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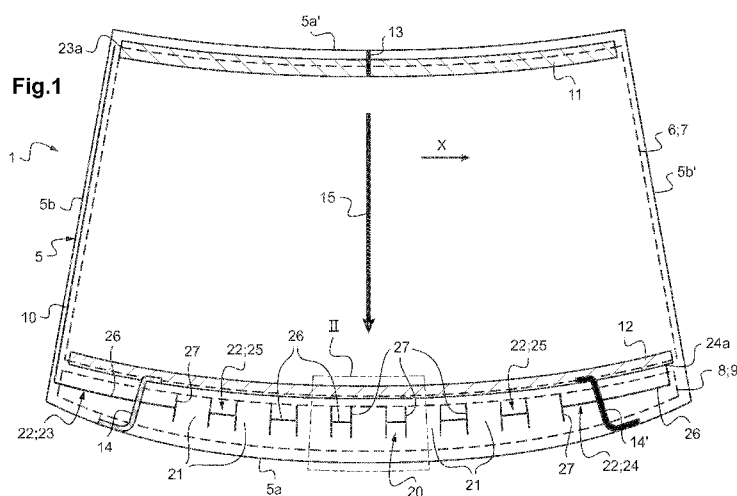
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(54) Title: TRANSPARENT WINDOW PANE WITH ELECTRICAL HEATING LAYER



(57) Abstract: A transparent window pane (1) comprises a main heating layer (6) and an additional heating layer (8) electrically isolated from each other, a first and a second electrode (11, 12) adapted to be electrically connected to a main power source and electrically connected directly to the main heating layer (6) such that after application of a supply voltage, a main heating current flows through the main heating layer (6) between the first and second electrodes (11, 12), and at least one conducting part (20) adapted to be electrically connected to the main power source or another power source. The conducting part (20) is interrupted by interruption zones (21), whereby the conducting part is formed of a plurality of conducting elements (22) physically separated from each other. Each conducting element (22) is electrically connected to the additional heating layer (8), such that after application of a supply voltage to the conducting part (20), an additional heating current flows through the heating layer (8) in each interruption zone (21).

TRANSPARENT WINDOW PANE WITH ELECTRICAL HEATING LAYER

TECHNICAL FIELD

The present invention is in the field of pane technology and relates to a transparent window pane having an electrical heating layer.

5 PRIOR ART

Transparent window panes having an electrical heating layer are well-known per se and have already been described many times in the patent literature. In motor vehicles, they are frequently used as windshields since the central visual field must, by law, have no substantial vision restrictions. By means
10 of the heat generated by the heating layer, condensed moisture, ice, and snow can be removed in a short time.

The heating current is usually introduced into the heating layer by at least one pair of strip- or band-shaped electrodes. These electrodes should introduce the heating current into the heating layer as uniformly as possible and distribute it
15 widely.

For most of the materials currently used in industrial mass production, the electrical sheet resistance of the heating layer is relatively high and may reach several ohms per square. In order to nevertheless obtain adequate heating output, the supply voltage must be correspondingly high, but, for example, in
20 motor vehicles, standardly, only an onboard voltage of 12 to 24 volts is available. Since the resistance of the heating layer increases with the length of the current path of the heating current, the bus bars of opposite polarity should have the least possible distance between them. In the case of motor vehicle panes, which are usually wider than they are high, the bus bars are, consequently, disposed along
25 the two longer edges of the panes such that the heating current can flow via the shorter path of the height of the pane. This design results, however, in the fact that the region of a resting or parked position of windshield wipers provided to wipe the pane customarily lies outside the heating field such that no adequate heating output remains present there and the wipers can freeze in place.

This problem was solved for example by additionally heating the region of
30 wiper storage through heating wires, as described in international patent application WO 2008/104728.

The object of the present invention consists in further improving transparent panes with an electrical heating layer, by reducing their energy
35 consumption.

This and other objects are accomplished according to the proposal of the invention by a transparent pane with the characteristics of the independent claims.

Advantageous embodiments of the invention are indicated by the characteristics of the subclaims.

SUMMARY OF THE INVENTION

5 A transparent window pane according to the present invention comprises:
- a main (electrical) heating layer extending over a main heating part of the transparent window pane and an additional (electrical) heating layer extending over an additional heating part of the transparent window pane, the additional heating layer being electrically isolated from the main heating layer,

10 - a first electrode and a second electrode adapted to be electrically connected to a main power source and electrically connected directly to the main heating layer such that after application of a supply voltage, a main heating current flows through the main heating layer between the first and second electrodes, and

15 - at least one conducting part in the additional heating part and adapted to be electrically connected to the main power source or another power source,

wherein the conducting part is interrupted by interruption zones, whereby the conducting part is formed of a plurality of conducting elements physically separated from each other by said interruption zones, each conducting element being electrically connected to the additional heating layer, such that after
20 application of a supply voltage to the conducting part, an additional heating current flows through the heating layer in each interruption zone.

The transparent window pane according to the invention is for example a pane exhibiting - on at least part of its surface - a transmission in the visible range higher than 70%.

25 The main and additional heating layers are both electrically heatable and can be electrically connected to a power source.

The first and second electrodes in the main heating part serve to introduce a heating current into the main heating layer and are electrically connected directly to the main heating layer such that after application of a supply voltage to
30 the electrodes, a heating current flows over a heating field formed by the heating layer. External connectors may be provided for connection of the first and second electrodes with the two terminals of the main power source.

In the windshield of a motor vehicle, the first electrode is located adjacent the upper edge of the pane and the second electrode, adjacent the lower edge of
35 the pane such that the two electrodes run in the transverse direction of the pane or the motor vehicle.

The first and second electrodes are generally designed in the form of strip or band electrodes (in particular "bus bars", notably silver busbars or busbars of

any other conductive material, for example made by printing such as ink jet printing or silk screen printing etc.), in order to introduce the heating current widely distributed into the heating layer.

According to an embodiment, the first and second electrodes may be electrically connected directly over their full strip length to the main heating layer. For this purpose, the two electrodes may be applied completely on the heating layer, for example, by screen printing, or only in a connection section extending along the full length of the electrode. The electrodes have preferably, in each case, a contact region that extends over the complete strip length and provides direct electrical contact with the heating layer.

The sheet resistance of the main and/or additional heating layer is, for example, in the range from 0,1 to 200 ohm/square, more particularly from 0,5 to 50 ohm/square.

Compared to the high-resistant main heating layer, the first and second electrodes have a relatively low resistance and therefore do not contribute to the electrical heating. The window pane according to the invention further comprises an additional heating layer located in an additional heating part. The additional heating layer is electrically isolated from the main heating layer. As a consequence, the additional heating part cannot be directly heated by the first and second electrodes located in the main heating part.

Preferably, the main heating layer and the additional heating layer are electrically separated from each other by a heating layer-free pane zone. This separation zone may be formed by removal of part of a heating layer (by laser cut for example) covering both the main and additional heating part or by masking during application of the said layer, or any other adapted method. Laser cut is particularly easy, fast and economic.

When the pane according to the invention is a motor vehicle windshield, the additional heating part can be the region of a resting or parked position of windshield wipers provided to wipe the pane.

In the additional heating part is provided a conducting part, which is directly connected to the additional heating layer.

The conducting part is interrupted by interruption zones. That is, the conducting part is formed of a plurality of conducting elements placed one next to the other, but physically separated from each other by said interruption zones.

The expression "physically separated" means that two adjacent conducting elements are not directly contacting each other, in any point.

Zones carrying the conducting elements are called hereafter "conducting zones".

When a supply voltage is applied between the two connection points of the conducting part, the current flows through each conducting element and, in each interruption zone, through the additional heating layer to which each conducting element is electrically connected.

5 In the conducting zones, the current flows mainly in said conducting elements, whereby the additional heating layer in said conducting zones is not heated. On the other hand, the conducting elements themselves do not – or only in a negligible amount - contribute to the electrical heating. Reason for that is that the conducting element generally has a resistance which is significantly lower than
10 the resistance of the additional heating layer.

As a consequence, the conducting zones are non- or low heated zones. On the contrary, the interruption zones separating two conducting elements are heated, due to the relatively higher resistance of the additional heating layer and the absence of conducting element.

15 The window pane is thus provided, in the additional heating part, with a row of alternate heated zones (corresponding to the interruption zones) and non-heated or low-heated zones (corresponding to the conducting zones carrying the conducting elements).

By duly interrupting the conducting part (i.e. by duly placing the conducting
20 elements forming said conducting part), it is thus possible to accurately design where the additional heating part of the window pane is electrically heated and where not.

This can be advantageous in particular in cases where some areas of the window pane are, in use, heated by an external system, for example a hot air
25 stream supplied by an air conditional system. In the window pane according to the invention, such air swept zones can be taken out from active heating.

As a consequence, for a given current intensity, an optimized heating power per surface unit can be obtained in the interruption zones compared with the prior art systems, in which a part of the heating power was wasted to parts of the
30 window pane which did not need extra heating.

Also, with the arrangement according to the present invention, the heating effect in all interruption zones can be made homogeneous.

Advantageously, the conducting elements and the interruption zones are alternated in a row extending in a transverse direction of the window pane.

35 Generally, the window pane has two edges, in particular long-side edges, extending in the said transverse direction. As explained hereabove, the first and second electrodes typically run in said transverse direction. The conducting part is advantageously configured such that the conducting elements and the interruption

zones are alternated along at least a part of one of said edges of the window pane, preferably along at least 50% of the entire length of said edge, still more preferably along at least 70% of the entire length of said edge, even more preferably 95%. In the case of a windshield, this edge is usually the long-side lower edge of the window pane.

The conducting elements may be formed of conducting tracks or wires.

According to an embodiment, the conducting elements may be formed of printed tracks or wires. Advantageously, the conducting elements may be printed in the same printing step as first and second electrodes, this allowing saving process steps (wiring).

A conducting element may be formed of copper, tungsten, silver, gold, or any other appropriate material.

According to an embodiment, the conducting tracks or wires have a thickness (measured in a direction orthogonal to the main surfaces of the window pane) of between 1 and 100 μm , more preferably between 5 and 15 μm and a width (measured in a direction tangential to the main surfaces of the window pane) of between 0,1 and 10 mm, more preferably between 0,5 and 5 mm.

Typically, the conducting part is an interrupted line comprising a plurality of line parts. In particular, each conducting element comprises at least one line part, generally extending (at least in part) in the transverse direction of the window pane. Each conducting element could also comprise two or more parallel line parts extending in the transverse direction of the window pane.

According to an embodiment, each conducting element further comprises at least one collecting end part running transversally to said line part at each end of the line part facing an adjacent conducting element.

The collecting end part of a first conducting element so faces the collecting end part of an adjacent second conducting element, an interruption zone being delimited by facing collecting end parts of two adjacent conducting elements.

By "collecting" is meant here which collects the current from the heating layer or introduces the current into the heating layer.

According to an embodiment, the conducting elements of the conducting part are H-shaped or T-shaped. Preferably, each conducting element located between two interruption zones is H-shaped. Preferably, the conducting part comprises two T-shaped conducting elements at its ends.

According to an embodiment, each conducting element is directly contacting at least one edge of the additional heating layer, notably an edge delimiting a heating-layer-free edge of the window pane and/or an edge delimiting

the heating-layer-free separating part between the main heating layer and the additional heating layer.

According to an embodiment, the length of each connecting element located between two interruption zones is at least 10%, preferably at least 50%,
5 of the length of any of the said adjacent interruption zone.

According to an embodiment, the transparent pane comprises at least two interruption zones, preferably at least five interruption zones, preferably distributed in the transverse direction of the pane.

According to an embodiment, the conducting part has only two (a first and
10 a second physical) connection points (terminals) physically connected to the main power source or another power source. In other words, one end conducting element (end connection section) of the conducting part is physically connected to the positive terminal of the power source and an opposite end conducting element (end connection section) is physically connected to the negative terminal of the
15 power source. The intermediate conducting elements located between interruption zones have no physical connection with the positive or negative terminals of the power source.

According to an embodiment, the conducting part is adapted to be electrically connected to the main power source, to which the main heating layer
20 part is connected. Preferably, the conducting part is electrically connected to the first and second electrodes of the main heating part, in an electrical parallel circuit with respect to the main heating field. For example, the conducting part may directly contact at least one of the first and the second electrode. In the latter case, end connection sections of the conducting part may sometimes be disposed,
25 at least in some regions, in physical contact with the main heating layer, with at least the regions of said sections disposed in physical contact with the heating layer provided with a sheathing electrically insulating against the environment. Such sheathing can, for example, be a polyurethane or polyimide coating. Preferably, however, the end connection sections are disposed at least partially in
30 a heating layer-free or heating field-free edge zone of the pane. In that particular case, it is possible to dispense with an insulating sheathing of the end connection sections.

The conducting part may thus be fed with the same supply voltage as the main heating layer, such that, advantageously, it is possible to do without
35 separate external connectors.

However, it may also be advantageous to connect the conducting part with separate external connectors and preferably with a separate power source, for

example to avoid connecting sections on the transparent pane or when the conducting part should be supplied with higher or lower voltage.

Typically, the transparent window pane comprises two sheets bonded to each other by an adhesive layer, wherein the heating layer is situated on at least one surface of the two sheets and/or on a surface of a carrier arranged between the two sheets, and wherein the conducting part is disposed between the two sheets.

The two sheets may be made of glass or of a non-glass material, for example, plastic.

The adhesive layer preferably comprises a thermoplastic material, for example polyvinyl butyral (PVB), ethylene vinyl acetate (EVA), polyurethane (PU) and/or polyethylene terephthalate (PET), and may be composed of one or several thermoplastic films.

The present invention is further directed to the use of a transparent pane as described above as a functional individual piece in particular in means of transportation on land, in the air, or on water, in particular in motor vehicles, for example, as a windshield or rear window.

The invention concerns, in particular, an assembly comprising a transparent window pane as defined hereabove, and air supplying means, the air supplying means being configured to supply air between interruption zones of the window pane.

According to an embodiment, the air supplying means comprise air ducts adapted to be fed with air, notably by an air conditioning system. The transparent window pane and the air ducts are then assembled such that each air duct is adapted to supply air between interruption zones of the window pane.

According to an embodiment, the assembly more specifically comprises an instrument panel, in particular an instrument panel of a vehicle, provided with the plurality of air ducts.

The present invention further is directed to an element, in particular a vehicle, comprising such an assembly and an air conditioning system feeding the air ducts.

It is to be understood that the different embodiments can be realized singly or in any combinations. In particular, the aforementioned technical features and those to be explained in the following can be used not only in the combinations indicated, but also in other combinations or alone, without departing from the scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be explained in more details with reference to particular and non-limitative embodiments of the invention. The figures depict, in a simplified, not-to-scale representation, schematic views of transparent window panes or parts thereof, according to these particular embodiments of the invention:

- Figure 1 is an overall view of a transparent window pane according to a first embodiment of the invention;
- Figure 2 is a detailed view of part II in figure 1;
- Figure 3 is a cross-section view of part II along plane III in figure 2;
- Figure 4 shows the heating power distribution in the additional heating part of the window pane of figure 1;
- Figure 5 shows the outer glass surface temperature distribution in the additional heating part of the window pane of figure 1;
- Figure 6 illustrates part II, according to a second possible embodiment of the invention;
- Figure 7 shows an assembly according to the invention, comprising a transparent window pane and an instrument pane of a vehicle from the front (in a main or longitudinal direction of the vehicle).

DETAILED DESCRIPTION OF THE DRAWINGS

In figure 1, a pane according to a first embodiment of the invention is embodied in the form of a motor vehicle windshield referred to as a whole by the reference 1.

As better shown in figure 3, the windshield 1 is a composite pane, which (as can be discerned from the interposed cross-sectional depiction) comprises a rigid outer sheet 2 and a rigid inner sheet 3, bonded to each other by means of a thermoplastic adhesive layer 4, here, for example, a polyvinyl butyral film (PVB), ethylene vinyl acetate film (EVA), polyurethane film (PU) and/or polyethylene terephthalate (PET). The basic structure of such a composite pane is well known to the person skilled in the art, for example, from the mass production of motor vehicles, such that there is no need to discuss it here in detail.

The two sheets 2, 3 are approximately the same size, have a roughly trapezoidal curved contour, and are, for example, made of glass, or of a non-glass material, such as plastic. For an application other than a windshield, it is possible to make the two individual sheets 2, 3 from a flexible material.

The contour of the windshield 1 is defined by an edge of the pane 5, which is, corresponding to the trapezoidal shape, composed of two long side edges 5a,

5a' (bottom and top in the installation position), and two short side edges 5b, 5b' (left and right in the installation position).

A transverse direction X of the window pane is generally defined as a direction orthogonal to a plane of symmetry of the window pane, and generally corresponding to the direction of the long side edges 5a, 5a'.

The window pane comprises a main heating layer 6 located in a main heating part 7 and an additional heating layer 8 located in an additional heating part 9 thereof. Both heating layers serve to electrically heat the windshield 1.

The main and additional heating layers 6, 8 together cover substantially the entire surface of the pane 1, with a circumferential edge strip 10 on all sides of the pane not coated such that a heating layer edge is set back inward relative to the edge of the pane 5 from a distance r (see figure 3 - constant or variable along the edge 5 of the pane) comprised for example between 2 and 50 mm. This provides electrical insulation of the heating layers 6, 8 against the outside and protection of the heating layers against corrosion penetrating from the edge 5 of the pane.

The main and additional heating layers 6, 8 are for example deposited on the side of the inner sheet 3 bonded to the adhesive layer 4.

As an example, the main and additional heating layers 6, 8 are deposited as one and the same heating layer. The said single layer may then be separated in two parts by laser or mechanical grinding process, as will be explained in more detail hereunder.

The heating layers may comprise, in a manner known per se, a layer sequence with at least one electrically conductive metallic sublayer, preferably silver, and, optionally, other sublayers (metallic or not), such as anti-reflection layers and blocker layers. The layer sequence advantageously has high thermal stability such that it withstands, without damage, the temperatures of typically more than 600° C necessary for the bending of glass panes; however, layer sequences with low thermal stability can also be provided. Instead of being applied directly on the inner pane 3, it could, for example, also be applied on a plastic film that is subsequently glued to the outer and inner sheet 2, 3. For example, the heating layer may be applied on a PET foil. The main and additional heating layers are, for example, applied by sputtering (magnetron cathode sputtering). The sheet resistance of the heating layers 6, 8 is, for example, in the range from 0,5 to 50 ohm.

In the particular embodiment, the main heating layer 6 is intended to heat the upper pane region, corresponding to the region of the pane intended to be placed in the visual field of a driver or operator.

As already explained previously, the main heating layer 6 is electrically connected directly to a (top) first electrode - here in the form of a first bus bar 11 - and to a (bottom) second electrode - here in the form of a second bus bar 12.

Both bus bars 11, 12 are band- or strip-shaped and serve as connection electrodes for the broad introduction of a supply current into the main heating layer 6. For this purpose, the bus bars 11, 12 are disposed on the main heating layer, with the first bus bar 11 extending along the upper long-side edge of the pane 5a' and the second bus bar 12 extending along the lower long-side edge of the pane 5a. The two bus bars 11, 12 are thus electrically connected directly to the main heating layer 6 along their full strip length and make contact with the main heating layer, in each case, in a contact region situated on their underside. The two bus bars 11, 12 run exclusively along the long-side edges 5a, 5a' of the pane, but not along the short edges 5b, 5b' of the pane. The two bus bars 11, 12 are made of one and the same material and can, for example, be produced by printing a paste on the main heating layer, for example, by screen printing. Alternatively, it would also be possible to make the bus bars 11, 12 from narrow metal foil strips, for example, of copper or aluminum. These can, for example, be fixed on the adhesive layer 4 and be disposed on the main heating layer 6 at the time of the bonding of the outer and inner sheets 2, 3. An electrical contact can be ensured through the action of heat and pressure at the time of the bonding of the individual panes.

A first connection lead 13 that is implemented as a flat ribbon cable (e.g., narrow metal foil) is electrically connected in direct contact to the first bus bar 11, and is connected to a first terminal of a main power source to make a supply voltage available. In the example, the first connection lead 13 is disposed roughly in the center of the upper long-side edge of the pane 5a' perpendicular to the first bus bar 11.

Two second connection leads 14, 14' (e.g., narrow metal foils) are electrically connected in direct contact with the second bus bar 12, and are connected to another terminal of the main power source. The two second connection leads 14, 14' are disposed at a distance on both sides of the central region of the pane.

A main heating field 15, in which a heating current flows upon application of a supply voltage, is enclosed by the two bus bars 11, 12. Because of a resistance negligible compared to the main heating layer 6, the bus bars 11, 12 do not heat up and make no appreciable contribution to the heating output.

The lower pane region, which is no longer part of the visual field but corresponds to the region of a resting or parked position of windshield wipers provided to wipe the pane, is heated by the additional heating layer 8.

In order to avoid any short circuit, the main heating layer 6 and the
5 additional heating layer 8 are electrically isolated, in particular galvanically isolated, for example by a heating-layer-free separating zone 16 (see figure 2 or 3). The separation zone 16 may be formed by removal of the heating layer either by laser or by a mechanical grinding process, or by masking during application of the layer. The separation zone 16 may have a width d of for example 10 μm to 2
10 mm in case of laser decoating or between 1 mm and 30mm in case of a mechanical grinding process.

The additional heating layer 8 forms a strip extending in the transverse direction X , almost on the entire length of the window pane 1 in the said transverse direction. It is delimited by the heating-layer-free separating zone 16
15 on one side and by the circumferential edge strip 10 on the other side. The additional heating layer 8 has a width g measured perpendicularly to the transverse direction typically comprised between 10mm and 250mm, depending notably on the glass geometry.

As a consequence, the additional heating layer 8 cannot be flowed through
20 by the heating current flowing in the main heating part 7 and is not directly heatable through the two bus bars 11, 12.

In order to heat the additional heating part 9, the latter is provided with a conducting part 20.

The conducting part 20 has globally the form of an interrupted line, in
25 particular of a regularly interrupted line, extending in the transverse direction of the window pane, from the vicinity of left short side edge 5b to the vicinity of right short side edge 5b'.

Typically, the conducting part extends along an edge (generally a lower edge) of the window pane, on at least 50%, preferably 80% of the length of said
30 edge.

The conducting part 20 has only two connection points with which it is (physically) connected to a power source for voltage supply, as will be described in more details hereafter.

As indicated hereabove, conducting part 20 is a discontinuous line
35 interrupted by interruption zones 21. It is so formed of a plurality of conducting elements 22 physically separated from each other by said interruption zones 21.

Each conducting element 22 is electrically connected to the additional electrical heating layer 8.

In the following description, the zones of the additional heating part 9 carrying the conducting elements 22 are referred to as conducting zones 50.

The conducting part 20 is advantageously formed of printed conducting tracks or wires. These tracks/wires are formed by applying electrically conductive paste on the inner sheet 3 in the same printing process, in particular screen printing process, as the first and second bus bars 11, 12. In other words, the conducting part 20 is directly printed on the additional heating layer 8. It is so into direct contact with said layer 8 and electrically connected thereto.

The tracks/wires have, for example, a width b between 0,1 and 10 mm and a thickness e between 1 and 100 μm .

The conducting elements 22 forming the conducting part 20 have a resistance which is low, such that they have almost no heating output with the customary onboard voltage of a motor vehicle of 12 to 24 V. For example, the conducting elements may be formed of the printed Ag tracks having a conductivity of $43.50\text{E}6$ S/m with the additional heating layer having a conductivity between $25.0\text{E}4$ S/m and $1.43\text{e}6$ S/m (this example being provided for the sake of illustration only, and being not limiting in any way).

In the illustrated embodiment, the conducting part 20 comprises a first end connecting section (end conducting element) 23, a second end connecting section (end conducting element) 24, and a plurality of intermediate conducting elements 25, all being separated by interruption zones 21.

The first end conducting element 23 of conducting part 20 comprises a line part 26 extending partially along the heating-layer-free short edge 5b of the window pane 1. One connecting end 23a of said line part is in direct contact with the first bus bar 11, so forming a first connection point of the conducting part 20 for voltage supply.

The second end conducting element 24 comprises a line part 26 extending in the vicinity of the opposite short edge 5b', with one connecting end 24a thereof directly contacting the second bus bar 12, so forming a second connection point of the conducting part 20 for voltage supply.

Each intermediate conducting element 25 also comprises a line part 26, straight or slightly curved, extending in the transverse direction and along the lower long-side edge 5a of the pane.

The length $L2$ of each intermediate connecting element is at least 10 %, preferably at least 50%, of the length $L1$ of any of the adjacent interruption zones 21 (see figure 2).

All line parts 26 of the conducting elements 22 so form a discontinuous conducting line along the lower edge 5a.

As shown in figures 1 and 2, each conducting element 22 further comprises a (strip-shaped) collecting end part 27 running transversely to its corresponding line part 26, at at least one end of the said line part 26.

The first end section comprises at its end opposite to the connecting end 23a, a transversally extending collecting end part 27, facing an adjacent intermediate conducting element 25.

The second end section comprises at its end opposite to the connecting end 24a, a transversally extending collecting end part 27, facing an adjacent intermediate conducting element 25.

Each intermediate conducting elements 25 also comprises a collecting end part 27 orthogonal to its line part 26, at each end.

It is to be noted that all conducting elements are arranged such that the strip-shaped collecting end part 27 of a first conducting element 22 faces the strip-shaped collecting end part 27 of an adjacent second conducting element 22 in the transverse direction X of the window pane.

An interruption zone 21 is so delimited by the facing strip-shaped collecting end parts 27 of two adjacent conducting elements 22 forming the conducting part 20.

In the example shown in figure 1, the transparent window pane comprises one conducting part 20 which has, between its connection points 23a, 24a, seven interruption zones 40 regularly distributed along the long-side lower edge 5a of the window pane 1, symmetrically with respect to a mid-plane of the pane.

As explained hereabove, each conducting element 22 is electrically connected to the additional electrical heating layer. In particular, each conducting element is directly contacting the heating layer, notably through its collecting end parts.

Taking one intermediate conducting element 25A of figure 2 as an example, the left collecting end part 27a thereof forms an electrode contacting the additional heating layer 8 and collecting the current flowing from the adjacent conducting element through said heating layer in interruption zone 21a. The collected current then flows through the line part 26 of the conducting element 25A to the right collecting end part 27b. The right collecting end part 27b forms an electrode contacting the heating layer 8 and serves to introduce the current flowing through the line part 26 into the additional heating layer 8 in the following interruption zone 21b. The current is then again collected by left collecting end part 27a of adjacent conducting element 25B and so on.

Because the resistance of the conducting elements 22 is negligible compared to that of the additional heating layer 8, in the conducting zones 50, the

current runs firstly in said conducting elements 22 and not through the additional heating layer 8. On the other hand, the conducting elements 22 do not – or only insignificantly- heat up. Therefore, the conducting zones 50 are not or low - electrically heated.

Advantageously, the lengths of all interruption zones 21 are equal. The electrical potential in all conducting elements 22 being the same, the heating effect in all interruption zones 21 is homogeneous.

Figure 4 shows the heating power distribution in the additional heating part of the window pane of figure 1, with an electrical potential of 14 V applied to the conducting part 20. The specific heating power measured in the interruption zones 21 is between 350 and 650 W/m². The calculated average specific heating power in these zones is 478.1 W/m². On the contrary, the average specific heating power in the conducting zones 50 located on either side of the interruption zones 21 is close to 0.

Figure 5 shows the outer glass surface temperature distribution in the additional heating part 9 of the window pane of figure 1, in the same conditions. The simulation shows a difference in the measured temperature of 12 to 16°C between the interruption zones 21 and the conducting zones 50.

In the example illustrated in figures 1 and 2, each collecting end part 27 of each conducting element 22 runs until the edge of the additional heating layer delimiting the separation part 16. This allows the current to flow directly and straight in the interruption zone from one collecting end part 27 to a facing one, without much deviating from a rectilinear trajectory orthogonal to the said end parts.

In this example, however, the other end of each collecting part 27 remains distant from the circumferential edge strip 10.

According to another embodiment illustrated in figure 6, each conducting element 22 may directly contact both heating-layer-free zones 16, 10 located on each side of the additional heating layer 8. As shown in the figure, each conducting element 22 extends on the entire width of the additional heating part 9, in a direction orthogonal to the transverse direction X. In particular, each collecting part 26 of each conducting element 22 contacts, at one end, the separation part 16, and, at its opposite end, the circumferential edge strip 10.

It is understood that each interruption zone 21 is so delimited exclusively by the two heating-zone-free parts and two conducting elements (in particular the strip-shaped end parts of two adjacent conducting elements).

This measure further improves the heating power per unit surface for a given current intensity, and the homogeneity of the heating in the interruption

zones. A simulation similar to that of figure 6 with the arrangement of figure 4 shows a specific heating power in the interruption zones between 550 and 650 W/m², with an average specific heating power in these zones of 597 W/m².

Advantageously, the conducting zones 50 correspond to areas of the window pane which are heated by another external system, and which do not need extra electrical heating.

As an example, figure 7 illustrates an assembly 60 according to an embodiment of the present invention, comprising a transparent window pane 1 of the type defined here above, and an instrument panel 70 of a vehicle.

The instrument panel comprises air ducts 72 adapted to be fed with hot air by an air conditioning system (not shown in the figure).

The transparent window pane 1 and the instrument panel 70 are assembled such that each duct 72 is adapted to supply air to a conducting zone 50 of the window pane 1.

In particular, as shown in the figures, the instrument panel 70 may be provided with a number of ducts equal to the number of conducting zones 50 in the window pane, each duct 72 being adapted to supply one respective conducting zone.

The hot air provided by the ducts 72 heat the conducting zones 50. These zones do therefore not need any extra heating.

On the contrary, interruption zones 21, which are not directly impacted by the hot air supplied by the ducts 72, need to be heated.

This heating is achieved by applying a supply voltage to the connection points 23a, 24a of the conducting part 20: As explained hereabove, current then flows from one conducting element 22 to an adjacent conducting element 22 in each interruption zone 21, through the additional heating layer 8.

CLAIMS

1. A transparent window pane (1) comprising:

- a main heating layer (6) extending over a main heating part (7) of the transparent window pane (1) and an additional heating layer (8) extending over an additional heating part (9) of the transparent window pane, the additional heating layer (8) being electrically isolated from the main heating layer (6),

- a first electrode (11) and a second electrode (12) adapted to be electrically connected to a main power source and electrically connected directly to the main heating layer (6) such that after application of a supply voltage, a main heating current flows through the main heating layer (6) between the first and second electrodes (11, 12), and

- at least one conducting part (20) in the additional heating part (9) and adapted to be electrically connected to the main power source or another power source,

wherein the conducting part (20) is interrupted by interruption zones (21), whereby the conducting part is formed of a plurality of conducting elements (22) physically separated from each other by said interruption zones (21), each conducting element (22) being electrically connected to the additional heating layer (8), such that after application of a supply voltage to the conducting part (20), an additional heating current flows through the heating layer (8) in each interruption zone (21).

2. The transparent window pane (1) according to claim 1, wherein the conducting elements (22) and the interruption zones (21) are alternated in a row extending in a transverse direction (X) of the window pane (1).

3. The transparent window pane (1) according to claim 1 or 2, wherein each conducting element (22) comprises at least one line part (26) and at least one collecting end part (26) running transversally to the said line part (26) at each end of the line part facing an adjacent conducting element (22).

4. The transparent window pane (1) according to any one of claims 1 to 3, wherein each conducting element (22) located between two interruption zones is H-shaped.

5. The transparent window pane (1) according to any one of claims 1 to 4, wherein the length of each conducting element (22) located between two

interruption zones (21) is at least 10 % of the length of any of the said interruption zones (21).

6. The transparent window pane (1) according to any one of claims 1 to 5, wherein the conducting part (20) has only two connection points (23a, 24a) physically connected to the main power source or another power source.

7. The transparent window pane (1) according to any one of claims 1 to 6, wherein each conducting element (22) is directly contacting at least one edge of the additional heating layer (8).

8. The transparent window pane (1) according to any one of claims 1 to 7, comprising at least two interruption zones (21), preferably at least five interruption zones.

9. The transparent window pane (1) according to any one of claims 1 to 8, wherein the conducting elements (22) are formed of conducting tracks or wires, notably printed tracks or wires.

10. The transparent window pane (1) according to claim 9, wherein the conducting tracks or wires have a thickness of between 1 and 100 μm , more preferably between 5 and 15 μm and a width of between 0,1 and 10 mm, more preferably between 0,5 and 5 mm.

11. The transparent window pane (1) according to any one of claims 1 to 10, comprising two sheets (2, 3) bonded to each other by an adhesive layer (4), wherein the heating layer (4) is situated on at least one surface of the two sheets (2, 3) and/or on a surface of a carrier arranged between the two sheets, and wherein the conducting part (20) is disposed between the two sheets (2, 3).

12. The transparent window pane (1) according to any one of claims 1 to 11, wherein the conducting part (20) is electrically connected to the first and second electrodes (11, 12) through at least one connection section (23), in particular a connection section (23) at least partially located in a heating-layer-free edge zone (10) of the transparent window pane (1).

13. An assembly (60) comprising a transparent window pane (1) according to any one of claims 1 to 12 and air supplying means, in particular air ducts (72) adapted

to be fed with air by an air conditioning system, the air supplying means (72) being configured to supply air between interruption zones (21) of the window pane (1).

- 5 14. A vehicle, comprising an assembly (60) according to claim 13 and an air conditioning system (80) supplying the air supplying means (72).

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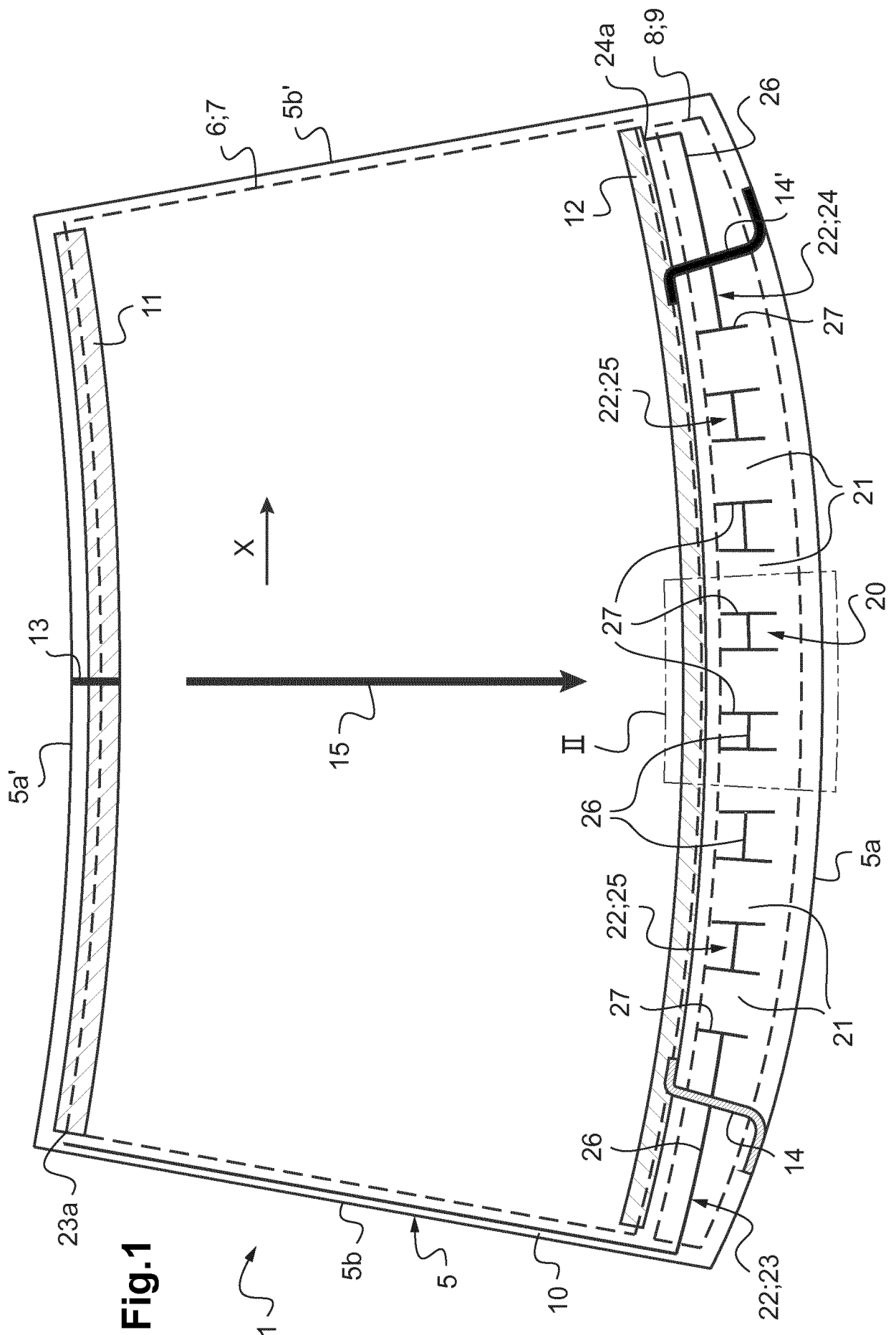


Fig.2

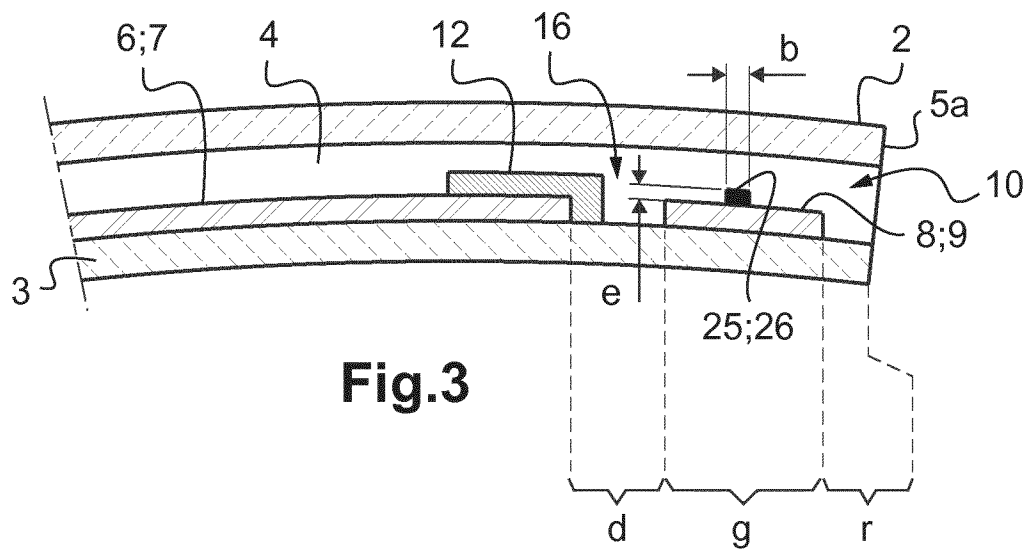
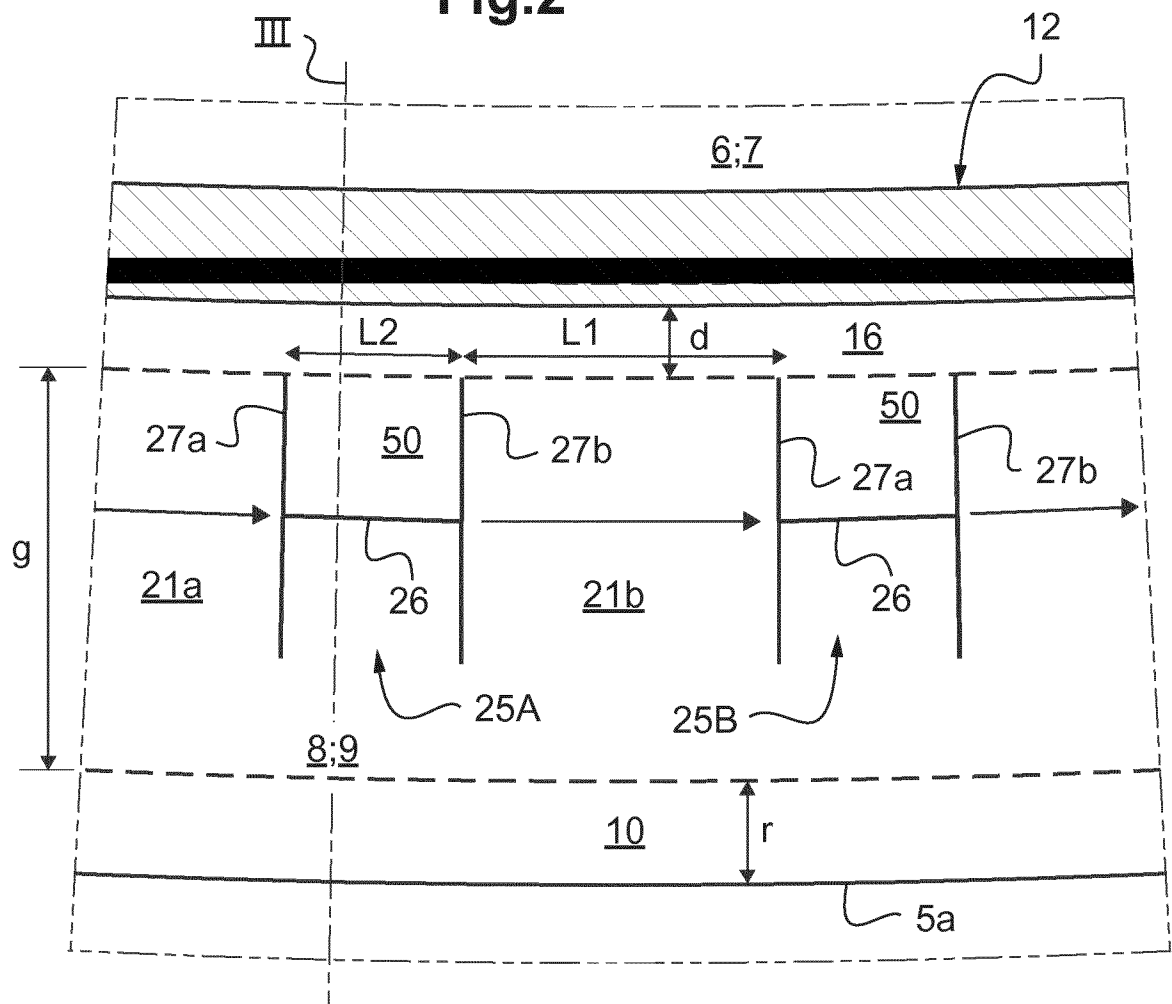


Fig.3

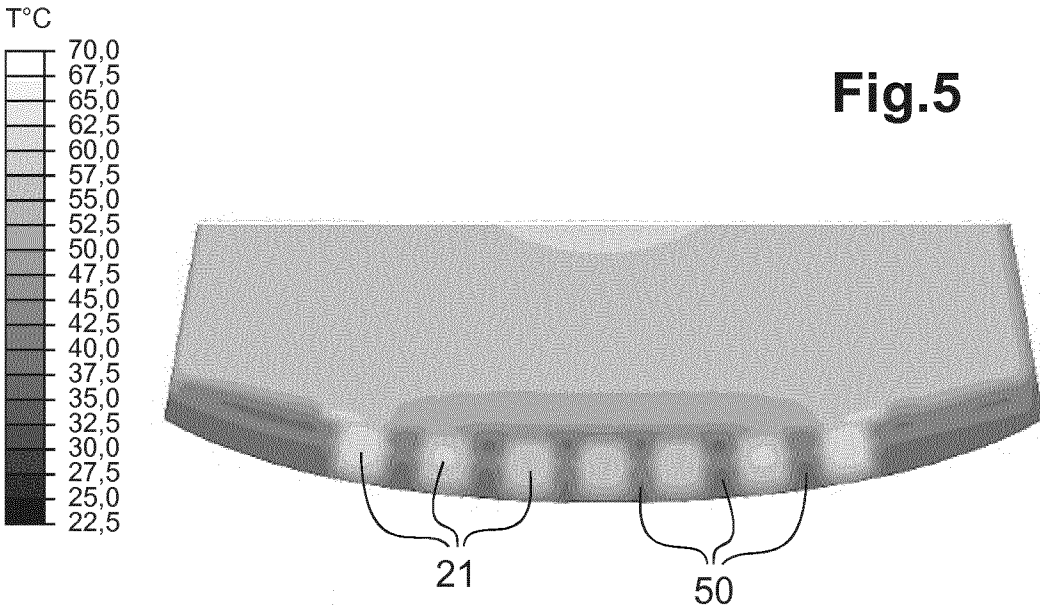
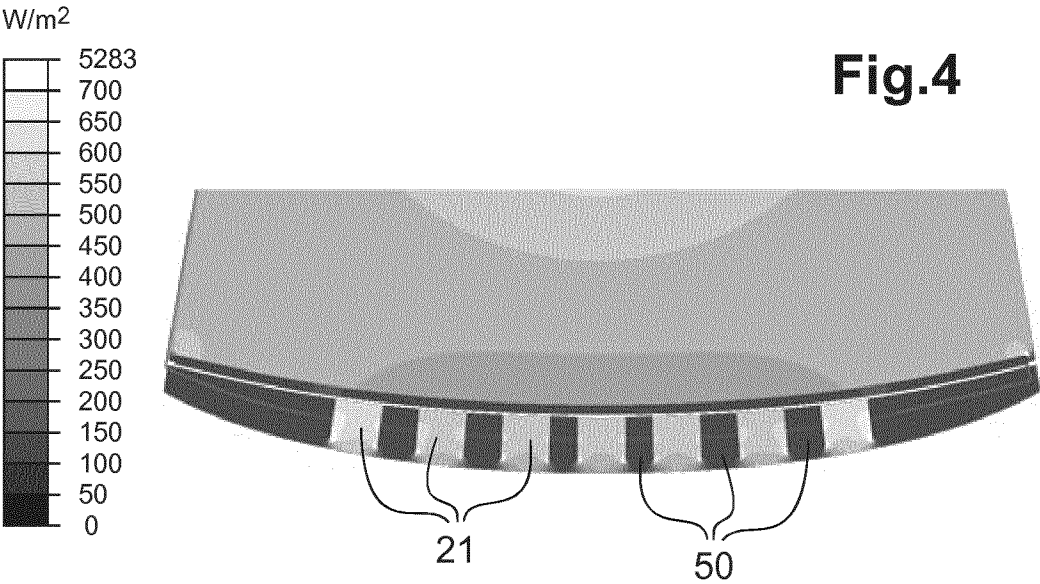


Fig.6

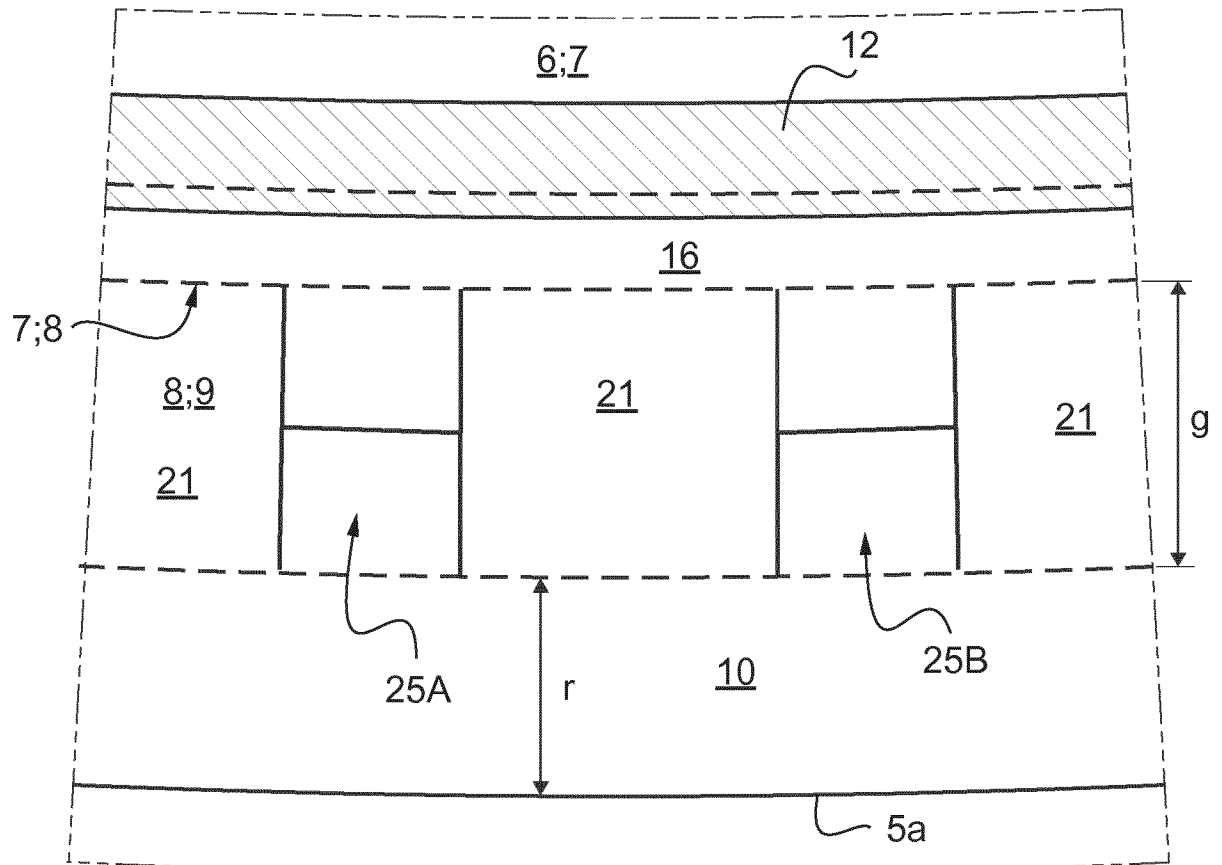
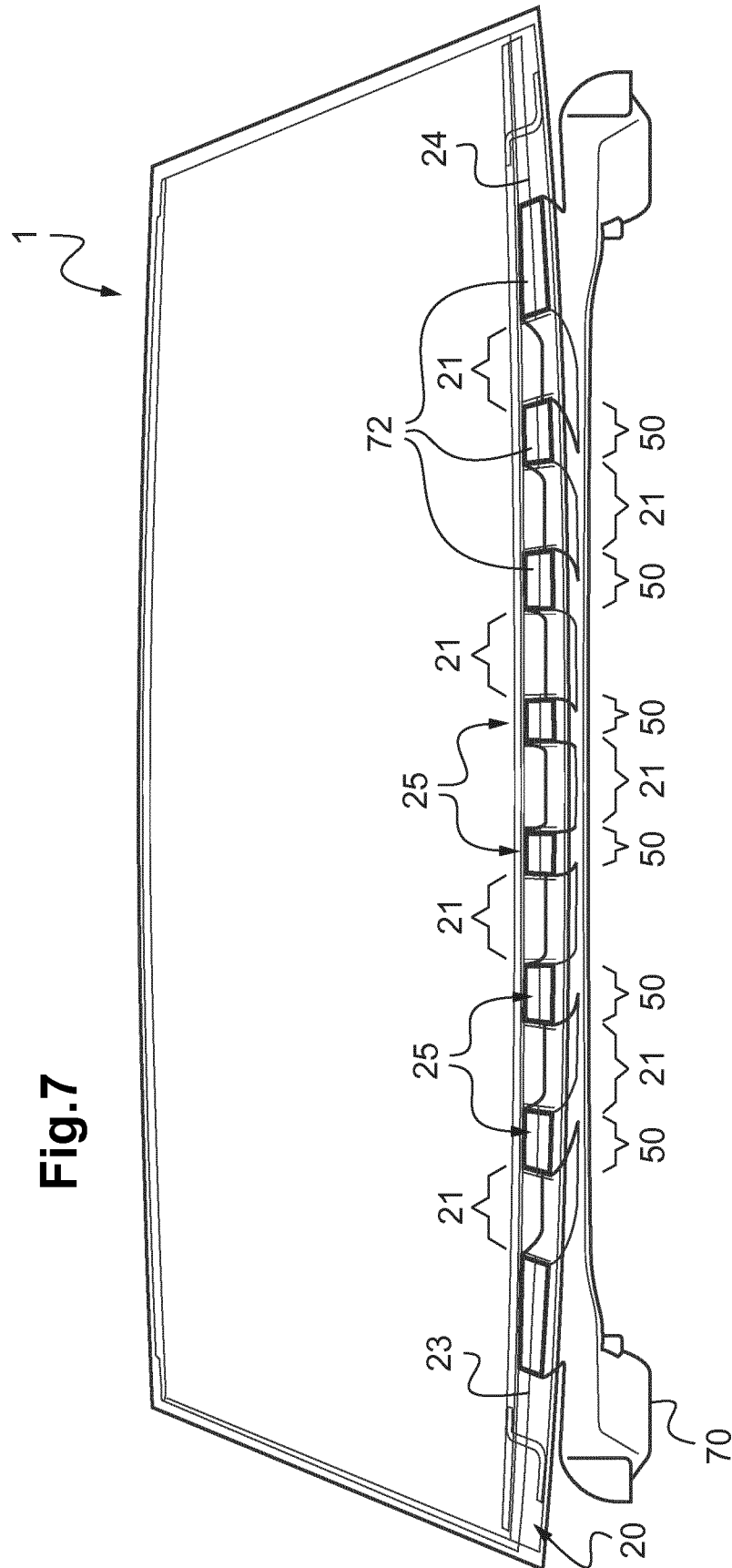


Fig. 7



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/055705

A. CLASSIFICATION OF SUBJECT MATTER
INV. H05B3/84
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

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A	page 1, line 10 - line 11 page 8, line 23 - page 10, line 9; figure 1 page 10, line 10 - line 19; figure 2 -----	3-6,13, 14
X	WO 2016/020114 A1 (SAINT GOBAIN [FR]) 11 February 2016 (2016-02-11)	1,3,6-12
A	page 1, line 4 - line 6 page 7, line 14 - line 31; figures 2-3 page 26, line 5 - line 24; figure 1 page 27, line 18 - page 28, line 29; figure 1 page 29, line 20 - page 31, line 14; figure 5 ----- -/--	2,4,5, 13,14



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

5 May 2017

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2017/055705

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A	abstract; figure 3 -----	2-14
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