

DESCRIPTION

Title of Invention

TRANSLUCENT MEMBER AND MULTILAYER TRANSLUCENT BODY

Technical Field

[0001] The present disclosure relates to a translucent member and a multilayer translucent body.

Background Art

[0002] Japanese Patent Application Laid-Open (JP-A) No. H07-220662 relates to an image element whose interior must be made to be a lower pressure than atmospheric pressure. A technique relating to a lightweight, thin and planar image element is disclosed in this JP-A No. H07-220662.

[0003] JP-A No. 2006-274662 discloses a technique relating to a glass plate fixing structure in which both end portions, in a direction in which compressive force is applied, of a glass plate to which compressive force is applied are fit in and fixed in concave groove portions of a fixing hardware at a framework side. Buffering materials are nipped between the both surfaces of the both end portions of the glass plate and the concave groove portions.

[0004] JP-A No. 2007-198016 discloses a technique relating to a glass panel fixing structure that fixes a glass panel at the inner side of a framework or a frame.

[0005] JP-A No. 2018-178372 discloses a technique relating to a translucent member using an aerogel, and in particular, to a translucent member that is utilized as a building material such as an outer wall panel. This translucent member uses a first translucent plate and a second translucent plate, and an aerogel having a semitransparent region formed between the first translucent plate and the second translucent plate. The semitransparent region is formed by filling at least semitransparent particles of an aerogel between the first translucent plate and the second translucent plate. The average particle diameter of the semitransparent particles is in the range of 0.05 – 0.5 mm.

SUMMARY OF INVENTION

Technical Problem

[0006] At the time of forming an aerogel layer by filling an aerogel between a pair of translucent plate members disposed so as to face one another, if the pair of translucent plate

members swell outwardly due to the pressure (lateral pressure) applied to the pair of translucent plate members from the aerogel layer, there is the concern that the aerogel will be overfilled between the pair of translucent plate members.

[0007] An object of the present disclosure is to suppress outward swelling of a pair of translucent plate members at the time when an aerogel layer is formed by filling an aerogel between the pair of translucent plate members.

Solution to Problem

[0008] A translucent member relating to a first aspect includes: a pair of translucent plate members disposed so as to face one another; an aerogel layer formed by an aerogel filled between the pair of translucent plate members; and holding members sealing outer edge portions that are between the pair of translucent plate members, and holding both side end portions in a width direction of the pair of translucent plate members in states of being tilted toward a thickness direction inner side, the holding members suppressing swelling of the pair of translucent plate members due to lateral pressure applied from the aerogel layer to the pair of translucent plate members.

[0009] In accordance with the first aspect, the both side end portions in the width direction of the pair of translucent plate members are both held by the holding members in states of being tilted toward the thickness direction inner side. Therefore, in a state in which the aerogel is not filled, the pair of translucent plate members curve toward the thickness direction inner side from the respective side end portions toward the width direction central portions thereof. Due thereto, in the first aspect, as compared with a case in which the side end portions of the pair of translucent plate members are not tilted, outward swelling of the pair of translucent plate members at the time when an aerogel is filled between the pair of translucent plate members and the aerogel layer is formed is suppressed. Accordingly, overfilling of the aerogel between the pair of translucent plate members is prevented or suppressed. Moreover, due to the pair of translucent plate members being held by the holding members in states of being tilted toward the thickness direction inner side, at the time when the translucent member is transported or is moved before the aerogel is filled between the pair of translucent plate members, it is easy to maintain the forms of the pair of translucent plate members.

[0010] Further, because the side end portions in the width direction of the pair of translucent plate members are both held by the holding members in states of being tilted toward the thickness direction inner side, compressive force is applied to the aerogel layer from the side portions in the width direction of the pair of translucent plate members. Vibrations and the

like of the aerogel layer are suppressed by this compressive force, and therefore, precipitation of the aerogel due to vibrations or the like is prevented or suppressed.

[0011] In a translucent member relating to a second aspect, in the translucent member relating to the first aspect, the holding members have frame portions running along end surfaces of the side end portions of the translucent plate members, and outer side claw portions projecting out from outer end portions of the frame portions in states of being tilted toward a thickness direction inner side of the translucent plate members, and disposed along outer surfaces of the side end portions; and rigidity of the holding members is greater than rigidity of the translucent plate members.

[0012] In accordance with the second aspect, the outer side claw portions of the holding members project out from the outer end portions of the frame portions in states of being tilted toward the thickness direction inner side of the translucent plate members. Further, the rigidity of the holding members is greater than that of the translucent plate members. Due thereto, when lateral pressure is applied from the aerogel layer to the outer side claw portions, collapsing of the outer side claw portions is suppressed. Therefore, the side end portions in the width direction of the pair of translucent plate members both can continue to be held in states of being tilted toward the thickness direction inner side by the holding members.

[0013] In a translucent member relating to a third aspect, in the translucent member relating to the second aspect, rigidity of the outer side claw portions is greater than rigidity of the translucent plate members.

[0014] In a translucent member relating to a fourth aspect, in the translucent member relating to the second aspect, the outer side claw portions project out from the outer end portions at both sides of the frame portions, and are respectively disposed along the outer surfaces of the side end portions of the pair of translucent plate members.

[0015] In a translucent member relating to a fifth aspect, in the translucent member relating to the second aspect, the holding members have inner side claw portions that project out from inner sides of the outer end portions at the frame portions in states of being tilted toward a thickness direction inner side of the translucent plate members, and are disposed along inner surfaces of the side end portions.

[0016] In accordance with the fifth aspect, the inner side claw portions of the holding members project out from the inner sides of the outer end portions at the frame portions in states of being tilted toward the thickness direction inner side of the translucent plate members. Further, the rigidity of the holding members is greater than that of the translucent plate members. Due thereto, when lateral pressure is applied from the aerogel layer to the

outer side claw portions and the inner side claw portions, collapsing of the outer side claw portions and the inner side claw portions is suppressed. Therefore, the side end portions in the width direction of the pair of translucent plate members both can continue to be held in states of being tilted toward the thickness direction inner side by the holding members.

[0017] In a translucent member relating to a sixth aspect, in the translucent member relating to the fifth aspect, rigidities of the outer side claw portions and the inner side claw portions are greater than the rigidity of the translucent plate members.

[0018] In a translucent member relating to a seventh aspect, in the translucent member relating to the fifth aspect, a length of the outer side claw portions in a projecting direction is greater than or equal to a length of the inner side claw portions in a projecting direction.

[0019] In a translucent member relating to an eighth aspect, in the translucent member relating to the fifth aspect, a length of the outer side claw portions in a projecting direction is the same as a length of the inner side claw portions in a projecting direction.

[0020] In a translucent member relating to a ninth aspect, in the translucent member relating to the fifth aspect, the inner side claw portions project out from inner sides of the outer end portions at both sides of the frame portions, and are respectively disposed along inner surfaces of the side end portions of the pair of translucent plate members.

[0021] In a translucent member relating to a tenth aspect, in the translucent member relating to the first aspect, the pair of translucent plate members swell out toward thickness direction outer sides from the side end portions toward central portions in a width direction.

[0022] In a translucent member relating to an eleventh aspect, in the translucent member relating to the first aspect, the holding members respectively hold the side end portions at both width direction sides of the pair of translucent plate members.

[0023] In a translucent member relating to a twelfth aspect, in the translucent member relating to the first aspect, the translucent plate members have plural hollow portions in which an aerogel is filled.

[0024] In a translucent member relating to a thirteenth aspect, in the translucent member relating to the fifth aspect, the translucent plate member has a pair of polycarbonate plates that face one another, and a plurality of ribs provided between the pair of polycarbonate plates, connecting the pair of polycarbonate plates; and forming plural hollow portions between the pair of polycarbonate plates, and an aerogel is filled in the hollow portions.

[0025] A multilayer translucent body relating to a fourteenth aspect includes: a plurality of translucent plates that face one another and at which regions between edge portions thereof are closed-off; and the translucent member relating to any one of the first aspect through the

thirteenth aspect provided in a hollow layer that is between translucent plates that are adjacent to one another, with intervals between the translucent member and the translucent plates.

[0026] In accordance with the fourteenth aspect, the translucent member, in which an aerogel layer is formed between a pair of translucent plate members, is provided in a hollow layer that is between translucent plates that are adjacent to one another. Therefore, the heat insulating ability of the multilayer translucent body improves. Further, the swelling of the pair of translucent plate members due to lateral pressure applied from the aerogel layer to the pair of translucent plate members is suppressed by the holding members. Due thereto, contacting of the translucent plates and the translucent plate members is prevented, and therefore, the insulation effectiveness of the multilayer translucent body improves.

[0027] In a multilayer translucent body relating to a fifteenth aspect, in the multilayer translucent body relating to the fourteenth aspect, the translucent plate members and the translucent plates are glass plates, and a thickness of the translucent plate members is less than or equal to a thickness of the translucent plates.

Advantageous Effects of Invention

[0028] In accordance with the present disclosure, outward swelling of a pair of translucent plate members at the time when an aerogel layer is formed by filling an aerogel between the pair of translucent plate members can be suppressed.

BRIEF DESCRIPTION OF DRAWINGS

[0029] Fig. 1 is a cross-sectional view illustrating a horizontal section of a central portion in a Z direction of a multilayer translucent body relating to a first embodiment.

Fig. 2 is a cross-sectional view illustrating a vertical section of a central portion in an X direction of the multilayer translucent body relating to the first embodiment.

Fig. 3A is a cross-sectional view of a holding member that holds an X direction side end portion of a hollow polycarbonate plate in the first embodiment.

Fig. 3B is a cross-sectional view of a holding member that holds a Z direction side end portion of the hollow polycarbonate plate in the first embodiment.

Fig. 4A is a cross-sectional view illustrating a horizontal section of central portions in the Z direction of a pair of the hollow polycarbonate plates before an aerogel is filled between the pair of hollow polycarbonate plates in a step of manufacturing the translucent member relating to the first embodiment.

Fig. 4B is a cross-sectional view illustrating a horizontal section of central portions in the Z direction of the pair of hollow polycarbonate plates after the aerogel is filled between the pair

of hollow polycarbonate plates in a step of manufacturing the translucent member relating to the first embodiment.

Fig. 5A is a cross-sectional view illustrating a vertical section of central portions in the X direction of the pair of hollow polycarbonate plates before the aerogel is filled between the pair of hollow polycarbonate plates in a step of manufacturing the translucent member relating to the first embodiment.

Fig. 5B is a cross-sectional view illustrating a vertical section of central portions in the X direction of the pair of hollow polycarbonate plates after the aerogel is filled between the pair of hollow polycarbonate plates and the region between the upper end portions of the pair of hollow polycarbonate plates is sealed in a step of manufacturing the translucent member relating to the first embodiment.

Fig. 6 is a graph illustrating the relationship between a bending moment applied to the hollow polycarbonate plate and a rotation angle curve of a side end portion of the hollow polycarbonate plate in the first embodiment.

Fig. 7 is a graph illustrating an elastic region of the graph illustrated in Fig. 6.

Fig. 8 is an explanatory drawing for explaining conditions of a calculation example of the graphs illustrated in Fig. 6 and Fig. 7.

Fig. 9 is a cross-sectional view illustrating a horizontal section of a central portion in the Z direction of a multilayer translucent body relating to a second embodiment.

Fig. 10 is a cross-sectional view illustrating a vertical section of a central portion in the X direction of the multilayer translucent body relating to the second embodiment.

Fig. 11A is a cross-sectional view of a holding member that holds an X direction side end portion of a hollow polycarbonate plate in the second embodiment.

Fig. 11B is a cross-sectional view of a holding member that holds a Z direction side end portion of the hollow polycarbonate plate in the second embodiment.

Fig. 12A is a cross-sectional view illustrating a horizontal section of central portions in the Z direction of the pair of hollow polycarbonate plates before an aerogel is filled between the pair of hollow polycarbonate plates in a step of manufacturing a translucent member relating to the second embodiment.

Fig. 12B is a cross-sectional view illustrating a horizontal section of central portions in the Z direction of the pair of hollow polycarbonate plates after the aerogel is filled between the pair of hollow polycarbonate plates in a step of manufacturing the translucent member relating to the second embodiment.

Fig. 13A is a cross-sectional view illustrating a vertical section of central portions in the X direction of the pair of hollow polycarbonate plates before the aerogel is filled between the pair of hollow polycarbonate plates in a step of manufacturing the translucent member relating to the second embodiment.

Fig. 13B is a cross-sectional view illustrating a vertical section of central portions in the X direction of the hollow polycarbonate plates after the aerogel is filled between the pair of hollow polycarbonate plates and the region between the upper end portions of the pair of hollow polycarbonate plates is sealed in a step of manufacturing the translucent member relating to the second embodiment.

Fig. 14A is a cross-sectional view illustrating a horizontal section of central portions in the Z direction of a pair of hollow polycarbonate plates before an aerogel is filled between the pair of hollow polycarbonate plates in a step of manufacturing a translucent member relating to a reference example.

Fig. 14B is a cross-sectional view illustrating a horizontal section of central portions in the Z direction of the pair of hollow polycarbonate plates after the aerogel is filled between the pair of hollow polycarbonate plates in a step of manufacturing the translucent member relating to the reference example.

Fig. 15 is a perspective view of the hollow polycarbonate plate in the first embodiment and the second embodiment.

DESCRIPTION OF EMBODIMENTS

[0030] <First Embodiment>

A multilayer translucent body of a first embodiment is described. Note that the two horizontal directions that are orthogonal to one another are considered to be the X direction and the Y direction, and these respective directions are denoted by arrow X and arrow Y.

The vertical direction that is orthogonal to the X direction and the Y direction is considered to be the Z direction, and this direction is denoted by arrow Z. Further, a multilayer translucent body 12 that is described later is set in a state in which the out-of-plane directions of glass plates 52 that are an example of the translucent plates is the Y direction. The structure of the multilayer translucent body 12 is described by using this state as a reference.

[0031] (Structure)

The structure of the multilayer translucent body is described first. Note that Fig. 1 is a cross-sectional view illustrating a horizontal section of the central portion in the vertical direction of

the multilayer translucent body. Fig. 2 is a cross-sectional view illustrating a vertical section of the central portion in the X direction of the multilayer translucent body.

[0032] The multilayer translucent body 12 illustrated in Fig. 1 and Fig. 2 has two of the glass plates 52 serving as examples of translucent plates, and a translucent member 10 provided between the two glass plates 52. The shapes of the glass plates 52 and the translucent member 10 as seen from the Y direction are quadrangular shapes. The multilayer translucent body 12 of the present embodiment is mounted to a window frame 16. However, the object to which the multilayer translucent body 12 is mounted is not limited to the window frame 16.

[0033] A hollow layer 55 is formed between the two glass plates 52. Spacers 21 are nipped between edge portions 53 of the two glass plates 52. In the present embodiment, butyl tape materials 22 are adhered between the edge portions 53 of the glass plates 52 and the spacers 21. However, the method of joining the edge portions 53 of the glass plates 52 and the spacers 21 can be changed appropriately. Further, the outer sides of the spacers 21 between the edge portions 53 of the two glass plates 52 are closed-off by silicone sealing materials 31 that serve as closing materials.

[0034] Note that the interiors of the spacers 21 of the present embodiment are cavities. An unillustrated drying agent is filled in the cavity portions of the spacers 21. However, the structure of the spacers 21 can be changed appropriately.

[0035] The translucent member 10 is provided in the hollow layer 55. The translucent member 10 is structured to have two hollow polycarbonate plates 100 serving as an example of translucent resin plates, holding members 150 (refer to Fig. 2 and Fig. 3B), holding members 151 (refer to Fig. 1 and Fig. 3A), and an aerogel layer 130. The aerogel layer 130 is formed by aerogel N being filled between the two hollow polycarbonate plates 100. The hollow polycarbonate plates 100 of the present embodiment are quadrangular when viewed from the Y direction.

[0036] As illustrated in Fig. 15, the hollow polycarbonate plate 100 has two polycarbonate plates 102 that face one another, and plural ribs 104 provided between the two polycarbonate plates 102. The plural ribs 104 connect the two polycarbonate plates 102. Plural hollow portions 106 that are lined-up in a predetermined direction are formed by these polycarbonate plates 102 and ribs 104. Aerogel M is filled in the hollow portions 106 of the hollow polycarbonate plate 100.

[0037] As illustrated in Fig. 1, the holding members 151 hold and seal side end portions 110X in the width direction, which runs along the X direction, of the two hollow

polycarbonate plates 100, and seal outer edge portions 132X that are between the two hollow polycarbonate plates 100.

[0038] The holding member 151 illustrated in Fig. 1 and Fig. 3A has a frame portion 151C, two outer side claw portions 151B projecting out from the outer end portions at the both sides of the frame portion 151C respectively, and two inner side claw portions 151A projecting out from the inner sides of the two outer side claw portions 151B at the frame portion 151C.

[0039] The frame portions 151C are provided along end surfaces 112X of the side end portions 110X of the hollow polycarbonate plates 100. The outer side claw portions 151B are provided along outer surfaces 113X of the side end portions 110X at the two hollow polycarbonate plates 100, respectively. The inner side claw portions 151A are provided along inner surfaces 114X of the side end portions 110X of the two hollow polycarbonate plates 100, respectively. The outer side claw portions 151B and the inner side claw portions 151A are inclined toward the thickness direction inner side of the hollow polycarbonate plates 100, i.e., toward the aerogel layer 130 side. Further, the rigidity of the holding members 151 is greater than that of the hollow polycarbonate plates 100. Further, the rigidity of the frame portion 151C is greater than those of the outer side claw portions 151B and the inner side claw portions 151A.

[0040] As illustrated in Fig. 1, the side end portions 110X of the pair of hollow polycarbonate plates 100 are both held in states of being tilted toward the thickness direction inner side (the aerogel layer 130 side) by the holding members 151.

[0041] Note that the rigidity of the hollow polycarbonate plates 100 is the bending rigidity in a case in which the hollow polycarbonate plates 100 are curved in the Y direction with the side end portions 110X at the both sides in the X direction that are fixed by pins (supported by pins) being the points of support.

[0042] Here, in Fig 1 and in Figs. 2, 4B, 5B and the like that are described later, the degree of bending of the hollow polycarbonate plates 100 is illustrated as being larger than the actual degree of bending thereof, in order to facilitate understanding.

[0043] As illustrated in Fig. 2, the holding members 150 hold and seal side end portions 110Z in the width direction, which runs along the Z direction, of the two hollow polycarbonate plates 100, and seal outer edge portions 132Z that are between the two hollow polycarbonate plates 100.

[0044] Note that, because the holding members 150 have the same structures as the above-described holding members 151, description of the structure of the holding members 150 is simplified. The holding member 150 illustrated in Fig. 2 and in Fig. 3B has a frame portion

150C, two outer side claw portions 150B projecting out from the outer end portions at the both sides of the frame portion 150C respectively, and two inner side claw portions 150A projecting out from the inner sides of the two outer side claw portions 150B at the frame portion 150C. The outer side claw portions 150B and the inner side claw portions 150A are inclined toward the thickness direction inner sides of these outer side claw portions 150B and inner side claw portions 150A, i.e., toward the aerogel layer 130 side. Further, the rigidity of the holding members 150 is greater than that of the hollow polycarbonate plates 100. Further, the rigidity of the frame portion 150C is greater than those of the outer side claw portions 150B and the inner side claw portions 150A.

[0045] Due thereto, as illustrated in Fig. 2, the side end portions 110Z of the pair of hollow polycarbonate plates 100 are both held in states of being tilted toward the thickness direction inner side (the aerogel layer 130 side) by the holding members 150.

[0046] Note that the rigidity of the hollow polycarbonate plates 100 is the bending rigidity in a case in which the hollow polycarbonate plates 100 are curved in the Y direction with the side end portions 110X at the both sides in the Z direction that are fixed by pins (supported by pins) being the points of support.

[0047] As illustrated in Fig. 1 and Fig. 2, the side end portions 110X, 110Z of the two hollow polycarbonate plates 100 are tilted inwardly. In the horizontal section illustrated in Fig. 1, the aerogel layer 130 is formed by the aerogel N that is filled between the two hollow polycarbonate plates 100. Due to the lateral pressure applied from this aerogel layer 130 to the inner surfaces of the two hollow polycarbonate plates 100, the two hollow polycarbonate plates 100 swell (bulge) out toward the thickness direction outer sides from the side end portions 110X, 110Z toward the central portions. However, intervals L are formed between the hollow polycarbonate plates 100 and the glass plates 52. Also in the vertical section illustrated in Fig. 2, due to the lateral pressure applied from the aerogel layer 130 to the two hollow polycarbonate plates 100, the two hollow polycarbonate plates 100 swell (bulge) out toward the thickness direction outer sides. This swelling of the two hollow polycarbonate plates 100 is large at the bottom and becomes smaller toward the top. The intervals L are formed between the hollow polycarbonate plates 100 and the glass plates 52.

[0048] As illustrated in Fig. 1 and Fig. 2, the gaps of the joined regions of the holding members 150 and the holding members 151 are filled-in by using a sealing material that is silicone or the like, a foam material such as a continuous foaming urethane sponge, or a hotmelt adhesive, or the like. Sealing is carried out to the extent that the aerogel N does not leak out from these gaps.

[0049] Note that the side end portions 110X, 110Z of the hollow polycarbonate plates 100 are fixed to the holding members 150, 151 by friction. However, the side end portions 110X, 110Z of the hollow polycarbonate plates 100 may be fixed to the holding members 150, 151 by using an adhesive such as a silicone sealing material.

[0050] As described above, the holding members 150, 151 seal the outer edge portions of the translucent member 10.

[0051] Further, the lengths of the outer side claw portions 150B, 151B in the projecting directions thereof in the present embodiment, and the lengths of the inner side claw portions 150A, 151A in the projecting directions thereof, are the same. However, the lengths of the outer side claw portions 150B, 151B in the projecting directions and the lengths of the inner side claw portions 150A, 151A in the projecting directions may be different. However, it is preferable that the lengths of the outer side claw portions 150B, 151B in the projecting directions are greater than or equal to the lengths of the inner side claw portions 150A, 151A in the projecting directions. Further, it is even more preferable that the lengths of the outer side claw portions 150B, 151B in the projecting directions are the same as the lengths of the inner side claw portions 150A, 151A in the projecting directions. Note that the lengths of the outer side claw portions 150B, 151B in the projecting directions and the lengths of the inner side claw portions 150A, 151A in the projecting directions are the lengths over which the claw portions hold (catch on) the side end portions 110X, 110Z.

[0052] Here, the aerogel is in the form of granules or a powder or the like that is obtained by substituting the solvent contained in the gel with air by supercritical drying or the like, and is a porous, low-density structure. Further, particle components such as silica fume, silica spherical particles, hollow silica or foamed styrol particles may be separately included in the aerogels M, N.

[0053] (Manufacturing Method)

An example of a method of manufacturing the translucent member 10 of the present embodiment is described next. Note that the following manufacturing method is an example, and can be changed appropriately.

[0054] First, the hollow polycarbonate plates 100 are set with the direction running along the ribs 104 (refer to Fig. 15), i.e., the axial directions of the tubular hollow portions 106 (refer to Fig. 15), being the vertical direction. Further, the holding members 150, 151 are joined to the side end portions 110X, 110Z of the hollow polycarbonate plates 100 except for the side end portions 110Z at the upper sides of the hollow polycarbonate plates 100, and the open ends at the lower sides of the hollow portions 106 and the aerogel layer 130 are closed-

off. Then, the aerogel M is filled into the hollow portions 106 from the openings at the upper sides of the hollow portions 106 of the hollow polycarbonate plates 100. Note that, at the time of filling the aerogel M into the hollow portions 106, vibrations may be imparted to the hollow polycarbonate plates 100.

[0055] Fig. 4A is a horizontal sectional view of the central portions in the Z direction of the hollow polycarbonate plates 100 that are in the above-described state. Fig. 5A is a vertical sectional view of the central portions in the X direction of the hollow polycarbonate plates 100 that are in the above-described state. Note that, if the holding members 150 are provided at the upper sides of the hollow polycarbonate plates 100 illustrated in Fig. 5A, there are cases in which the curvatures of the hollow polycarbonate plates 100 differ. However, with regard to the point that the hollow polycarbonate plates 100 curve toward the thickness direction inner side from the side end portions 110Z toward the width direction central portions, the hollow polycarbonate plates 100 become shapes that are the same as those of the hollow polycarbonate plates 100 illustrated in Fig. 4A.

[0056] Moreover, the aerogel N is filled in between the two hollow polycarbonate plates 100, and the holding members 150 are joined to the side end portions 110Z at the upper sides of the hollow polycarbonate plates 100, and the open ends at the upper sides of the hollow portions 106 and the aerogel layer 130 are closed-off. Note that, at the time of filling the aerogel N in between the two hollow polycarbonate plates 100, vibrations may be imparted to the hollow polycarbonate plates 100.

[0057] Fig. 4B is a horizontal section of the central portions in the Z direction of the hollow polycarbonate plates 100 that are in the above-described state. Fig. 5B is a vertical section of the central portions in the X direction of the hollow polycarbonate plates 100 that are in the above-described state.

[0058] (Operation and Effects)

Operation and effects of the present embodiment are described next.

[0059] In the translucent member 10 of the present embodiment, the side end portions 110X, 110Z of the pair of hollow polycarbonate plates 100 are both held in states of being inclined toward the thickness direction inner side by the holding members 150, 151.

[0060] Therefore, in the state in which the aerogel N is not filled between the pair of hollow polycarbonate plates 100, the pair of hollow polycarbonate plates 100 curve toward the thickness direction inner side from the side end portions 110X, 110Z toward the width direction central portions (refer to Fig. 4A). Due thereto, in the present embodiment, as compared with a case in which the side end portions 110X, 110Z are not tilted, at the time

when the aerogel N is filled between the pair of hollow polycarbonate plates 100 and the aerogel layer 130 is formed, the pair of hollow polycarbonate plates 100 swelling outwardly is suppressed. Accordingly, overfilling of the aerogel N between the pair of hollow polycarbonate plates 100 is prevented or suppressed. Further, because the hollow polycarbonate plates 100 approaching or contacting the glass plates 52 is suppressed, the intervals L between the hollow polycarbonate plates 100 and the glass plates 52 are maintained.

[0061] Further, due to the pair of hollow polycarbonate plates 100 being held in states of being tilted toward the thickness direction inner side by the holding members 150, 151, at the time when the translucent member 10 is transported or is moved before the aerogel N is filled between the pair of hollow polycarbonate plates 100, it is easy to maintain the forms of the pair of hollow polycarbonate plates 100.

[0062] Here, a case is described in which the pair of hollow polycarbonate plates 100 are held by holding members 950 relating to a comparative example as illustrated in Fig. 14A and Fig. 14B. At the holding members 950 relating to the comparative example, outer side claw portions 950B and inner side claw portions 950A are not tilted.

[0063] As illustrated in Fig. 14A, before the aerogel N is filled between the two hollow polycarbonate plates 100, the two hollow polycarbonate plates 100 are parallel. Then, as illustrated in Fig. 14B, when the aerogel N is filled between the two hollow polycarbonate plates 100, due to the lateral pressure applied from the aerogel layer 130 to the two hollow polycarbonate plates 100, the width direction central portions of the two hollow polycarbonate plates 100 curve and swell-out in directions of moving apart from one another. Note that, in Fig. 14B, the amounts of swelling of the two hollow polycarbonate plates 100 are illustrated so as to be larger than in actuality, in order to facilitate understand.

[0064] Therefore, the filled amount of the aerogel N that is filled in between the two hollow polycarbonate plates 100 is large. Namely, the aerogel N is overfilled at the two hollow polycarbonate plates 100. Further, because the width direction central portions of the hollow polycarbonate plates 100 approach or contact the glass plates 52 (refer to Fig. 1), the intervals L between the hollow polycarbonate plates 100 and the glass plates 52 are not maintained.

[0065] In contrast, in the present embodiment, the side end portions 110X, 110Z of the hollow polycarbonate plates 100 are held by the holding members 150, 151 in states of being tilted toward the thickness direction inner side. Due thereto, at the time when the aerogel N is filled in between the two hollow polycarbonate plates 100 and the aerogel layer 130 is

formed, swelling that is such that the pair of hollow polycarbonate plates 100 curve in directions of moving apart from one another is suppressed.

[0066] Note that the hollow polycarbonate plates 100 of the present embodiment curve in the Y direction with the side end portions 110Z at the both sides in the Z direction that are fixed by pins being the points of support, and curve in the Y direction with the side end portions 110X at the both sides in the X direction that are fixed by pins being the points of support. Therefore, the hollow polycarbonate plates 100 become complex, curved shapes in which ridgelines are formed from the corner portions toward the central portion. Moreover, the plural ribs 104 that run along the Z direction are formed at the interiors of the hollow polycarbonate plates 100 of the present embodiment (refer to Fig. 15). Therefore, to be exact, the bending rigidity of the hollow polycarbonate plates 100 that curve in the Y direction with the side end portions 110Z that are fixed by pins being the points of support, and the bending rigidity of the hollow polycarbonate plates 100 that curve in the Y direction with the side end portions 110X at the both sides in the X direction that are fixed by pins being the points of support, are different. Accordingly, the curved shapes of the hollow polycarbonate plates 100 become even more complex.

[0067] Here, in the present embodiment, the holding members 150, 151 and the like are set such that the swelling of the hollow polycarbonate plates 100 is kept less than a prescribed value by the holding members 150, 151.

[0068] A setting that is such that the swelling of the hollow polycarbonate plates 100 is kept less than a prescribed value is preferably a setting such that the swelling of the hollow polycarbonate plates 100 of the present embodiment is smaller than the swelling of the hollow polycarbonate plates 100 in a case in which the hollow polycarbonate plates 100 are held by the holding members 950 of the comparative example.

[0069] Further, a setting that is such that the swelling of the hollow polycarbonate plates 100 is kept less than a prescribed value is more preferably a setting such that the offset from the set value of the intervals L is kept within a predetermined range, e.g., less than 10%. For example, in a case in which the set value of the intervals L is 10 mm, a setting that is such that the swelling of the hollow polycarbonate plates 100 is kept less than a prescribed value is a setting such that the intervals L are kept between 9 mm – 11 mm. Further, a setting that is such that the swelling of the hollow polycarbonate plates 100 is kept less than a prescribed value is preferably, for example, a setting such that the offset from the set amount of the aerogel N in a case in which the aerogel N is filled between the pair of hollow polycarbonate plates 100 without gaps is kept within a predetermined range, e.g., less than 10%.

[0070] Further, at the multilayer translucent body 12, the translucent member 10, at which the aerogel layer 130 is formed between the pair of hollow polycarbonate plates 100, is provided in the hollow layer 55 that is between the glass plates 52 that are adjacent to one another. Due thereto, the heat insulating ability of the multilayer translucent body 12 improves. Further, at the multilayer translucent body 12, the swelling of the pair of hollow polycarbonate plates 100 is kept less than a prescribed value by the holding members 150, 151. Due thereto, contact between the glass plates 52 and the hollow polycarbonate plates 100 is prevented, and therefore, the insulation effectiveness of the multilayer translucent body 12 improves.

[0071] Further, the side end portions 110X, 110Z of the pair of hollow polycarbonate plates 100 are both held in states of being tilted toward the thickness direction inner side by the holding members 150, 151. Therefore, even at a portion where the lateral pressure applied from the aerogel layer 130 to the pair of hollow polycarbonate plates 100 is low such as at the upper end portion of the aerogel layer 130 for example, compressive force is applied to the aerogel layer 130 from the pair of hollow polycarbonate plates 100. Due to this compressive force, movement of the aerogel due to vibrations of the aerogel layer 130 or the like is suppressed, and therefore, precipitation of the aerogel N due to vibrations or the like is prevented or suppressed.

[0072] Further, even if the pair of hollow polycarbonate plates 100 were to stretch due to heat, precipitation of the aerogel N is suppressed because compressive force is applied from the pair of hollow polycarbonate plates 100 to the aerogel layer 130.

[0073] Further, the rigidity of the holding member 150 is greater than that of the hollow polycarbonate plates 100. Thus, even if lateral pressure is applied from the aerogel layer 130 to the outer side claw portions 150B, 151B and the inner side claw portions 150A, 151A, the outer side claw portions 150B, 151B and the inner side claw portions 150A, 151A do not collapse. Accordingly, the side end portions 110X, 110Z of the hollow polycarbonate plates 100 both can continue to be maintained in states of being tilted toward the thickness direction inner side by the holding members 150.

[0074] Here, as described above, the rigidities of the respective members that resist the out-of-plane direction forces of the hollow polycarbonate plates 100 is the following relationship. frame portions 150C, 151C > outer side claw portions 150B, 151B and inner side claw portions 150A, 151A > hollow polycarbonate plates 100

[0075] Due to the lateral pressure applied from the aerogel layer 130 to the hollow polycarbonate plates 100, the outer side claw portions 150B, 151B and the inner side claw

portions 150A, 151A resist the moments that are generated at the hollow polycarbonate plates 100. The frame portions 150C, 151C resist the moments generated at the outer side claw portions 150B, 151B and the inner side claw portions 150A, 151A. At this time, when deformation of the frame portions 150C, 151C and of the outer side claw portions 150B, 151B and the inner side claw portions 150A, 151A arises, the side end portions 110X, 110Z of the hollow polycarbonate plates 100 apparently rotate, and the deflection of the central positions of the hollow polycarbonate plates 100 increases in accordance with this angle of rotation.

[0076] Therefore, the order of the rigidities of the respective members in order to suppress the generation of deflection at the central positions of the hollow polycarbonate plates 100 is as follows.

frame portions 150C, 151C $\geq$ outer side claw portions 150B, 151B and inner side claw portions 150A, 151A $>$ hollow polycarbonate plates 100

Further, the following is preferable as the order of the rigidities of the respective members in order to suppress the generation of deflection at the central positions of the hollow polycarbonate plates 100.

frame portions 150C, 151C $>$ outer side claw portions 150B, 151B and inner side claw portions 150A, 151A $>$ hollow polycarbonate plates 100

[0077] (Calculation Example)

An example of calculating the amount of deflection of the hollow polycarbonate plates 100 is described next by using Fig. 6, Fig. 7 and Fig. 8. Note that the inner side claw portions 151A of the holding members 151 are not tilted in Fig. 8 in order to facilitate explanation.

[0078] First, as illustrated in Fig. 8, the maximum deflection amount of the hollow polycarbonate plates 100 in a case in which the hollow polycarbonate plates 100 are curved and fixed by the holding members 151 is used as the deflection amount at the time when the two hollow polycarbonate plates 100 contact one another.

[0079] Given that the central line in the thickness direction of the hollow polycarbonate plate 100 is CH, the thickness of the aerogel layer 130 is t , the width in the X direction of the hollow polycarbonate plate 100 is L , the maximum deflection amount of the hollow polycarbonate plate 100 is δ_{MAX} , and the rotation angle (the maximum rotation angle) of the hollow polycarbonate plate 100 at this time is Θ_{MAX} , following (formula 1) and (formula 2) are obtained.

$$\delta_{MAX} = t/2 \quad \dots(\text{formula 1})$$

$$\Theta_{MAX} = t/L \quad \dots(\text{formula 2})$$

[0080] Accordingly, the side end portions 110X of the hollow polycarbonate plates 100 are fixed and held by the holding members 151 at a rotation angle of $0 \text{ rad} - t/L \text{ rad}$. The X direction width of the hollow polycarbonate plate 100 is considered to be 300 mm ($= L$), the Z direction width of the hollow polycarbonate plate 100 is considered to be 1000 mm, and the thickness of the hollow polycarbonate plate 100 is considered to be 4 mm. Further, as illustrated in Fig. 8, interval t of the side end portions 110X of the two hollow polycarbonate plates 100 that face one another with an interval therebetween is considered to be 5 mm.

[0081] Fig. 6 is a graph illustrating the rigidity of these hollow polycarbonate plates 100 by the relationship between the bending moment and the rotation angle curve of the side end portions 110X.

[0082] Fig. 7 illustrates elastic region DS (rectilinear portion) of Fig. 6. An approximate expression of the elastic region DS (rectilinear portion) is following formula 3.

$$y = 1657x - 1.0832 \quad (\text{formula 3})$$

[0083] In the case of the above-described conditions, when the side end portions 110X both ends are fixed by pins, the lateral pressure that is applied to one of the hollow polycarbonate plates 100 from the aerogel layer 130 that is formed by filling the aerogel N between the two hollow polycarbonate plates 100 is determined by the volume of the aerogel layer 130, the density of the aerogel N, and the surface area of the hollow polycarbonate plate 100 that receives the load. For example, in a case in which aerogel N of a density of 80g/L (liters) is filled between the two hollow polycarbonate plates 100 that are not bent and fixed, the weight (60 g), which is half of the weight (120 g) of the aerogel layer 130 that is determined by multiplying the density 80 g/L by the volume ($1.5 \text{ L} = 5 [\text{mm}] \times 300 [\text{mm}] \times 1000 [\text{mm}]$) of the aerogel N, is applied to the one hollow polycarbonate plate 100. At this time, in a cross-section of the hollow polycarbonate plate 100 along the X direction, the uniformly distributed load applied to the hollow polycarbonate plate 100 is 0.2 g/mm ($= 60 [\text{g}] / 300 [\text{mm}]$).

Further, the line load applied to the width direction central portion of the hollow polycarbonate plate 100 is 0.00196 N/mm ($= 0.2 [\text{g/mm}] \times 9.8 / 1000$). The bending moment that is generated at the side end portion 110X at this time is 22.05 N·mm ($= 0.00196 [\text{N/mm}] \times 300^2 [\text{mm}] / 8$).

[0084] When this value is substituted into above (formula 3), the rotation angle generated at the side end portions 110X is 0.014 rad.

Further, the deflection amount of the central portion of the hollow polycarbonate plate 100 when the rotation angle of the side end portions 110X is 0.014 rad is 2.09 mm.

[0085] From above (formula 1) and (formula 2), δ_{MAX} under these conditions is 2.5 mm, and Θ_{MAX} is 0.016 rad.

[0086] Under the present conditions, swelling of the hollow polycarbonate plates 100 is suppressed by generating, in advance, a rotation angle of 0.014 rad of the side end portions 110X, which is generated by the lateral pressure applied to the hollow polycarbonate plates 100 from the aerogel layer 130, at the side end portions 110X of the hollow polycarbonate plates 100 and maintaining the rotation angle. As a result thereof, a prescribed amount of the aerogel N can be filled between the two hollow polycarbonate plates 100.

[0087] Note that the above computation is an example of computation in a case in which the hollow polycarbonate plates 100 curve in the Y direction with the side end portions 110X at the both sides in the X direction that are fixed by pins being the points of support.

[0088] However, as described above, the hollow polycarbonate plates 100 of the above-described first embodiment curve also in the Y direction with the side end portions 110Z at the both sides in the Z direction that are fixed by pins being the points of support. Further, the plural ribs 104 that run along the Z direction are formed at the interiors of the hollow polycarbonate plates 100 (refer to Fig. 15). Therefore, the hollow polycarbonate plates 100 of the first embodiment become complex, curved shapes. Accordingly, although the above computational example cannot be utilized as an accurate computational example of the above first embodiment, it can be used as a simple computational example of the above first embodiment. Note that, when accurately determining the curved shape and the rotation angle and the like of the hollow polycarbonate plates 100, it suffices to determine the curved shape and the rotation angle and the like from numerical analysis using a computer or results of experiments using prototypes or the like.

[0089] (Experimental Example)

A experimental example that confirms that overfilling of the aerogel N is suppressed by suppressing swelling of the pair of hollow polycarbonate plates 100 in the translucent member 10 of the above-described first embodiment is described next.

[0090] Specifically, overfilling of the aerogel N at the translucent member 10 of the first embodiment that is illustrated in Fig. 1, Fig. 2, Fig. 4A, Fig. 4B, Fig. 5A and Fig. 5B and at the translucent member 900 of the comparative example illustrated in Fig. 14A and Fig. 14B was compared. Note that the comparison of the translucent member 10 of the first embodiment and the translucent member 900 of the comparative example was carried out under the following conditions.

[0091] In the translucent member 10 of the present embodiment that was used in the experiment, solid polycarbonate plates of a thickness of 2 mm were used, and not the hollow polycarbonate plates 100. Further, in the translucent member 900 of the comparative example that was used in the experiment, hollow polycarbonate plates of a thickness of 4 mm at which an aerogel was not filled in the hollow portions thereof were used.

[0092] Further, the holding members 150, 151 of the present embodiment that were used in the experiment were made of ASA resin. The wall thicknesses of the inner side claw portions 150A, 151A and the outer side claw portions 150B, 151B of the present embodiment that were used in the experiment were 1.0 mm. The wall thickness of the frame portions 150C, 151C of the present embodiment that were used in the experiment was 1.5 mm. The holding members 950 of the comparative example that were used in the experiment were similarly made of ASA resin. The wall thicknesses of the inner side claw portions 950A, the outer side claw portions 950B and the frame portions 950C of the comparative example that were used in the experiment was 0.5 mm.

[0093] Further, the size of the aerogel layer between the pair of polycarbonate plates in the present embodiment that were used in the experiment was a height of 1.5 m, a width of 0.3 m, and a thickness of 9 mm. Prescribed amount α of the aerogel N that was filled between the pair of polycarbonate plates in the present embodiment that were used in the experiment was 311.85 g. Note that the size of the aerogel layer and the prescribed filled amount of the aerogel N are numerical values of a case in which the pair of polycarbonate plates are not curved. Further, the aerogel N used in the experiment had an average particle diameter of approximately 3 mm and a density of 77 g/L (liter).

[0094] The size of the aerogel layer between the pair of polycarbonate plates of the comparative example that were used in the experiment was a height of 1.0 m, a width of 0.3 m, and a thickness of 5 mm. The prescribed amount α of the aerogel N that was filled between the pair of polycarbonate plates of the comparative example was 115.5 g. Similarly, the aerogel N had an average particle diameter of approximately 3 mm and a density of 77 g/L.

[0095] Further, the aerogel N was filled between the pairs of polycarbonate plates while applying vibrations. Specifically, the pairs of polycarbonate plates, to which the holding members 150, 151, 950 were joined except at the side end portions at the upper sides (refer to Fig. 4A and Fig. 5A), were placed on and fixed to a plate member made of wood or the like. Then, in a state in which the plate member was vibrated by a vibration device such as a ball

vibrator or the like, the aerogel N was made to free-fall and was filled in between the pairs of polycarbonate plates.

[0096] As a result, filled amount β of the aerogel N in the case of using the holding members 150, 151 of the present embodiment was 321.89 g. Accordingly, ratio β/α was 1.03. The filled amount β of the aerogel N in the case of using the holding members 950 of the comparative example was 168.45 g. Accordingly, ratio β/α was 1.46.

[0097] In this way, the filled amount β of the aerogel N in the case of using the holding members 150, 151 of the present embodiment was approximately equal to the prescribed amount α . However, the filled amount β of the aerogel N in the case of using the holding members 950 of the comparative example was greater than near 1.5 times the prescribed amount α , and the filled amount of the aerogel N was excessive. Namely, it was confirmed by the present experimental example that overfilling of the aerogel N is suppressed in the translucent member 10 of the present embodiment.

[0098] <Second Embodiment>

A multilayer translucent body of a second embodiment is described next. Note that, in the second embodiment, the same reference numerals as in the first embodiment are given to members that are the same as those of the first embodiment, and description of members that are the same as those of the first embodiment is simplified or omitted. Further, only the holding members of the translucent member are different in the second embodiment and the first embodiment. Accordingly, description of members other than the holding members in the second embodiment is simplified or omitted.

[0099] (Structure)

The structure of the multilayer translucent body is described first. Note that Fig. 9 is a cross-sectional view of a horizontal section of the central portion in the vertical direction of the multilayer translucent body. Fig. 10 is a cross-sectional view of a vertical section of the central portion in the X direction of the multilayer translucent body.

[0100] Multilayer translucent body 13 illustrated in Fig. 9 and Fig. 10 has the two glass plates 52 serving as an example of the translucent plates, and a translucent member 11 provided between the two glass plates 52.

[0101] The translucent member 11 is provided in the hollow layer 55 between the two glass plates 52. The translucent member 11 is structured to have the two hollow polycarbonate plates 100 serving as an example of the translucent resin plates, holding members 250 (refer to Fig. 10 and Fig. 11B), holding members 251 (refer to Fig. 9 and Fig. 11A), and the aerogel

layer 130. The aerogel layer 130 is formed by the aerogel N being filled between the two hollow polycarbonate plates 100.

[0102] The holding members 251 illustrated in Fig. 9 hold and seal the side end portions 110X in the width direction, which runs along the X direction, of the two hollow polycarbonate plates 100, and seal the outer edge portions 132X that are between the two hollow polycarbonate plates 100.

[0103] The holding member 251 illustrated in Fig. 9 and Fig. 11A has a frame portion 251B, and outer side claw portions 251A projecting out from the outer end portions of the frame portion 251B. From another standpoint, the holding member 251 is the same as a structure in which the inner side claw portions 151A (refer to Fig. 3A) are omitted from the holding member 151 of the first embodiment.

[0104] The frame portions 251B are provided along the end surfaces 112X of the side end portions 110X of the hollow polycarbonate plates 100. The outer side claw portions 251A are provided along the outer surfaces 113X of the side end portions 110X. The outer side claw portions 251A are inclined toward the thickness direction inner side of the hollow polycarbonate plates 100, i.e., toward the aerogel layer 130 side. Further, the rigidity of the holding members 251 is greater than that of the hollow polycarbonate plates 100. Further, the rigidity of the frame portion 251B is greater than that of the outer side claw portions 251A.

[0105] Due thereto, as illustrated in Fig. 9, the side end portions 110X of the pair of hollow polycarbonate plates 100 are both held in states of being tilted toward the thickness direction inner side (the aerogel layer 130 side) by the holding members 251.

[0106] Note that the rigidity of the hollow polycarbonate plates 100 is the bending rigidity in a case in which the hollow polycarbonate plates 100 are curved in the Y direction with the side end portions 110X at the both sides in the X direction that are fixed by pins being the points of support.

[0107] Here, in Fig. 9 and in Fig. 12B that is described later and the like, the degree of bending of the hollow polycarbonate plates 100 is illustrated as being larger than the actual degree of bending thereof, in order to facilitate understanding.

[0108] The holding members 250 illustrated in Fig. 10 hold and seal the side end portions 110Z in the width direction, which runs along the Z direction, of the two hollow polycarbonate plates 100, and seal the outer edge portions 132Z that are between the two hollow polycarbonate plates 100.

[0109] The holding member 250 illustrated in Fig. 10 and Fig. 11B has a frame portion 250B, and outer side claw portions 250A projecting out from the outer end portions of the frame portion 250B.

[0110] The frame portions 250B are provided along end surfaces 112Z of the side end portions 110Z of the hollow polycarbonate plates 100. The outer side claw portions 250A are provided along outer surfaces 113Z of the side end portions 110Z. The outer side claw portions 250A are orthogonal to the frame portions 250B and are not inclined with respect to the frame portions 250B. Further, the rigidity of the holding members 250 is greater than that of the hollow polycarbonate plates 100. Further, the rigidity of the frame portion 250B is greater than that of the outer side claw portions 250A.

[0111] Note that the rigidity of the hollow polycarbonate plates 100 is the bending rigidity in a case in which the hollow polycarbonate plates 100 are curved in the Y direction with the side end portions 110Z at the both sides in the Z direction that are fixed by pins being the points of support.

[0112] Here, in Fig. 10 and in Fig. 13B that is described later, the two hollow polycarbonate plates 100 are parallel or substantially parallel, but, in actuality, the central portions of the two hollow polycarbonate plates 100 slightly swell outwardly.

[0113] As illustrated in Fig. 9, the side end portions 110X of the two hollow polycarbonate plates 100 are tilted toward the thickness direction inner side. Further, due to the lateral pressure applied from the aerogel layer 130 to the two hollow polycarbonate plates 100, the two hollow polycarbonate plates 100 swell (bulge) out toward the thickness direction outer sides from the side end portions 110X toward the central portions. However, the intervals L are formed between the hollow polycarbonate plates 100 and the glass plates 52.

[0114] As illustrated in Fig. 10, the two hollow polycarbonate plates 100 are parallel or substantially parallel. However, the intervals L are formed between the hollow polycarbonate plates 100 and the glass plates 52.

[0115] Note that the gaps of the joined regions of the holding members 250 and the holding members 251 are filled-in by using a sealing material that is silicone or the like, a foam material such as a continuous foaming urethane sponge, or a hotmelt adhesive, or the like. Sealing is carried out to the extent that the aerogel N does not leak out from these gaps.

[0116] The side end portions 110X, 110Z of the hollow polycarbonate plates 100 are fixed to the holding members 250, 251 by using an adhesive such as a silicone sealing material.

[0117] As described above, the holding members 250, 251 seal the outer edge portions of the translucent member 11.

[0118] (Manufacturing Method)

An example of a method of manufacturing the translucent member 10 of the present embodiment is described next. Note that the following manufacturing method is an example, and can be changed appropriately.

[0119] First, the hollow polycarbonate plates 100 are set with the direction running along the ribs 104 (refer to Fig. 15), i.e., the axial directions of the tubular hollow portions 106 (refer to Fig. 15), being the vertical direction. Further, the holding members 250, 251 are joined to the side end portions 110X, 110Z of the hollow polycarbonate plates 100 except for the side end portions 110Z at the upper sides of the hollow polycarbonate plates 100, and the open ends at the lower sides of the hollow portions 106 and the aerogel layer 130 are closed-off. Then, the aerogel M is filled into the hollow portions 106 from the openings at the upper sides of the hollow portions 106 of the hollow polycarbonate plates 100.

[0120] Fig. 12A is a horizontal section of the central portions in the Z direction of the hollow polycarbonate plates 100 that are in the above-described state. Fig. 13A is a vertical section of the central portions in the X direction of the hollow polycarbonate plates 100 that are in the above-described state.

[0121] Moreover, the aerogel N is filled in between the two hollow polycarbonate plates 100, and the holding members 250 are joined to the side end portions 110Z at the upper sides of the hollow polycarbonate plates 100, and the open ends at the upper sides of the hollow portions 106 and the aerogel layer 130 are closed-off. Fig. 12B is a horizontal section of the central portions in the Z direction of the hollow polycarbonate plates 100 that are in the above-described state. Fig. 13B is a vertical section of the central portions in the X direction of the hollow polycarbonate plates 100 that are in the above-described state.

[0122] Note that, due to the lateral pressure applied from the aerogel layer 130 to the hollow polycarbonate plates 100, the side end portions 110X tilt toward the thickness direction inner side, and the hollow polycarbonate plates 100 swell (bulge) out toward the thickness direction outer sides from the side end portions 110X toward the central portions.

[0123] (Operation and Effects)

Operation and effects of the present embodiment are described next.

[0124] In the translucent member 10, the side end portions 110X, 110Z of the pair of hollow polycarbonate plates 100 are both held in states of being inclined toward the thickness direction inner side by the holding members 251. Therefore, in the present embodiment, as compared with a case in which the side end portions 110X are not tilted, the pair of hollow polycarbonate plates 100 swelling outwardly due to the lateral pressure, which is applied to

the pair of the hollow polycarbonate plates 100 from the aerogel layer 130 formed by the aerogel N being filled in between the pair of hollow polycarbonate plates 100, is suppressed. Accordingly, overfilling of the aerogel N between the pair of hollow polycarbonate plates 100 is prevented or suppressed. Further, because the hollow polycarbonate plates 100 approaching or contacting the glass plates 52 is suppressed, the intervals L between the hollow polycarbonate plates 100 and the glass plates 52 are maintained.

[0125] Here, in the present embodiment, the holding members 250, 251 and the like are set such that the swelling of the hollow polycarbonate plates 100 is kept less than a prescribed value by the holding members 250, 251.

[0126] A setting that is such that the swelling of the hollow polycarbonate plates 100 is kept less than a prescribed value is preferably a setting that is such that the swelling of the hollow polycarbonate plates 100 of the embodiment is smaller than the swelling of the hollow polycarbonate plates 100 in a case in which the hollow polycarbonate plates 100 are held by the holding members 950 of the comparative example.

[0127] Further, a setting that is such that the swelling of the hollow polycarbonate plates 100 is kept less than a prescribed value is more preferably a setting such that the offset from the set value of the intervals L is kept within a predetermined range, e.g., less than 10%. For example, in a case in which the set value of the intervals is 10 mm, a setting that is such that the swelling of the hollow polycarbonate plates 100 is kept less than a prescribed value is a setting such that the intervals L are kept between 9 mm – 11 mm. Further, a setting that is such that the swelling of the hollow polycarbonate plates 100 is kept less than a prescribed value is preferably a setting in which the offset from the set amount of the aerogel N in a case in which the aerogel N is filled between the pair of hollow polycarbonate plates 100 without gaps is kept to less than a predetermined value, e.g., less than 10%.

[0128] Further, at the multilayer translucent body 13, the translucent member 11, at which the aerogel layer 130 is formed between the pair of hollow polycarbonate plates 100, is provided in the hollow layer 55 that is between the glass plates 52 that are adjacent to one another. Due thereto, the heat insulating ability of the multilayer translucent body 12 improves. Further, the swelling of the pair of hollow polycarbonate plates 100 due to the lateral pressure that is applied from the aerogel layer 130 to the pair of hollow polycarbonate plates 100 is suppressed by the holding members 250, 251, and is kept less than a prescribed value. Accordingly, contact between the glass plates 52 and the hollow polycarbonate plates 100 is prevented, and therefore, the insulation effectiveness of the multilayer translucent body 13 improves.

[0129] Further, the side end portions 110X of the pair of hollow polycarbonate plates 100 are both held in states of being tilted toward the thickness direction inner side by the holding members 251. Therefore, even at a portion where the lateral pressure applied from the aerogel layer 130 to the pair of hollow polycarbonate plates 100 is low such as at the upper end portion of the aerogel layer 130 for example, compressive force is applied to the aerogel layer 130 from the pair of hollow polycarbonate plates 100. Due to this compressive force, vibrations and the like of the aerogel layer 130 are suppressed, and therefore, precipitation of the aerogel N due to vibrations or the like is prevented or suppressed.

[0130] Further, even if the hollow polycarbonate plates 100 were to stretch due to heat, the effect of suppressing precipitation of the aerogel N is obtained because compressive force is applied from the pair of hollow polycarbonate plates 100 to the aerogel layer 130.

[0131] Further, the rigidity of the holding members 250 is greater than that of the hollow polycarbonate plates 100. Thus, even if lateral pressure is applied from the aerogel layer 130 to the outer side claw portions 251A, the outer side claw portions 251A do not collapse. Accordingly, the side end portions 110X of the hollow polycarbonate plates 100 both can continue to be maintained in states of being tilted toward the thickness direction inner side by the holding members 250.

[0132] <Other Points>

Note that the present disclosure is not limited to the above-described first embodiment and second embodiment.

[0133] For example, in the above-described first embodiment and second embodiment, the spacers 21 are provided at all of the four sides of the glass plates 52. However, the spacers 21 can be omitted as appropriate. If the spacers 21 are omitted, for example, the holding members 151, 251 and the silicone sealing materials 31 may be adhered directly.

[0134] Further, for example, in the above-described first embodiment and second embodiment, as illustrated in Fig. 1, Fig. 2, Fig. 10 and the like, the pair of hollow polycarbonate plates 100 swell (bulge) out toward the thickness direction outer sides due to the lateral pressure applied to the pair of hollow polycarbonate plates 100 from the aerogel layer 130 that is formed by the aerogel N being filled between the pair of hollow polycarbonate plates 100. However, the pair of hollow polycarbonate plates 100 do not have to swell out toward the thickness direction outer sides. For example, in a case such as when the width of ones of sides of the hollow polycarbonate plates 100 is small at around 50 cm, even after the aerogel N is filled between the pair of hollow polycarbonate plates 100, the pair of hollow polycarbonate plates 100 hardly swell out at all, or there are cases in which the

curved shapes of from before the aerogel N was filled between the pair of hollow polycarbonate plates 100 are maintained.

[0135] Further, for example, in the above-described first embodiment, the holding members 150, 151 hold both the side end portions 110X and the side end portions 110Z at the hollow polycarbonate plates 100 in states of being tilted toward the thickness direction inner side. However, the holding members 150, 151 may be structures that hold only either the side end portions 110X or the side end portions 110Z in states of being tilted toward the thickness direction inner side.

[0136] Further, for example, in the above-described second embodiment, the holding members 250, 251 hold the side end portions 110 at the hollow polycarbonate plates 100 in states of being tilted toward the thickness direction inner side. However, the holding members 250, 251 may be structures that hold either the side end portions 110X or the side end portions 110Z, or hold both of the side end portions 110X and the side end portions 110Z, in states of being tilted toward the thickness direction inner side.

[0137] The holding members 150, the holding members 151, the holding members 250 and the holding members 251 can be used by being combined appropriately. For example, the holding members 151 and the holding members 251 may be combined, or the holding members 151 and the holding members 250 may be combined.

[0138] Further, the holding members may be structures that hold at least ones of the side end portions 110X and the side end portions 110Z at the hollow polycarbonate plates 100 in states of being tilted toward the thickness direction inner side. For example, groove portions, which hold the side end portions 110X and the side end portions 110Z in states of being tilted toward the thickness direction inner side due to the side end portions 110X and the side end portions 110Z being fit therein, may be provided at the holding members.

[0139] Note that, in a case in which swelling of the hollow polycarbonate plates 100 is not sufficiently suppressed, the swelling of the hollow polycarbonate plates 100 is suppressed by a measure such as making the interval between the two hollow polycarbonate plates 100 narrower or making the density of the aerogel N low. Even in cases in which the above-described measures are taken, by applying the technique of the present disclosure to the two hollow polycarbonate plates 100, the extent to which such measures are taken can be reduced.

[0140] Further, for example, the hollow polycarbonate plates 100 are used as the translucent resin plates in the above-described first embodiment and second embodiment. However, the translucent resin plates are not limited to the hollow polycarbonate plates 100. The translucent resin plates may have hollow portions in which an aerogel can be filled, but do not

have to have hollow portions. The translucent resin plates may be, for example, solid polycarbonate plates or acrylic plates. Moreover, the translucent plate members may be, for example, glass plates or the like that are other than translucent resin plates.

[0141] If the translucent plate members are glass plates, the thickness (corresponding to the thickness of the hollow polycarbonate plates 100 in Fig. 1) of the translucent plate member (the glass plate) is preferably less than or equal to the thickness of the translucent plates (the glass plates 52) (thickness of translucent plate members (glass plates) $\leq$ thickness of translucent plates (the glass plates 52)).

[0142] By making the thickness of the translucent plate members (glass plates) less than or equal to the thickness of the translucent plates (the glass plates 52) in this way, lightening of the weight of the translucent plate members (glass plates) can be devised. Due thereto, because the workability at the time of filling the aerogel N between the two translucent plate members (glass plates) improves, the efficiency of manufacturing the translucent member 10 improves. Moreover, by making the thickness of the translucent plate members (glass plates) less than or equal to the thickness of the translucent plates (the glass plates 52), at the time of structuring a multilayer glass by the translucent plate members (glass plates) and translucent plates (the glass plates 52), the transparency of the multilayer glass can be increased.

[0143] Further, in the above-described first embodiment and second embodiment, for example, the two glass plates 52 are provided at the multilayer translucent body 12, 13. However, the number of the glass plates 52 that are provided at the multilayer translucent body 12, 13 is not limited to two, and, for example, three or more of the glass plates 52 may be provided at the multilayer translucent body 12, 13. Note that, in a case in which three or more glass plates are provided at the multilayer translucent body 12, 13, the multilayer translucent body 12, 13 has plural hollow layers. In this case, the translucent member to which the technique of the present disclosure is applied can be provided in at least one of the plural hollow layers.

[0144] Further, in the above-described first embodiment and second embodiment, for example, the glass plates 52 are used as the translucent plates. However, the translucent plates are not limited to the glass plates 52. The translucent plates may be made of resin, such as acrylic plates or polycarbonate plates for example. Note that, with translucent plates that are made of resin, although the fire resistance and durability thereof are low as compared with glass, resin translucent plates are lighter weight than glass.

[0145] Further, it suffices for light to be able to pass-through the translucent member, translucent plates and translucent plate members, and they may be transparent or semi-transparent.

[0146] Moreover, the above-described first embodiment and second embodiment can be implemented in various forms within a scope that does not depart from the gist of the present disclosure. Further, the above-described first embodiment, second embodiment, modified examples and the like can be implemented by being combined appropriately.

[0147] The disclosure of Japanese Patent Application No. 2022-065815 filed on April 12, 2022 is, in its entirety, incorporated by reference into the present specification.

All publications, patent applications, and technical standards mentioned in the present specification are incorporated by reference into the present specification to the same extent as if such individual publication, patent application, or technical standard was specifically and individually indicated to be incorporated by reference.

[0148] Note that the following notes are disclosed in relation to the above-described first embodiment and second embodiment.

[0149] <Note 1>

A translucent member including:

a pair of translucent plate members disposed so as to face one another;

an aerogel layer formed by an aerogel filled between the pair of translucent plate members; and

holding members sealing outer edge portions that are between the pair of translucent plate members, and holding both side end portions in a width direction of the pair of translucent plate members in states of being tilted toward a thickness direction inner side, the holding members suppressing swelling of the pair of translucent plate members due to lateral pressure applied from the aerogel layer to the pair of translucent plate members.

<Note 2>

The translucent member of Note 1, wherein:

the holding members have:

frame portions running along end surfaces of the side end portions of the translucent plate members, and

outer side claw portions projecting out from outer end portions of the frame portions in states of being tilted toward a thickness direction inner side of the translucent plate members, and disposed along outer surfaces of the side end portions; and

rigidity of the holding members is greater than rigidity of the translucent plate members.

<Note 3>

The translucent member of Note 2, wherein
rigidity of the outer side claw portions is greater than rigidity of the translucent plate members.

<Note 4>

The translucent member of Note 2, wherein
the outer side claw portions project out from the outer end portions at both sides of the frame portions, and are respectively disposed along the outer surfaces of the side end portions of the pair of translucent plate members.

<Note 5>

The translucent member of any one of Note 2 through Note 4, wherein
the holding members have inner side claw portions that project out from inner sides of the outer end portions at the frame portions in states of being tilted toward a thickness direction inner side of the translucent plate members, and are disposed along inner surfaces of the side end portions.

<Note 6>

The translucent member of Note 5, wherein
rigidities of the outer side claw portions and the inner side claw portions are greater than the rigidity of the translucent plate members.

<Note 7>

The translucent member of Note 5, wherein
a length of the outer side claw portions in a projecting direction is greater than or equal to a length of the inner side claw portions in a projecting direction.

<Note 8>

The translucent member of Note 5, wherein
a length of the outer side claw portions in a projecting direction is the same as a length of the inner side claw portions in a projecting direction.

<Note 9>

The translucent member of any one of Note 5 through Note 8, wherein
the inner side claw portions project out from inner sides of the outer end portions at both sides of the frame portions, and are respectively disposed along inner surfaces of the side end portions of the pair of translucent plate members.

<Note 10>

The translucent member of any one of Note 1 through Note 9, wherein

the pair of translucent plate members swell out toward thickness direction outer sides from the side end portions toward central portions in a width direction.

<Note 11>

The translucent member of any one of Note 1 through Note 10, wherein the holding members respectively hold the side end portions at both width direction sides of the pair of translucent plate members.

<Note 12>

The translucent member of any one of Note 1 through Note 11, wherein the translucent plate members have a plurality of hollow portions in which an aerogel is filled.

<Note 13>

The translucent member of any one of Note 1 through Note 11, wherein:
the translucent plate member has:
a pair of polycarbonate plates that face one another, and
a plurality of ribs provided between the pair of polycarbonate plates, connecting the pair of polycarbonate plates and forming a plurality of hollow portions between the pair of polycarbonate plates; and
an aerogel is filled in the hollow portions.

<Note 14>

A multilayer translucent body including:
a plurality of translucent plates that face one another and at which regions between edge portions thereof are closed-off; and
the translucent member of any one of Note 1 through Note 13 provided in a hollow layer that is between the translucent plates that are adjacent to one another, with intervals between the translucent member and the translucent plates.

<Note 15>

The multilayer translucent body of Note 14, wherein:
the translucent plate members and the translucent plates are glass plates, and
a thickness of the translucent plate members is less than or equal to a thickness of the translucent plates.

[0150] Moreover, the following notes are disclosed in relation to the above-described first embodiment and second embodiment.

[0151] <Note 1>

A translucent member including:

a pair of translucent plate members disposed so as to face one another;
an aerogel layer formed by an aerogel being filled between the pair of translucent plate members; and

holding members sealing outer edge portions that are between the pair of translucent plate members, and holding side end portions at both width direction sides in states of being tilted toward a thickness direction inner side, the holding members suppressing swelling of the translucent plate members due to lateral pressure of the aerogel layer.

<Note 2>

The translucent member of Note 1, wherein:

the holding members have:

frame portions running along end surfaces of the side end portions of the translucent plate members, and

outer side claw portions projecting out from outer end portions of the frame portions so as to be tilted toward a thickness direction inner side, and running along outer surfaces of the side end portions; and

rigidity of the holding members is greater than rigidity of the translucent plate members.

<Note 3>

The translucent member of Note 2, wherein

the holding members have inner side claw portions projecting out from inner sides of the outer end portions at the frame portions so as to be tilted toward a thickness direction inner side, and running along inner surfaces of the side end portions.

<Note 4>

A multilayer translucent body wherein the translucent member of any one of Note 1 through Note 3 is provided in a hollow layer that is between a plurality of translucent plates at which regions between edge portions thereof are closed-off, with intervals between the translucent member and translucent plates.

CLAIMS

Claim 1. A translucent member comprising:

- a pair of translucent plate members disposed so as to face one another;
- an aerogel layer formed by an aerogel filled between the pair of translucent plate members; and
- holding members sealing outer edge portions that are between the pair of translucent plate members, and holding both side end portions in a width direction of the pair of translucent plate members in states of being tilted toward a thickness direction inner side, the holding members suppressing swelling of the pair of translucent plate members due to lateral pressure applied from the aerogel layer to the pair of translucent plate members.

Claim 2. The translucent member of Claim 1, wherein:

- the holding members have:
 - frame portions running along end surfaces of the side end portions of the translucent plate members, and
 - outer side claw portions projecting out from outer end portions of the frame portions in states of being tilted toward a thickness direction inner side of the translucent plate members, and disposed along outer surfaces of the side end portions; and
- rigidity of the holding members is greater than rigidity of the translucent plate members.

Claim 3. The translucent member of Claim 2, wherein

- rigidity of the outer side claw portions is greater than rigidity of the translucent plate members.

Claim 4. The translucent member of Claim 2, wherein

- the outer side claw portions project out from the outer end portions at both sides of the frame portions, and are respectively disposed along the outer surfaces of the side end portions of the pair of translucent plate members.

Claim 5. The translucent member of Claim 2, wherein

- the holding members have inner side claw portions that project out from inner sides of the outer end portions at the frame portions in states of being tilted toward a thickness

direction inner side of the translucent plate members, and are disposed along inner surfaces of the side end portions.

Claim 6. The translucent member of Claim 5, wherein

rigidities of the outer side claw portions and the inner side claw portions are greater than the rigidity of the translucent plate members.

Claim 7. The translucent member of Claim 5, wherein

a length of the outer side claw portions in a projecting direction is greater than or equal to a length of the inner side claw portions in a projecting direction.

Claim 8. The translucent member of Claim 5, wherein

a length of the outer side claw portions in a projecting direction is the same as a length of the inner side claw portions in a projecting direction.

Claim 9. The translucent member of Claim 5, wherein

the inner side claw portions project out from inner sides of the outer end portions at both sides of the frame portions, and are respectively disposed along inner surfaces of the side end portions of the pair of translucent plate members.

Claim 10. The translucent member of Claim 1, wherein

the pair of translucent plate members swell out toward thickness direction outer sides from the side end portions toward central portions in a width direction.

Claim 11. The translucent member of Claim 1, wherein

the holding members respectively hold the side end portions at both width direction sides of the pair of translucent plate members.

Claim 12. The translucent member of Claim 1, wherein

the translucent plate members have a plurality of hollow portions in which an aerogel is filled.

Claim 13. The translucent member of Claim 1, wherein:

the translucent plate member has:

a pair of polycarbonate plates that face one another, and
a plurality of ribs provided between the pair of polycarbonate plates, connecting the pair of polycarbonate plates and forming a plurality of hollow portions between the pair of polycarbonate plates; and
an aerogel is filled in the hollow portions.

Claim 14. A multilayer translucent body comprising:

a plurality of translucent plates that face one another and at which regions between edge portions thereof are closed-off; and

the translucent member of any one of Claim 1 through Claim 13 provided in a hollow layer that is between translucent plates that are adjacent to one another, with intervals between the translucent member and the translucent plates.

Claim 15. The multilayer translucent body of Claim 14, wherein:

the translucent plate members and the translucent plates are glass plates, and
a thickness of the translucent plate members is less than or equal to a thickness of the translucent plates.