by say eight very thin air gaps each between two horizontal foil lines and the vertical border tapes. When the metal conductor or foil strip gets warm a little of its heat also flows into this air gap and the air expands a little. This helps in demisting the film.

As a variant of the guidance of a single metal foil strip into a meander form and fixing it on the polyester film already covered by adhesive lines the production method described in British Pat. No. 905,867 and U.S. Pat. No. 3,020,378 can be used, where the metal foil pattern is produced directly from a wide foil and expanded. However for medium quantities the method hereinbefore referred to is preferred. The method of U.S. Pat. No. 3,149,406 may also be used.

The window heating panel as herein described is permanently stuck to the glass. In countries where de-icing requirements are rare a readily detachable rear window heating panel is desired, and in countries where the winter is very severe a detachable front window heating panel is desired. This detachable panel may be pivoted on a horizontal axle above the window and swung down for attaching it to the inside of the glass. For the front window it may be fixed to the sun visor. Its construction would differ in a number of features from the stick on panel of the present invention. It would have a relatively substantial soft rubber frame; it would use for the second layer of adhesive tape covering the metal foil strip not a double coated tape but a single sided one or one which is readily detached from the glass without leaving a mark, and the whole panel is pressed onto the glass by it having an opening from which air trapped between the film and the glass is pumped out. Alternatively the film can be made to act like a suction fitting, the trapped air being manually pressed out and prevented to come in again by the tight fitting of the soft rubber frame to the glass.

Reference is now made to the accompanying drawings which illustrate embodiments of the present invention here given by way of example. In the drawings:

FIG. 1 illustrates a plan view of a heating panel for the rear window of a car;

FIG. 2 illustrates an enlarged view around a corner of the panel the mode of construction;

FIG. 3 illustrates a modification for selective circuit switching.

In the embodiment illustrated in FIGS. 1 to 3, a heating panel is indicated by the general reference numberal **10** of overall dimensions 11 inches vertical height and 28 inches horizontal width. The panel has as base a thin, transparent, flexible, plastic material which may be 0.005 inches in thickness clear or anti-glare tinted polyester film and may be formed of clear material made by Imperial Chemical Industries under the registered trade mark "MELINEX". This base is indicated by the reference numeral **11.** On this base **11** on one surface thereof there is put down a pattern of double-sided adhesive strips of "MELINEX" of appropriate width indicated at **12** FIG. 3 and by the full lines **12** of the pattern in FIG. 1, the "MELINEX" strips **12** being made to adhere to the plastic base **11.**

The backing paper of these adhesive strips **12** is stripped off exposing the second sticky surface. The heating element is preferably in the form of a single continuous metal wire or conductor. A length of edge-folded aluminum foil strip or round or flattened metal wire indicated at **13,** FIG. 3 and by the dashed lines **13** of FIG. 1, is laid down to adhere to this so-exposed second sticky surface of the strips **12.** The lay out of the aluminum foil or metal wire thereby achieved provides a run of electrical conductor **13** in meander form adhering to the surface of the transparent base **11.**

Towards the lower left hand side of the base **11** in FIG. **1** there is indicated a terminal contact **14**, with circuit connection for earth, while towards the lower right hand side of the base **11** in FIG. **1** there is indicated a terminal contact **15** indicated with a circuit connection for the positive terminal of a car battery. A further terminal contact **16** may be provided as shown towards the extreme bottom left of FIG. **3**, the circuit connections as shown on FIG. **3** being the terminal contact **16** to earth and to mid-left hand side of **13**, terminal contact **14** to positive terminal and/or to terminal contact **15** towards the bottom right-hand side of the base **11**. Selective switching means, not shown, enable the two circuits indicated in FIG. **3** to be utilized in series, to constitute an arrangement as indicated in FIG. **1**, or to constitute a parallel circuit arrangement whereby each of the two circuits indicated in FIG. **3** can be switched on separately or a parallel circuit arrangement can be made.

As shown in FIG. **2** the terminal contact **15** is in the form of an L-shaped copper strip. The longitudinally extending limb of the copper strip **15** is connected to the appropriate part of the run of electrical conductor **13** indicated to the right hand side of FIG. **2** at **17** by ultrasonic or resistance welding. The terminal contacts **14** and **16** are likewise connected to appropriate parts of the run of electrical conductor **13** by ultrasonic or resistance welding or by soldering.

The profile of the run of electrical conductor **13** in meander form protruding from the base **11** which is thereby produced is then covered by strips **12***a* of the same "MELINEX" material as for the strips **12** of double sided adhesive, only this time the backing paper, indicated at **18** in FIG. **2**, is not removed. Press studs as indicated at **19** in FIG. **2** are inserted in each of the respective contacts **14, 15, 16.** The release backing paper is allowed to stay on until the panel is to be mounted on the rear window of a car when it is stripped off.

Instead of strips **12***a* of flat form as the strip **12** there may be utilized for the covering strips **12***a* a strip of curvilinear profile to envelop a run of conductors also of curvilinear form such as solid wires of round section. The run of conductors **13** may be of circular cross-section and the covering strips **12***a* of partly circular cross-section with their edges flat to the underlying flat strip **12.**

The panel as hereinbefore described may be stored for vending purposes in a carton. This carton may have printed on it a pattern corresponding to the conductive lines of the run of conductors of the panel. When installing the panel heater on the rear window of a car, this carton is temporarily affixed to the rear window from the outside. This helps the panel heater to be properly aligned with respect to the rear window and installation of the panel heater is facilitated.

It will be appreciated that for demisting purposes a series arrangement of a circuit or of the circuits provided by the run of electrical conductors may be utilized while for deicing purposes a parallel arrangement of circuits provided by the run of electrical conductors may be utilized. Switching to one or other of these modes of use may be a suitable form of selector switch provided for use with the panel heater. A thermostat, or time switch, or both such devices, may be incorporated in the switch arrangement for use with the panel heater.

In a device as hereinbefore described the transfer of heat by direct conduction from the conductors of the panel heater to the glass of the vehicle rear window is facilitated. The conductors of the panel heater may be in the form of a wire or a strip of aluminum alloy, forming metallic heating elements as distinct from powders or deposited metal embodied in a printed circuit. The heating elements formed by the conductors are stuck to the vehicle rear window and conduction of heat to the glass of the rear window can take place in a direct manner over the whole width of the conductors. The self-adhesive tape covering the conductors is of larger dimension than the maximum width of the respective conductors.

The adhesive material covering the conductors may be stuck to the glass of the rear window of the vehicle such that it envelopes the respective conductors. With a solid wire completely enveloped in the adhesive material firm adherence to the glass and conduction of heat to the glass is attained. This tends to ensure intimate contact with the glass despite high current values with avoidance of hot spots.

Use of an edge folded aluminum alloy foil gives additional strength and avoids cutting when the tape is handled manually. The aluminum alloy strip may be utilized in the form of a reel on which there is wound a strip of width 85 thousands of an inch, the minimum width of the adhesive strip being 125 thousands of an inch, there thus being a possible overlap on each side of 20 thousands of an inch. Ideally the aluminum strip should be centered on the pressure adhesive tape and it should not show at all after the second layer of adhesive tape has been applied.

The heating of a rear window of a car by 85 watts from a 12 volt battery has been found to result in quick de-icing. The heating circuits should not have a power consumption of more than **200** watts to avoid excessive drain on the vehicle battery. With a panel heater designed to consume 80/200 watts it never gets really too hot to be unsafe to touch.

With a view to making the whole panel adherent to the rear window of a vehicle, with the practical exclusion of air and, therefore, moisture, the conductor heating foil is first stuck to a thin film of "MELINEX". The film carrying the conductor heating elements can be attached to the rear window of a vehicle in various ways:

1. The "MELINEX" film is coated with a uniform layer of pressure-sensitive solvent based acrylic adhesive, and dried until all the solvent has evaporated. The uniform application of the adhesive is essential for the optical clarity and lack of distortion expected from the assembly. When attaching the film to the window it is advisable to warm the window first in order to free it from any traces of moisture which normally adhere to glass.
2. The "MELINEX" film is coated with a uniform layer of a non-tacky, solvent based acrylic adhesive capable of being plasticized. The window is painted or sprayed with a uniform 'ayer of a plasticizer capable of combining with the acrylic adhesive. When the film is pressed against the window, it will at first adhere merely through the liquid film of plasticizer. After a limited time, as plasticizer and acrylic resin combine adhesion will become positive.

3. The "MELINEX" film is coated only immediately prior to applying it to the window with an acrylic resin of low molecular weight which has been mixed with peroxides and unsaturated monomers of the type of "SARTOMER" resins (supplied by Anchor Chemical Co. Ltd., London). The coated film is pressed against the window and curing starts forthwith. By using low molecular weight resins a liquid solvent-less system results. Acrylic resins are recommended as they combine optical clarity, resistance to ultraviolet light, resistance to heat and to yellowing. Solvent based systems exhibit good water resistance as well.

I claim:

1. A combined de-misting and defrosting heating panel for windows and other transparent areas comprising a thin, transparent, flexible plastic base panel, a series of narrow, parallel, longitudinal solid metal heating elements forming a meander pattern mounted on said base panel and sufficiently distanced from each other to permit substantially uninterrupted vision, the parallel heating elements forming at least one electric circuit for heating the transparent area and are adapted to be connected to a supply of current and adhesive means applied over and completely covering said heating elements without said adhesive means covering any substantial part of the area of the window between said parallel heating elements so that the transparent panel can be stuck directly to the inside of the window so as to permit heat to be conducted directly from the heating elements to the window.

2. A heating panel as claimed in claim **1** wherein the heating panel is applied to the rear window of a motor vehicle.

3. A heating panel as claimed in claim **1** wherein the heating elements are in the form of a continuous single strip of metal foil.

4. A heating panel as claimed in claim **1** wherein the heating element is in the form of a single continuous metal wire.

5. A heating panel as claimed in claim **1** wherein the heating element is in the form of a continuous single, edge-folded strip of metal alloy foil.

6. A heating panel as claimed in claim **1** wherein the heating element consists of an alloy of aluminum.

7. A heating panel as claimed in claim **1** wherein the heating element is in the form of a continuous strip of crimped metal foil.

8. A heating panel as claimed in claim **1** wherein the adhesive means used to stick the base transparent panel to the inside of the rear window of a motor vehicle comprises double-sided self-adhesive tapes of slightly greater width than the heating elements, said tapes being placed over the heating elements.

9. A heating panel as claimed in claim **1** wherein said adhesive means comprises double-sided self-adhesive tape of slightly greater width than the heating elements placed over said heating elements and somewhat wider self-adhesive tape is placed along the panel borders and is adapted to be stuck to the inside of the window.

10. A heating panel as claimed in claim **1** wherein the space between adjacent parallel heating elements forms thin enclosed air pockets which are heated by the surrounding heating elements.

11. A heating panel as claimed in claim **1** wherein the heating elements are connected in two circuits which can be selectively switched on in series and parallel.

12. A heating panel as claimed in claim **1** wherein the parallel heating elements are arranged horizontally and are joined with shorter vertical portions to form a continuous circuit in the meander pattern.

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