(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 669 444 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
**04.12.2013 Bulletin 2013/49**

(21) Application number: **13169951.4**

(22) Date of filing: **31.05.2013**

(51) Int Cl.:
***E04B 2/58*** *(2006.01)* ***E04B 2/70*** *(2006.01)*
***E04D 3/35*** *(2006.01)* ***E04C 3/36*** *(2006.01)*
*E04B 1/80* *(2006.01)* *E04B 1/68* *(2006.01)*

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
**BA ME**

(30) Priority: **01.06.2012 FI 20125602**

(71) Applicant: **Rautaruukki Oyj**
**00810 Helsinki (FI)**

(72) Inventors:
- **Turpeenniemi, Pasi**
  **00810 Helsinki (FI)**
- **Sipilä, Risto**
  **00810 Helsinki (FI)**

(74) Representative: **Kolster Oy Ab**
**Iso Roobertinkatu 23**
**PO Box 148**
**00121 Helsinki (FI)**

(54) **Wall or roof structure and building panel**

(57) The present invention relates to a wall or roof structure and building panels (2). The wall structure comprises support pillars (10) and building panels (2) comprising a first surface sheet (4) and a second surface sheet (6) and an insulation material layer (8) between surface sheets (4, 6). The building panels (2) are secured to the support pillars (10) such that the second surface sheet (4) is arranged against a support pillar (10) for providing a support joint. The support joint is provided with an elastic support joint sealing (16) arranged between the support pillar (10) and the second surface sheet (4) for providing airtight sealing, and that at least one of the first and second surface sheets (4, 6) is provided with restricted thermal expansion for maintaining the airtight sealing by decreasing mechanical stress subjected to the elastic support joint sealing (16) due to thermal expansion.

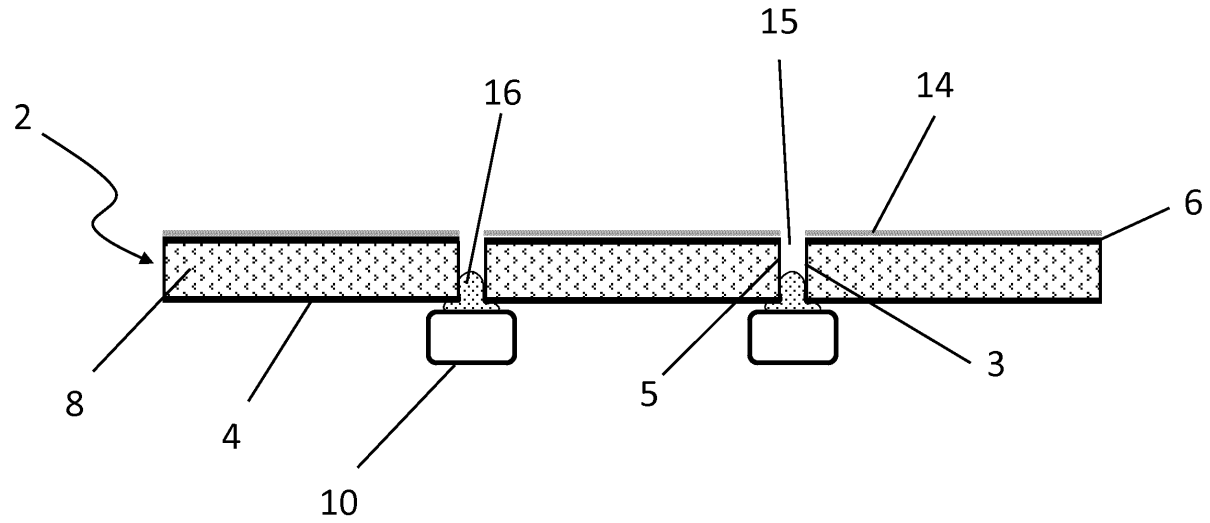


Fig. 3

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## Description

### FIELD OF THE INVENTION

**[0001]** The present invention relates to wall or roof structure and more particularly to a substantially airtight wall or roof structure according to the preamble of claim 1. The present invention further relates to a building panel and more particularly to an energy efficient building panel according to the preamble of claim 9.

### BACKGROUND OF THE INVENTION

**[0002]** Insulated building panels, having two oppositely positioned thin metal sheets forming the side faces of the panel and a central core insulating material provided between the metal sheets, are commonly used for constructing wall and roof structures. This kind of insulated panels are usually joined together from side edges with interlock, tongue-and-groove or butment joints. These joints have usually one, two or possibly more respectively interlocking female and male connector elements. Accordingly the male connector elements extend along the first side edge of the panel, preferably along the entire length of the first side edge, and female side edge connector elements extend along the second side edge of panel, preferably along the entire length of the second side edge. Each panel is therefore configured to be joined with a like adjacent second panel along the side edges such that the male connector elements on the first side edge of a panel interlock with the female connector elements on the second side edge of a like adjacent second panel.

**[0003]** The wall or roof structure further comprises pillars or the like to which the building panels are secured. Usually the building panels are secured to the pillars such that the building panel extends substantially between two pillars and is secured to the pillars in the vicinity of the end edges. Two horizontally adjacent building panels, having end edges arranged opposite to each other, are secured to a common pillar such that a gap is provided between the building panels. One of the surface sheets of the building panels is placed against the pillar for providing a support joint between the pillar and the building panel. The gap between the horizontally adjacent building panels is filled with polyurethane foam or mineral wool or some other sealing material for sealing the gap between the building panels.

**[0004]** One of the problems with the prior art wall and roof structures is that prior art wall and roof structures as well as building panels are unable to provide an airtight wall or roof structure or building panel and especially an airtight wall or roof structure or joint between building panels which remains substantially airtight long times in varying conditions. The prior art wall or roof structures and also building panels and joints between building panels are not formed airtight and especially they are exposed to deterioration which will further weaken the sealing properties. Sealing of the wall or roof structures and the joints between the adjacent building panels is important for providing energy efficient buildings and also safe structures which may prevent hazardous gases from spreading in a case of fire.

**[0005]** The sealing of the prior art wall and roof structures as well joints between adjacent building panels may be deteriorated due to thermal expansion of the surface sheets of the building panels as the temperature conditions and thermal radiation varies during seasons and day times. The building panels tend to bend due to thermal expansion as they are secured to the support pillars and the joints between the building panels deform. The bending and deformation causes the joints between the building panels and the support open, spread or break and form flaws such that gases may freely flow through the wall or roof structures or joint between the adjacent building panels. Therefore the energy efficiency is deteriorated.

### BRIEF DESCRIPTION OF THE INVENTION

**[0006]** An object of the present invention to provide a wall or roof structure and building panel so as to overcome or at least alleviate the above disadvantages. The objects of the invention are achieved with a wall or roof structure according to the characterizing portion of claim 1. The objects of the invention are further achieved with a building panel according to the characterizing portion of claim 9.

**[0007]** The preferred embodiments of the invention are disclosed in the dependent claims.

**[0008]** The invention is based on the idea of providing a wall or roof structure comprising support pillars and two or more building panels comprising a first surface sheet and a second surface sheet and an insulation material layer between the first and second surface sheets, the building panels further comprising first and second end edges, and first and second side edges provided with connection means for joining building panels together along the first and second side edges. The building panels are secured to the support pillars such that the second surface sheet is arranged against a support pillar for providing a support joint between the building panel and the second surface sheet extending along the support pillar. According to the present invention the support joint is provided with an elastic support joint sealing arranged between the support pillar and the second surface sheet for providing substantially airtight sealing. In the present invention the at least one of the first and second surface sheets is further provided with restricted thermal expansion for maintaining the airtight sealing by decreasing mechanical stress subjected to the elastic support joint sealing due to thermal expansion.

**[0009]** The invention is further based on the idea of providing a building panel An energy efficient building panel comprising a first surface sheet and a second surface sheet forming first and second side surfaces, an

insulation material layer between the first and second surface sheets, first and second end edges and first and second side edges. the first and second side edges are provided with first and second male side edge connectors extending longitudinally on the first side edge and first and second female side edge connectors extending longitudinally on the second side edge, the male side edge connectors and female side edge connectors being arranged to be respectively joined with female and male side edge connectors of a like adjacently positioned other building panel for interlocking the building panels together. According to the present invention the building panel further comprises elastic panel seals arranged into and extending along both the first and second female side edge connectors for providing substantially airtight sealing between the building panels along the joined side edges. In the present invention the at least one of the first and second surface sheets is provided with restricted thermal expansion for retaining the panel seals in the first and second female side edge connectors by decreasing deformations of the female and male side edge connectors due to thermal expansion.

**[0010]** The present invention provides a substantially airtight wall or roof structure which may maintain the substantially airtight sealing in long-term irrespective of the temperature and thermal radiation variations. The elastic sealing material in the support joint and also in the female side edge connectors stands deformations and it also itself has airtight properties such that the sealing material may be substantially gas impermeable. The airtight sealing of the wall or roof structure is further provided by providing at least one of the first and second surface sheets of the building panel with restricted thermal expansion. This means that the thermal expansion of the surface sheet is decreased or restricted such that the bending of the building element is diminished and also the deformations of the male and side edge connectors are diminished. Accordingly the present invention is based on the cooperation of the elastic sealing material and the restricted thermal expansion of the surface sheet. The decreased thermal expansion of the building panel reduces the opening, spreading or breaking and forming of flaws in the support joints and the panel joints. Because the thermal expansion and deformation is reduced, the elastic sealing material may stand the mechanical stresses subjected to it due to thermal expansion as the elastic sealing material may stretch and adapt to reduced thermal expansion without opening, breaking or forming flaws. Therefore, the wall or roof structure and building panel of the present invention enables long-term substantially airtight sealing.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0011]** In the following the invention will be described in greater detail by means of preferred embodiments with reference to the attached [accompanying] drawings, in which

Figures 1A and 1 B show schematic views of a building panel;

Figure 2 shows schematically a prior art wall structure;

Figure 3 shows schematically one embodiment of a wall structure according to the present invention;

Figure 4 shows schematically another embodiment of a wall structure according to the present invention;

Figure 5 shows schematically one embodiment of a support joint of a wall structure according to the present invention; and

Figure 6 shows schematically one embodiment of a side edge of a building panel according to the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

**[0012]** Figures 1A and 1 B show schematically side and end views, respectively, of a building panel or sandwich element 2. The building panel 2 comprise first and second oppositely positioned first and second surface sheets 4, 6 forming first and second side faces of the building panel. The surface sheets 4, 6 may be formed made of relatively thin metal sheets. The first surface sheet forms the inner surface of the building panel 2 and the second surface sheet 6 forms the outer surface of the building panel 2. Between the first and second surface sheets 4, 6 is provided a central core insulating material 8, or an insulation material layer 8, that may be attached to the surface sheets 4, 8 for example by gluing or some other way. The insulating material 8 may be any possible material that provides sufficient insulation and structural rigidity for the building panel 2. The building panel 2 comprises also first and second side edges 9, 11, which are provided with male and female side edge connectors, respectively, for joining or interlocking adjacent building panels 2 together along the side edges 9, 11. The building panel 2 further comprises first and second end edge 3, 5. The end edges are normally cut edges having substantially planar end surface. However, in some embodiments the end edges may also be provided with male and female side edge connectors of the same type as the first and second side edges, if desired. Usually the side edges 9, 11 are longer than the end edges 3, 5. In this context building panels 2 joined together along the side edges 9, 11 are generally said to be vertically adjacent building panels 2, even if that is not the case in all roof structures or some wall structure. Likewise building panels joined together along the end edges is said to be horizontally adjacent.

**[0013]** Figure 2 shows schematically a prior art wall structure comprising support pillars 10 and two or more building panels 2 secured to the support pillars 10 for forming the wall structure. The support pillars 10 may be any kind of longitudinal supports. For example the support pillars 10 may be steel pillars having closed profile, C-profile or I-profile or some other kind of profile. Alternative the support pillars 10 may be made of some other

material such as wood. In a wall structure the support pillars 10 may extend substantially vertically. However, in some embodiments the support pillars may also extend in an angle to the vertical direction and in roof structure the support pillars 10 may extends even horizontally. It should be noted that the wall or roof structure may also comprise some other support elements (not shown).

**[0014]** The building panels 2 are secured to the support pillars 10 such that the building panels 2 extend between two support pillars 10. The building panels 2 are secured to the support pillars 10 from the end edges 3, 5 or in the vicinity of the end edges 3, 5. As shown in figure 2, the horizontally adjacent building panels 2 may be secured to a common, or same, support pillar 10 such that the first end face of one building panel 2 is substantially opposite to the second end edge 5 of another building panel 2. The building panels 2 may further be secured to the support pillars 10 such that the first surface sheet 4 is arranged against a support pillar 10 for providing a support joint between the support pillar 10 and the first surface sheet 4 extending along the support pillar 10. There is gap 15 formed between the end edges 3, 5 of the horizontally adjacent building panels 2. This gap 15 is usually filled with conventional sealing material 12 such as mineral wool or polyurethane.

**[0015]** Figure 2 shows a normal situation what happens when the temperature variations are high due to thermal radiation for example from the sun. The sun heats the outer second surface sheet 6 causing thermal expansion of the second surface sheet 6. As the building panel 6 is secured to the support pillars 10 the building panel 2 is not allowed to expand freely. Therefore the thermal expansion causes the building panel 2 to bend as shown with the dotted line 7. The temperature variations of the surface sheets 4, 6 may be significant and thus the thermal expansion causes deformations and displacements to the support joint between the support pillars 10 and the building panels 2 and also to the gap 15 and further to the panel joint of vertically adjacent building panels joined along the side edges 9, 11 with the connector elements. The deformations and the displacements cause mechanical stress due to thermal expansion to the support joint, gap 15 and the panel joints to open, spread and break such that the flaws or cracks are formed to the joints and sealing materials through which gasses may flow through the wall or roof structure from one side to the other. The building panel 2 may have a width X for example 6 meters and the bending of the building panel 2 in Y direction, perpendicularly to the width direction, may be as much as 6 cm or even more due to thermal expansion of the outer surface sheet 6.

**[0016]** Figure 3 shows one embodiment of a wall or roof structure of the present invention. In this embodiment at least one of the surface sheets 4, 6 of the building panel 2 is provided with restricted or reduced thermal expansion. In this case the outer second surface sheet 6 provided with a reflective outer surface or outer surface coating 14 for reflecting thermal radiation. In other words the second surface sheet 6 is manufactured such that it reflects thermal radiation or it is coated with a reflective coating for reflecting thermal radiation. The outer surface sheet may be polished or manufactured from a highly reflective material. The reflective coating 14 may be a painting provided with reflective pigments reflecting thermal radiation. In one embodiment the second surface sheet 6 or the reflective coating is arranged to reflect thermal radiation in the infrared region. The reflective coating 14 may be coating having Solar Reflective Index (SRI, ATME E 1980-1) considerably higher than a conventional coating or surface sheet colour. Thermal radiation in the infrared region or near infrared red region (NIR) at wave lengths 700 - 2500 nm is most significant for reflecting thermal radiation of the sun. In a reflective painting the thermal radiation is implemented by replacing colour pigments and/or filler pigments with reflective pigments, infrared reflective pigments or other reflective constituents. The reflective or infrared reflective pigments comprise for example cadmium stannate ($Cd_2SnO_4$), $TiO_2$, $Cr_2O_3$, $Fe_2O_3$, ZnS, $Sb_2O_3$, $ZrO_2$ and ZnO.

**[0017]** The reflective surface or reflective coating 14 of the building panel 2 reflects the thermal radiation and thus the surface temperature of the second surface sheet 6 does not absorb as much heat. Therefore the temperature of the second surface sheet 6 does not rise as much as in the conventional building panels 2 having no reflective surface or reflective coating. As the temperature of the second surface sheet 6 is lower due to the reflective surface or coating 14, the building element does not undergo such a great thermal expansion. Thus the bending and deformation of the building panel 2, support joint, panel joint and gap 15 due to thermal expansion is decreased. However, it should be noted that the thermal expansion of the building panel 2 may not be totally prevented, but some thermal expansion still occurs. In addition it should be noted that the reflective surface or reflective coating 14 may also be provided to the inner first surface sheet 4 or to both the first and second surface sheets 4, 6. Furthermore, the reflective coating 14 or reflective surface layer is provided to the outer surface of the building panel 2 on the surface sheets 4, 6.

**[0018]** As shown in figure 3, the support joint, between a building panel 2 and a support pillar 10, is further provided with an elastic support joint sealing 16 arranged between the support pillar 10 and the first surface sheet 4 for providing substantially airtight sealing. The elastic sealing 16 is arranged between the inner first surface sheet 4 such that it seals the building panel 2 and the support pillar 10 together in substantially airtight manner. The elastic sealing 16 extends along longitudinally the support pillar 10 for sealing the whole support joint between the support pillar 10 and the building panel 2, and especially between the support pillar 10 and the first surface sheet 4. As shown in figure 3, the adjacent building panels 2 are secured to a common support pillar 10 with support joints such that the first end edge 3 of one building panel 2 is opposite to the second end edge 5 of another

adjacent building panel 2. In this embodiment the elastic support joint sealing 16 is provided between the common support pillar 10 and both the adjacent building panels 2. Alternatively there could be a separate elastic support joint sealing 16 between the horizontally adjacent building panels 2 secured to a common support pillar 10. In the embodiment of figure 3, the elastic support joint sealing 16 is further provided to extend between the end edges 3, 5 of the horizontally adjacent building panels 2 secured to a common support pillar 10. In other words the elastic support joint sealing 16 extends to the gap 15 between the horizontally adjacent building panels 2. Alternative the gap 15 may be provided with a separate elastic or non-elastic gap sealing or in an elastic support joint sealing 16 of only one building panel 2 may extend to the gap 15.

**[0019]** The term elastic in connection with the sealing 16 refers in this context to characteristics of the sealing material meaning sealing material having physical property which allows the sealing material to stretch and deform without breaking or cracking or forming flaws. The term elastic also means that the sealing material of sealing 16 may substantially or at least partly return to its original shape after the stress cause by the deformation due to thermal expansion is no longer applied to the sealing 16. The elastic support joint sealing 16 may be made from expanding sealing material, elastic polyurethane foam, or other elastic sealing material capable of providing substantially airtight sealing. The elastic support joint sealing 16 may itself be substantially gas impermeable such that airtight sealing is provided. The material of the elastic sealing 16 is chosen such that it may stand, preferably repeatedly, the restricted or reduced thermal expansion and deformations of the building panel 2. Thus at least one of the first and second surface sheets 4, 6 is provided with restricted thermal expansion for maintaining the airtight sealing by decreasing mechanical stress subjected to the elastic support joint sealing 16 due to thermal expansion. Accordingly in the present invention a long term airtight wall or roof structure is achieved with the combination of the elastic sealing 16 and the building panel 2 with restricted or reduced thermal expansion.

**[0020]** The elastic sealing material may be a sealing material having elastic performance up to 35 % movement accommodation or even up to 45 % movement accommodation ensuring integrity of the seal in event of movement. Thus the term elastic in connection with the sealing means that the sealing or sealing material may tolerate movements without breaking or otherwise compromising the tightness of the seal due to movements in the joint. Thus the elastic performance of the sealing material enhances to maintain the airtight sealing. Furthermore, the airtight formulation of the elastic sealing material may fulfil EN 1026 0.1$m^3$/h @10 Pa, for example in a case of elastic polyurethane foam or expandable sealing band. Thermal conductivity of expandable elastic sealing material may be less than 0,08 W/m·K, or less than 0,05 W/m.K, for example 0,048 W/m·K. Furthermore, the thermal conductivity of elastic polyurethane foam may be less 50 mW/m·K, or less than 40 mW/m·K, for example 36 mW/m·K. The elastic sealing may be for example elastic polyurethane foam, such as sold under trade name FM330 by Tremco illbruck. The elastic expandable sealing material may be elastic sealing band, such as sold under trade name Compriband Trio by Tremco illbruck. These sealing materials may be used in support joint sealing 16, or in other sealings of the building panels, such as between the panels.

**[0021]** Figure 4 shows an alternative embodiment of a roof or wall structure according to the present invention. In this embodiment the thermal expansion of the building panel 2 is restricted or reduced by profiling at least one of the surface sheets 4, 6. Thus at least one of the first and second surface sheets 4, 6 may be a profiled thin sheet comprising one or more longitudinal grooves and/or protrusions 18, as shown in figure 4. In the embodiment of figure 4 the one or more longitudinal grooves and/or protrusions 18 extend substantially parallel to the first and second end edges 3, 5 of the building panel 2 for dividing the building panel 2 to successive bending zones in the direction of the first and second side edges 9, 11. In this embodiment the successive longitudinal grooves and/or protrusions 18 from bending lines such that the bending of the building panel 2 due to thermal expansion occurs substantially as local bending in the mentioned bending zones which reduces the overall bending of the whole building panel 2 and therefore reduces or restricts the thermal expansion along the building panel 2. Thus the reduced overall thermal expansion and deformation reduces the mechanical stress subjected to the elastic support joint sealing 6. In an alternative embodiment the one or more longitudinal grooves and/or protrusions 18 extend substantially parallel, or in angle, to the first and second side edges 9, 11 of the building panel 2 for stiffening the building panel 2 in the direction of the first and second side edges 9, 11. In this embodiment grooves and/or protrusions 18 form stiffeners which prevent the building panel 2 from bending in the manner shown in figure 2.

**[0022]** Figure 5 shows a detailed view of one support joint according to the present invention. Two building panels 2 are secured to a common support pillar 10 with bolt 26, screws or the like in the vicinity of the end edges 3, 5. The horizontally adjacent building panels 2 are arranged such that the first end edge 3 of one building panel 2 is opposite the second end edge 5 of another building panel 2 and a gap 15 is provided between them. The elastic support joint sealing 16 is arranged between the first surface sheet 4 of the building panels 2 and the support pillar 10 such that the elastic support joint sealing 16 extends partly into the gap 15. The gap 15 is covered with a cover plate 24 extending along the gap 15 in the direction of the support pillar 10. The cover plate 24 forms a washer for the securing bolts 26. The gap 15 is also provided with a gap sealing 20 arranged between the

cover plate 24 and the elastic support joint sealing 16. The gap sealing 16 fills the gap 15 and provides additional sealing to the support joint. The gap sealing 20 may be made of any conventional sealing material such as polyurethane foam or mineral wool. One or more additional separate support seals 22 provided between the support pillar 10 and the first surface sheet 4. The additional support seals 22 may be made from expandable sealing material or sealing strip or the like and they are separate to each building panel 2. The additional support seals 22 ensure airtight sealing of the support joint

**[0023]** Figure 6 shows a detailed view of the second side edge a building panel 2 according to one embodiment of the present invention. The present invention therefore also relates to an energy efficient building panel 2 comprising a first surface sheet 4 and a second surface sheet 6 forming first and second side surfaces, an insulation material layer 8 between the first and second surface sheets 4, 6 and first and second end edges 3, 5. The first and second side edges 9, 11 are provided with first and second male side edge connectors extending longitudinally on the first side edge 9 and first and second female side edge connectors 30, 32 extending longitudinally on the second side edge 11. The male side edge connectors and female side edge connectors 30, 32 are arranged to be respectively joined with female 30, 32 and male side edge connectors of a like adjacently positioned other building panel 2 for interlocking the building panels 2 together. The female connector elements may be formed as grooves 30 and 32 and the male side edge connectors as tongues. In the embodiment of figure 6 the first surface sheet 4 is arranged to form the first female side edge connector 30 to the second side edge 11 and the first male side edge connector to the first side edge 9. Correspondingly, the second surface sheet 6 is arranged to form the second female side edge connector 32 to the second side edge 11 and the second male side edge connector to the first side edge 9. According to the present invention the building panel 2 further comprises elastic panel seals 34, 36 arranged into and extending along both the first and second female side edge connectors 30, 32 for providing substantially airtight sealing between the building panels 2 along the joined side edges 9, 11. Furthermore, the building panel 2 is implemented such that at least one of the first and second surface sheets 4, 6 is provided with restricted thermal expansion for retaining the panel seals 30, 32 in the first and second female side edge connectors 30, 32 by decreasing deformations of the female 30, 32 and male side edge connectors due to thermal expansion. The restricted or reduced thermal expansion may be carried out as described above. Accordingly the building panels 2 may form a wall or roof structure in which the connection means of the building panel 2 comprise first and second tongues provided to the first side edge 9 of the building panel 2 and first and second grooves 30, 32 provided to the second side edge 11 of the building panel 2 for joining building panels 2 together along the first and second side edges 9, 11 with a tongue and groove joint, and that both of the grooves 30, 32 are provided with panel seals 34, 36 extending along the bottom of the groove 30, 32 for providing airtight sealing between the building panels 2 along the side edges 9, 11.

**[0024]** The elastic panel seal 34, 36 is provided to both of the two female side edge connectors 30, 32 or to at least female side edge connectors in a case where the second side edge 11 comprises more than two side female side edge connectors 30, 32. The elastic panel seals 34, 36 may be arranged to the bottom of the female side edge connector 30, 32 such that they extend along the whole side second edge 11 of the building element. At least one of the elastic panel seals 34, 36 may be made from expanding sealing material or other elastic sealing material capable of providing substantially airtight sealing. The restricted or reduced thermal expansion of the building panel 2 together with the elastic panel seals 34, 36 in at least two female side edge connectors enables maintaining the substantially airtight sealing between the building panels 2 joined along the side edges irrespective of the temperature variations. The restricted thermal expansion reduces the deformations of the male and female connector elements and elastic properties of the panel seals 34, 36 stand the reduced deformations without breaking or slipping away from the female side edge connectors. Thus a long term airtight sealing between the building panels 2 may be achieved. The panel seals 34, 36 may be provided from the same material as the elastic sealing material of the support joint sealing 16.

**[0025]** The present invention also relates to use of elastic sealing material 16 together with a surface sheet 4, 6 having restricted thermal expansion for forming a substantially airtight wall or roof structure in which two or more building panels 2, comprising a first surface sheet 4 and a second surface sheet 6 and an insulation material layer 8 between the first and second surface sheets 4, 6, are joined together and secured to support pillars 10 such that the airtight sealing is maintained with the elastic sealing material 16 arranged between the building panels 2 and the pillars 10 and by reducing the mechanical stress subjected to the elastic sealing material 16 due to thermal expansion with the restricted thermal expansion of the surface sheet 4, 6.

**[0026]** The present invention additionally relates to use of elastic sealing material 34, 36 together with a surface sheet 4, 6 having restricted thermal expansion for forming a building panel 2 enabling long-term substantially airtight joint between the adjacent building panels 2 comprising a first surface sheet 4 and a second surface sheet 6, an insulation material layer 8 between the first and second surface sheets 4, 6, first and second end edges 3, 5, first and second side edges 9, 11 provided with first and second male side edge connectors extending longitudinally on the first side edge 9 and first and second female side edge connectors 30, 32 extending longitudinally on the second side edge 11, the male side edge connectors and female side edge connectors 30, 32 be-

ing arranged to be respectively joined with female 30, 32 and male side edge connectors of a like adjacently positioned other building panel 2 for interlocking the building panels 2 together, in which building panel 2 the long-term substantially airtight sealing is enabled with the elastic sealing material 34, 36 provided into and along the first and second female side edge connectors 30, 32 and by decreasing deformations of the female 30, 32 and male side edge connectors due to thermal expansion with the restricted thermal expansion of the surface sheet 4, 6.

**[0027]** It will be obvious to a person skilled in the art that, as the technology advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

## Claims

**1.** An energy efficient wall or roof structure comprising:

- support pillars (10); and
- two or more building panels (2) comprising a first surface sheet (4) and a second surface sheet (6) and an insulation material layer (8) between the first and second surface sheets (4, 6), the building panels (2) further comprising first and second end edges (3, 5), and first and second side edges (9, 11) provided with connection means for joining building panels (2) together along the first and second side edges (9, 11),

in which wall or roof structure the building panels (2) are secured to the support pillars (10) such that the first surface sheet (4) is arranged against a support pillar (10) for providing a support joint between the building panel (2) and the support pillar (10),

**characterized in that** the support joint is provided with an elastic support joint sealing (16) arranged between the support pillar (10) and the first surface sheet (4) for providing substantially airtight sealing, and that at least one of the first and second surface sheets (4, 6) is provided with restricted thermal expansion for maintaining the airtight sealing by decreasing mechanical stress subjected to the elastic support joint sealing (16) due to thermal expansion.

**2.** A wall or roof structure according to claim 1, **characterized in that:**

- at least one of the first and second surface sheets (4, 6) is provided with a reflective outer surface or outer surface coating (14) for reflecting thermal radiation; or
- at least one of the first and second surface sheets (4, 6) is provided with a painting provided with reflective pigments reflecting thermal radiation in the infrared region for providing a reflective thermal coating (14)..

**3.** A wall or roof structure according to claim 1 or 2, **characterized in that:**

- at least one of the first and second surface sheets (4, 6) is a profiled thin sheet comprising one or more longitudinal grooves and/or protrusions (18); or
- at least one of the first and second surface sheets (4, 6) is a profiled thin sheet comprising one or more longitudinal grooves and/or protrusions (18), the one or more longitudinal grooves and/or protrusions (18) extending substantially parallel to the first and second side edges (9, 11) of the building panel (2) for stiffening the building panel (2) in the direction of the first and second side edges (9, 11); or

at least one of the first and second surface sheets (4, 6) is a profiled thin sheet comprising one or more longitudinal grooves and/or protrusions (18), the one or more longitudinal grooves and/or protrusions (18) extending substantially parallel to the first and second end edges (3, 5) of the building panel (2) for dividing the building panel (2) to successive bending zones in the direction of the first and second side edges (9, 11).

**4.** A wall or roof structure according to any one of claims 1 to 3, **characterized in that** that adjacent building panels (2) are secured to a common support pillar (10) with support joints such that the first end edge (3) of one building panel (2) is opposite to the second end edge (5) of another adjacent building panel (2).

**5.** A wall or roof structure according to claim 4, **characterized in that:**

- the elastic support joint sealing (16) is provided between the common support pillar (10) and both the adjacent building panels (2); or
- the elastic support joint sealing (16) is provided to extend between the end edges (3, 5) of the adjacent building panels (2).

**6.** A wall or roof structure according to any one of claims 1 to 5, **characterized in that** that the elastic support joint sealing (16) is made from expanding sealing material, elastic polyurethane foam, or other elastic sealing material capable of providing substantially airtight sealing.

**7.** A wall or roof structure according to any one of claims 1 to 6, **characterized in that** one or more support seals (22) is provided between the support pillar (10)

and the first surface sheet (4).

**8.** A wall or roof structure according to any one of claims 1 to 7, **characterized in that** the connection means comprise first and second tongues provided to the first side edge (9) of the building panel (2) and first and second grooves (30, 32) provided to the second side edge (11) of the building panel (2) for joining building panels (2) together along the first and second side edges (9, 11) with a tongue and groove joint, and that both of the grooves (30, 32) are provided with panel seals (34, 36) extending along the bottom of the groove (30, 32) for providing airtight sealing between the building panels (2) along the side edges (9, 11).

**9.** An energy efficient building panel (2) comprising:

- a first surface sheet (4) and a second surface sheet (6) forming first and second side surfaces;
- an insulation material layer (8) between the first and second surface sheets (4, 6);
- first and second end edges (3, 5); and
- first and second side edges (9, 11) provided with first and second male side edge connectors extending longitudinally on the first side edge (9) and first and second female side edge connectors (30, 32) extending longitudinally on the second side edge (11), the male side edge connectors and female side edge connectors (30, 32) being arranged to be respectively joined with female (30, 32) and male side edge connectors of a like adjacently positioned other building panel (2) for interlocking the building panels (2) together,

**characterized in that** the building panel (2) further comprises elastic panel seals (34, 36) arranged into and extending along both the first and second female side edge connectors (30, 32) for providing substantially airtight sealing between the building panels (2) along the joined side edges (9, 11), and that at least one of the first and second surface sheets (4, 6) is provided with restricted thermal expansion for retaining the panel seals (34, 36) in the first and second female side edge connectors (30, 32) by decreasing deformations of the female (30, 32) and male side edge connectors due to thermal expansion.

**10.** A building panel (2) according to claim 9, **characterized in that** the first surface sheet (4) is arranged to form the first female side edge connector (30) and the first male side edge connector, and that the second surface sheet (6) is arranged to form the second female side edge connector (32) and the second male side edge connector.

**11.** A building panel (2) according to claim 9 or 10, **characterized in that:**

- at least one of the first and second surface sheets (4, 6) is provided with a reflective outer surface or outer surface coating (14) for reflecting thermal radiation; or
- at least one of the first and second surface sheets (4, 6) is provided with a painting provided with reflective pigments reflecting thermal radiation in the infrared region for providing a reflective thermal coating (14).

**12.** A building panel (2) according to any one of claims 9 to 11, **characterized in that**:

- at least one of the first and second surface sheets (4, 6) is a profiled thin sheet comprising one or more longitudinal grooves and/or protrusions (18); or
- at least one of the first and second surface sheets (4, 6) is a profiled thin sheet comprising one or more longitudinal grooves and/or protrusions (18), the one or more longitudinal grooves and/or protrusions (18) extending substantially parallel to the first and second side edges (9, 11) of the building panel (2) for stiffening the building panel (2) in the direction of the first and second side edges (9, 11); or
- at least one of the first and second surface sheets (4, 6) is a profiled thin sheet comprising one or more longitudinal grooves and/or protrusions (18) the one or more longitudinal grooves and/or protrusions (18) extending substantially parallel to the first and second end edges (3, 5) of the building panel (2) for dividing the building panel (2) to successive bending zones in the direction of the first and second side edges (9, 11).

**13.** A building panel (2) according to any one of claims 9 to 12, **characterized in that** at least one of the elastic panel seals (34, 36) is made from expanding sealing material or other elastic sealing material capable of providing substantially airtight sealing.

**14.** Use of elastic sealing material (16) together with a surface sheet (4, 6) having restricted thermal expansion for forming a substantially airtight wall or roof structure in which two or more building panels (2), comprising a first surface sheet (4) and a second surface sheet (6) and an insulation material layer (8) between the first and second surface sheets (4, 6), are joined together and secured to support pillars (10) such that the airtight sealing is maintained with the elastic sealing material (16) arranged between the building panels (2) and the pillars (10) and by reducing the mechanical stress subjected to the

elastic sealing material (16) due to thermal expansion with the restricted thermal expansion of the surface sheet (4, 6).

**15.** Use of elastic sealing material (34, 36) together with a surface sheet (4, 6) having restricted thermal expansion for forming a building panel (2) enabling long-term substantially airtight joint between the adjacent building panels (2) comprising a first surface sheet (4) and a second surface sheet (6), an insulation material layer (8) between the first and second surface sheets (4, 6), first and second end edges (3, 5), first and second side edges (9, 11) provided with first and second male side edge connectors extending longitudinally on the first side edge (9) and first and second female side edge connectors (30, 32) extending longitudinally on the second side edge (11), the male side edge connectors and female side edge connectors (30, 32) being arranged to be respectively joined with female (30, 32) and male side edge connectors of a like adjacently positioned other building panel (2) for interlocking the building panels (2) together, in which building panel (2) the long-term substantially airtight sealing is enabled with the elastic sealing material (34, 36) provided into and along the first and second female side edge connectors (30, 32) and by decreasing deformations of the female (30, 32) and male side edge connectors due to thermal expansion with the restricted thermal expansion of the surface sheet (4, 6).

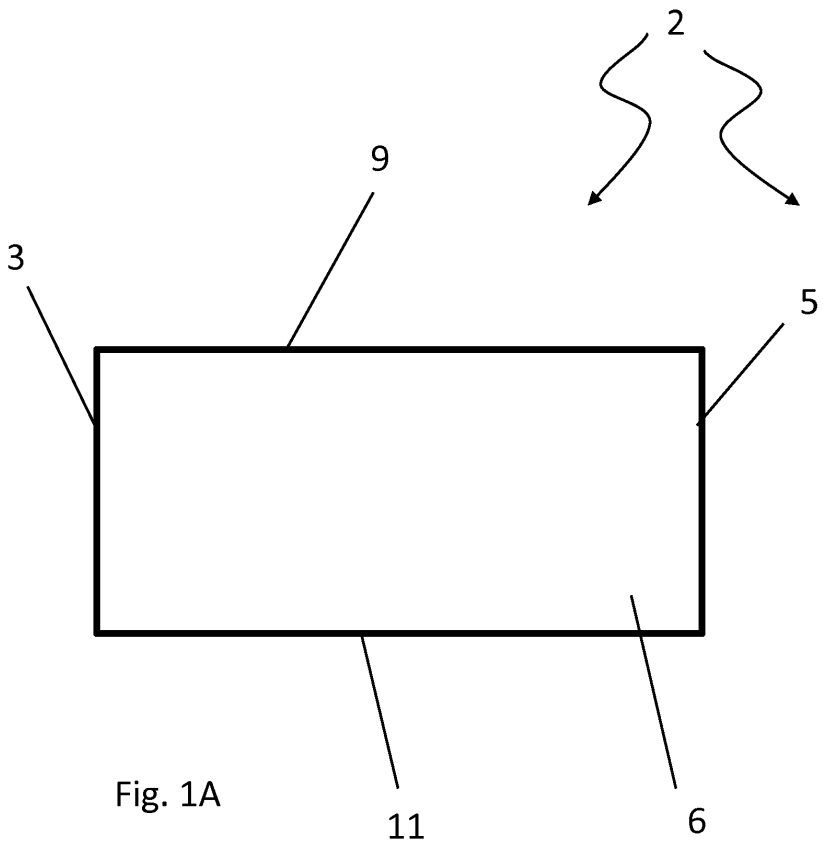


Fig. 1A

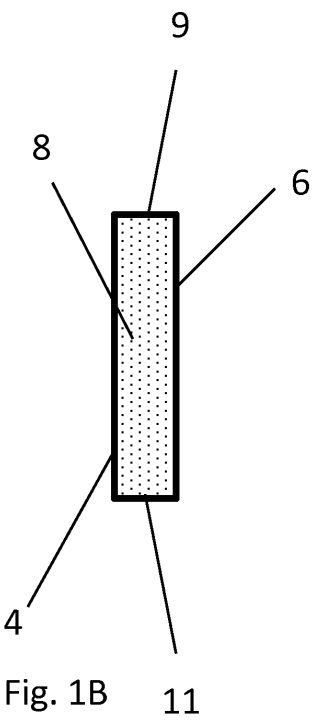


Fig. 1B

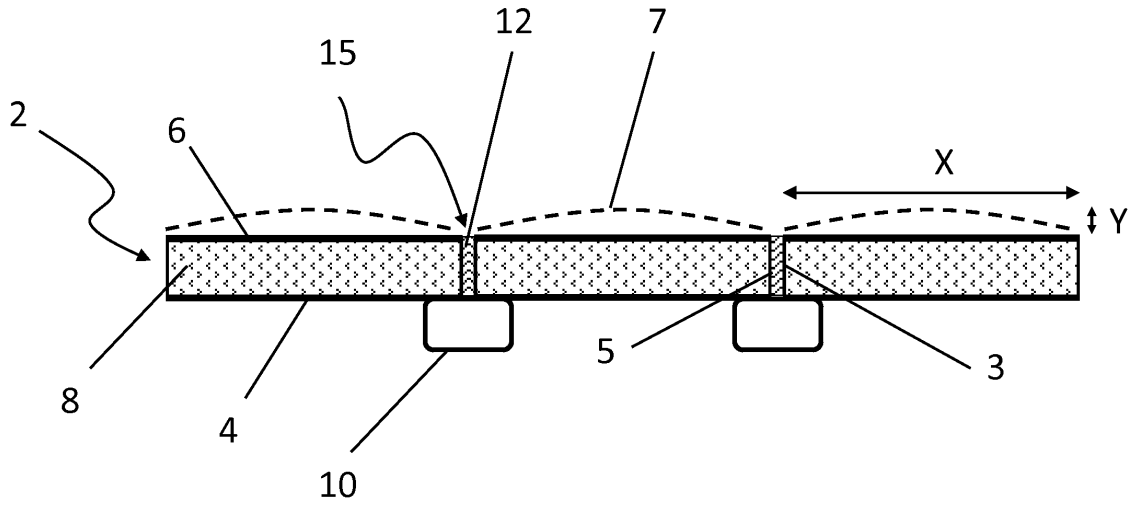


Fig. 2

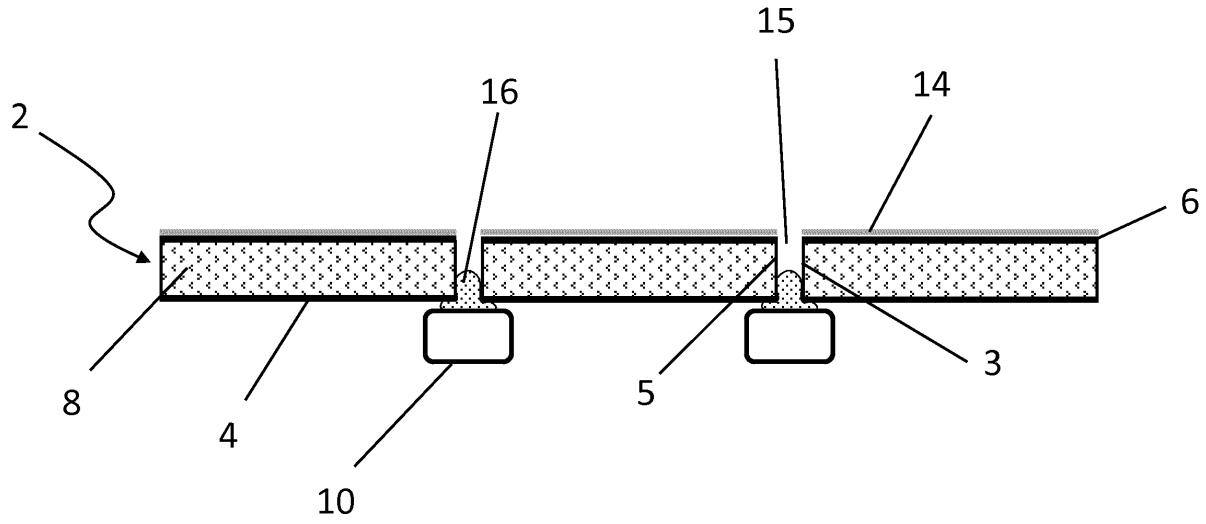


Fig. 3

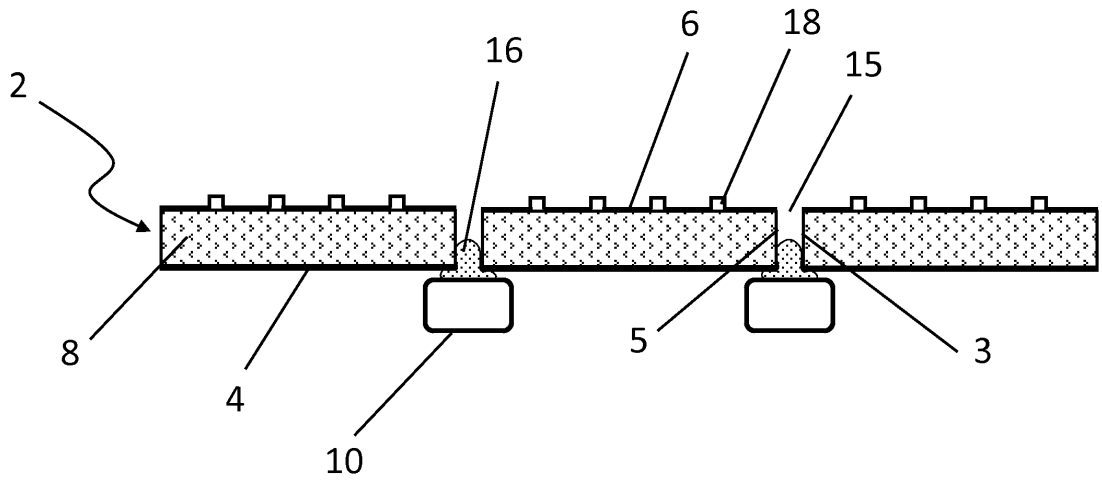


Fig. 4

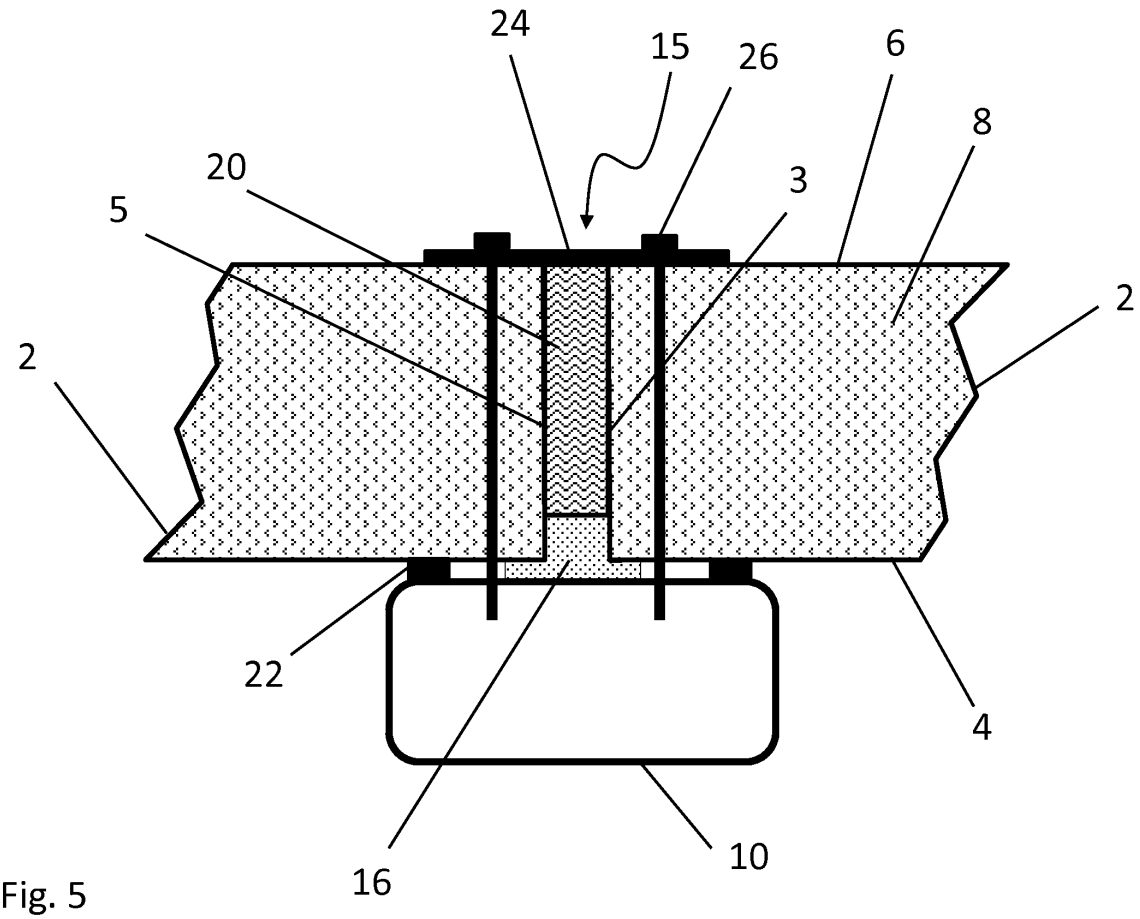


Fig. 5

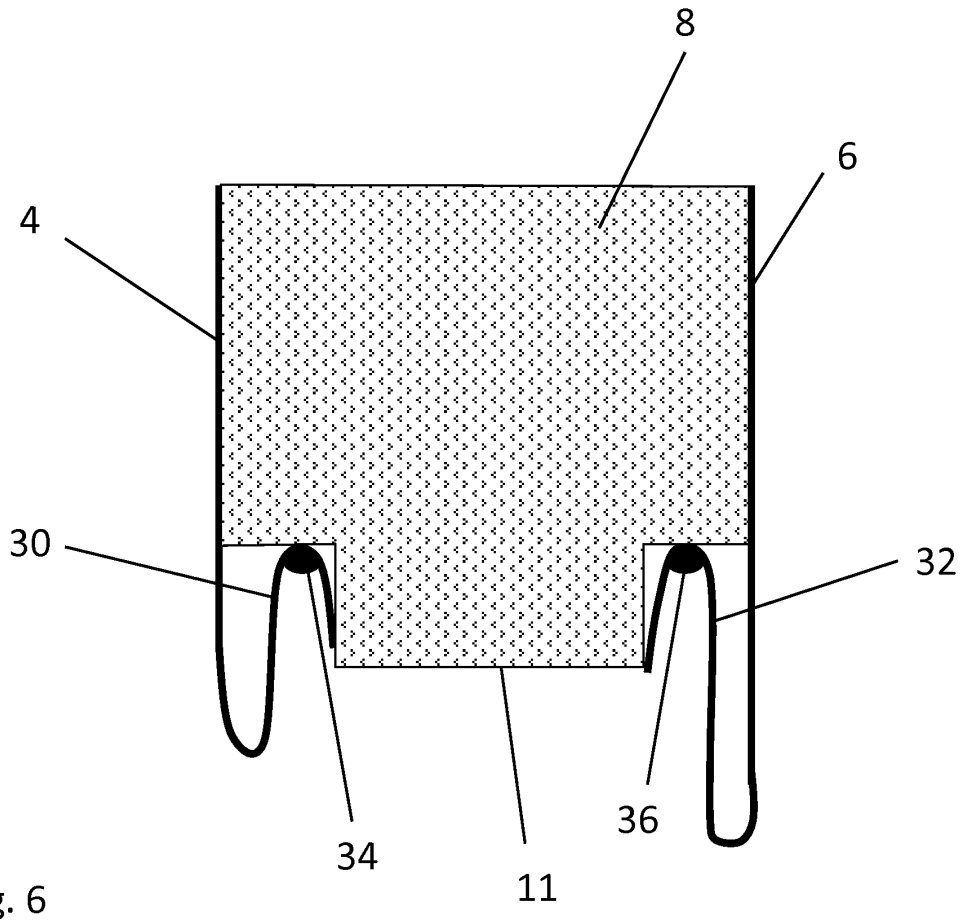


Fig. 6