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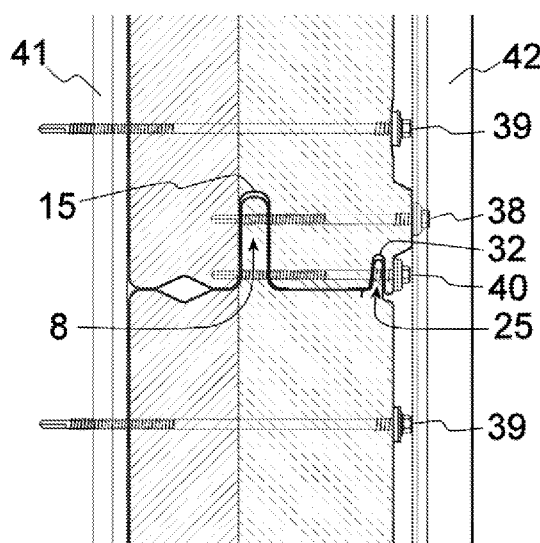


Figure 14

(57) Abstract: The invention relates to an assembly of at least two sandwich panels (1) having a ratio between the length L4 of the secondary mortise (32) and the length L2 of the main mortise (15) such that a fastener can be inserted from the outer metallic sheet (4) perpendicularly into the main mortise (15) without going through the secondary mortise (32), the two panels (1) being bound by means of the interlocking of the main tenon (8) of the first panel (1) with the main mortise (15) of the second panel (1), the interlocking of the secondary tenon (25) of the first panel (1) with the secondary mortise (32) of the second panel (1) and at least one stitching fastener (40) whose body goes through the secondary mortise (32) of the second panel (1), the secondary tenon (25) of the first panel (1), the main mortise (15) of the second panel (1) and the main tenon (8) of the first panel (1).

Sandwich panel assembly and associated building

The present invention relates to an assembly of sandwich panels, intended for the construction of building envelopes, and more particularly intended for the construction of building roofs and walls, without being limited thereto.

It is known to assemble sandwich panels comprising an insulation layer between two metallic sheets to build walls or roofs. Each sandwich panel usually comprises on one of its longitudinal edges a male interlocking part and on its other longitudinal edge a female interlocking part such that the male and female interlocking parts interlock into one another when two panels are assembled.

In case of fire, the interlocking area between the two panels is a weak point and, as temperature rises up, the sandwich panels expand and the interlocking area breaks up, which allows fire to spread. It is known notably from WO03/091016 to add a fire-resistant edge seal in the joint between adjacent panels. In a fire, the edge seal cures to provide a thermal shield to the joint. Nevertheless, such edge seal is not enough to prevent the interlocking area from breaking up.

Moreover, it is known to fasten, on the external side of the assembly of sandwich panels, an exterior facing, such as sidings or cassettes. Nevertheless, the resistance to wind suction is not enough and the sandwich panels tend to break apart.

The aim of the present invention is therefore to remedy the drawbacks of the prior art by providing an assembly of sandwich panels which provides an improved fire resistance along with an improved resistance to wind suction when an exterior facing is fixed on the assembly.

For this purpose, a first subject of the present invention consists of an assembly of at least two panels comprising an insulation material sandwiched between an inner metallic tray and an outer metallic sheet wherein the inner metallic tray comprises in cross-section:

- An inner central part substantially lying down in a plane P,

- A first inner flange extending inwards from a first extremity of the inner central part and comprising a U-shaped bend forming a main tenon extending in parallel to plane P and outwards,
- A second inner flange extending inwards from a second extremity of the inner central part and comprising a U-shaped bend forming a main mortise extending in parallel to plane P and inwards, the main tenon and main mortise having shapes that allow their interlocking,

wherein the outer metallic sheet comprises in cross-section:

- An outer central part,
- A first outer flange extending inwards from a first extremity of the outer central part and comprising a U-shaped bend forming a secondary tenon extending outwards and in parallel to the main tenon,
- A second outer flange extending inwards from a second extremity of the outer central part and comprising a U-shaped bend forming a secondary mortise extending inwards and in parallel to the main mortise, the secondary tenon and secondary mortise having shapes that allow their interlocking,

wherein the ratio between the length L4 of the secondary mortise and the length L2 of the main mortise is such that a fastener can be inserted from the outer metallic sheet perpendicularly into the main mortise without going through the secondary mortise,

The two panels being bound by means of:

- The interlocking of the main tenon of the first panel with the main mortise of the second panel,
- The interlocking of the secondary tenon of the first panel with the secondary mortise of the second panel,
- At least one stitching fastener whose body goes through the secondary mortise of the second panel, the secondary tenon of the first panel, the main mortise of the second panel and the main tenon of the first panel.

The assembly according to the invention may also have the optional features listed below, considered individually or in combination:

- the main tenon and the main mortise are located in the upper half of, respectively, the first inner flange and the second inner flange,
- the main mortise is comprised in a portion of the sandwich panel located between 35 and 75% of the panel thickness,
- the ratio between the width W_2 of the main mortise and its length L_2 is comprised between 0.1 and 0.3,
- the ratio between the length L_3 of the secondary tenon and the length L_1 of the main tenon is such that a fastener can be inserted from the outer metallic sheet perpendicularly into the main tenon without going through the secondary tenon,
- the head of the stitching fastener lies on the outer metallic sheet of the second panel,
- the assembly further comprises an external facing and at least one facing fastener whose head lies on the external facing and whose body goes through the main mortise of the second panel and the main tenon of the first panel without going through the secondary mortise of the second panel and the secondary tenon of the first panel,
- the first inner flange comprises a first inner section perpendicular to the inner central part, extending between the first lateral extremity of the inner central part and the main tenon,
- the second inner flange comprises a second inner section perpendicular to the inner central part, extending between the second lateral extremity of the inner central part and the main mortise,
- the insulation material is a composite comprising a lower layer of mineral wool and an upper layer of foamed material,
- the outer central part of the outer metallic sheet comprises a longitudinal rib adjacent to the second outer flange,
- the longitudinal rib is vertically aligned with the part of the main mortise which is not vertically aligned with the secondary mortise,
- the outer central part of the outer metallic sheet comprises a longitudinal groove adjacent to the second outer flange,
- the longitudinal groove is vertically misaligned with the main mortise and positioned ahead of the extremity of the main mortise.

A second subject of the invention consists of a pre-assembly of two panels comprising an insulation material sandwiched between an inner metallic tray and an outer metallic sheet wherein the inner metallic tray comprises in cross-section:

- An inner central part substantially lying down in a plane P,
- A first inner flange extending inwards from a first extremity of the inner central part and comprising a U-shaped bend forming a main tenon extending in parallel to plane P and outwards,
- A second inner flange extending inwards from a second extremity of the inner central part and comprising a U-shaped bend forming a main mortise extending in parallel to plane P and inwards, the main tenon and main mortise having shapes that allow their interlocking,

wherein the outer metallic sheet comprises in cross-section:

- An outer central part,
- A first outer flange extending inwards from a first extremity of the outer central part and comprising a U-shaped bend forming a secondary tenon extending outwards and in parallel to the main tenon,
- A second outer flange extending inwards from a second extremity of the outer central part and comprising a U-shaped bend forming a secondary mortise extending inwards and in parallel to the main mortise, the secondary tenon and secondary mortise having shapes that allow their interlocking,

wherein the ratio between the length L4 of the secondary mortise and the length L2 of the main mortise is such that a fastener can be inserted from the outer metallic sheet perpendicularly into the main mortise without going through the secondary mortise,

The two panels being bound by means of:

- The interlocking of the main tenon of the first panel with the main mortise of the second panel,
- The interlocking of the secondary tenon of the first panel with the secondary mortise of the second panel,

- At least one stitching fastener whose body goes through the secondary mortise of the second panel, the secondary tenon of the first panel, the main mortise of the second panel and the main tenon of the first panel.

Other characteristics and advantages of the invention will be described in greater detail in the following description, which is provided purely for purposes of explanation and is in no way intended to be restrictive, with reference to:

- Figure 1, which is a perspective view of a sandwich panel according to one variant of the invention,
- Figure 2, which is a cross-section of the sandwich panel of Figure 1,
- Figure 3, which is a perspective view of the first longitudinal edge of a sandwich panel according to a second variant of the invention,
- Figure 4, which is a perspective view of the second longitudinal edge of a sandwich panel according to a second variant of the invention,
- Figure 5, which is a perspective view of the first and second longitudinal edges of a sandwich panel according to a second variant of the invention,
- Figure 6, which is a cross-section of a sandwich panel according to a third variant of the invention,
- Figure 7, which is a perspective view of the first longitudinal edge of a sandwich panel of Figure 5,
- Figure 8, which is a perspective view of the second longitudinal edge of a sandwich panel of Figure 5,
- Figure 9, which is a cross-section of a sandwich panel according to a fourth variant of the invention,
- Figure 10, which is a perspective view of the first longitudinal edge of a sandwich panel of Figure 9,
- Figure 11, which is a perspective view of the second longitudinal edge of a sandwich panel of Figure 9,
- Figure 12, which is the assembly of panels according to the second variant of the invention,
- Figure 13, which represents details of the assembly of panels according to the second variant of the invention,

- Figure 14, which represents details of the assembly of panels according to the second variant of the invention,
- Figure 15, which is the assembly of panels according to the third variant of the invention,
- Figure 16, which represents details of the assembly of panels according to the third variant of the invention.
- Figure 17, which represents details of the assembly of panels according to the fourth variant of the invention

It should be noted that the terms “inward”, “inwards”, “outward” and “outwards” as used in this application refer to the positions and orientations of the different constituent elements of the panel in relation to the position of the insulation material. Consequently, if an element extends inwards, it extends in the direction of the insulation panel. Similarly, if the element extends outwards, it extends in the opposite direction of the insulation panel.

It should also be noted that, to ease the description, the panels will be described in relation to their usual position on a building. Consequently, the terms “inner” and “outer” as used in this application refer to this usual position. Accordingly, the outer sheet is facing the outside and the inner tray is facing the inside of the building. Consequently, the inner flange refers to the flange of the inner tray and the outer flange refers to the flange of the outer sheet. Nevertheless, the panels and the corresponding assembly can be positioned upside down on a building, i.e. with the outer sheet facing the inside of the building.

It should be noted that the terms “lower”, “upper”, “above”, “below”, “lowest”, “highest”, “top”, “bottom”... as used in this application refer to the positions and orientations of the different constituent elements of the panel when the latter is lying on an horizontal plane.

Throughout the text, a sheet is understood to mean an element that has a flat shape, i.e., its thickness is low compared to its other dimensions. Generally speaking, its thickness is 500 to 4000 times lower than its width. The sheet may be made of a single material or a composite assembly. In the latter case, the sheet is

a stack or a plurality of layers of the same material or different materials. The material in question may be, among others, a metallic material or a polymer. Steel, aluminum, copper and zinc may be cited as non-restricting examples of metallic materials. The sheet is preferably a metallic sheet. It is preferably made of previously galvanized and pre-coated steel to protect it against corrosion. The inner tray and the outer sheet are examples of sheets.

Within the framework of the invention, the sheet will preferably have been previously formed with the aid of any known forming method, including, by way of non-restricting examples, bending, forming, stamping and molding. In particular, the U-shaped bend described later on is an element of the panel whose manufacturing process is not limited to bending.

This forming leads among other things to the formation of ribs, stiffeners or grooves on the surface of the sheet. Throughout the text, a rib is understood to mean a projection formed on the surface of the sheet. The rib may have a trapezoidal shape or a rectangular, corrugated, sinusoidal or even omega shape, for example. It includes a top central part and two lateral wings. A stiffener is a rib of limited height, generally 10 to 30 times lower than a rib. Throughout the text, a groove is understood to mean a recess formed on the surface of the panel. The groove can have shapes similar to the ones offered for ribs. Ribs, stiffeners or grooves are generally placed in parallel to the longitudinal edges of the sheet notably to render the sheet more rigid.

With reference to Figures 1 and 2, the panel 1 according to the invention first comprises an insulation material 2 sandwiched between an inner metallic tray 3 and an outer metallic sheet 4. The sides of the insulation material thus form the sides of the panel.

The insulation material 2 can be any material providing some insulation to the panel. It can be, by way of non-restricting examples, polyurethane foam, polyisocyanurate foam, phenolic foam, mineral wool. According to a variant of the invention, the insulation material is a composite comprising a lower layer of mineral wool and an upper layer of foamed material.

The inner metallic tray 3 and an outer metallic sheet 4 are largely substantially flat. The substantially flat portions lie in a plane P. Flanges extend

from each of their lateral extremities along the lateral sides of the insulation material. The flanges thus cover partially the sides. The uncovered part of each lateral side is preferably perpendicular to plane P to ease the interlocking of panels.

The inner metallic tray 3 is a metallic sheet of rectangular shape, comprising longitudinal edges and transversal edges, which has been formed at a previous stage. It comprises, in cross-section perpendicular to its longitudinal axis, an inner central part 5 and two inner flanges extending inwards from each extremity of the inner central part. The central part substantially lies down flat in plane P. According to a variant of the invention, the inner central part 5 comprises stiffeners extending longitudinally to increase the stiffness of the metallic sheet.

As illustrated on Figures 3 and 5, the first inner flange 6 extends inwards from a first lateral extremity of the inner central part, along the first lateral side of the insulation material and comprises a U-shaped bend forming a main tenon 8 extending in parallel to the inner central part, i.e. parallel to plane P, and outwards. In particular, the first inner flange 6 comprises a first inner section 7 perpendicular to the inner central part, extending between the first lateral extremity of the inner central part and the main tenon. According to a variant of the invention, the first inner section 7 comprises a stiffener extending longitudinally to increase the stiffness of the section. In particular, the stiffener extends inwards so that a gasket can be added.

Preferably, the first inner flange also comprises a first inner end wing 12, located above the main tenon and perpendicular to it. This helps stiffening the first inner flange 6.

In particular, the main tenon 8 comprises two parallel branches 9, 10 linked by a U-turn 11. More preferably, the two parallel branches 9,10 have substantially the same length. The ratio between the width W1 of the main tenon 8 (measured along the Y axis) and its length L1 (measured along the X axis, starting from the uncovered part 46 of the first lateral side of the insulation material) is preferably comprised between 0.07 and 0.75. Preferably, it is comprised between 0.1 and 0.3. Preferably, the width is comprised between 5mm and 30mm. The length of the main tenon is preferably comprised between 40mm and 70mm. Other dimensions

or this main tenon will be described later on in relation to the secondary tenon or the outer metallic sheet.

Preferably, the main tenon 8 is located in the upper half of the first inner flange 6, i.e. the lowest portion of the main tenon is located in the upper half of the first inner flange. In particular, the first parallel branch 9 of the main tenon is located above half the height of the inner flange. Thanks to this position, the main tenon is close enough from the outer metallic sheet so that a fastener inserted from the outside (so that its head lies on the outer metallic sheet) can easily go through the main tenon without reaching the inner central part. Preferably, the ratio between the position P1 of the main tenon (i.e. the distance between the lowest portion of the main tenon and the inner central part) and the height H1 of the first inner flange is comprised between 0.45 and 0.9. More preferably, this ratio is comprised between 0.70 and 0.85.

As illustrated on Figures 4 and 5, the second inner flange 13 extends inwards from the second lateral extremity of the inner central part, along the second lateral side of the insulation material and comprises a U-shaped bend forming a main mortise 15 extending in parallel to the central part, i.e. parallel to plane P, and inwards. In particular, the second inner flange 13 comprises a second inner section 14 perpendicular to the inner central part, extending between the second lateral extremity of the inner central part and the main mortise. According to a variant of the invention, the second inner section 14 comprises a stiffener extending longitudinally to increase the stiffness of the section. In particular, the stiffener extends inwards so that a gasket can be added.

Preferably, the second inner flange also comprises a second inner end wing 19, located above the main mortise and perpendicular to it. This helps stiffening the second inner flange 13.

The main tenon 8 and main mortise 15 have shapes that allow their interlocking when one panel is assembled with an adjacent panel. Preferably, their shapes are substantially complementary and their dimensions are such that:

- The width W2 of the main mortise 15 (measured along the Y axis) is substantially equal to the width W1 of the main tenon 8,
- The length L2 of the main mortise (measured along the X axis, starting from the uncovered part 47 of the second lateral side of the insulation

material) is superior or substantially equal to the length L1 of the main tenon,

- The position P2 of the main mortise (i.e. the distance between the lowest portion of the main mortise and the inner central part) is substantially equal to the position P1 of the main tenon.

Preferably, the shape and dimensions of the main tenon are such that it perfectly fits into the main mortise. By “perfectly fits” it is meant that the main tenon and the main mortise are substantially in contact to one another except in areas where a gasket is added for sealing purposes, such as airtightness or thermal insulation. In particular, the main mortise 15 comprises two parallel branches 16, 17 linked by a U-turn 18. More preferably, the two parallel branches 16, 17 have substantially the same length. The internal distance between the two parallel branches 16, 17 is equal to the external distance between the two parallel branches 9, 10 of the main tenon. The U-turn 11 of the main tenon and the U-turn 18 of the main mortise are preferably separated by a gap allowing the insertion of a gasket, positioned in the U-turn of the main mortise before assembling of the panels. The gasket can be, among others, of an elastomeric material which is preferably shaped to substantially conform to the shape of the main mortise on assembly, PVC foam, PU foam, PVC hollow section joint or of an intumescent material, such as a mineral fibre based mat incorporating phosphate or exfoliating graphite.

The ratio between the width W2 of the main mortise 15 and its length L2 is preferably comprised between 0.07 and 0.75. Preferably, it is comprised between 0.1 and 0.3. Preferably, the width is comprised between 5mm and 30mm. The length of the main mortise is preferably comprised between 40mm and 70mm. Other dimensions of this main mortise will be described later on in relation to the secondary mortise of the outer metallic sheet.

Preferably, the main mortise is located in the upper half of the second inner flange, i.e. the lowest portion of the main mortise is located in the upper half of the second inner flange. In particular, the first parallel branch 16 of the main mortise is located above half the height of the inner flange. Thanks to this position, the main mortise is close enough from the outer metallic sheet so that a fastener inserted from the outside (so that its head lies on the outer metallic sheet) can easily go

through the main mortise without reaching the inner central part. Moreover, in the case where the insulation material is a composite comprising a lower layer and an upper layer of a different material, the lower layer can be easily inserted below the main mortise and held in place by the main mortise. Preferably, the ratio between the position P2 of the main mortise and the height H2 of the second inner flange is comprised between 0.45 and 0.9. More preferably, this ratio is comprised between 0.70 and 0.85. Preferably the gap between the main mortise and the outer metallic sheet 4 is at least of 40mm so that the panel provides enough thermal insulation.

The outer metallic sheet 4 is a metallic sheet of rectangular shape, comprising longitudinal edges and transversal edges, which has been formed at a previous stage. It comprises, in cross-section perpendicular to its longitudinal axis, an outer central part 20 and two outer flanges extending inwards from each extremity of the outer central part. Preferably, most of the outer central part is lying down in a plane parallel to plane P. In one variant illustrated on Figures 3-5 and 12-14 where the panel 1 is intended to be used in façade, the outer central part 20 preferably comprises at least one longitudinal rib 21 on which an external facing 42, such as sidings, cassettes, decorative laminates or clay tiles can be easily fixed, directly or indirectly with the use of an additional profile or secondary steel frame. Thanks to this longitudinal rib, the external facing can be fixed without secondary frame. The panel for façade can also comprise stiffeners. In another variant illustrated on Figures 6-8 and 15-16 where the panel is intended to be used for roofs, the outer central part 20 preferably comprises at least one longitudinal groove 22 so that repartition plates 43 and fastener heads can be hidden below the waterproof membrane to be applied on the roof. In another variant illustrated on Figures 9-11 and 17 where the panel is intended for architectural purposes, the outer central part 20 preferably comprises stiffeners.

As illustrated on Figures 3 and 5, the first outer flange 23 extends inwards from a first extremity of the outer central part 20, along the first lateral side of the insulation material and comprises a U-shaped bend forming a secondary tenon 25 extending outwards and in parallel to the main tenon. By “secondary” it is meant that the corresponding tenon is significantly smaller than the main tenon. This secondary tenon is on the same side of the panel than the main tenon. In

particular, the secondary tenon is linked to the outer central part by a S-shaped bend 24. This S-shaped bend can be very small, as in the case where panel 1 is intended to be used in façade, its height being of approximately the same size than the width of the secondary tenon 25. In another variant illustrated on Figure 6 where the panel is intended to be used for roofs, the S-shaped bend 24 is deeper so that fastener heads can be hidden below the waterproof membrane to be applied on the roof. In that case, the S-shaped bend is preferably 3 to 5 times deeper than the width of the secondary tenon 25. In another variant illustrated on Figure 10 where the panel is intended for architectural purposes, the S-shaped bend 24 comprises a hidden groove 44 located in the lower part of the S-shaped bend. Thanks to this hidden groove, the head of the panel fastener 39 can be hidden below the adjacent panel.

Preferably, the first outer flange also comprises a first outer end wing 29, located below the secondary tenon and perpendicular to it. This helps stiffening the first outer flange 23.

In particular, the secondary tenon 25 comprises two parallel branches 26, 27 linked by a U-turn 28. More preferably, the two parallel branches 26, 27 have substantially the same length. The ratio between the width $W3$ of the secondary tenon (measured along the Y axis) and its length $L3$ (measured along the X axis, starting from the uncovered part 46 of the first lateral side of the insulation material) is preferably comprised between 0.1 and 0.7. Preferably, it is comprised between 0.15 and 0.35. Preferably, the width is comprised between 3mm and 7mm. The length of the secondary tenon is preferably comprised between 10mm and 30mm so that a fastener can easily go through it.

Preferably, the secondary tenon 25 and the main tenon 8 are aligned one above the other. In other words, the base of the secondary tenon and the base of the main tenon are in the same vertical plane, perpendicular to plane P. More preferably, the base of one parallel branch of the secondary tenon and the base of one parallel branch of the main tenon are in the same vertical plane, perpendicular to plane P. More preferably, the vertical plane in question is the plane of the uncovered part 46 of the first lateral side of the insulation material. More preferably, the first inner end wing 12 and the first outer end wing 29 are in the same vertical plane.

The second outer flange 30 extends inwards from a second extremity of the outer central part 20, along the second lateral side of the insulation material and comprises a U-shaped bend forming a secondary mortise 32 extending inwards and in parallel to the main mortise. By "secondary" it is meant that the corresponding mortise is significantly smaller than the main mortise. This secondary mortise is on the same side of the panel than the main mortise. In particular, the secondary mortise is linked to the outer central part by a bridge 31. In one variant illustrated on Figures 3-5 and 12-14 where the panel 1 is intended to be used in façade, the bridge is in the form of a C-shaped bend, which preferably fits with the S-shaped bend 24 of the first outer flange 23. In another variant illustrated on Figures 6-8 and 15-16 where the panel is intended to be used for roofs, the bridge is in the form of a S-shaped bend, similar to the one of the first outer flange 23, and preferably vertically aligned with the secondary mortise. In another variant illustrated on Figures 9-11 and 17 where the panel is intended for architectural purposes, the bridge is in the form of an external male projecting form 45 which extremity protrudes from the vertical plane comprising the start of the secondary groove. Thanks to this protrusion, the external male projecting form of a first panel hides the head of the panel fastener 39 of a second panel.

Preferably, the second outer flange also comprises a second outer end wing 36, located below the secondary mortise and perpendicular to it. This helps stiffening the second outer flange 30.

The secondary tenon 25 and secondary mortise 32 have shapes that allow their interlocking when one panel is assembled with an adjacent panel. Preferably, their shapes are substantially complementary and their dimensions are such that:

- The width W4 of the secondary mortise 32 (measured along the Y axis) is substantially equal to the width W3 of the secondary tenon 25,
- The length L4 of the secondary mortise (measured along the X axis, starting from the uncovered part 47 of the second lateral side of the insulation material) is superior or substantially equal to the length L3 of the secondary tenon,
- The position of the secondary mortise (i.e. the distance between the lowest portion of the secondary mortise and the inner central part) is substantially equal to the position of the secondary tenon.

Preferably, the shape and dimensions of the secondary tenon are such that it perfectly fits into the secondary mortise. By “perfectly fits” it is meant that the secondary tenon and the secondary mortise are substantially in contact to one another except in areas where a gasket has been added for sealing purposes, such as airtightness or thermal insulation. In particular, the secondary mortise 32 comprises two parallel branches 33, 34 linked by a U-turn 35. More preferably, the two parallel branches 33, 34 have substantially the same length. The internal distance between the two parallel branches 33, 34 is equal to the external distance between the two parallel branches 26, 27 of the secondary tenon. The U-turn 28 of the secondary tenon and the U-turn 35 of the secondary mortise are preferably separated by a gap allowing the insertion of a gasket, positioned in the U-turn of the secondary mortise before assembling of the panels. The gasket can be, among others, of an elastomeric material which is preferably shaped to substantially conform to the shape of the main mortise on assembly, PVC foam, PU foam, PVC hollow section joint or of an intumescent material, such as a mineral fibre based mat incorporating phosphate or exfoliating graphite.

The ratio between the width $W4$ of the secondary mortise and its length $L4$ is preferably comprised between 0.1 and 0.7. Preferably, it is comprised between 0.15 and 0.35. Preferably, the width is comprised between 3mm and 7mm. The length of the secondary mortise is preferably comprised between 10mm and 30mm, so that a fastener can easily go through it.

Preferably, the secondary mortise 32 and the main mortise 15 are aligned one above the other. In other words, the start of the secondary mortise and the start of the main mortise are in the same vertical plane, perpendicular to plane P. More preferably, the start of one parallel branch of the secondary mortise and the start of one parallel branch of the main mortise are in the same vertical plane, perpendicular to plane P. More preferably, the vertical plane in question is the plane of the uncovered part 47 of the second lateral side of the insulation material. More preferably, the second inner end wing 19 and the second outer end wing 36 are in the same vertical plane.

The ratio between the length $L4$ of the secondary mortise and the length $L2$ of the main mortise is such that a fastener can be inserted from the outer metallic sheet perpendicularly into the main mortise without going through the secondary

mortise. In other words, the main mortise is longer than the secondary mortise by at least the width of the fastener. Consequently, it is very easy to fix on the inner metallic tray 3 an external facing, such as sidings, cassettes, decorative laminates or clay tiles, directly or indirectly with the use of an additional profile or secondary steel frame. This significantly increases the static and dynamic loads of the façade, and in particular the resistance to wind suction. Preferably this ratio is comprised between 0.15 and 0.75, more preferably between 0.3 and 0.5.

Preferably, the ratio between the length L3 of the secondary tenon and the length L1 of the main tenon is such that a fastener can be inserted from the outer metallic sheet perpendicularly into the main tenon without going through the secondary tenon. In other words, the main tenon is longer than the secondary tenon by at least the width of the fastener. Consequently, the facing fastener 38 used to fix the external facing on the inner tray goes through the main mortise and the main tenon, i.e. through 4 layers of metallic sheets, which double the mechanical anchoring of the external facing on the inner metallic tray. Preferably the ratio $L3 / L1$ is comprised between 0.15 and 0.75, more preferably between 0.3 and 0.5.

In the case where the panel 1 is intended to be used in façade and comprises at least one longitudinal rib 21, the latter is preferably located adjacent to the second outer flange 30 so that a first sandwich panel can be fixed to the building structure before a second panel is connected to the first panel by inserting its main and secondary tenons in the main and secondary mortises of the first panel. More preferably, the longitudinal rib 21 is preferably vertically aligned with the part of the main mortise which is not vertically aligned with the secondary mortise, referred to as the second part of the main mortise in this description. Thanks to this positioning, the facing fastener 38 used to fix the external facing on the sandwich panel and inserted in the longitudinal rib will go through the main mortise for sure. This makes the assembling easier.

In the case where the panel is intended to be used for roofs and comprises at least one longitudinal groove 22, the latter is preferably located adjacent to the second outer flange 30 so that a first sandwich panel can be fixed to the building structure before a second panel is connected to the first panel by inserting its main and secondary tenons in the main and secondary mortises of the first panel. More

preferably, the longitudinal groove is vertically misaligned with the main mortise 15 and positioned ahead of the extremity of the main mortise. Thanks to this positioning, the panel fastener 39 used to fix the sandwich panel on the building structure and inserted in the groove will go through the panel without going through the main mortise for sure. This makes the assembling easier.

Preferably, the panel intended to be used for roofs further comprises a second longitudinal groove 22 located adjacent to the first outer flange 23 so that the sandwich panel can be fixed to the building structure on both longitudinal edges.

As illustrated on Figures 12 to 17, when two panels are assembled on the building structure 41, they are bound by means of:

- The interlocking of the main tenon of the first panel with the main mortise of the second panel,
- The interlocking of the secondary tenon of the first panel with the secondary mortise of the second panel,
- At least one stitching fastener 40 whose body goes through the secondary mortise of the second panel, the secondary tenon of the first panel, the main mortise of the second panel and the main tenon of the first panel.

By “go through”, it is meant that the fastener body is present on both sides of each mortise, respectively each tenon. In the case where tenons and mortises have parallel branches, the fastener goes through both parallel branches of each mortise, respectively each tenon.

In other words, the secondary tenon and secondary mortise are long enough so that the stitching fastener can go through them.

Thanks to the stitching of the two panels on the specifically designed tenons and mortises, the fire resistance of the panel assembly is greatly improved. In case of fire, the interlocking area have a better resistance. It may burst at the end but after a much longer time than with sandwich panels from the prior art. In particular, the fact that the stitching fastener 40 goes through each mortise and each tenon strongly blocks the interlocking area between the two panels and prevents the rotation of the connection, and thus its opening, when the panels arch

upon exposure to the fire heat. Moreover, the stitching on the specifically designed tenons and mortises greatly improves the static and dynamic loads of the panel assembly, and in particular the resistance to wind suction and the resistance to snow load. The interlocking area doesn't open when panels are bended under load.

Thanks to the specifically designed tenons and mortises of the two panels, the stitching fastener 40 can be easily inserted from the outer metallic sheet, i.e. from the outside of the building during the assembly. It is preferably done so and the head of the stitching fastener thus lies on the outer metallic sheet of the second panel. This simplifies the assembly process since all fasteners are inserted from the same side, the external one, and since it is no longer necessary to turn to scaffolds or lifting platforms in the inside of the building to insert the stitching fasteners from the inside. In particular, when the panel is intended to be used for walls and its outer metallic sheet comprises a longitudinal rib 21 vertically aligned with the second part of the main mortise as illustrated on Figures 14 and 15, the point where the stitching fastener has to be inserted is easily located as the area between the longitudinal rib and the adjacent extremity of the outer central part, i.e. the C-shaped bend if any. When the panel is intended to be used for roofs and its outer metallic sheet comprises a S-shaped bend vertically aligned with the secondary mortise as illustrated on Figure 16, the point where the stitching fastener has to be inserted is easily located as the S-shaped bend.

According to another variant of the invention illustrated on Figure 17, the stitching fastener 40 can be inserted from the inner metallic tray, i.e. from the inside of the building during the assembly. The head of the stitching fastener thus lies on the inner metallic tray of the second panel. This makes the stitching fasteners invisible from the outside of the building which is preferred for architectural purposes.

The stitching of the two panels is preferably done with stitching fasteners regularly spaced. More preferably, the fastener spacing is between 250mm and 500mm.

Preferably, the ratio between the position P2 of the main mortise and the panel thickness H_p is comprised between 0.35 and 0.7. More preferably, the ratio between the position P2 of the main mortise and the panel thickness H_p is at least

0.35 and the ratio between the position of the mortise top and the panel thickness is at most 0.75. The position of the mortise top corresponds to the sum of P2 and W2. In other words, the main mortise is comprised in a portion of the sandwich panel located between 35 and 75% of the panel thickness. Thanks to this central positioning of the main mortise, the static loads are greatly increased. The panel thickness is meant to be the distance between the inner central part 5 of the inner metallic tray and the outer central part 20 of the outer metallic sheet.

As illustrated on Figure 14, when an external facing 42 has to be fixed on the assembly of sandwich panels, the facing fastener 38 is used to fix the external facing on the inner tray. It is inserted in the sandwich panel from the outside so that its head lies on the external facing and its body goes through the main mortise of the second panel and the main tenon of the first panel without going through the secondary mortise of the second panel and the secondary tenon of the first panel. As the external facing is thus fixed on the inner metallic tray, the static and dynamic loads of the façade are significantly increased, and in particular the resistance to wind suction.

According to one variant of the invention, two panels are pre-assembled, which means that they are bound to one another before being delivered to the construction site. They thus form a pre-assembly of panels. In particular, they are bound to one another thanks to the stitching fasteners 40. Thanks to this pre-assembling, the stitching is done in better reproducible conditions. Moreover, the assembling on site of the panels is much faster.

CLAIMS

1) Assembly of at least two panels (1) comprising an insulation material (2) sandwiched between an inner metallic tray (3) and an outer metallic sheet (4) wherein the inner metallic tray comprises in cross-section:

- An inner central part (5) substantially lying down in a plane P,
- A first inner flange (6) extending inwards from a first extremity of the inner central part and comprising a U-shaped bend forming a main tenon (8) extending in parallel to plane P and outwards,
- A second inner flange (13) extending inwards from a second extremity of the inner central part and comprising a U-shaped bend forming a main mortise (15) extending in parallel to plane P and inwards, the main tenon and main mortise having shapes that allow their interlocking,

wherein the outer metallic sheet (4) comprises in cross-section:

- An outer central part (20),
- A first outer flange (23) extending inwards from a first extremity of the outer central part and comprising a U-shaped bend forming a secondary tenon (25) extending outwards and in parallel to the main tenon (8),
- A second outer flange (30) extending inwards from a second extremity of the outer central part and comprising a U-shaped bend forming a secondary mortise (32) extending inwards and in parallel to the main mortise, the secondary tenon and secondary mortise having shapes that allow their interlocking,

wherein the ratio between the length L4 of the secondary mortise and the length L2 of the main mortise is such that a fastener can be inserted from the outer metallic sheet perpendicularly into the main mortise without going through the secondary mortise,

The two panels being bound by means of:

- The interlocking of the main tenon (8) of the first panel with the main mortise of the second panel (15),
- The interlocking of the secondary tenon (25) of the first panel with the secondary mortise (32) of the second panel,

- At least one stitching fastener (40) whose body goes through the secondary mortise (32) of the second panel, the secondary tenon (25) of the first panel, the main mortise (15) of the second panel and the main tenon (8) of the first panel.
- 2) Assembly of panels according to claim 1 wherein the main tenon and the main mortise are located in the upper half of, respectively, the first inner flange and the second inner flange.
 - 3) Assembly of panels according to any one of claims 1 or 2 wherein the main mortise (15) is comprised in a portion of the sandwich panel located between 35 and 75% of the panel thickness.
 - 4) Assembly of panels according to any one of the preceding claims wherein the ratio between the width W_2 of the main mortise (15) and its length L_2 is comprised between 0.1 and 0.3.
 - 5) Assembly of panels according to any one of the preceding claims wherein the ratio between the length L_3 of the secondary tenon (25) and the length L_1 of the main tenon (8) is such that a fastener can be inserted from the outer metallic sheet perpendicularly into the main tenon without going through the secondary tenon.
 - 6) Assembly of panels according to any one of the preceding claims wherein the base of the secondary tenon (25) and the base of the main tenon (8) are in a same vertical plane, perpendicular to plane P.
 - 7) Assembly of panels according to any one of the preceding claims wherein the start of the secondary mortise (32) and the start of the main mortise (15) are in a same vertical plane, perpendicular to plane P.
 - 8) Assembly of panels according to any one of the preceding claims wherein the head of the stitching fastener (40) lies on the outer metallic sheet of the second panel.

- 9) Assembly of panels according to any one of the preceding claims wherein the assembly further comprises an external facing (42) and at least one facing fastener (38) whose head lies on the external facing and whose body goes through the main mortise (15) of the second panel and the main tenon (8) of the first panel without going through the secondary mortise (32) of the second panel and the secondary tenon (25) of the first panel.
- 10) Assembly of panels according to any one of the preceding claims wherein the first inner flange (6) comprises a first inner section (7) perpendicular to the inner central part (5), extending between the first lateral extremity of the inner central part and the main tenon (8).
- 11) Assembly of panels according to any one of the preceding claims wherein the second inner flange (13) comprises a second inner section (14) perpendicular to the inner central part (5), extending between the second lateral extremity of the inner central part and the main mortise (15).
- 12) Assembly of panels according to any one of the preceding claims wherein the insulation material (2) is a composite comprising a lower layer of mineral wool and an upper layer of foamed material.
- 13) Assembly of panels according to any one of the preceding claims wherein the outer central part (20) of the outer metallic sheet (4) comprises a longitudinal rib (21) adjacent to the second outer flange (30).
- 14) Assembly of panels according to 13 wherein the longitudinal rib is vertically aligned with the part of the main mortise (15) which is not vertically aligned with the secondary mortise (32).
- 15) Assembly of panels according to any one of claims 1 to 12 wherein the outer central part (20) of the outer metallic sheet (4) comprises a longitudinal groove (22) adjacent to the second outer flange (30).

16) Assembly of panels according to 15 wherein the longitudinal groove (22) is vertically misaligned with the main mortise (15) and positioned ahead of the extremity of the main mortise.

17) Pre-assembly of two panels (1) comprising an insulation material (2) sandwiched between an inner metallic tray (3) and an outer metallic sheet (4) wherein the inner metallic tray comprises in cross-section:

- An inner central part (5) substantially lying down in a plane P,
- A first inner flange (6) extending inwards from a first extremity of the inner central part and comprising a U-shaped bend forming a main tenon (8) extending in parallel to plane P and outwards,
- A second inner flange (13) extending inwards from a second extremity of the inner central part and comprising a U-shaped bend forming a main mortise (15) extending in parallel to plane P and inwards, the main tenon and main mortise having shapes that allow their interlocking,

wherein the outer metallic sheet (4) comprises in cross-section:

- An outer central part (20),
- A first outer flange (23) extending inwards from a first extremity of the outer central part and comprising a U-shaped bend forming a secondary tenon (25) extending outwards and in parallel to the main tenon (8),
- A second outer flange (30) extending inwards from a second extremity of the outer central part and comprising a U-shaped bend forming a secondary mortise (32) extending inwards and in parallel to the main mortise, the secondary tenon and secondary mortise having shapes that allow their interlocking,

wherein the ratio between the length L4 of the secondary mortise and the length L2 of the main mortise is such that a fastener can be inserted from the outer metallic sheet perpendicularly into the main mortise without going through the secondary mortise,

The two panels being bound by means of:

- The interlocking of the main tenon (8) of the first panel with the main mortise of the second panel (15),

- The interlocking of the secondary tenon (25) of the first panel with the secondary mortise (32) of the second panel,
- At least one stitching fastener (40) whose body goes through the secondary mortise (32) of the second panel, the secondary tenon (25) of the first panel, the main mortise (15) of the second panel and the main tenon (8) of the first panel.

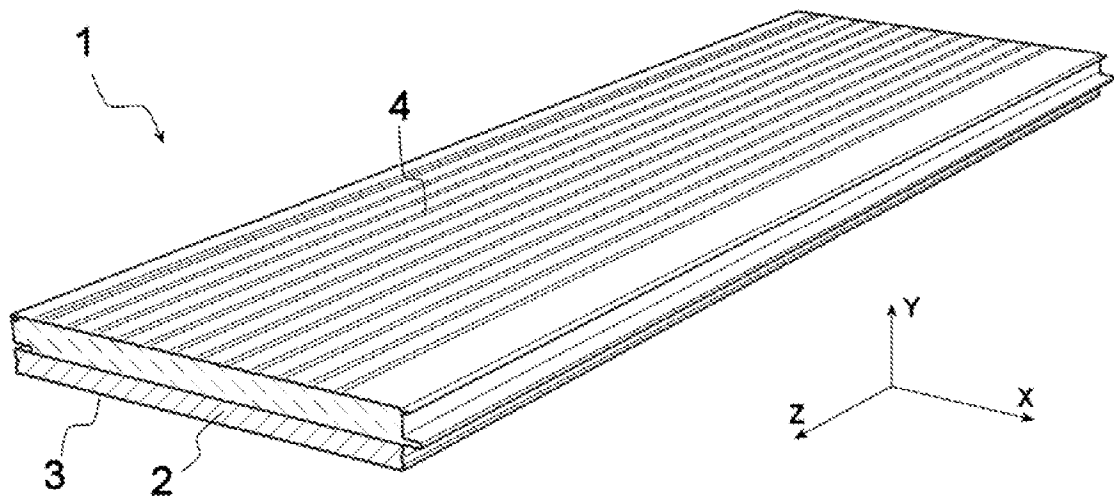


Figure 1

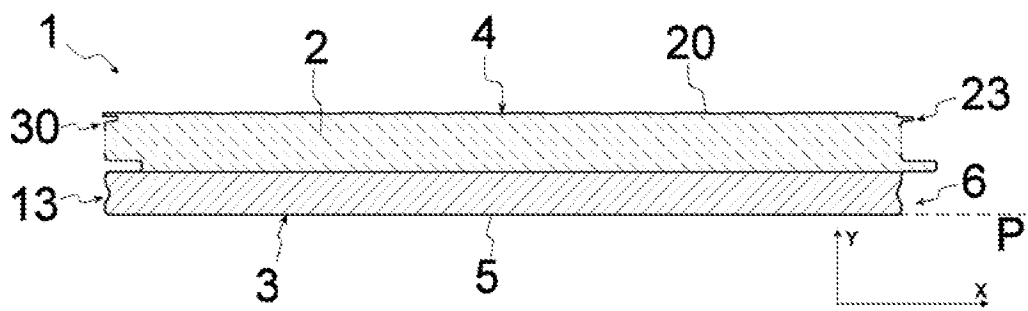


Figure 2

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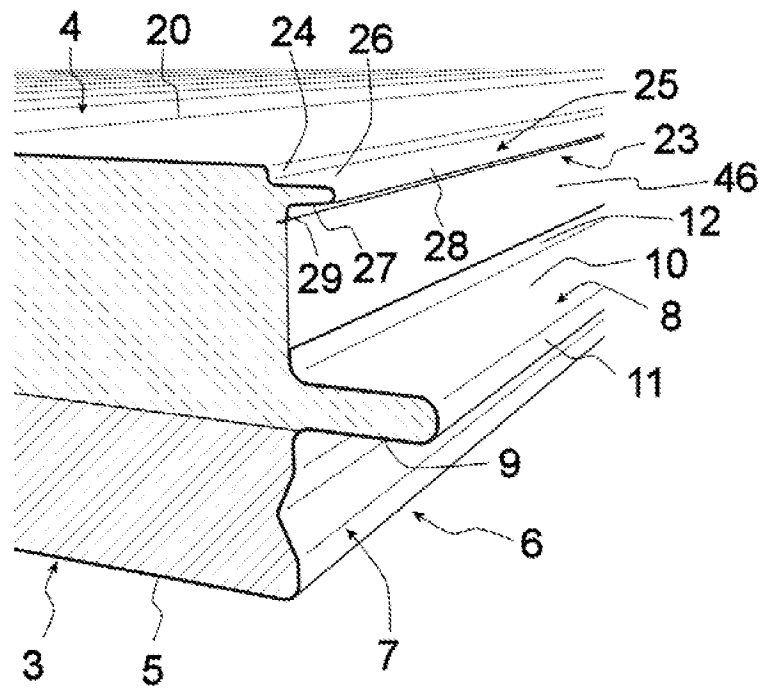


Figure 3

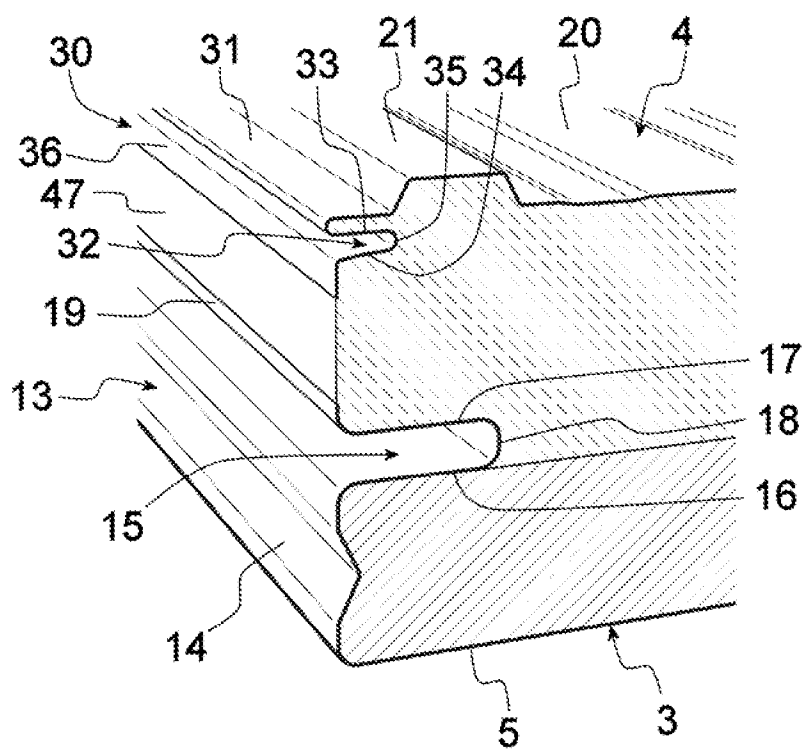


Figure 4

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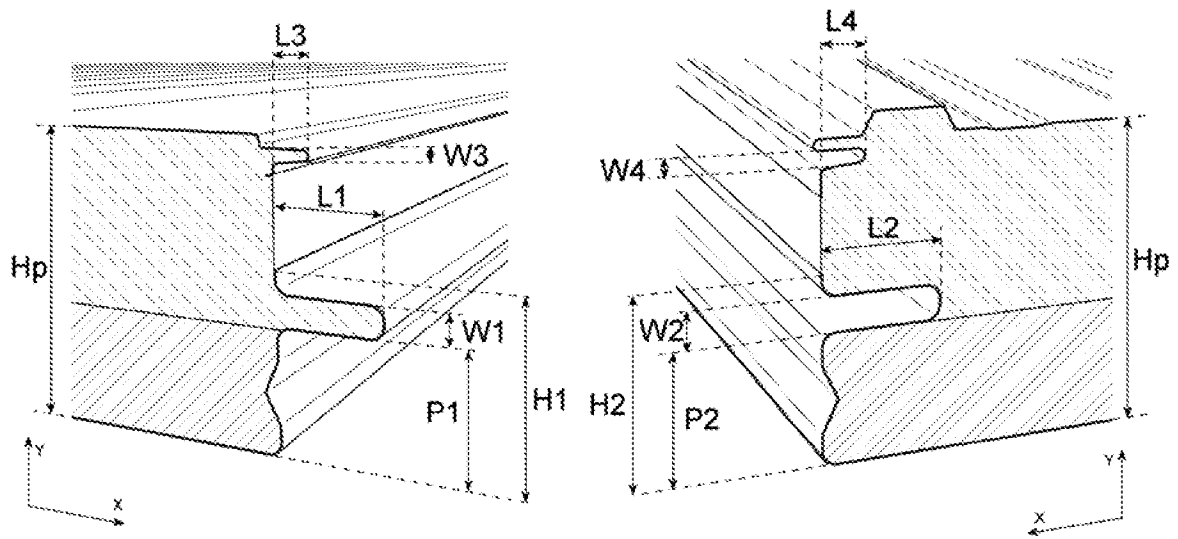


Figure 5

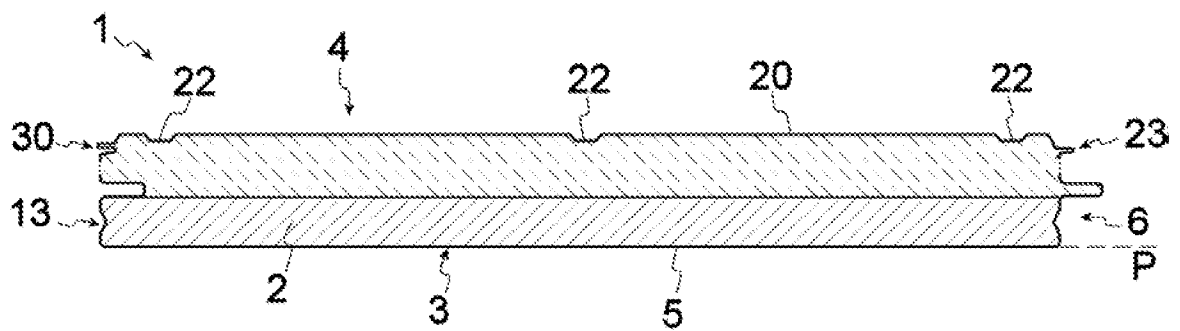


Figure 6

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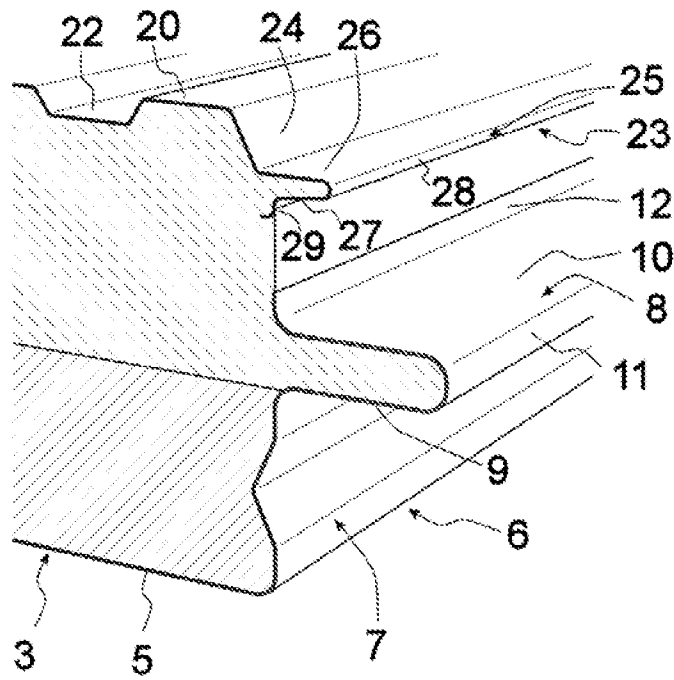


Figure 7

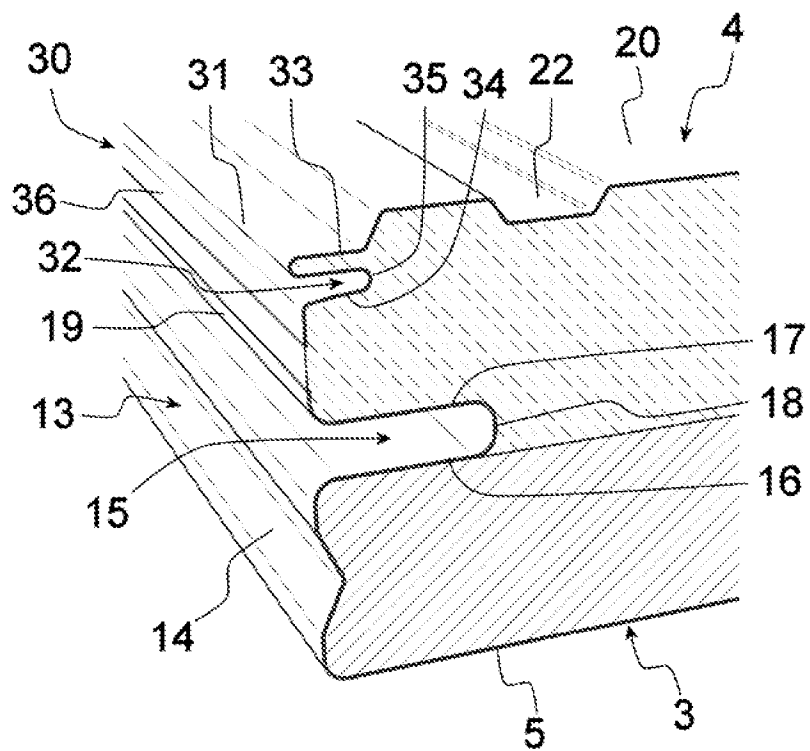


Figure 8

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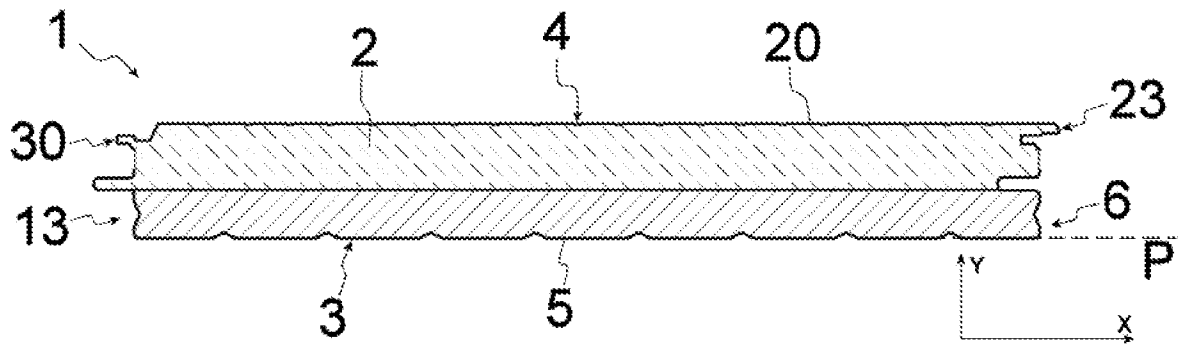


Figure 9

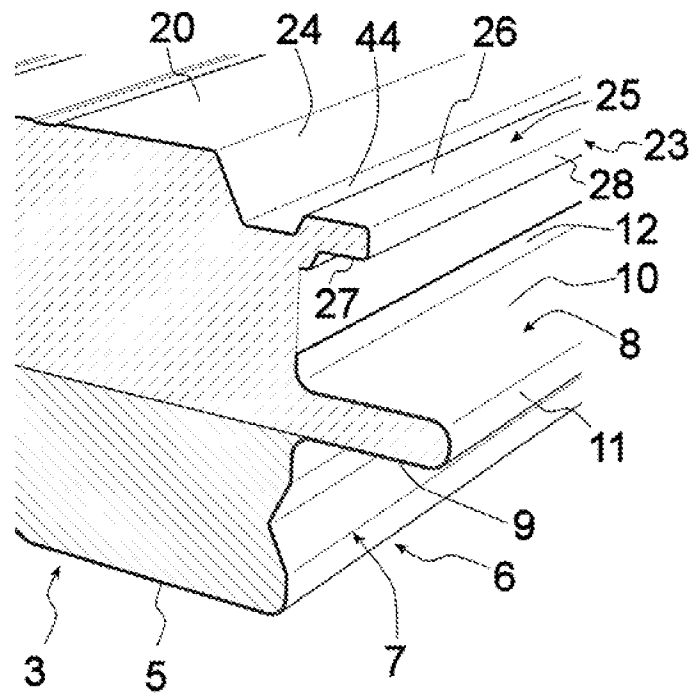


Figure 10

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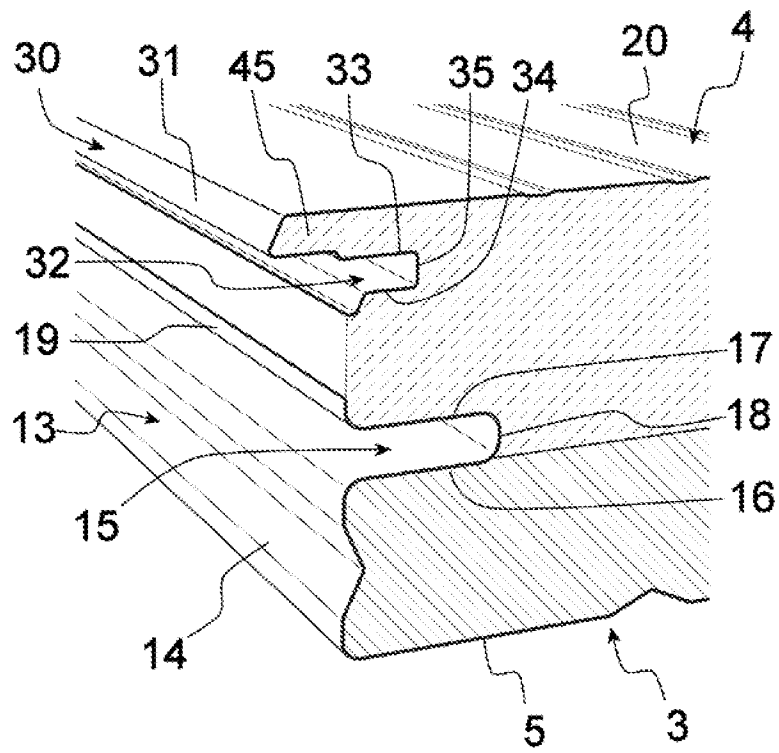


Figure 11

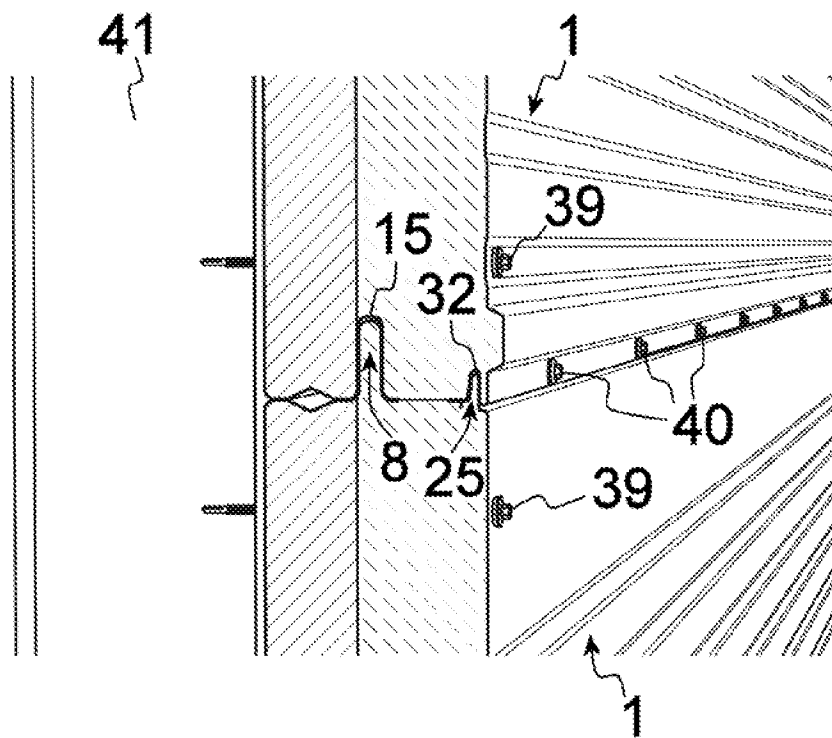


Figure 12

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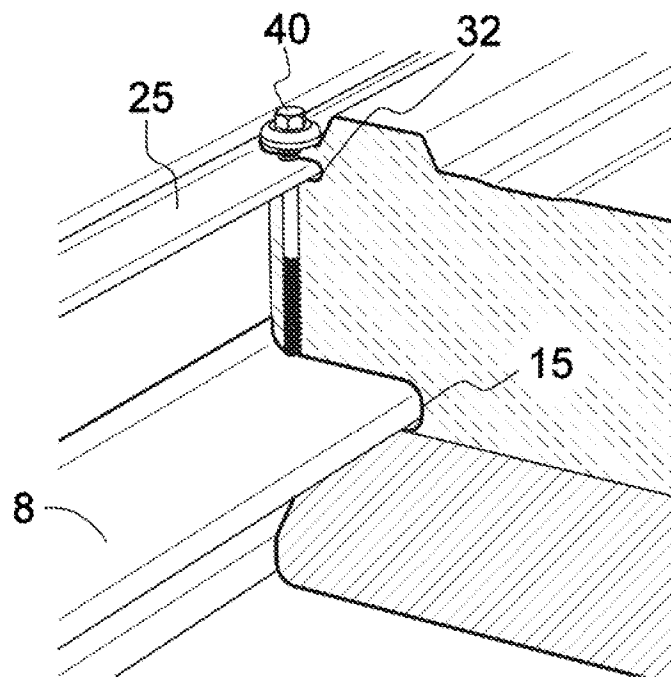


Figure 13

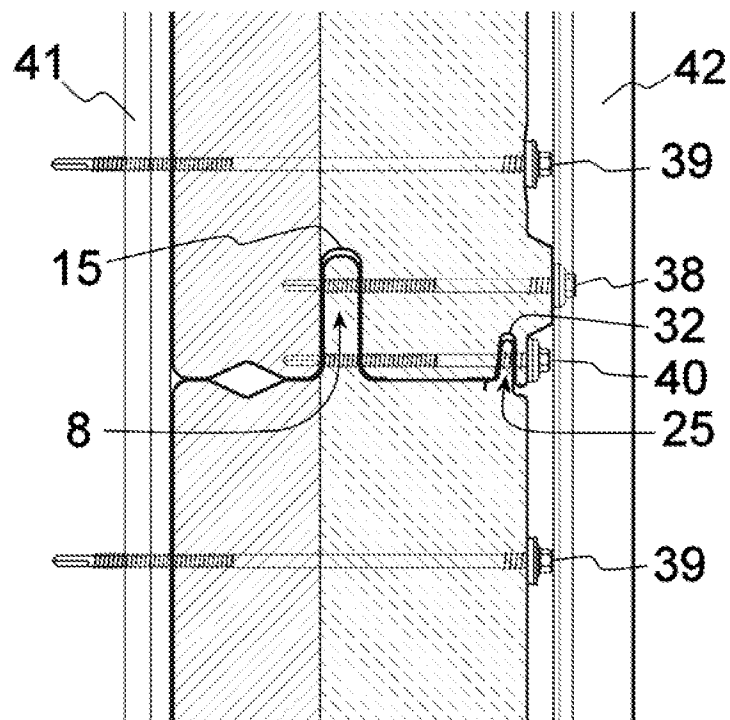


Figure 14

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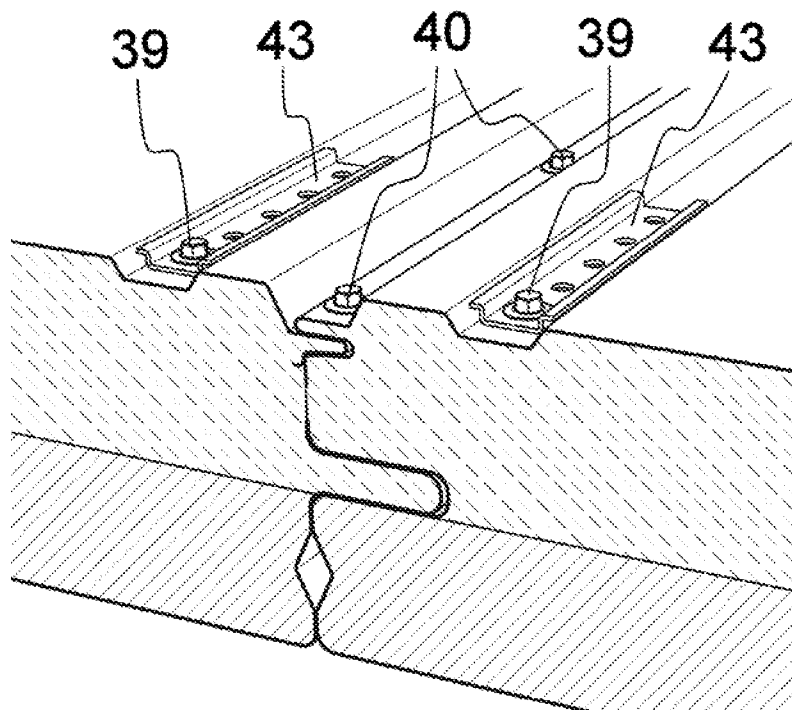


Figure 15

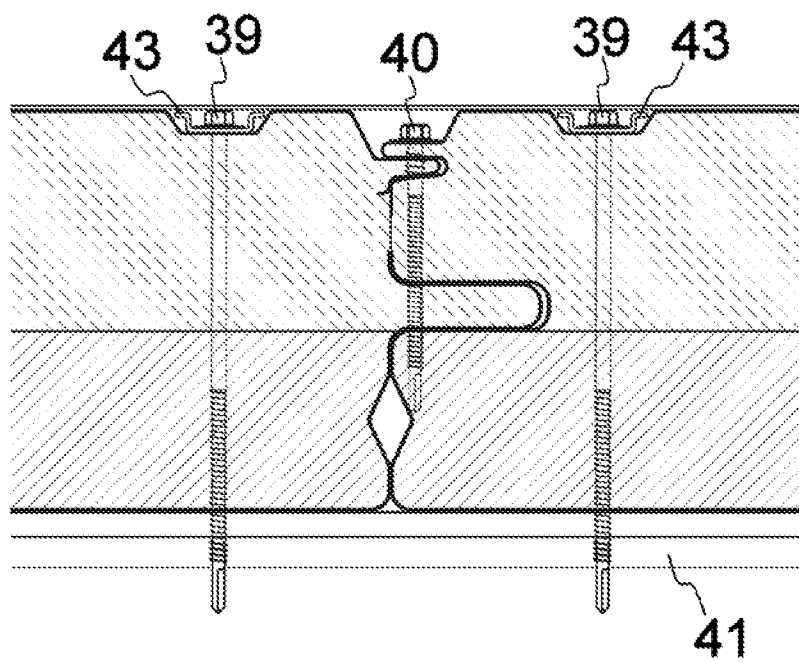


Figure 16

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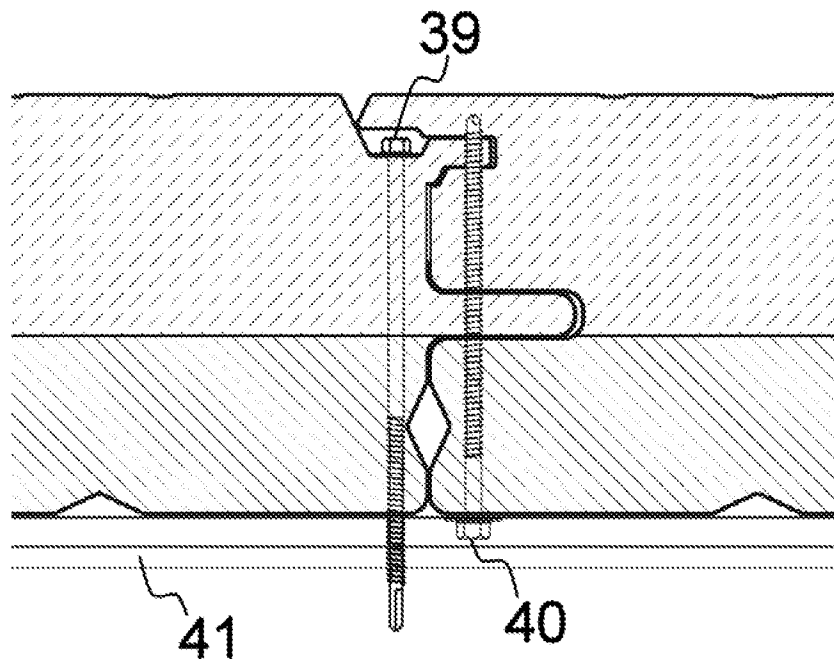


Figure 17

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2019/060402

A. CLASSIFICATION OF SUBJECT MATTER

INV. E04C2/292 E04B1/61 E04B7/22 E04F13/08
 ADD. E04B1/24

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E04C E04B

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 30 20 836 A1 (HOESCH ESTEL WERKE AG [DE]) 10 December 1981 (1981-12-10)	1-8,10, 11,17
Y	page 1, paragraph 1 page 6, paragraph 4 - page 7, paragraph 1; figures 1,2	9,12-16
X	WO 03/091016 A2 (KINGSPAN RES & DEV LTD [IE]; COPPOCK VINCENT [GB]) 6 November 2003 (2003-11-06)	1-5,8, 10,11,17
Y	page 1, line 5 - line 7 page 6, line 14 - page 9, line 10; figures 2,4	9,12-16
Y	DE 24 49 917 A1 (ACIEROID ITALIANA S P A) 29 April 1976 (1976-04-29) page 1, paragraph 1 page 2, paragraph 7 - page 4, paragraph 3; figures 1, 2	9,13-16
	-/--	



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

23 January 2020

Date of mailing of the international search report

31/01/2020

Name and mailing address of the ISA/

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Authorized officer

Giannakou, Evangelia

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/060402

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 684 348 A1 (ISOBOUW SYSTEMS BV [NL]) 29 November 1995 (1995-11-29) column 1, line 1 - line 4 column 2, line 1 - line 40; figure 1 -----	12
A	US 2018/016786 A1 (BOYD MARK A [US]) 18 January 2018 (2018-01-18) paragraph [0001] paragraph [0010] - paragraph [0014]; figures 1-4 -----	1-15
A	EP 3 406 815 A1 (CANTONA APS [DK]) 28 November 2018 (2018-11-28) paragraph [0001] paragraph [0036] - paragraph [0076]; figures 1A-5B -----	1-15

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Information on patent family members

International application No

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EP 3406815	A1	28-11-2018	NONE