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(54) **GLAZING PANEL**

VERGLASUNGSSCHEIBE

PANNEAU DE VITRAGE

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Description

[0001] This invention relates to glazing panels, and in particular to vacuum insulating glazing panels, and to a process for manufacturing such glazing panels.

[0002] Vacuum insulating glazing panels typically comprise two spaced apart sheets of glass, having a "vacuum", i.e. a low pressure space at a pressure less than atmospheric, arranged between them. These sheets are interconnected by a peripheral joint and an array of supporting pillars, also called spacers.

[0003] There are several difficulties to address in the design and production of low pressure evacuated windows: for example, to achieve a low level of vacuum and maintain it over a long period of time, it is necessary to make a seal around the perimeter of the window using materials which have extremely low permeability to gases and negligible outgassing over long periods of time. In addition, an array of supports must generally be provided between the sheets of glass to ensure sufficient mechanical strength to withstand atmospheric pressure and maintain the sheets of glass spaced apart. These supports or spacers may lead to localised concentrations of mechanical stress in the glass, and in the supports themselves, which may increase the danger of breakage. Furthermore, the mechanical supports may act as points of thermal conduction through the window.

[0004] A low emissivity (low-E) coating may be provided on one or both sheets of glass, for example on the interior surface (i.e. the surface facing the low pressure space or gap between the glass sheets) of one or both sheets of glass. The emissivity of such coating is usually at most 0.2. This may lead to a further difficulty in the design and production of vacuum insulating glazing panels, as the materials forming the peripheral seal and/or the spacers should be compatible with the low-E layer, i.e. the layer should not be damaged or its performance reduced when contacted by the materials forming the peripheral seal and/or the spacers or merely by vapours which may come from these materials.

[0005] WO01/90525 shows a vacuum panel according to the preamble of claim 1.

[0006] According to one of its aspects, the present invention provides a glazing panel as defined by claim 1. Other claims define preferred and/or alternative aspects of the invention.

[0007] Providing the defined combination of hermetic seal and spacers in a vacuum insulating glazing panel may provide an advantageous combination of properties. The present invention may provide an advantageous combination of:

- Hermetic sealing: the organic material forming the hermetic seal may afford low permeability to gases and negligible outgassing over long periods of time.
- Structural solidity: the organic material and/or any inorganic charge comprised in the spacers and the hermetic seal, may help to ensure the necessary spacing between the glass sheets and may help to avoid localised concentrations of mechanical stress in the glass, and in the supports themselves. This may reduce the risk of breakage.
- Thermal insulation: a vacuum insulating glazing panel according to the invention may show thermal insulation performance at least equivalent to a double-glazing panel incorporating two sheets of glass separated by a gap filled with gas, while being of a lighter and thinner structure than such a double-glazing. The presence of a low-E coating may further improve this thermal insulation performance. The fact that the spacers comprise an organic material may reduce or avoid thermal conduction through the spacers, in comparison with known spacers of, for example, metals.
- Compatibility with a low-E coating layer: the organic material may avoid or reduce any danger of damage to the low-E layer.
- Aesthetic appearance: organic materials may provide aesthetic advantages, for example being less visible or more discreet than other known materials for the spacers.

[0008] Glazing panels according to the invention present a distance between the two sheets of glass in the range 0.1 to 0.6 mm, over substantially the whole surface of the glazing panel. This distance may be maintained by means of the spacers, and/or by means of the hermetic peripheral seal. The spacers comprise an organic material, or alternatively, consist essentially of an organic material, or consist of an organic material. The nature of the spacers and the spacing between them are such that they may prevent the two glass sheets from moving closer to each other under atmospheric pressure. Examples of convenient organic materials for the spacers are epoxy materials (for example DELO-KATIOBOND VE 13900, BISON), acrylate materials (for example DELO-PHOTOBOND 4468, CONLOC), butyl materials, polyurethane materials, polysulfide materials, acrylic materials and mixtures of one or more thereof (for example mixtures of urethane and acrylate, e.g. DELO-PHOTOBOND GB350, DELO-PHOTOBOND GB368, or mixtures of urethane and metacrylate, e.g. LOCTITE 350, LOCTITE 366, LOCTITE 661).

[0009] At least some of the spacers, and more preferably all the spacers, adhere to at least one of the glass sheets. This may be advantageous in that the spacers will remain in place if the vacuum insulating glazing panel ages, loses its vacuum qualities or if the glass sheets move apart from each other.

[0010] Preferably, the spacers have a diameter of less than 3 mm, less than 2 mm, or less than 1.5 mm. These values may offer a good mechanical resistance and/or an acceptable thermal conductivity whilst being aesthetically discreet.

[0011] The glass sheets are sealed together along their edges with a hermetic seal comprising an organic mate-

rial or alternatively, consisting essentially of an organic material, or consisting of an organic material. Convenient organic materials for the seal may be the same as those described hereinabove for the spacers. The organic material used in the sealing of the glass sheets is the same as the material used for the spacers. This facilitates manufacture as a single material may be used on the production line. In some embodiments, the hermetic seal may be made of two or more individual seals.

[0012] The distance between the two sheets of glass is in the range 0.1 to 0.6 mm, more preferably in the range 0.1 to 0.4 mm, still more preferably in the range 0.1 to 0.3 mm or 0.15 to 0.25 mm. These values may offer good thermal insulation properties to the vacuum insulating glazing panel.

[0013] At least some of the spacers may comprise a charge, for example a mineral charge, adapted to maintain or to assist in maintaining the spacing between the sheets of glass. The hermetic peripheral seal may also comprise such a charge. The charge may for example comprise alumina, e.g. corundum, and/or zirconium. The organic material may have a mechanical resistance adapted and sufficient to maintain the sheets of glass spaced apart without a charge, so that a predetermined quantity of organic material allows maintenance of the desired distance between the two glass sheets.

[0014] The spacers may be arranged linearly or in alternate rows. Alternatively, they may be arranged without any particular organisation or be more numerous in one portion of the glazing panel and less in another, for example they may be less numerous in the central vision portion of the glazing panel. The distance between the spacers is preferably equal to or greater than 1, 2, 3 or 4 cm and equal to or less than 10, 8, or 6 cm, more preferably between 1 and 10 cm and still more preferably between 4 and 6 cm. Such ranges of distances between the spacers may provide insulating glazing panels with a maintained distance between the two sheets of glass. By "distance between the spacers" it is meant herein the distance between at least 50% of the spacers, or preferably between at least 75% of the spacers, or still more preferably, the distance between all of the spacers. This means that, for example, at least 50% of the spacers do not have another neighbouring spacer inside a circle of which they are the central point and which has a radius equal to the distance between the spacers.

[0015] In a preferred embodiment, the thickness of each of the two sheets of glass is in the range 2 to 6 mm, preferably 3 to 5 mm, and more preferably of the order of 4 mm. The two sheets of glass may be of the same thickness or have different thicknesses.

[0016] A surface of each of the two sheets of glass may be coated with a low emissivity layer, in particular the surfaces facing the space between them. One of the glass sheets may, for example, be coated with a low-E layer on its surface facing the low pressure space. The low emissivity layer may be deposited by known techniques including vacuum deposition or chemical vapour deposition. Examples of convenient low-E coatings are sputtered coating stacks of the type dielectric/silver/dielectric, fluorine doped tin oxide layers. The glass surface provided with the low emissivity coating layer may have an emissivity of less than 0.3, less than 0.2 or preferably less than 0.1.

[0017] Vacuum insulating glazing panels according to the invention may be incorporated in multiple glazing panels, for example in a double glazing panel wherein it is associated with a further sheet of glass, such that the vacuum insulating glazing panel and the further sheet of glass are spaced apart from each other and sealed together along their edges and wherein the space between them is filled with gas.

[0018] Vacuum insulating glazing panels according to the invention preferably show a thermal transmittance, i.e. a U value, of at most 2.6 $W/m^2.K$, preferably at most 2.2, at most 1.9, at most 1.5 or at most 1.1 $W/m^2.K$.

[0019] Preferably, vacuum insulating glazing panels according to the invention satisfy standardised Fogging and CEN tests. The Fogging test is described in Annex C of European Standard EN 1279-6:2002. Its purpose is to verify that no unacceptable condensation appears inside the glazing panel due to emission of volatile substances. The CEN test is described in European Standard EN 1279-2:2002. It simulates ageing of an insulating glass unit and tests the humidity rate inside the glazing panel. The humidity rate is measured for example with the parameter "dew point temperature" (see Annex A of EN 1279-2:2002). Preferably, vacuum insulating glazing panels according to the invention do not show visible permanent condensation after the Fogging test and/or show a dew point temperature of less than -30°C after the CEN test.

[0020] According to another aspect, the present invention provides a process for manufacturing a vacuum insulating glazing panel as defined by claim 17.

[0021] In a preferred embodiment, a sheet of glass is profiled (for example by grinding) on at least one portion of at least one of its edges, for example, to form a chamfered edge. Alternatively, one entire edge or the entire periphery of the glass sheet may be profiled. A groove may be provided in a surface of this sheet of glass, extending from the profiled edge portion, for example perpendicularly to the edge of the glass sheet. This groove may have for example a length in the range of 1 to 5 cm and a width in the range of 0.1 to 2 mm. The groove may be adapted to receive a capillary tube, preferably made of glass. The length of the groove may be such as being the least visible whilst allowing a capillary tube to be positioned therein. The width of the groove may be chosen according to the diameter of the capillary tube and the spacing desirable between the two glass sheets of the vacuum insulating glazing. The capillary tube is positioned so that it extends outside of the glass sheet surface. Preferably, the end of the capillary tube which extends outside of the glass sheet surface has a funnel shape which may be adapted to a pumping apparatus.

The capillary tube may be maintained in the groove with the presence of an organic material of the type described for the spacers according to this invention, or any adhesive material. The spacers and the hermetic seal may be deposited on the same surface of the same glass sheet or on a surface of the other glass sheet. It may be preferred that all these operations are made on the same glass sheet for easiness on the production line. It may also be preferred, for the same reason, to use the same organic material for the spacers, the hermetic seal and for maintaining the capillary tube in the groove.

[0022] After all these steps, a second sheet of glass may be placed in an opposing and spaced relationship with the first sheet of glass with a gap, the spacers, the hermetic seal and the capillary tube therebetween. The first and second glass sheets may have different size. The second sheet of glass may also be profiled on at least one portion of at least one of its edges or on an entire edge or on its entire periphery. Preferably the profiled portion of the second glass sheet is placed in front of the profiled portion of the first glass sheet. The glass sheets may then be pressed together and treated under specific temperatures or under UV rays, for example, so that the organic material, if necessary, may polymerise.

[0023] In a next step, a vacuum, i.e. an environment of less than the atmospheric pressure, is created between the sheets of glass by pumping out gases through the capillary tube. Preferably the vacuum level between the sheets of glass is less than 10^{-1} bar, preferably less than 10^{-2} bar, more preferably in the range 10^{-3} to 10^{-6} bar, and still more preferably in the range 10^{-4} to 10^{-5} bar. Preferably the pumping-out phase is made under an ambient temperature of between 40 and 160 °C, preferably between 50 and 80 °C. This may facilitate the desorption of the glazing panel. The capillary tube may then be sealed and broken, so that it no longer extends outside of the glass sheets surfaces, for example by heating and bending it, in particular when it is made of glass. The zone where the broken end of the capillary tube is exposed may further be provided with an organic material, for example of the type used for the spacers.

[0024] This method may have the advantage of avoiding the presence of a hole in one of the glass sheet, which was previously necessary for the pumping-out process. It may also be advantageous in that the system is very discreet and may be hidden by the frame of the finished window, when the vacuum insulating glazing panel is incorporated in such a window.

[0025] Embodiments of the invention will now be described, by way of example only, with reference to figures 1 to 5, and to example 1. Figure 1 shows a glazing panel according to the present invention. Figure 2 shows a transversal view through the glazing panel of figure 1 along line A-A'. Figure 3 shows a portion of a glazing panel according to the present invention fitted with the capillary tube for the pumping out process. Figures 4 and 5 show transversal views through the glazing panel of figure 3 along line B-B' at different stages of the glazing manufacture. The drawings are not to scale.

[0026] Figure 1 and 2 show a glazing panel 1 comprising two sheets of glass 2 and 2' disposed in an opposing and spaced relationship with a gap 3 formed therebetween, the gap being a low pressure space having a pressure less than atmospheric pressure. This low pressure space is sealed off with a hermetic seal 4 positioned at or towards and running around the periphery of the glazing. The glazing panel is provided with a plurality of spacers 5 between the two sheets of glass 2 and 2'. In these figures, the spacers are arranged linearly and form an array of spacers with a regular interval between them.

[0027] Figures 3, 4 and 5 illustrate a process of manufacturing a vacuum insulating glazing panel according to the invention. In this particular example, both glass sheets have chamfered edges 6 and 6'. A groove 7 is present at the surface of one of the glass sheet and a capillary tube 8 is positioned in the groove where it is maintained with an organic material, represented in the figures by the hatching. Figures 3 and 4 show the system while gases are being pumped out through the capillary tube, and figure 5 shows the finished glazing panel.

Example 1

[0028] A sheet of glass of 4 mm thickness with a dimension of 1 x 1 m is provided with a low emissivity coating layer. The layer consists of the following coating stack: $TiO_x/ZnO_x/Ag/TiO_x/ZnO_x/SnO_x$. The edges of the sheet of glass are chamfered in such a way that the coated surface of the glass sheet is smaller than the other surface. On one edge of the glass sheet a groove is made at the coated surface of the glass sheet. The groove is made perpendicularly to the edge of the glass sheet with a length of 2 cm, a width of 1 mm and a depth of about 2 mm. A capillary tube, made of glass, is placed in the groove in a manner represented in figures 3 and 4. The capillary tube is maintained in the groove by placing an organic material around it. This material is a modified urethane acrylate, available from the company DELO under the name DELO-PHOTOBOND GB350. Attention should be given to the fact that the capillary tube should not be obstructed by the organic material. Spacers of DELO-PHOTOBOND GB350 comprising a corundum core are deposited on the coated side of the sheet of glass, linearly in an array, with a regular interval between the deposits of 5 cm and a seal of DELO-PHOTOBOND GB350 is positioned at the periphery of the glass sheet.

[0029] A second sheet of glass of 4 mm thickness with a dimension of 1 x 1 m and with chamfered edges is placed over the first glass sheet in a manner represented in figure 4. The glass sheets are pressed together and placed under an UV-light for the curing of the DELO-PHOTOBOND GB350.

[0030] After curing, a pumping apparatus is connected to the capillary tube and gas present between the two sheets of glass is evacuated to create a vacuum of about 10^{-4} bar. This operation is carried out at an ambient tem-

perature of approximately 70°C. The capillary tube is then heated, bended, sealed and broken in the space created by the chamfered edges of the glass sheets, as represented in figure 5, and this space is filled with DELO-PHOTOBOND GB350. The glazing panel is then placed again under an UV-light for the curing of the DELO-PHOTOBOND GB350.

[0031] This vacuum insulating glazing panel may then incorporated in a double-glazing, where it is associated with a glass sheet of 4 mm thickness and with a gap filled with gas between them. The structure of this double-glazing is thus:

glass (4 mm) / gas / glass (4 mm) / vacuum / low-E layer / glass (4 mm).

This double-glazing panel may be incorporated in a window frame and placed preferably with the vacuum insulating glazing panel on the indoor side.

Claims

1. A vacuum glazing panel (1) comprising

- two sheets of glass (2,2') disposed in an opposing and spaced relationship with each other with a gap (3) formed therebetween, the gap being a low pressure space having a pressure less than atmospheric pressure,
- a hermetic seal (4) for sealing off said low pressure space, comprising an organic material,
- a plurality of spacers (5) provided between said two sheets of glass for spacing the sheets of glass from one another, comprising an organic material,

wherein the distance between the two sheets of glass is in the range 0.1 to 0.6 mm, **characterized in that** at least some of the spacers adhere to at least one of the glass sheets, and the organic material of the hermetic seal and the spacers is the same.

2. A vacuum glazing panel according to claim 1, wherein at least one of the sheets of glass is coated on at least one of its faces with a low emissivity coating layer.

3. A vacuum glazing panel according to claim 1 or claim 2, wherein the vacuum level between the sheets of glass is in the range 10^{-3} to 10^{-6} bar.

4. A vacuum glazing panel according to any of the preceding claims, wherein the organic material is selected from the group consisting of epoxy materials, acrylate materials, butyl materials, polyurethane materials, polysulfide materials, acrylic materials and mixtures of one or more thereof.

5. A vacuum glazing panel according to any of the preceding claims, wherein at least some of the spacers, or the hermetic seal, or both comprise a charge adapted to maintain the spacing between the sheets of glass.

6. A vacuum glazing panel according to claim 5, wherein the charge is a mineral charge.

7. A vacuum glazing panel according to claim 6, wherein the charge is selected from the group consisting of alumina and zirconium.

8. A vacuum glazing panel according to any of the preceding claims, wherein the distance between the two sheets of glass is in the range 0.15 to 0.25 mm.

9. A vacuum glazing panel according to any of the preceding claims, wherein the hermetic seal comprises two or more individual seals.

10. A vacuum glazing panel according to any of the preceding claims, wherein the spacers are arranged with a distance between them of between 1 and 10 cm.

11. A vacuum glazing panel according to claim 10, wherein the distance between the spacers is between 4 and 6 cm.

12. A vacuum glazing panel according to any of the preceding claims, wherein the thickness of each of the two sheets of glass is in the range 2 to 6 mm.

13. A vacuum glazing panel according to any of the preceding claims, wherein the glazing panel shows no visible permanent condensation after the Fogging test according to European Standard EN 1279-6:2002.

14. A vacuum glazing panel according to any of the preceding claims, wherein the glazing panel has a dew point temperature of less than -30°C after the CEN test according to European Standard EN1279-2:2002.

15. A vacuum glazing panel according to any of the preceding claims, wherein the glazing panel has a U value of at most 1.9 $W/m^2.K$

16. A double glazing panel incorporating a vacuum glazing panel according to any of the preceding claims and a further spaced sheet of glass, wherein the sealed space between them is filled with gas.

17. A process for manufacturing a vacuum glazing panel comprising the steps of

- providing a first sheet of glass
- providing a groove in a surface of said sheet of glass extending from an edge of the sheet of glass
- depositing a plurality of spacers comprising an organic material on said surface of the glass sheet
- depositing an hermetic seal comprising the same organic material on said surface of the glass sheet
- depositing a capillary tube in the groove so that it extends outside of the glass sheet surface and ensuring that it is maintained in the groove
- placing a second sheet of glass in an opposing and spaced relationship with the first sheet of glass with a gap, the spacers, the hermetic seal and the capillary tube therebetween, with a distance between the two sheets of glass in the range 0.1 to 0.6 mm
- creating a vacuum between both sheets of glass by pumping out gases through the capillary tube, such that the gap is a low pressure space having a pressure less than atmospheric pressure
- breaking the portion of the capillary tube which extends outside of the glass sheets surfaces
- closing the capillary tube at its broken end
- ensuring that at least some of the spacers adhere to at least one of the glass sheet.

18. A process according to claim 17, wherein the first sheet of glass has at least one portion of one edge profiled and that the groove extends from this profiled edge portion.

19. A process according to any of claims 17 or 18, wherein the capillary tube is maintained in the groove with an organic material.

20. A process according to any of claims 17 to 19, wherein the capillary tube is made of glass.

21. A process according to any of claims 17 to 20, wherein the broken end of the capillary tube is surrounded by an organic material.

22. A process according to any of claims 17 to 21, wherein the organic material used in the spacers, the hermetic seal, the groove and for surrounding the broken end of the capillary tube is the same.

23. A process according to any of claims 17 to 22, wherein after having placed the second sheet of glass over the first one, the glass sheets are pressed together and the organic material is allowed to polymerise.

Patentansprüche

1. Vakuumverglasungsscheibe (1), umfassend:

- zwei Glasscheiben (2, 2'), die mit einem dazwischen gebildeten Spalt (3) auf eine einander gegenüberliegende und beabstandete Weise angeordnet sind, wobei der Spalt ein Niederdruckraum ist, der einen Druck von weniger als dem Atmosphärendruck aufweist,
- eine hermetische Abdichtung (4), um den Niederdruckraum abzuschotten, die ein organisches Material umfasst,
- mehrere Distanzstücke (5), die zwischen den beiden Glasscheiben bereitgestellt sind, um die Glasscheiben voneinander zu beabstanden, und ein organisches Material umfassen,

wobei der Abstand zwischen den beiden Glasscheiben in einem Bereich von 0,1 bis 0,6 mm liegt, **dadurch gekennzeichnet, dass**
zumindest einige der Distanzstücke an zumindest einer der Glasscheiben haften, und das organische Material der hermetischen Abdichtung und der Distanzstücke das gleiche ist.

2. Vakuumverglasungsscheibe nach Anspruch 1, wobei zumindest eine der Glasscheiben an zumindest einer ihrer Flächen mit einer Überzugsschicht mit geringem Emissionsvermögen überzogen ist.

3. Vakuumverglasungsscheibe nach Anspruch 1 oder Anspruch 2, wobei der Vakuumgrad zwischen den Glasscheiben in einem Bereich von 10-3 bis 10-6 Bar liegt.

4. Vakuumverglasungsscheibe nach einem der vorhergehenden Ansprüche, wobei das organische Material aus der Gruppe gewählt ist, die aus Epoxidmaterialien, Acrylatmaterialien, Butylmaterialien, Polyurethanmaterialien, Polysulfidmaterialien, Acrylmaterialien und Gemischen aus einem oder mehreren davon besteht.

5. Vakuumverglasungsscheibe nach einem der vorhergehenden Ansprüche, wobei zumindest einige der Distanzstücke oder die hermetische Abdichtung oder beide eine Füllung umfassen, die dazu ausgelegt ist, die Beabstandung zwischen den Glasscheiben beizubehalten.

6. Vakuumverglasungsscheibe nach Anspruch 5, wobei die Füllung eine mineralische Füllung ist.

7. Vakuumverglasungsscheibe nach Anspruch 6, wobei die Füllung aus der Gruppe gewählt ist, die aus Aluminiumoxid und Zirconium besteht.

8. Vakuumverglasungsscheibe nach einem der vorhergehenden Ansprüche, wobei der Abstand zwischen den beiden Glasscheiben in einem Bereich von 0,15 bis 0,25 mm liegt.

9. Vakuumverglasungsscheibe nach einem der vorhergehenden Ansprüche, wobei die hermetische Abdichtung zwei oder mehr einzelne Dichtungen umfasst.

10. Vakuumverglasungsscheibe nach einem der vorhergehenden Ansprüche, wobei die Distanzstücke mit einem dazwischen vorhandenen Abstand zwischen 1 und 10 cm angeordnet sind.

11. Vakuumverglasungsscheibe nach Anspruch 10, wobei der Abstand zwischen den Distanzstücken zwischen 4 und 6 cm beträgt.

12. Vakuumverglasungsscheibe nach einem der vorhergehenden Ansprüche, wobei die Dicke einer jeden der beiden Glasscheiben in einem Bereich von 2 bis 6 mm liegt.

13. Vakuumverglasungsscheibe nach einem der vorhergehenden Ansprüche, wobei die Verglasungsscheibe nach dem Fogging-Test gemäß der Europäischen Norm EN1279-6:2002 keine sichtbare dauerhafte Kondensation zeigt.

14. Vakuumverglasungsscheibe nach einem der vorhergehenden Ansprüche, wobei die Glasscheibe nach dem CEN-Test gemäß der Europäischen Norm EN1279-2:2002 eine Taupunkttemperatur von weniger als -30 °C aufweist.

15. Vakuumverglasungsscheibe nach einem der vorhergehenden Ansprüche, wobei die Verglasungsscheibe einen U-Wert von höchstens 1,9 $W/m^2.K$ aufweist.

16. Doppelverglasungsscheibe, die eine Vakuumverglasungsscheibe nach einem der vorhergehenden Ansprüche und eine weitere beabstandete Glasscheibe umfasst, wobei der abgedichtete Raum dazwischen mit einem Gas gefüllt ist.

17. Prozess zur Herstellung einer Vakuumverglasungsscheibe, umfassend die folgenden Schritte:

- Bereitstellen einer ersten Glasscheibe,
- Bereitstellen einer Nut in einer Oberfläche der Glasscheibe, die sich von einem Rand der Glasscheibe erstreckt,
- Anordnen mehrerer Distanzstücke, die ein organisches Material umfassen, auf der Oberfläche der Glasscheibe,
- Anordnen einer hermetischen Abdichtung, die das gleiche organische Material umfasst, auf der Oberfläche der Glasscheibe,
- derartiges Anordnen eines Kapillarröhrchens in der Nut, dass sich dieses nach außerhalb der Glasscheibenoberfläche erstreckt, und Sicherstellen, dass es in der Nut behalten wird,
- Platzieren einer zweiten Glasscheibe auf eine der ersten Glasscheibe gegenüberliegende und davon beabstandete Weise, wobei sich ein Spalt, die Distanzstücke, die hermetische Abdichtung und das Kapillarröhrchen dazwischen befinden, wobei ein Abstand zwischen den beiden Glasscheiben in einem Bereich von 0,1 bis 0,6 mm liegt,
- Erzeugen eines Vakuums zwischen den beiden Glasscheiben durch Auspumpen von Gasen durch das Kapillarröhrchen, so dass der Spalt ein Niederdruckraum mit einem Druck von weniger als dem Atmosphärendruck ist,
- Abbrechen des Abschnitts des Kapillarröhrchens, das sich nach außerhalb der Glasscheibenoberfläche erstreckt;
- Verschließen des Kapillarröhrchens an seinem abgebrochenen Ende,
- Sicherstellen dass zumindest einige der Distanzstücke an zumindest einer der Glasscheiben haften.

18. Prozess nach Anspruch 17, wobei zumindest ein Abschnitt eines Rands der ersten Glasscheibe profiliert ist und sich die Nut von diesem profilierten Randabschnitt erstreckt.

19. Prozess nach einem der Ansprüche 17 oder 18, wobei das Kapillarröhrchen durch ein organisches Material in der Nut behalten wird.

20. Prozess nach einem der Ansprüche 17 bis 19, wobei das Kapillarröhrchen aus Glas besteht.

21. Prozess nach einem der Ansprüche 17 bis 20, wobei das abgebrochene Ende des Kapillarröhrchens von einem organischen Material umgeben wird.

22. Prozess nach einem der Ansprüche 17 bis 21, wobei das organische Material, das in den Distanzstücken, der hermetischen Abdichtung, der Nut und zum Umgeben des abgebrochenen Endes des Kapillarröhrchens verwendet wird, das gleiche ist.

23. Prozess nach einem der Ansprüche 17 bis 22, wobei die Glasscheiben nach dem Platzieren der zweiten Glasscheibe über der ersten zusammengepresst werden und das organische Material polymerisiert wird.

Revendications

1. Panneau de vitrage sous vide (1), comprenant:

- deux feuilles de verre (2, 2') disposées de manière opposée et espacée l'une de l'autre avec un espace (3) formé entre celles-ci, l'espace étant un espace à basse pression affichant une pression inférieure à la pression atmosphérique,
- un joint hermétique (4) pour sceller ledit espace à basse pression, comprenant un matériau organique,
- une pluralité d'espaceurs (5) fournis entre lesdites deux feuilles de verre pour espacer les feuilles de verre l'une de l'autre, comprenant un matériau organique,

dans lequel la distance entre les deux feuilles de verre est comprise dans la gamme de 0,1 mm à 0,6 mm,
caractérisé en ce que:

au moins certains espaceurs adhèrent à au moins une des feuilles de verre, et le matériau organique du joint hermétique et des espaceurs est le même.

2. Panneau de vitrage sous vide selon la revendication 1, dans lequel au moins une des feuilles de verre est revêtue sur au moins une de ses faces d'une couche de revêtement à faible émissivité.

3. Panneau de vitrage sous vide selon la revendication 1 ou la revendication 2, dans lequel le niveau de vide entre les feuilles de verre se situe dans la gamme de 10^{-3} bar à 10^{-6} bar.

4. Panneau de vitrage sous vide selon l'une quelconque des revendications précédentes, dans lequel le matériau organique est sélectionné dans le groupe consistant en des matériaux époxy, des matériaux acrylates, des matériaux butyles, des matériaux polyuréthanes, des matériaux polysulfures, des matériaux acryliques ainsi que des mélanges d'un ou de plusieurs de ceux-ci.

5. Panneau de vitrage sous vide selon l'une quelconque des revendications précédentes, dans lequel au moins certains espaceurs, ou le joint hermétique, ou les deux, comprennent une charge apte à maintenir l'espacement entre les feuilles de verre.

6. Panneau de vitrage sous vide selon la revendication 5, dans lequel la charge est une charge minérale.

7. Panneau de vitrage sous vide selon la revendication 6, dans lequel la charge est sélectionnée dans le groupe consistant en l'alumine et le zirconium.

8. Panneau de vitrage sous vide selon l'une quelconque des revendications précédentes, dans lequel la distance entre les deux feuilles de verre est comprise dans la gamme de 0,15 mm à 0,25 mm.

9. Panneau de vitrage sous vide selon l'une quelconque des revendications précédentes, dans lequel le joint hermétique comprend deux ou plus de deux joints individuels.

10. Panneau de vitrage sous vide selon l'une quelconque des revendications précédentes, dans lequel les espaceurs sont agencés avec une distance entre eux comprise entre 1 cm et 10 cm.

11. Panneau de vitrage sous vide selon la revendication 10, dans lequel la distance entre les espaceurs est comprise entre 4 cm et 6 cm.

12. Panneau de vitrage sous vide selon l'une quelconque des revendications précédentes, dans lequel l'épaisseur de chacune des deux feuilles de verre est comprise dans la gamme de 2 mm à 6 mm.

13. Panneau de vitrage sous vide selon l'une quelconque des revendications précédentes, dans lequel le panneau de vitrage ne présente aucune condensation permanente visible après le test de Fogging selon la norme européenne EN 1279-6:2002.

14. Panneau de vitrage sous vide selon l'une quelconque des revendications précédentes, dans lequel le panneau de vitrage présente une température du point de rosée inférieure à -30°C après le test CEN selon la norme européenne EN 1279-2:2002.

15. Panneau de vitrage sous vide selon l'une quelconque des revendications précédentes, dans lequel le panneau de vitrage présente une valeur U de maximum 1,9 $W/m^2.K$.

16. Panneau de double vitrage incorporant un panneau de vitrage sous vide selon l'une quelconque des revendications précédentes et une feuille de verre supplémentaire espacée, dans lequel l'espace scellé entre ceux-ci est rempli avec un gaz.

17. Procédé de fabrication d'un panneau de vitrage sous vide, comprenant les étapes suivantes:

- fournir une première feuille de verre,
- former une rainure dans une surface de ladite feuille de verre qui s'étend à partir d'un bord de la feuille de verre,
- déposer une pluralité d'espaceurs comprenant un matériau organique sur ladite surface de la feuille de verre,
- déposer un joint hermétique comprenant le mê-

me matériau organique sur ladite surface de la feuille de verre,

- déposer un tube capillaire dans la rainure de telle sorte qu'il s'étende à l'extérieur de la surface de la feuille de verre et s'assurer qu'il soit maintenu dans la rainure,
- placer une seconde feuille de verre de manière opposée et espacée avec la première feuille de verre avec un espace, les espaceurs, le joint hermétique et le tube capillaire entre celles-ci, avec une distance entre les deux feuilles de verre comprise dans la gamme de 0,1 mm à 0,6 mm,
- créer un vide entre les deux feuilles de verre en pompant des gaz à travers le tube capillaire de telle sorte que l'espace soit un espace à basse pression affichant une pression inférieure à la pression atmosphérique,
- casser la partie du tube capillaire qui s'étend à l'extérieur des surfaces des feuilles de verre,
- fermer le tube capillaire à son extrémité cassée,
- s'assurer qu'au moins certains espaceurs adhèrent à au moins une des feuilles de verre.

18. Procédé selon la revendication 17, dans lequel la première feuille de verre présente au moins une partie d'un bord profilé, et la rainure s'étend à partir de cette partie de bord profilé.

19. Procédé selon la revendication 17 ou 18, dans lequel le tube capillaire est maintenu dans la rainure avec un matériau organique.

20. Procédé selon l'une quelconque des revendications 17 à 19, dans lequel le tube capillaire est fait de verre.

21. Procédé selon l'une quelconque des revendications 17 à 20, dans lequel l'extrémité cassée du tube capillaire est entourée par un matériau organique.

22. Procédé selon l'une quelconque des revendications 17 à 21, dans lequel le matériau organique utilisé dans les espaceurs, le joint hermétique, la rainure et pour entourer l'extrémité cassée du tube capillaire est le même.

23. Procédé selon l'une quelconque des revendications 17 à 22, dans lequel, après avoir placé la seconde feuille de verre sur la première, les feuilles de verre sont pressées l'une contre l'autre et le matériau organique est polymérisé.

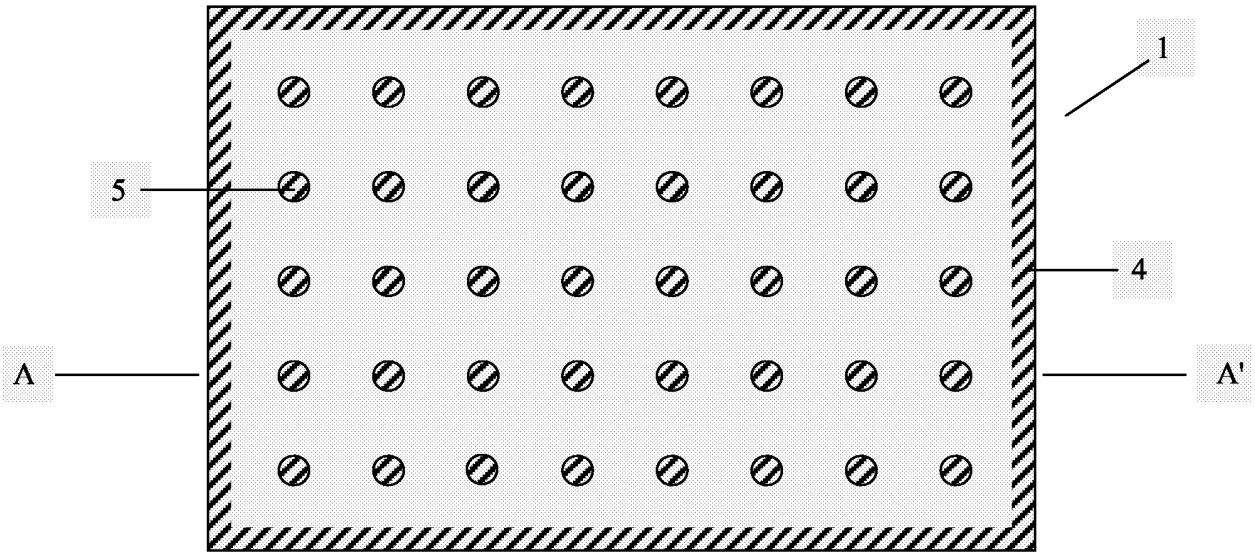

Fig.1

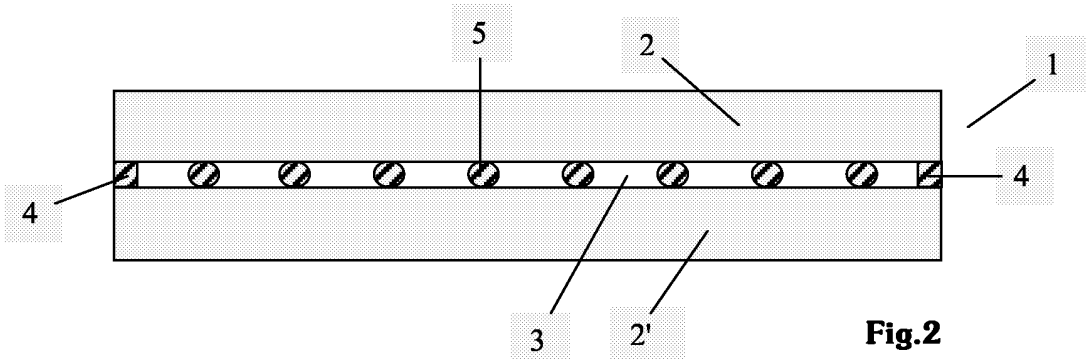

Fig.2

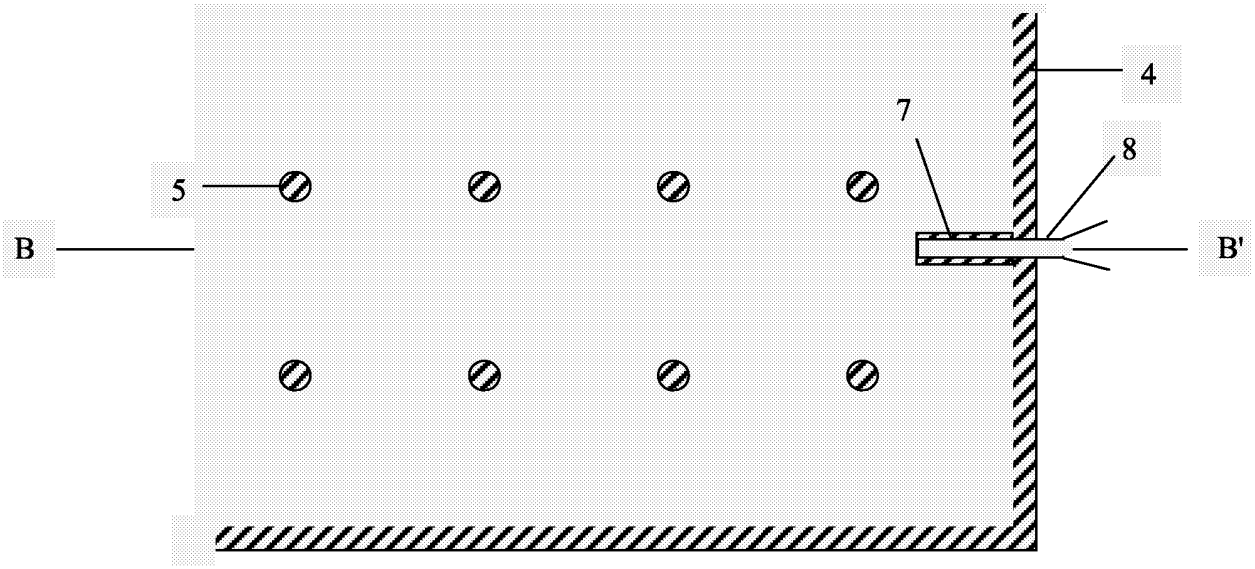

Fig.3

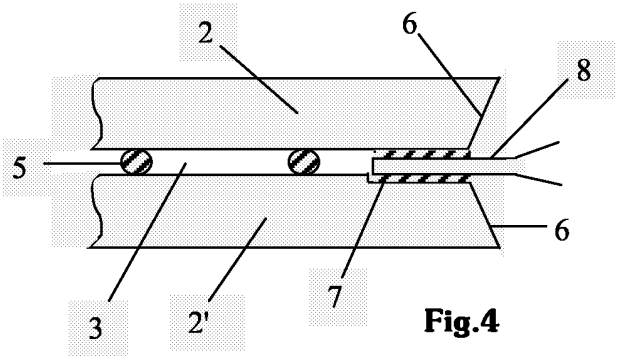

Fig.4

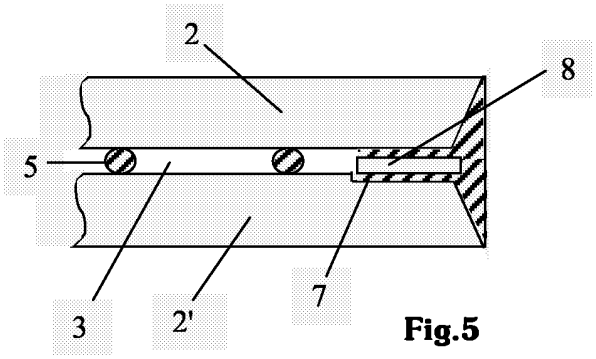

Fig.5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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