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(54) Title: SET OF BUILDING PANELS COMPRISING A LOCKING DEVICE

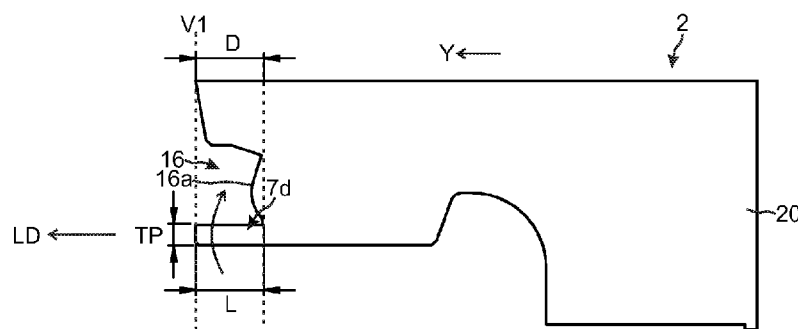


Fig. 5a

(57) Abstract: The disclosure relates to a set of building panels comprising a first panel (1) and a second panel (2) and a locking device for locking a first edge portion (1a) of the first panel to a second edge portion (2b) of the second panel to obtain an assembled state of the first and second panels. A core (20) of the first and second panels comprises a polymer-based material. The locking device comprises a locking element (3) extending upwards from a lower strip (5) provided in the first edge portion, and a locking groove (4) arranged in the second edge portion, wherein the locking element and the locking groove are configured to cooperate for horizontal locking of the first and second edge portions. The locking device further comprises a cavity (6) arranged in the first edge portion and a displaceable protrusion (7) arranged in the second edge portion, wherein the protrusion and the cavity are configured to cooperate for vertical locking of the first and second edge portions. The protrusion extends at least partially upwards and is integrally formed with the second edge portion.

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SET OF BUILDING PANELS COMPRISING A LOCKING DEVICETECHNICAL FIELD

The disclosure relates to a set of building panels, such as floor panels or wall panels, comprising a locking device. The locking device comprises a protrusion integrally formed with a panel in the set, extending at least partially upwards, and being
5 configured to cooperate with a cavity in an adjacent panel for vertical locking. A core of the panels comprises a polymer-based material, such as a thermoplastic material or a thermosetting resin.

BACKGROUND

WO 2019/175695 A1 discloses a method for producing a profiled strip using
10 thermoforming. The method comprises supplying a panel-shaped profiled section made of plastic, sawing the profiled section produced to the desired length, performing one or several milling operations to produce at least one foldable flexible projecting element on a first end side of the sawed profiled section, heating the produced projecting element and subsequently bending it at a desired angle to form
15 a bent locking element. The locking element may be used with a large number of base materials from which the profiled strip is made, preferably PVC or polyolefins, such as PE or PP. Moreover, the locking element can be used with profiled strips of reduced thicknesses. Additionally, it is possible to produce complicated connecting systems by means of the method of thermoforming.

20 WO 2019/142161 A1 and WO 2019/141954 A1 disclose similar methods.

However, the locking configurations of the panels may be even further improved, especially, but not exclusively, by utilizing the method of thermoforming and similar techniques.

SUMMARY

25 An object of at least embodiments of the present disclosure to provide a set of panels comprising an upwardly extending protrusion integrally formed with a panel in the set which may provide stronger vertical locking, preferably while reducing cupping effects.

Another object of at least embodiments of the present disclosure is to provide a set of panels comprising such a protrusion with an improved sealing capability.

Yet another object of at least embodiments of the present disclosure is to provide a set of panels comprising such a protrusion that may be produced in a more material
5 saving manner, preferably by means of thermoforming.

These and other objects and advantages that will be apparent from the description have been achieved by the various aspects, embodiments and examples described below.

In accordance with the present disclosure, there is provided a set of building panels,
10 such as floor panels, comprising a first panel and a second panel and a locking device for locking a first edge portion of the first panel to a second edge portion of the second panel to obtain an assembled state of the first and second panels. A core of the first and second panels comprises a polymer-based material. The locking device comprises a locking element extending upwards from a lower strip provided in
15 the first edge portion, and a locking groove arranged in the second edge portion, wherein the locking groove is open downwards. The locking element and the locking groove are configured to cooperate for horizontal locking of the first and second edge portions. The locking device further comprises a cavity arranged in the first edge portion and a displaceable, such as pivotable and/or bendable, protrusion
20 arranged in the second edge portion, wherein the cavity is open horizontally outwards with respect to the first panel. The protrusion and the cavity are configured to cooperate for vertical locking of the first and second edge portions. The protrusion extends at least partially upwards and is integrally formed with the second edge portion.

25 The assembled state (or a disassembled state) of the first and second panels may include vertical and horizontal locking (or unlocking) of the first and second edge portions.

The protrusion may extend upwards, and preferably also horizontally in a direction away from the second edge portion.

30 By being integrally formed with the second edge portion, the protrusion may be formed in a single piece with the second edge portion, preferably with the core.

During locking, the protrusion may be displaced, such as pivoted and/or bent, inwards in a first stage of the locking by cooperation with the first edge portion, and

the protrusion may then be displaced, such as pivoted and/or bent, outwards in a second stage of the locking when the cooperation with the first edge portion is reduced or eliminated, preferably by means of an intrinsic biasing force of the protrusion.

- 5 Preferably, the first and second edge portion are short edge portions. In some embodiments, however, the first and second edge portions may be long edge portions.

Generally herein, cooperating surfaces, members, or elements, etc., may cooperate by direct engagement or indirectly. Examples of such cooperating surfaces or
10 elements include the locking surfaces of the protrusion and cavity, overlapping cooperating surfaces of a shelf portion and a lap portion, the upper portions of the first and second edge portions, cooperating surfaces of a locking element and a locking groove or locking member, a tongue and a tongue groove, a supplementary tongue and supplementary tongue groove, etc. In any embodiment described herein,
15 there may be a sealing agent, such as a wax or an adhesive, provided between the cooperating surfaces, thereby providing examples of an indirect engagement.

In the assembled state, the protrusion may extend at least partially horizontally inwardly of a vertical plane with respect to the second panel, wherein the vertical plane extends between upper portions, such as uppermost portions, of the first and
20 second edge portions. Thereby, the vertical locking of the panels may be arranged inside of the vertical plane, for example by means of a shelf portion and a lap portion (see below). Also, the protrusion may be produced in a more material saving manner, especially when it is formed by thermoforming by bending or shaping of a protruding lip, since a smaller horizontal extension of the protruding lip may be
25 needed. Additionally, a risk of damaging the protrusion during transport, such as when the panels are arranged in a package, may decrease.

In some embodiments, a length of the protrusion from its inner portion does not exceed a horizontal distance from the inner portion of the protrusion to a vertical plane extending along an uppermost portion of the second edge portion. For
30 example, the inner portion may be an innermost portion of the protrusion. By means of this embodiment, the protrusion may be produced in an even more material saving manner. Indeed, with reference to the previous paragraph, an even smaller extension of the protruding lip may be needed.

The protrusion may extend, in a direction along the second edge portion, outwards of an upper portion of a fourth edge portion of the second panel. The fourth edge portion may be configured to be locked to a third edge portion of a third panel. For example, the third and fourth edge portions may be long edge portions. By means of this embodiment, an improved seal may be provided at a first corner portion between the second and fourth edge portions of the second panel.

The protrusion may lock against the cavity by pretension. Thereby, higher tolerances of the cavity may be accepted, and a more failsafe locking device may be provided.

The protrusion may have a uniform thickness. Thereby, lower tolerances during production of the protrusion, such as by machining, may be obtained.

A length of the protrusion may be smaller than five times, such as smaller than four times, a minimal thickness of the protrusion. Such a smaller length may contribute to a more rigid protrusion and, hence a higher locking strength.

A tip of the protrusion may be arranged at a distance from a front side of the second panel. The distance may exceed a quarter, such as exceeding a third, of a thickness, preferably a maximal thickness, of the second panel. Thereby, the vertical locking configuration may be arranged at a vertically lower position. Moreover, the upper portions of the edge portions may become thicker and, consequently, the joint of the first and second edge portions may become stronger, e.g., during load. Additionally, cupping effects at the joint may become reduced.

Upper portions of the first and second edge portions may comprise a shelf portion and a lap portion, respectively, configured to cooperate with each other at overlapping cooperating surfaces. Preferably, the cavity extends below the shelf portion. By means of the shelf portion and lap portion, a better seal in the joint may be provided. Preferably, the overlapping cooperating surface of the shelf portion is provided in an upper section of the shelf portion, and the overlapping cooperating surface of the lap portion is provided in a lower section of the lap portion. For example, the overlapping cooperating surfaces may extend essentially horizontally, such as essentially in parallel with a main plane of the first and/or second panel extending along a front side and/or a rear side of the first and/or second panel.

Upper portions of the first and second edge portions may comprise joining surfaces which are inclined with respect to a normal of a main plane extending along a front side and/or a rear side of the first and/or second panel. By means of the inclined

joining surfaces, an improved guiding of the first and second panels may be provided during their assembly.

The protrusion may be displaceable, such as pivotable and/or bendable, into a recess of the second edge portion, and the protrusion may contact a base edge portion of the second edge portion along a contacting section in the assembled state, preferably also in a disassembled state. Preferably, the base edge portion is arranged below or at a bottom portion of the recess. By means of the contacting section, the protrusion may become more rigid and/or may become more less prone to damage, such as breaking, during assembly.

10 The protrusion may be displaceable, such as pivotable and/or bendable, into a recess of the second edge portion, wherein the recess comprises a protuberant inner wall. By means of the protuberant inner wall, a force from an inward displacement of the protrusion during locking may become distributed over a larger area. Thereby, a risk of breaking, such as cracking, the protrusion may be reduced, or even entirely prevented. Moreover, the protuberant inner wall may allow for a contacting configuration between the protrusion and the base edge portion. The inner wall may be convex.

The protrusion may be thermoformed. The protrusion may be thermoformed by forming a protruding lip, applying heat, such that the protruding lip becomes pliable, and bending or shaping the protruding lip upwards around an axis for forming the protrusion. The contacting section may be formed by thermoforming.

The first and second edge portions may be configured to be locked to each other by a relative essentially vertical displacement of the first and second panels against each other. Preferably, the relative essentially vertical displacement comprises a folding displacement, or equivalently, scissor displacement (so-called fold down).

The first and second edge portions may be configured to be unlocked from each other by angling the first and second panels relative to each other. This also allows for an improved assembly of the panels, since they may be reassembled more easily.

30 A horizontal locking surface of the locking element may be inclined against a main plane extending along a front side and/or a rear side of the first panel by a locking angle, which preferably is less than 80°. In some embodiments, the locking angle may be 35°-80°, preferably 60°-80°, more preferably 65°-75°. A horizontal locking surface of the locking groove may also be inclined against a main plane extending

along a front side and/or a rear side of the second panel by a locking angle, which preferably is the same as the locking angle of the horizontal locking surface of the locking element. By means of the inclined horizontal locking surface(s), the first and second edge portions may be unlocked from each other by angling.

- 5 The core of the first and second panels may comprise a thermoplastic material, such as polyvinyl chloride, PVC. For example, the core of the first and second panels may comprise 20-40 wt% of a thermoplastic material, such as PVC, and 50-80 wt% of an inorganic filler.

- For example, each panel in the set may be a Luxury Vinyl Tile (LVT tile), a Stone
10 Plastic (Polymer) Composite panel or Solid Polymer Core panel (SPC panel), or an Expanded Polymer Core panel (EPC panel), also known as Water Proof Core panel or Wood Plastic Composite panel (WPC panel).

- In some embodiments, the core of the first and second panels may comprise a
thermosetting resin, such as a melamine-formaldehyde, MF, resin, or urea-
15 formaldehyde, UF, resin.

- Generally, all terms used herein, such as in the claims, are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise. All references to "a/an/the [element, device, component, means, step, etc.]" are to be interpreted openly as referring to at least one instance of said
20 element, device, component, means, step, etc., unless explicitly stated otherwise. Reference to one or a plurality of "at least one element", etc., may shortly be referred to as "the element(s)".

BRIEF DESCRIPTION OF THE DRAWINGS.

- The disclosure will in the following be described in connection to exemplary
25 embodiments and in greater detail with reference to the appended exemplary drawings, wherein:

- Figs. 1a-1c illustrate in a sectional perspective view (Fig. 1a) an embodiment of an inner region of a first and a second panel between third and fourth edge portions of the panels in a disassembled state, and in a
30 cross-sectional side view (Fig. 1b) and an enlarged cross-sectional side view (Fig. 1c) an embodiment of the first and second panels in an assembled state.

- Figs. 2a-2d illustrate in cross-sectional side views (Figs. 2a and 2d) and corresponding enlarged cross-sectional side views (Figs. 2b and 2c, respectively) embodiments of the first and second panels in an assembled state.
- 5 Figs. 3a-3c illustrate in cross-sectional views an embodiment of a first and a second panel during assembly (Figs. 3a-3b) and in an assembled state (Fig. 3c).
- Figs. 4a-4c illustrate in a perspective view an embodiment of a set of panels in which a first and a second panel are assembled to a third panel
10 (Fig. 4a) and in cross-sectional views embodiments of a disassembly of a first and a second panel (Figs. 4b-4c).
- Figs. 5a-5c illustrate in cross-sectional views an embodiment of thermoforming of a protrusion (Figs. 5a-5b), and in a sectional perspective view an embodiment of an inner region of a first panel between its third and
15 fourth edge portions (Fig. 5c).
- Figs. 6a-6b illustrate in cross-sectional views embodiments of a first and a second panel in an assembled state.
- Figs. 6c-6d illustrate in a top view (Fig. 6c) and a cross-sectional side view (Fig. 6d) an embodiment of a first or a second panel.
- 20 Figs. 7a-7e illustrate in sectional perspective views embodiments of a first (Figs. 7a-7b), a second (Fig. 7c), a third (Fig. 7d), and a fourth (Fig. 7e) corner portion of a first or a second panel, such as that shown in Figs. 6c-6d.

DETAILED DESCRIPTION

- 25 In the following, various embodiments of a set of building panels, often abbreviated herein as “panels”, such as floor panels, will be described with reference to, e.g., Figs. 1a-1c, 2a-2d, 3a-3c, 4a-4c, 5a-5c, 6a-6d and 7a-7e. The set comprises a first 1 and a second 2 panel comprising a first edge portion 1a and an adjacent second edge portion 2b, respectively, and a, preferably mechanical, locking device for
30 locking the first edge portion 1a to the second edge portion 2b to obtain an assembled state of the first 1 and second 2 panels. Preferably, the panels 1, 2, 1' disclosed herein are similar or essentially identical. Moreover, the panels may be floor panels for installing a floor covering on a subfloor 40, but wall panels for

installing a wall cladding on a vertically extending substructure are equally conceivable. The panels 1, 2 each comprises a front side 1e, 2e and a rear side 1f, 2f, preferably extending along a first X and a perpendicular second Y horizontal direction. For example, a longitudinal extension of the first 1a and second 2b edge portions may extend along the first horizontal direction X. A normal N1, N2 of a main plane M1, M2 extending along the front side 1e, 2e and/or the rear side 1f, 2f may define a vertical direction Z. The vertical direction Z may be parallel with a thickness direction of the panels 1, 2.

The first 1a and second 2b edge portions are configured to be locked to each other by a relative essentially vertical displacement of the first 1 and second 2 panels against each other. Examples of such locking are shown in, e.g., Figs. 3a-3c and 4a.

The relative essentially vertical displacement preferably comprises a folding displacement, or equivalently, scissor displacement (so-called fold down), whereby the second edge portion 2b is gradually vertically displaced towards the first edge portion 1a along a longitudinal extension of the edge portions. Thereby, the first and second edge portions may be locally interlocked in a first side section 34 of the edge portions, while the second edge portion may be arranged at an angle with respect to the first edge portion in a second side section 35, cf. Fig. 4a. The first and second edge portions may thereafter become locally interlocked also in the second side section 35 by further vertically displacing the second edge portion against the first edge portion such that the second side section is arranged at a lower angle with respect to the subfloor 40. The second edge portion may be further lowered until the front sides 1e, 2e of the first 1 and second 2 panels are substantially arranged along the same horizontal plane in the form of M1 and/or M2.

The panels 1, 2 in the set may be rectangular. Preferably, the first 1a and second 2b edge portions are short edge portions. It is clear that the panels 1, 2 may further comprise opposing edge portions 1b, 2a, which preferably are short edge portions, as shown in, e.g., Figs. 6c-6d and 7a-7e. The panels 1, 2 may further comprise perpendicularly arranged edge portions in the form of third 1c, 2c and fourth 1d, 2d opposing edge portions, which preferably are long edge portions. For example, a longitudinal extension of the third and fourth edge portions may extend along the second horizontal direction Y.

The set may comprise additional panels, such as a plurality of panels. For example, and as illustrated in, e.g., Fig. 4a, the set may comprise a third panel 1' to which the panels 1, 2 may be assembled, such as along a third edge portion 1c'.

5 It is emphasized that embodiments in which the opposing edge portions 1a, 1b, 2a, 2b are long edge portions and the opposing edge portions 1c, 2c, 1d, 2d are short edge portions are included herein mutatis mutandis. In yet some embodiments, the panels may be square.

10 In non-limiting examples, a panel thickness T, such as a maximal panel thickness, of any panel 1, 2, 1' herein may be 3.0-10 mm, preferably 4.0-6.0 mm, for example, 5 mm. Preferably, the panel thickness T is determined without the inclusion of an underlay member, such as a foam layer.

The panels 1, 2, 1' herein may be building panels, such as floor panels or wall panels, and may be configured to be arranged on, or connected to, a substructure, such as a subfloor 40. In preferred embodiments, the panels are floor panels
15 configured to be arranged on and along a subfloor 40, preferably in a floating manner. The horizontal directions X, Y may extend in parallel with the substructure, such as the subfloor 40, and the vertical direction Z may extend perpendicularly thereto, see, e.g., Figs. 1b and 4a. Consequently, in the case of wall panels, the horizontal directions X, Y may extend along a visible wall surface, one of which (say
20 X) typically being provided perpendicularly to a subfloor 40 in an environment in which the wall panels are assembled, and the vertical direction Z, together with the other horizontal direction (say Y), extending along the subfloor.

A core 20 of the first 1 and second 2 panels, preferably of all panels in the set, may comprise a polymer-based material.

25 In some embodiments, the core 20 may comprise a thermoplastic material, such as PVC, polyester, polyethylene, PE, polypropylene, PP, polystyrene, PS, thermoplastic polyurethane, TPU, or polyethylene terephthalate, PET, polyacrylate, methacrylate, polycarbonate, PC, polyvinyl butyral, PVB, polybutylene terephthalate, PBT, or a combination thereof, and a filler, preferably an inorganic filler. In preferred
30 embodiments, the core may comprise 20-40 wt% of a thermoplastic material, such as PVC, and 50-80 wt% of an inorganic filler, such as calcium carbonate, CaCO_3 , limestone, talc, fly ash, barium sulphate, BaSO_4 , magnesium oxide, MgO , or a stone material, such as stone powder. A degree of plasticizer in the core 20 may be less than 5 wt%, preferably less than 3 wt% or less than 1 wt%, and may be in the range

of 0.1-5 wt%, 0.5-5 wt%, or 0.5-3 wt%, for example comprising no plasticizer. Generally herein, the core 20 may be dense or, alternatively, foamed. In any embodiment herein, the core 20 and/or the panel 1, 2 per se, may have an E modulus (preferably Young's modulus), of 2-12 GPa, such as 4-9 GPa or 3-7 GPa.

5 In some embodiments, the core 20 is dense, thereby not being foamed, and comprises PVC and a mineral filler. For example, the panels 1, 2 may be SPC or WPC panels. In some embodiments, the core 20 is foamed, e.g., by means of a foaming agent, and comprises PVC and a filler. For example, the panels 1, 2 may be foamed SPC or WPC panels.

10 Also other types of fillers are conceivable herein, such as an organic filler, e.g., a wood material, such as wood fibres or dust, a bamboo material or rice husks.

In some embodiments, the core 20 of the panels 1, 2 may comprise a thermosetting resin, such as a MF or UF resin.

Any panel 1, 2 herein may comprise a top layer 21, such as a print layer 21a and/or
15 a wear layer 21b, applied, such as bonded, to the core 20, see, e.g., Fig. 4b. In some embodiments, the top layer 21 is formed by digitally printing a print P directly on the core 20 or a print-receiving layer arranged thereon, and optionally by applying a wear layer 21b thereon, cf. Fig. 4c. The print layer and/or wear layer and/or the print-receiving layer in any of the examples above may be provided as a thermoplastic-
20 based foil or film, for example, comprising PVC. For example, a thickness of the print layer and wear layer may be 0.02-0.20 mm and 0.05-1.0 mm, respectively.

Alternatively, or additionally, the wear layer may be a transparent coating layer, such as a UV curable coating layer, a lacquer or a hotmelt coating layer. Optionally, the top layer 21 may be embossed, such as by an embossing roller or digitally. It is
25 noted that, in some embodiments, the top layer 21 may comprise a veneer adhered to the core 20, which may comprise thermoplastic material or a thermosetting resin.

By means of the locking device, the panels 1, 2 may be assembled to each other to obtain an assembled state in which the first edge portion 1a of the first panel 1 and the second edge portion 2b of the second panel 2 are horizontally and vertically
30 locked to each other.

The locking device comprises a locking element 3 extending upwards from a lower strip 5 provided in the first edge portion 1a, and a locking groove 4 arranged in the second edge portion 2b and being open downwards. The lower strip 4 may protrude horizontally outwards from a lower portion of the first edge portion 1a. The locking

element 3 and the locking groove 4 are configured to cooperate, such as engage, for horizontal locking of the first 1a and second 2b edge portions, preferably at horizontal locking surfaces 3a, 4a. Preferably, an inner surface of the locking element 3 and an outer surface of the locking groove 4 may comprise the horizontal locking surfaces 3a, 4a.

The horizontal locking surface 3a of the locking element 3 may be inclined against the main plane M1 by a locking angle α , which preferably is less than 80° . The locking angle α may be specified as a deviation from a horizontal direction, preferably the second horizontal direction Y. The locking groove 4 may also comprise an inclined horizontal locking surface 4a, preferably being inclined against the main plane M2 by a locking angle β , which may be the same as for the horizontal locking surface 3a. In preferred embodiments, the locking angle α , β for the horizontal locking surface 3a and/or 4a may be 35° - 80° , preferably 60° - 80° , more preferably 65° - 75° .

The locking device further comprises a cavity 6 arranged in the first edge portion 1a and a displaceable protrusion 7 arranged in the second edge portion 2b. The protrusion may be formed in the core 20. Preferably, the protrusion 7 is displaceable by pivoting and/or bending of at least a section of the protrusion, such as the entire protrusion. The protrusion 7 may be pivotable around at least one axis A, A' arranged along the second edge portion 2b, for example arranged along an inner portion 7b and/or an outer portion 7e of the protrusion 7. Alternatively, or additionally, at least a section of the protrusion 7, such as the entire protrusion, may be bendable along its length, such as from the inner portion 7b to the outer portion 7e. Preferably, the displaceability, such as pivotability and/or bendability, may be implemented by means of a flexibility of the protrusion 7. The cavity 6 is open horizontally outwards with respect to the first panel 1. Moreover, the protrusion 7 extends at least partially upwards and is integrally formed with the second edge portion 2b, such as with the core 20 of the second panel 2. The protrusion 7 may extend upwards along the vertical direction Z and horizontally in a direction away from the second edge portion 2b along the second horizontal direction Y. The protrusion 7 and the cavity 6 are configured to cooperate, such as engage, for vertical locking of the first 1a and second 2b edge portions, preferably at vertical locking surfaces 6a, 7a. Preferably, an upper surface of the cavity 6 and a tip 7c of the protrusion 7 may comprise the vertical horizontal locking surfaces 6a, 7a. The vertical locking surface 6a and/or 7a may be disposed at a locking angle ϕ with respect to the main plane M1 and/or M2.

For example, the locking angle ϕ may be specified as a deviation from a horizontal direction, preferably the second horizontal direction Y. The locking angle ϕ may be 10° - 60° , preferably 25° - 50° , more preferably 30° - 40° , for example about 35° .

5 In an assembled state and/or in a disassembled state of the second panel 2, the protrusion 7 may extend along a protrusion direction PD, which is provided at an angle λ with respect to a direction along the main plane M2, preferably extending in parallel with the second horizontal direction Y. For example, $40^\circ \leq \lambda \leq 80^\circ$, such as $50^\circ \leq \lambda \leq 70^\circ$.

10 Optionally, the locking device further comprises a locking member 22 extending downwards from an upper strip 23 provided in the second edge portion 2b, and an upper strip wall 5a arranged horizontally inside of the locking element 3 with respect to the first panel 1, see, e.g., Figs. 1a and 2a. The upper strip 23 may protrude horizontally outwards from an upper portion of the second edge portion 2b. With respect to the second panel 2, the locking member 22 may be arranged horizontally
15 outside of the locking groove 4. The locking member 22 and the upper strip wall 5a may be configured to cooperate, such as engage, with each other for vertical locking of the first 1a and second 2b edge portions.

However, it is emphasized that in some embodiments, and as shown in, e.g., Fig. 6a, there may be a gap 24 between the locking member 22 and the upper strip wall 5a.
20 For example, the gap 24 may extend between the entire locking member 22 and the upper strip wall 5a, preferably all the way to a base 3b of the locking element 3.

An upper portion 11 of the first edge portion 1a may be configured to cooperate, such as engage, with an upper portion 12 of the second edge portion 2b in the assembled state. The upper portions 11, 12 may lock the edge portions 1a, 2b in a
25 single horizontal direction. For example, the upper portions 11, 12 may comprise joining surfaces 18, 19 extending substantially vertically (see, e.g., Fig. 6a) or being inclined, extending at an angle θ with respect to the vertical direction Z (see, e.g., Figs. 1a-1c, 2a-2d, 3a-3c, 4b-4c, 5a-5c, 6b, 6d and 7a-7e). For example, the angle θ may be 0° - 30° , preferably 5° - 15° .

30 A vertical plane V1, V2 may extend between the upper portions 11, 12 in the assembled state, such as along the joining surfaces 18, 19 and/or along their uppermost portions 11a, 12a. Preferably, the uppermost portions 11a, 12a also are outer portions, such as outermost portions, of the edge portions 1a, 2b with respect to the respective panel 1, 2. For example, the vertical plane V2 may extend along an

outermost portion 18a of the joining surface 18. The upper portions 11, 12 may cooperate at least along these uppermost portions, such as along essentially the entire joining surfaces 18, 19. In the assembled state, the second horizontal direction Y may be perpendicular to the vertical plane V1 and/or V2. For example, a horizontal
5 distance between V1 and V2 may be 0-1.0 mm, such as 0.1-0.9 mm or 0.1-0.5 mm.

The upper portion 11 may in some embodiments comprise a shelf portion 8 and the upper portion 12 may comprise a lap portion 9, see, e.g., Figs. 1a-1c, 2a-2d, 3a-3c, 4b-4c, 5a-5c, 6b, 6d and 7a-7e. The cavity 6 may extend below the shelf portion 8, such as being arranged below the shelf portion. Overlapping cooperating surfaces
10 8a, 9a of the shelf portion 8 and the lap portion 9 may be configured to cooperate, such as engage, with each other. The overlapping cooperating surface 8a may be provided in an upper section of the shelf portion 8, and the overlapping cooperating surface 9a may be provided in a lower section of the lap portion 9. The overlapping cooperating surfaces 8a, 9a may contribute to provide a better seal in the joint of the
15 first 1a and second 2b edge portions and/or to provide vertical locking of the edge portions 1a, 2b. The overlapping cooperating surface 8a (or 9a) may extend, preferably essentially horizontally, at a vertical distance CV1 (or CV2) from the front side 1e (or 2e). In non-limiting examples, CV1 and/or CV2 may be 0.5-2.0 mm, such as 0.8-1.5 mm. For example, the overlapping cooperating surface 8a (or 9a) may
20 extend horizontally a distance OC1 (or OC2) of about 0.1-1.5 mm, such as 0.3-1.0 mm.

In the assembled state, the vertical plane V1 may extend between the uppermost portions 11a, 12a of the first 1a and second 2b edge portions. The vertical plane V2 may extend along a horizontally innermost section 8b of the shelf portion 8 and/or
25 along an outermost, lower section 9b of the lap portion 9.

The protrusion 7 may be displaceable, such as pivotable and/or bendable, into a recess 16 of the second edge portion 2b, which preferably is arranged under the lap portion 9.

Figs. 2a-2b and Figs. 2c-2d illustrate two different embodiments of the second panel
30 2 with different lengths L of the protrusion 7. Alternatively, Figs. 2a-2b and Figs. 2c-2d illustrate two different cross-sections of the first 1 and second 2 panels along the first 2a and second 2b edge portions, with a varying length L of the protrusion 7.

The protrusion 7 may lock against the cavity 6 by pretension. For example, as shown in Figs. 2c-2d, as compared to the embodiment in Figs. 2a-2b, the protrusion 7 may

be partially displaced inwards into the recess 16, such as being compressed, for causing an outwardly directed biasing force. By means of the pretension, a higher tolerance on a length L of the protrusion 7, preferably determined from its inner portion 7b, may be accepted. Indeed, a variation of the length L of the protrusion 7
 5 between different panels 2 and/or along the second edge portion 2b may still provide a satisfactory locking strength. For example, and as shown in Figs. 2b-2c, a larger (or smaller) length L may imply a larger (or smaller) relative angle γ between the vertical locking surfaces 6a, 7a. Indeed, the length L is larger in Figs. 2c-2d than in Figs. 2a-2b. For example, the relative angle may be $0^\circ \leq \gamma \leq 40^\circ$, such as $0^\circ \leq \gamma \leq 30^\circ$ or
 10 $0^\circ \leq \gamma \leq 20^\circ$ along the joint. In the non-limiting embodiments in Figs. 1b-1c, Figs. 2a-2b and Figs. 2c-2d, the angle λ is 65° , 55° and 75° , respectively, while the locking angle ϕ is 35° , so that the relative angle γ is 10° , 0° and 20° , respectively.

It is emphasized that the overlapping upper portions 11, 12 are optional and that the upper portions 11, 12 in some embodiments may extend essentially vertically, see,
 15 e.g., Fig. 6a.

As shown in, e.g., Figs. 1b, 2a, 2d, 3c and 6a, the protrusion 7 may in the assembled state extend at least partially, such as entirely, horizontally inwardly of the vertical plane V1 and/or V2 with respect to the second panel 2. The protrusion 7 may thereby cooperate with the cavity 6 horizontally inwardly, for example entirely, of the
 20 vertical plane V1 and/or V2 with respect to the second panel 2.

An outermost portion of the tip 7c may be arranged at a horizontal distance HD from an uppermost 12a of the second edge portion 2b. For example, the horizontal distance HD in the assembled state may be larger than or equal to the horizontal distance HD in the disassembled state of the second panel 2. In non-limiting
 25 examples, a difference between the horizontal distance HD in the assembled state compared to the horizontal distance HD in the disassembled state may be 0.01-0.20 mm, such as 0.01-0.15 mm or 0.03-0.10 mm.

In some embodiments, the length L of the protrusion 7 from its inner portion 7b to the tip 7c does not exceed, i.e., is smaller than or equal to, a horizontal distance D from
 30 the inner portion 7b to the vertical plane V1, see, e.g., Fig. 3c. Also see, e.g., Fig. 5a, where the protrusion 7 is illustrated as protruding lip 7d before it is bent or shaped to a protrusion by thermoforming, as explained further below. For example, the length L of the protrusion 7 may be smaller than five times, such as smaller than four times, a minimal thickness TP of the protrusion 7. In non-limiting examples, $1 \text{ mm} \leq L \leq 3 \text{ mm}$

and $1\text{ mm} \leq D \leq 3\text{ mm}$, such as $1\text{ mm} \leq L \leq 2\text{ mm}$ and $1\text{ mm} \leq D \leq 2\text{ mm}$. Moreover, in non-limiting examples, $0.3\text{ mm} \leq TP \leq 1.0\text{ mm}$, such as $0.3\text{ mm} \leq TP \leq 0.7\text{ mm}$ or $0.35\text{ mm} \leq TP \leq 0.45\text{ mm}$. For example, when the length L and horizontal distance D are equal, they may be between 1 mm and 3 mm, such as between 1 mm and 2 mm.

- 5 The length L and horizontal distance D may be determined by the measuring method described below.

Generally herein, the protrusion 7 may have a uniform thickness TP . However, as shown in Fig. 6b, a varying thickness TP , preferably an outwardly tapering thickness TP , is equally conceivable in any embodiment herein.

- 10 As illustrated in, for example, Fig. 1b, the tip 7c of the protrusion 7 may be arranged at a, preferably vertical, distance H from the front side 2e, such as the main plane $M2$. The protrusion 7, such as the tip 7c, may be arranged vertically below the cooperating surface 8a; also see, e.g., Fig. 6d. The distance H may be a distance from a vertically uppermost portion of the tip 7c. Preferably, the distance H exceeds
 15 a quarter, such as exceeding a third, of a thickness T of the second panel 2. For example, $1/4 \leq H/T \leq 1/2$, such as $1/3 \leq H/T \leq 1/2$, preferably for $4\text{ mm} \leq T \leq 6\text{ mm}$.

- It is understood that any, some, or all of the locking element 3, locking groove 4, lower strip 5, cavity 6, protrusion 7, shelf portion 8, lap portion 9, locking member 22, upper strip 23, etc., may extend along the first 1a and second 2b edge portions, e.g.,
 20 along the first horizontal direction X , such as along substantially their entirety, cf. Figs. 1a, 4a, 6c and 7a-7e.

In preferred embodiments, the protrusion 7 disclosed herein may be thermoformed, preferably by heating and bending or shaping a protruding lip 7d. An embodiment of such a process is illustrated in Figs. 5a-5b.

- 25 First, the protruding lip 7d is formed in the second edge portion 2b, preferably by mechanical machining. The protruding lip 7d may extend outwards from the second edge portion 2b along a lip direction LD , which preferably extends along the main plane $M2$, e.g., extending in parallel with the second horizontal direction Y .

- Thereafter heat, for example hot air or infrared radiation, is applied, such that the
 30 protruding lip 7d becomes pliable. For example, when the core material comprises PVC and a mineral filler, the protruding lip may be heated to a temperature of 40-220 °C, such as 75-180 °C, for example by a hot air device emitting a stream of hot air at a temperature exceeding 300 °C or even exceeding 400 °C, such as 400-600 °C.

Finally, the protruding lip 7d is bent upwards, such as around an axis A, for forming the protrusion 7, for example by means of a pressure member 50. Preferably, the protruding lip 7d is gradually bent along the second edge portion 2b, e.g., along the axis A. For example, the pressure member 50 may comprise a longitudinally
5 extending bevel 51 which may implement the gradual bending. For example, the protruding lip may be gradually bent for 0.1-10 seconds, such as 0.3-2 seconds. Moreover, pressure may preferably be applied at an upper portion of the protruding lip 7d. The protrusion 7 may thereby extend along a protrusion direction PD, which is provided at an angle λ with respect to the lip direction LD. For example, $40^\circ \leq \lambda \leq 80^\circ$,
10 such as $50^\circ \leq \lambda \leq 70^\circ$.

Other ways of forming the protrusion 7 is described, e.g., in WO 2019/141954 A1, such as in Figs. 1-5 and the related text, in WO 2019/142161 A1, such as in Figs. 5, 7, 8, 12 and 13 and the related text, and in WO 2019/175695 A1, such as in Figs. 1, 5-7 and 9a-9h and the related text.

15 It is stressed that, in some embodiments, for example in Figs. 6a-6b, the locking device, including the protrusion 7, may be entirely formed by mechanical machining.

In some embodiments, and as shown in, e.g., Figs. 1a-1b, 2a, 2d, 3a-3c, 4b-4c and 5b, the protrusion 7 may contact a base edge portion 15 of the second edge portion 2b along a contacting section 17 in the assembled state, preferably also in a
20 disassembled state. Preferably, the base edge portion 15 is arranged below or at a bottom portion 16b of the recess 16. For example, an extension E of the contacting section 17 along a length direction of the protrusion 7, preferably along the protrusion direction PD, may be at least 10%, such as 10%-50%, of the length L of the protrusion 7. In some embodiments, the extension E may be at least 20%, such
25 as 20%-40%, of the length L. The extension E may be determined by the measuring method described below.

It is noted that the length L of the protrusion 7 from its inner portion 7b may include the extension E of the contacting section 17.

The recess 16 may comprise a protuberant inner wall 16a, which preferably is
30 convex. For example, the base edge portion 15 may be provided in the protuberant inner wall 16a, such that the protrusion 7 may be in contact therewith.

The contact between the protrusion 7 and the base edge portion 15 along the contacting section 17 may be accomplished by thermoforming, for example in accordance with any of the processes described herein.

The contacting section 17 described herein is optional. Indeed, it is emphasized that in some embodiments, there is no contacting section 17 at the base edge portion 15. The protrusion 7 may be spaced from the base edge portion 15 by a space S as shown in Fig. 6a. For example, the recess 16 may comprise the space S.

5 The third 1c, 2c and fourth 1d, 2d edge portions may comprise a locking device configured to be joined to adjacent fourth 1d, 2d and third 1c, 2c, 1c' edge portions, respectively, preferably by angling, cf. Figs. 4a, 6c and 7a-7e. Also, consult page 6, line 26 to page 7, line 17 together with Figs. 3 and 4a in WO 2021/058137, which parts are hereby explicitly incorporated by reference. The third edge portion 1c, 2c,
10 1c' may be horizontally locked to the adjacent fourth edge portion 1d and/or 2d by means of a locking element 27 provided on a lower strip 28 cooperating with a locking groove 29 and vertically locked thereto by means of a cooperating tongue 30 and tongue groove 31. The lower strip 28 may protrude horizontally from a lower portion of the third edge portion 1c, 2c, 1c' and the locking groove 29 may be
15 provided in the fourth edge portion 1d, 2d, preferably being open downwards. Moreover, the tongue 30 and tongue groove 31 may be provided in the fourth edge portion 1d, 2d and in the third edge portion 1c, 2c, 1c', respectively.

Optionally, the locking device may further comprise a supplementary tongue 32 and supplementary tongue groove 33 in the third 1c, 2c, 1c' and fourth 1d, 2d edge
20 portion, respectively, for vertical locking. The shelf portion 8 and the supplementary tongue 32 preferably are continuously joined to each other in a third corner portion 26c arranged between the first 1a, 2a and third 1c, 2c edge portions, cf. Fig. 7d. In a first example, the shelf portion 8 and the supplementary tongue 32 are arranged at the same vertical level, and in a second example they are arranged at different
25 levels, preferably the shelf portion 8 being arranged above the supplementary tongue 32.

The protrusion 7 may extend along substantially the entire second edge portion 1b, 2b, preferably between a first corner portion 26a arranged between the second 1b, 2b and fourth 1d, 2d edge portions and a second corner portion 26b arranged
30 between the second 1b, 2b and third 1c, 2c edge portions. Figs. 7a-7b illustrate two different embodiments of the first corner portion 26a. In Fig. 7a, the protrusion 7 extends, in a direction 2g (or 1g) along the second edge portion 2b (or 1b), outwards of an upper portion 13 of the fourth edge portion 2d (or 1d) of the second panel 2 (or first panel 1). The direction 2g (or 1g) may be parallel with the first horizontal
35 direction X. For example, the protrusion 7 may extend in the direction 2g (or 1g)

outwards of a joining surface 13a of the upper portion 13, such as outwards of its outermost portion. In Fig. 7b, the protrusion 7 extends, in the direction 2g inwards of, or to, the upper portion 13.

By having the shelf portion 8, and a protrusion 7, as shown in, e.g., Fig. 7a, a sealing function may be provided all the way to the third edge portion 1c' to which the fourth edge portions 1d, 2d are locked, see, e.g., Fig. 4a. This is to be compared to known locking systems, in which there typically may be non-sealing openings at the meeting of the corners 26a, 26d and the third edge portion 1c', at a vertical level at which the vertical locking system, such as a tongue and a tongue groove, is arranged.

It is noted that generally herein, liquid, such as water, may be collected in the recess 16, and may be adapted to flow down to the third edge portion 1c, 2c to which the fourth edge portion 1d, 2d is locked, for example flowing down to the lower strip 28, see, e.g., Figs. 7a-7b. Once at the third edge portion, preferably in the form of a long edge portion, the flow of the liquid may decrease or even entirely stop, e.g., being collected by the lower strip 28. In addition, due to its longer length, the long edge portion may be more resistant to moist or wetness. Any of these effects may be particularly strong for the configuration shown in Fig. 7a.

Fig. 7c illustrates the second corner portion 26b. The extension of the protrusion 7 along the direction 2g (or 1g) may have to be adapted to a tongue 30 arranged on a fourth edge portion 1d, 2d with which the tongue groove 31 of the third edge portion 1c, 2c is configured to cooperate with. In a first example, the protrusion 7 may extend along the direction 2g (or 1g) inwards of, or to, an upper portion 14 of the third edge portion 2c (or 1c). In a second example, the protrusion 7 may extend in the direction 2g (or 1g) inwards of, or to, a joining surface 14a of the upper portion 14, such as inwards of, or to, its outermost portion.

Fig. 7e illustrates a fourth corner portion 26d arranged between the first 1a, 2a and fourth 1d, 2d edge portions. The cavity 6 may extend along substantially the entire first edge portion 1a, 2a, preferably between the third 26c and fourth 26d corner portions.

Figs. 3a-3c illustrate the first 1a and second 2b edge portions during locking. A manual pressure, such as from a thumb, of an installer of the set of panels, may be sufficient for assembling the panels 1, 2. In particular, a no tools, such as a rubber mallet, may be needed.

First, the second panel 2 is displaced against the first panel 1 by an essentially vertical displacement, as detailed above. The protrusion 7 may be in an outer starting position. Thereafter, or concurrently, the protrusion 7 is displaced, such as pivoted and/or bent, inwards in a first stage of the locking by cooperation with the first edge portion 1a, such as with the shelf portion 8 and/or with the upper portion 11, such as the uppermost portion 11a. The protrusion 7 is then displaced, such as pivoted and/or bent, outwards in a second stage of the locking when the cooperation with the first edge portion, such as with the shelf portion 8 and/or with the upper portion 11, is reduced or eliminated. The displacement outwards may be caused by an intrinsic biasing force of the protrusion. The protrusion 7 may then assume an outer locking position, which may be substantially the same as the starting position or may at least be partially displaced towards it. Preferably, the first 1a and second 2b edge portions are locked to each other by means of a clicking or snapping engagement, e.g., whereby the protrusion 7 clicks or snaps into engagement with the cavity 6.

Optionally, the tip 7c of the protrusion 7 in any embodiment herein may comprise a chamfer 7f, see, e.g., Figs. 2c-2d. By means of the chamfer 7f, the protrusion may be more easily displaced into the cavity 6 during locking and, hence, a more controlled and/or failsafe locking device may be provided. The chamfer 7f may be planar or curved (see the broken line in Fig. 2c), preferably as specified in the cross-sectional side view of the protrusion 7. The chamfer 7f may form an angle δ with respect to the protrusion direction PD and/or or an outer protrusion wall 7g. In non-restrictive examples, $30^\circ \leq \delta \leq 70^\circ$, such as $40^\circ \leq \delta \leq 60^\circ$, such as $\delta \approx 45^\circ$.

In some embodiments herein, the second panel 2 may comprise a calibration groove 36, preferably provided horizontally inwards of the locking groove 4 with respect to the second panel 2. Such a calibration groove may provide an easier assembly of panels having varying thicknesses. The calibration groove 36 may be provided in the rear side 2f and may be open towards the locking groove 4. Moreover, it may extend along the second edge portion 2b, e.g., along the first horizontal direction X, such as along substantially its entirety. Preferably, the second edge portion 2b is resilient such that it may be bent downwards towards the subfloor 40. A, preferably maximal, depth DG of the calibrating groove 36 may be less than 0.5 mm, preferably less than 0.3 mm, such as being 0.05-0.2 mm.

In some embodiments, the first 1a and second 2b edge portions may be configured to be unlocked from each other by angling the first 1 and second 2 panels relative to each other, as shown in Fig. 4b. Thereby, the first 1 and second 2 panels may assume a disassembled state. Preferably, the locking device comprises inclined
5 horizontal locking surfaces 3a, 4a for enabling and/or simplifying the unlocking.

Alternatively, or additionally, the first 1a and second 2b edge portions may be configured to be unlocked from each other by means of a separate tool 25, such as an elongated rod, interacting with the locking device, see Fig. 4c. Preferably, the separate tool 25 comprises a cylindrical end portion, for example having a cylindrical
10 cross-section along its entire length direction, but other geometries are also possible. In non-limiting embodiments, a thickness Q of the separate tool may be 0.5-2.0 mm, preferably 0.8-1.5 mm. The separate tool 25 may be inserted into the cavity 6 such that the protrusion 7, such as the vertical locking surface 7a, may be gradually displaced out from the cavity 6 along the first edge portion 1a and inserted towards
15 and/or into the recess 16 along the second edge portion 2b. For example, the tip 7c of the protrusion 7 may be arranged at, or may be horizontally spaced from, the shelf portion 8 such that the second edge portion 2b may be vertically displaced upwards. Thereby, the edge portions 1a, 2b may be gradually unlocked from each other.

It is emphasized that any extension or angle herein, such as any of the vertical
20 distance CV1 or CV2, horizontal distance D, depth DG, extension E, distance H, horizontal distance HD, length L, distance OC1 or OC2, thickness T, thickness TP, any of the angles δ , γ , λ , θ , or any of the locking angles α , β or ϕ , may be determined by the following measuring method. First, the second panel 2 is cut, for example sawed, in a direction along the third 2c and fourth 2d edge portions, such as along
25 the second horizontal direction Y, preferably in the middle region between the third 2c and fourth 2d edge portions, see the broken line C in Fig. 6c. Thereby, a representative of a cross-section of the second panel, such as that in, e.g., Fig. 1b, may be obtained. Alternatively, the first panel 1 or the assembled panels 1, 2 is cut similarly, depending on which quantity that is to be determined. Thereafter, any
30 extension or angle of the first 1 or second 2 panel, in a disassembled or assembled state, may be measured with a digital or analog profile projector, for example from Mitutoyo or Dravitec AB.

EXAMPLE

A level of water resistance of samples of a set of building panels in the form of SPC panels, each comprising a core comprising PVC and chalk, and a wear layer arranged on the core was tested. The panels comprised a shelf portion and a lap
5 portion with a geometry and dimensions as depicted in Fig. 1b. An average thickness of the core was 4.5 mm, a thickness of the wear layer was 0.4 mm, and an average modulus of elasticity (E-modulus) of the core was 8.2 GPa, determined in accordance with ISO 178:2010/A1:2013 with the modifications that the sample width was 15 mm, the load span was 80 mm, and the preload was 3 N. The samples were
10 set up in accordance with the test of ISO 4760:2022 and were exposed to surface water at the junction of three panels in the form of a T-joint. The joint leakage was tested by measuring whether water had penetrated down to a paper arranged under the samples after 24 hours. It was found that all of the samples passed the test, in the sense that no water was detected at the paper.

15 Aspects of the disclosure have mainly been described above with reference to a few embodiments. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope of the disclosure. In particular, it is understood that embodiments without a shelf portion 8 also are included as embodiments herein, and may, for example, be combined with
20 any of the embodiments of the protrusion 7, such as the contacting section 17, length L, extension E, horizontal distance HD, or the unlocking by the separate tool 25, or embodiments of other parts of the locking device, such as the inclined horizontal locking surfaces 3a, 4a, etc., described herein.

EMBODIMENTS

25 Further aspects of the disclosure are provided below. Embodiments, examples etc. of these aspects are largely analogous to the embodiments, examples, etc. as described above, whereby reference is made to the above for a detailed description.

Item 1. A set of building panels, such as floor panels, comprising a first panel (1) and a second panel (2) and a locking device for locking a first edge portion (1a) of
30 the first panel to a second edge portion (2b) of the second panel to obtain an assembled state of the first (1) and second (2) panels, wherein a core (20) of the first (1) and second (2) panels comprises a polymer-based material, the locking device comprising:

a locking element (3) extending upwards from a lower strip (5) provided in the first edge portion (1a), and a locking groove (4) arranged in the second edge portion (2b), the locking groove being open downwards, wherein the locking element (3) and the locking groove (4) are configured to cooperate for horizontal locking of the first
5 (1a) and second (2b) edge portions, and

a cavity (6) arranged in the first edge portion (1a) and a displaceable, such as pivotable and/or bendable, protrusion (7) arranged in the second edge portion (2b), the cavity (6) being open horizontally outwards with respect to the first panel (1), wherein the protrusion and the cavity are configured to cooperate for vertical locking
10 of the first (1a) and second (2b) edge portions,

wherein the protrusion (7) extends at least partially upwards and is integrally formed with the second edge portion (2b).

Item 2. The set of building panels according to item 1, wherein, in the assembled state, the protrusion (7) extends at least partially horizontally inwardly of a vertical
15 plane (V1; V2) with respect to the second panel (2), said vertical plane extending between upper portions (11; 12) of the first (1a) and second (2b) edge portions.

Item 3. The set of building panels according to item 1 or 2, wherein a length (L) of the protrusion (7) from its inner portion (7b) does not exceed a horizontal distance (D) from said inner portion (7b) of the protrusion (7) to a vertical plane (V1) extending
20 along an uppermost portion (12a) of the second edge portion (2b).

Item 4. The set of floor panels according to any of the preceding items, wherein the protrusion (7) extends, in a direction (2g) along the second edge portion (2b), outwards of an upper portion (13) of a fourth edge portion (2d) of the second panel (2).

25 Item 5. The set of building panels according to any of the preceding items, wherein the protrusion (7) locks against the cavity (6) by pretension.

Item 6. The set of building panels according to any of the preceding items, wherein the protrusion (7) has a uniform thickness (TP).

Item 7. The set of building panels according to any of the preceding items, wherein
30 a length (L) of the protrusion (7) is smaller than five times, such as smaller than four times, a minimal thickness (TP) of the protrusion (7).

Item 8. The set of building panels according to any of the preceding items, wherein a tip (7c) of the protrusion (7) is arranged at a distance (H) from a front side (2e) of

the second panel (2), said distance exceeding a quarter, such as exceeding a third, of a thickness (T) of the second panel (2).

Item 9. The set of building panels according to any of the preceding items, wherein upper portions (11; 12) of the first (1a) and second (2b) edge portions comprise a shelf portion (8) and a lap portion (9), respectively, configured to cooperate with each other at overlapping cooperating surfaces (8a; 9a), wherein said cavity (6) extends below the shelf portion (8).

Item 10. The set of building panels according to item 9, wherein the overlapping cooperating surface (8a) of the shelf portion (8) is provided in an upper section of the shelf portion (8), and wherein the overlapping cooperating surface (9a) of the lap portion (9) is provided in a lower section of the lap portion (9).

Item 11. The set of building panels according to any of the preceding items, wherein upper portions (11; 12) of the first (1a) and second (2b) edge portions comprise joining surfaces (18, 19) which are inclined with respect to a normal (N1; N2) of a main plane (M1; M2) extending along a front side (1e; 2e) and/or a rear side (1f; 2f) of the first (1) and/or second (2) panel.

Item 12. The set of building panels according to any of the preceding items, wherein the protrusion (7) is displaceable, such as pivotable and/or bendable, into a recess (16) of the second edge portion (2b), and wherein the protrusion (7) contacts a base edge portion (15) of the second edge portion (2b) along a contacting section (17) in the assembled state, preferably also in a disassembled state, the base edge portion (15) preferably being arranged below or at a bottom portion (16b) of the recess (16).

Item 13. The set of floor panels according to any of the preceding items, wherein the protrusion (7) is displaceable, such as pivotable and/or bendable, into a recess (16) of the second edge portion (2b), said recess (16) comprising a protuberant inner wall (16a).

Item 14. The set of building panels according to any of the preceding items, wherein the protrusion (7) is thermoformed.

Item 15. The set of building panels according to any of the preceding items, wherein the first (1a) and second (2b) edge portions are configured to be locked to each other by a relative essentially vertical displacement of the first (1) and second (2) panels against each other.

Item 16. The set of building panels according to any of the preceding items, wherein the first (1a) and second (2b) edge portions are configured to be unlocked from each other by angling the first (1) and second (2) panels relative to each other.

- 5 Item 17. The set of building panels according to any of the preceding items, wherein a horizontal locking surface (3a) of the locking element (3) is inclined against a main plane (M1) extending along a front side (1e) and/or a rear side (1f) of the first panel (1) by a locking angle (α), preferably being less than 80°.

Item 18. The set of building panels according to item 17, wherein the locking angle (α) is 35°-80°, preferably 60°-80°, more preferably 65°-75°.

- 10 Item 19. The set of building panels according to any of the preceding items, wherein the core (20) of the first (1) and second (2) panels comprises a thermoplastic material.

CLAIMS

1. A set of building panels, such as floor panels, comprising a first panel (1) and a second panel (2) and a locking device for locking a first edge portion (1a) of the first panel to a second edge portion (2b) of the second panel to obtain an assembled state of the first (1) and second (2) panels, wherein a core (20) of the first (1) and second (2) panels comprises a polymer-based material, the locking device comprising:

a locking element (3) extending upwards from a lower strip (5) provided in the first edge portion (1a), and a locking groove (4) arranged in the second edge portion (2b), the locking groove being open downwards, wherein the locking element (3) and the locking groove (4) are configured to cooperate for horizontal locking of the first (1a) and second (2b) edge portions, and

a cavity (6) arranged in the first edge portion (1a) and a displaceable, such as pivotable and/or bendable, protrusion (7) arranged in the second edge portion (2b), the cavity (6) being open horizontally outwards with respect to the first panel (1), wherein the protrusion and the cavity are configured to cooperate for vertical locking of the first (1a) and second (2b) edge portions,

wherein the protrusion (7) extends at least partially upwards and is integrally formed with the second edge portion (2b),

wherein, in the assembled state, the protrusion (7) extends at least partially horizontally inwardly of a vertical plane (V1; V2) with respect to the second panel (2), said vertical plane extending between upper portions (11; 12) of the first (1a) and second (2b) edge portions, and

wherein upper portions (11; 12) of the first (1a) and second (2b) edge portions comprise a shelf portion (8) and a lap portion (9), respectively, configured to cooperate with each other at overlapping cooperating surfaces (8a; 9a), said cavity (6) extending below the shelf portion (8),

the overlapping cooperating surface (8a) of the shelf portion (8) being provided in an upper section of the shelf portion (8), and the overlapping cooperating surface (9a) of the lap portion (9) being provided in a lower section of the lap portion (9).

2. The set of floor panels according to claim 1, wherein the protrusion (7) extends, in a direction (2g) along the second edge portion (2b), outwards of an upper portion (13) of a fourth edge portion (2d) of the second panel (2).

3. The set of building panels according to claim 1 or 2, wherein the protrusion (7) locks against the cavity (6) by pretension.
4. The set of building panels according to any of the preceding claims, wherein a tip (7c) of the protrusion (7) is arranged at a distance (H) from a front side (2e) of the second panel (2), said distance exceeding a quarter of a thickness (T) of the second panel (2).
5. The set of building panels according to any of the preceding claims, wherein upper portions (11; 12) of the first (1a) and second (2b) edge portions comprise joining surfaces (18, 19) which are inclined with respect to a normal (N1; N2) of a main plane (M1; M2) extending along a front side (1e; 2e) and/or a rear side (1f; 2f) of the first (1) and/or second (2) panel.
6. The set of building panels according to any of the preceding claims, wherein the protrusion (7) is displaceable into a recess (16) of the second edge portion (2b), and wherein the protrusion (7) contacts a base edge portion (15) of the second edge portion (2b) along a contacting section (17) in the assembled state.
7. The set of floor panels according to any of the preceding claims, wherein the protrusion (7) is displaceable into a recess (16) of the second edge portion (2b), said recess (16) comprising a protuberant inner wall (16a).
8. The set of building panels according to any of the preceding claims, wherein the protrusion (7) is thermoformed.
9. The set of building panels according to any of the preceding claims, wherein the first (1a) and second (2b) edge portions are configured to be locked to each other by a relative essentially vertical displacement of the first (1) and second (2) panels against each other.
10. The set of building panels according to any of the preceding claims, wherein the first (1a) and second (2b) edge portions are configured to be unlocked from each other by angling the first (1) and second (2) panels relative to each other.
11. The set of building panels according to any of the preceding claims, wherein a horizontal locking surface (3a) of the locking element (3) is inclined against a main plane (M1) extending along a front side (1e) and/or a rear side (1f) of the first panel (1) by a locking angle (α), which is less than 80°.
12. The set of building panels according to any of the preceding claims, wherein the core (20) of the first (1) and second (2) panels comprises a thermoplastic material.

13. A set of building panels, such as floor panels, comprising a first panel (1) and a second panel (2) and a locking device for locking a first edge portion (1a) of the first panel to a second edge portion (2b) of the second panel to obtain an assembled state of the first (1) and second (2) panels, wherein a core (20) of the first (1) and second (2) panels comprises a polymer-based material, the locking device comprising:

a locking element (3) extending upwards from a lower strip (5) provided in the first edge portion (1a), and a locking groove (4) arranged in the second edge portion (2b), the locking groove being open downwards, wherein the locking element (3) and the locking groove (4) are configured to cooperate for horizontal locking of the first (1a) and second (2b) edge portions, and

a cavity (6) arranged in the first edge portion (1a) and a displaceable, such as pivotable and/or bendable, protrusion (7) arranged in the second edge portion (2b), the cavity (6) being open horizontally outwards with respect to the first panel (1), wherein the protrusion and the cavity are configured to cooperate for vertical locking of the first (1a) and second (2b) edge portions,

wherein the protrusion (7) extends at least partially upwards and is integrally formed with the second edge portion (2b), and

wherein a length (L) of the protrusion (7) from its inner portion (7b) does not exceed a horizontal distance (D) from said inner portion (7b) of the protrusion (7) to a vertical plane (V1) extending along an uppermost portion (12a) of the second edge portion (2b).

14. The set of floor panels according to claim 13, wherein the protrusion (7) extends, in a direction (2g) along the second edge portion (2b), outwards of an upper portion (13) of a fourth edge portion (2d) of the second panel (2).

15. The set of building panels according to claim 13 or 14, wherein the protrusion (7) locks against the cavity (6) by pretension.

16. The set of building panels according to any of the preceding claims 13-15, wherein a length (L) of the protrusion (7) is smaller than five times, such as smaller than four times, a minimal thickness (TP) of the protrusion (7).

17. The set of building panels according to any of the preceding claims 13-16, wherein a tip (7c) of the protrusion (7) is arranged at a distance (H) from a front side

(2e) of the second panel (2), said distance exceeding a quarter, such as exceeding a third, of a thickness (T) of the second panel (2).

18. The set of building panels according to any of the preceding claims 13-17, wherein upper portions (11; 12) of the first (1a) and second (2b) edge portions
5 comprise a shelf portion (8) and a lap portion (9), respectively, configured to cooperate with each other at overlapping cooperating surfaces (8a; 9a), wherein said cavity (6) extends below the shelf portion (8).

19. The set of building panels according to any of the preceding claims 13-18, wherein the protrusion (7) is displaceable into a recess (16) of the second edge
10 portion (2b), and wherein the protrusion (7) contacts a base edge portion (15) of the second edge portion (2b) along a contacting section (17) in the assembled state.

20. The set of floor panels according to any of the preceding claims 13-19, wherein the protrusion (7) is displaceable into a recess (16) of the second edge portion (2b), said recess (16) comprising a protuberant inner wall (16a).

15 21. The set of building panels according to any of the preceding claims 13-20, wherein the protrusion (7) is thermoformed.

22. The set of building panels according to any of the preceding claims 13-21, wherein the first (1a) and second (2b) edge portions are configured to be locked to each other by a relative essentially vertical displacement of the first (1) and second
20 (2) panels against each other.

23. The set of building panels according to any of the preceding claims 13-22, wherein the first (1a) and second (2b) edge portions are configured to be unlocked from each other by angling the first (1) and second (2) panels relative to each other, a horizontal locking surface (3a) of the locking element (3) being inclined against a
25 main plane (M1) extending along a front side (1e) and/or a rear side (1f) of the first panel (1) by a locking angle (α), which is less than 80°.

24. The set of building panels according to any of the preceding claims 13-23, wherein the core (20) of the first (1) and second (2) panels comprises a thermoplastic material.

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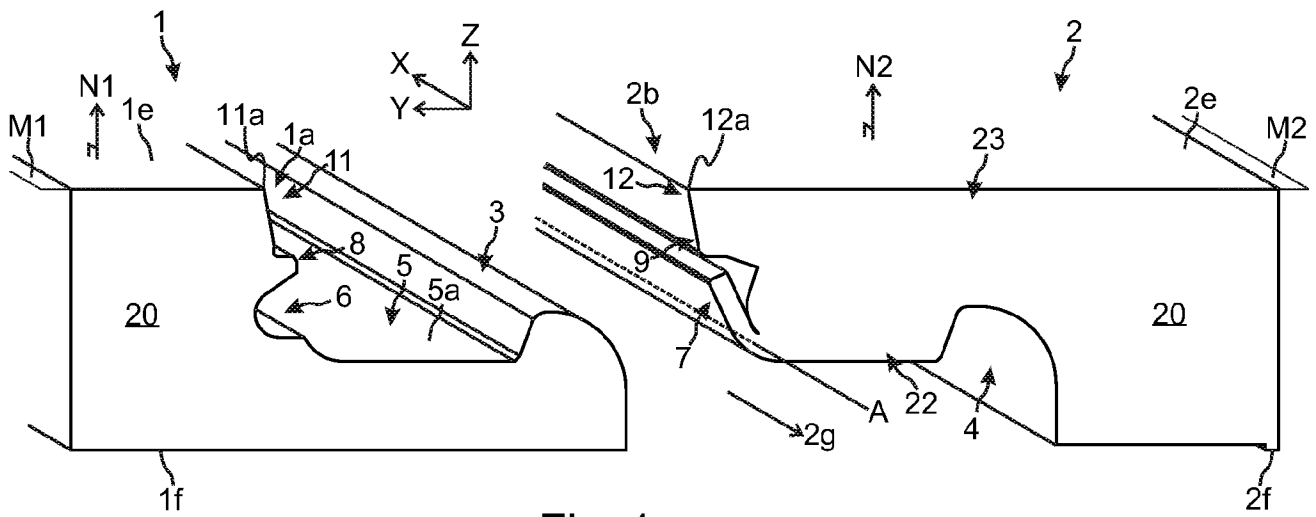


Fig. 1a

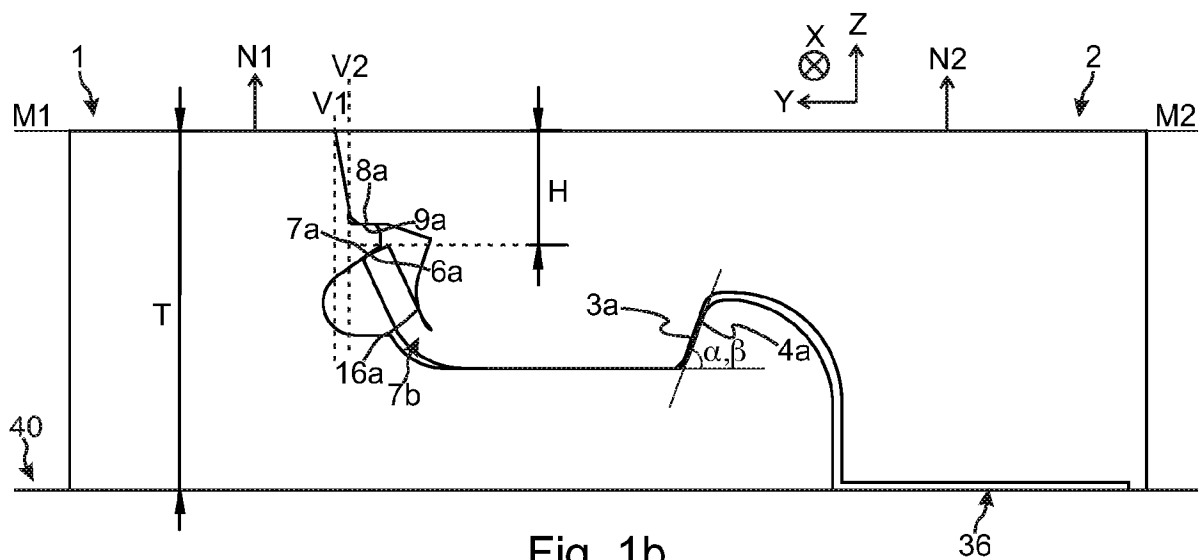


Fig. 1b

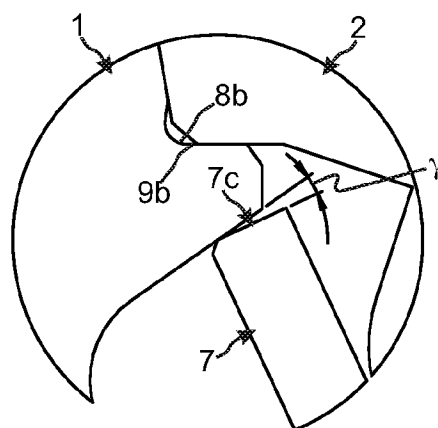
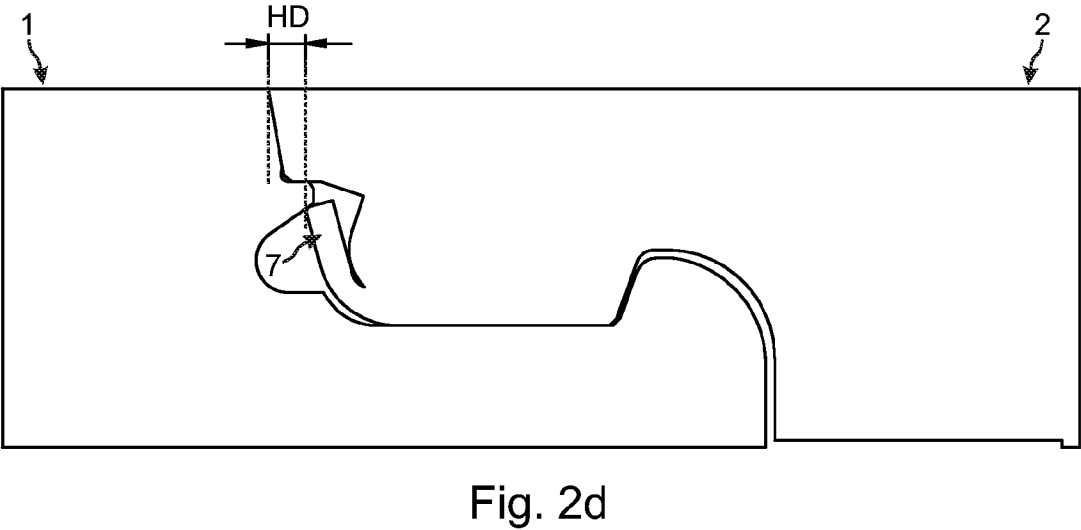
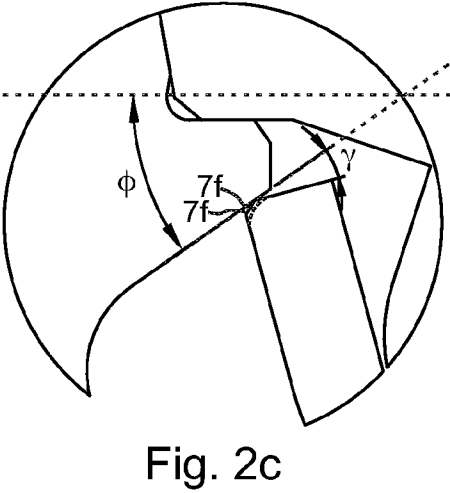
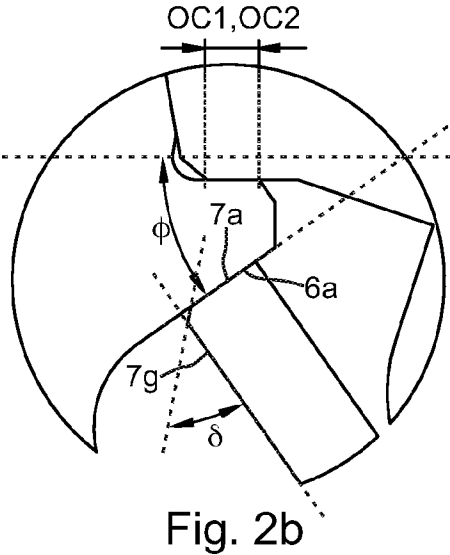
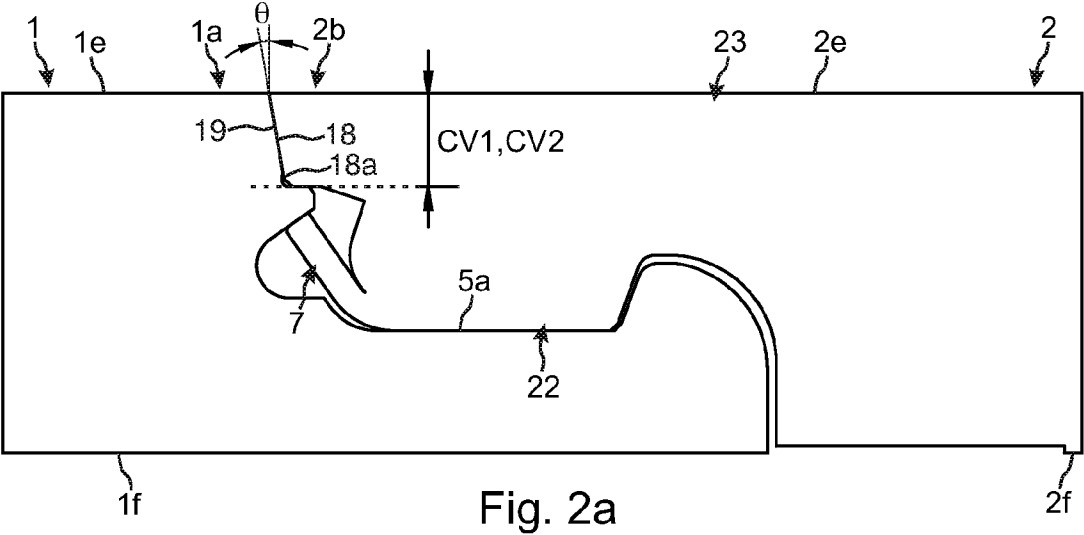


Fig. 1c



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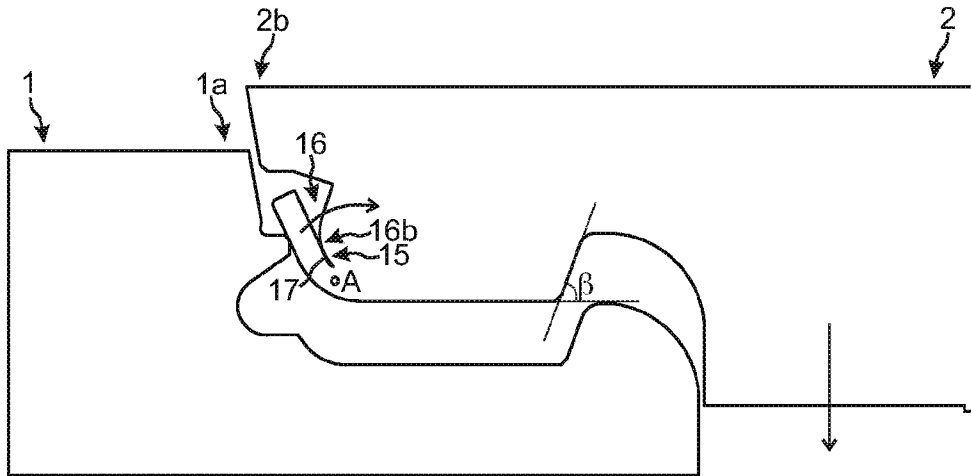


Fig. 3a

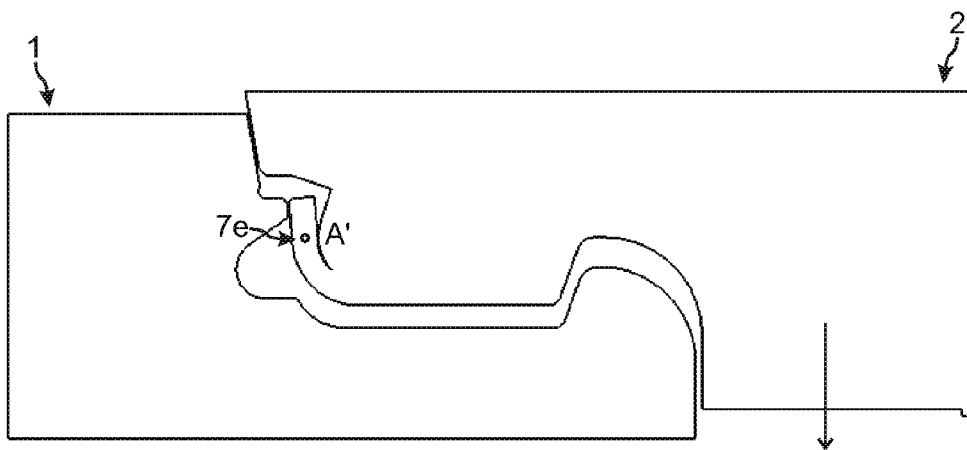


Fig. 3b

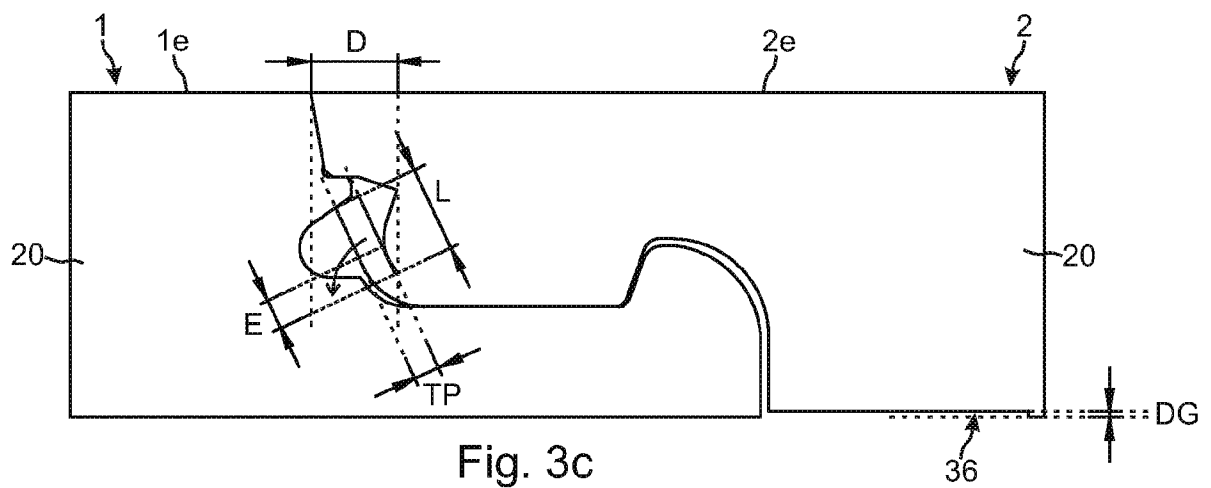


Fig. 3c

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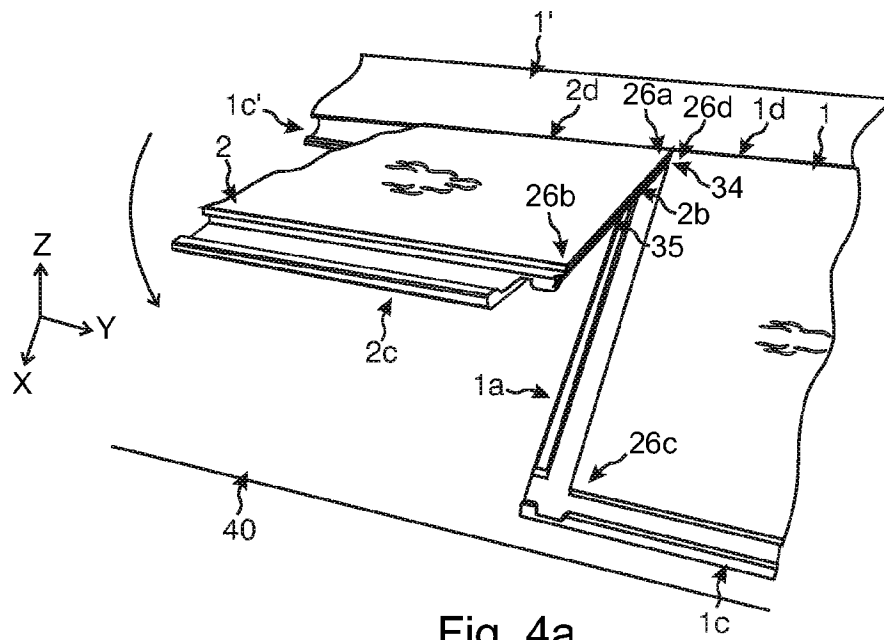


Fig. 4a

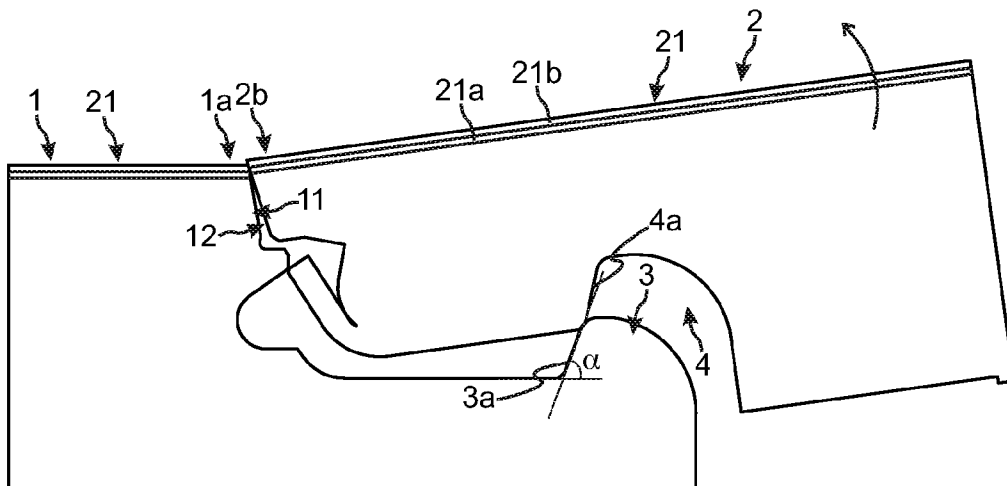


Fig. 4b

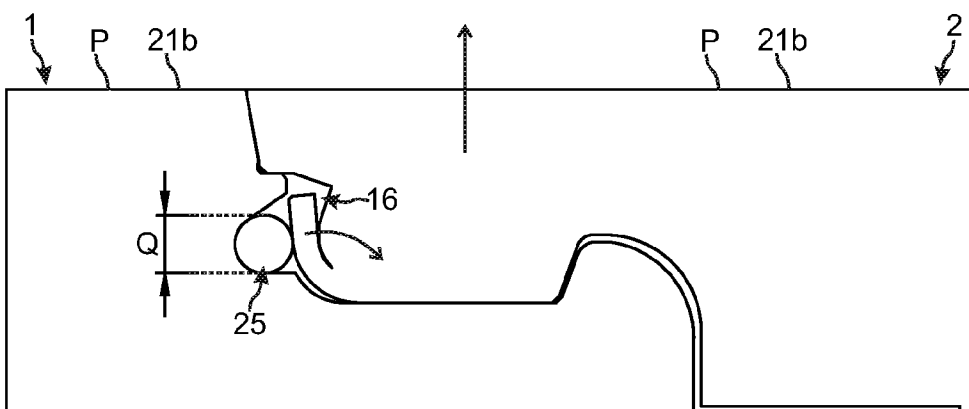


Fig. 4c

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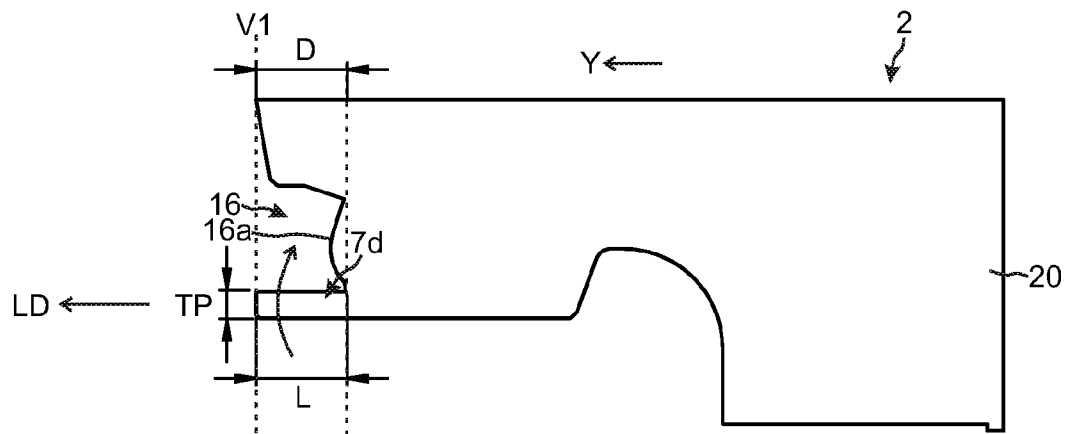


Fig. 5a

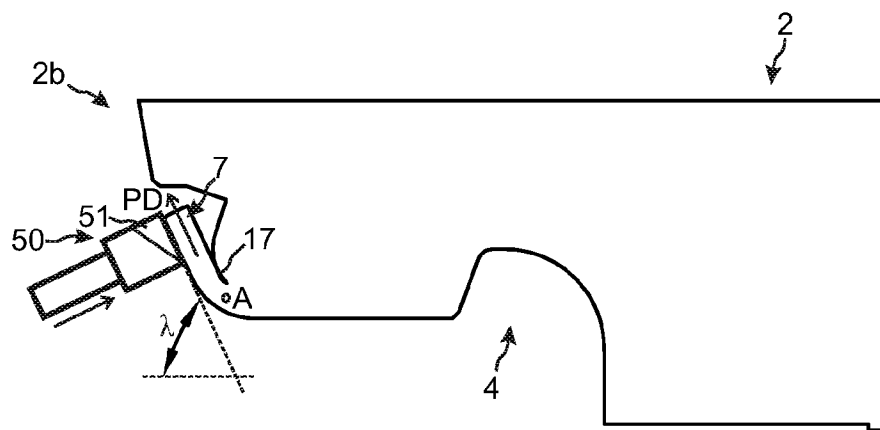


Fig. 5b

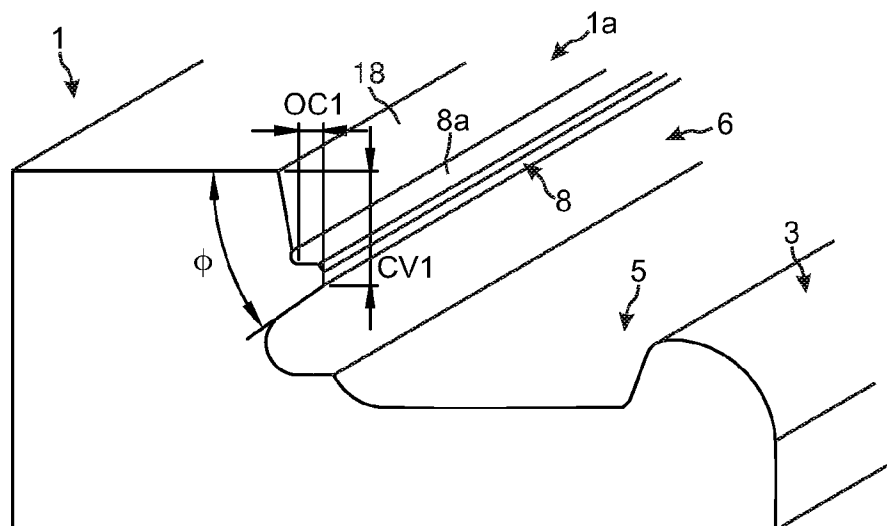


Fig. 5c

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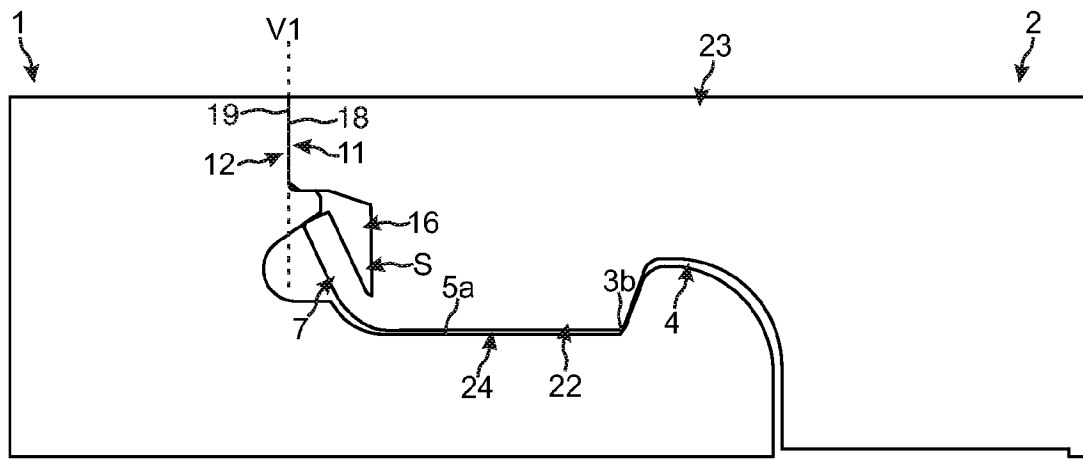


Fig. 6a

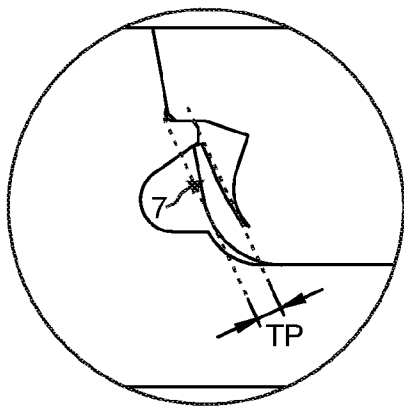


Fig. 6b

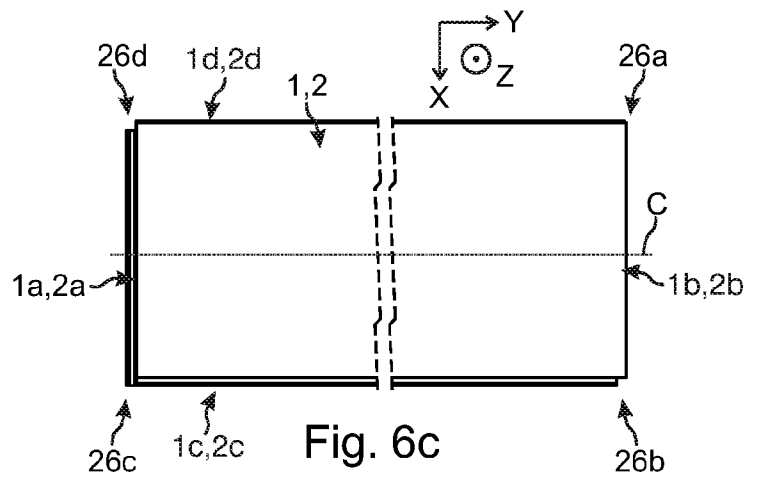


Fig. 6c

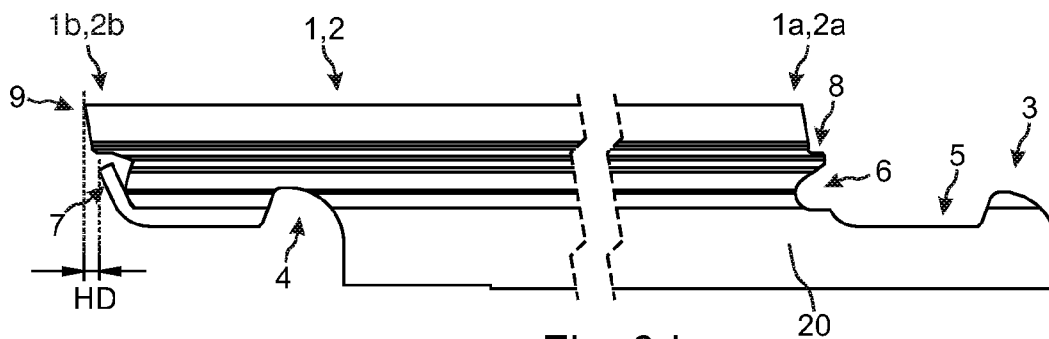


Fig. 6d

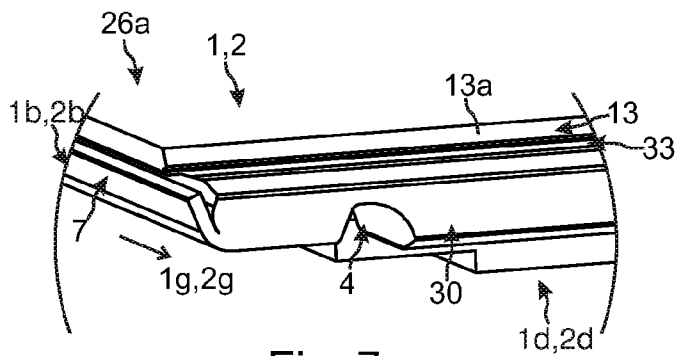


Fig. 7a

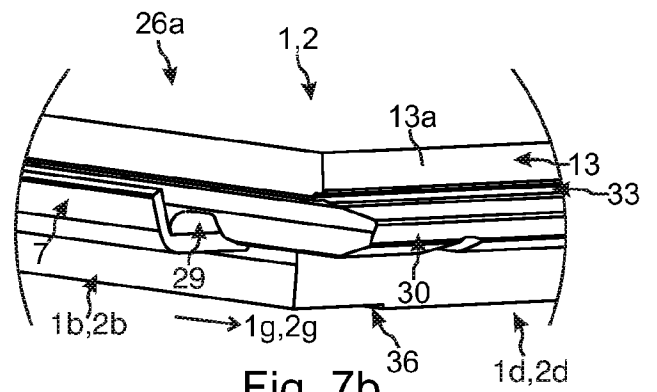


Fig. 7b

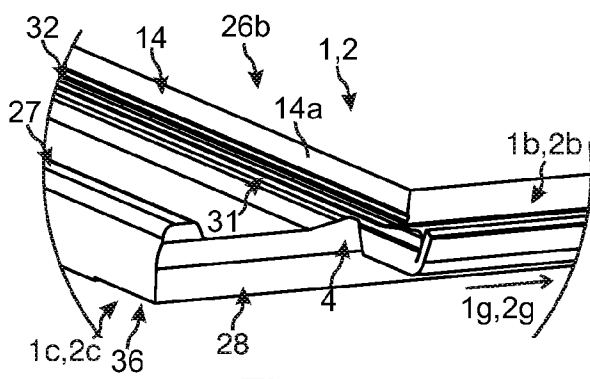


Fig. 7c

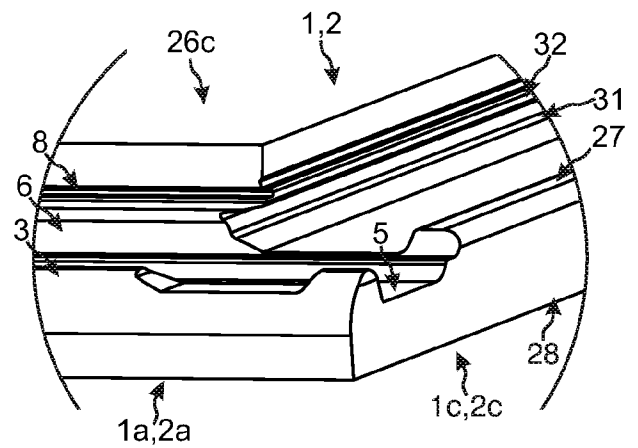


Fig. 7d

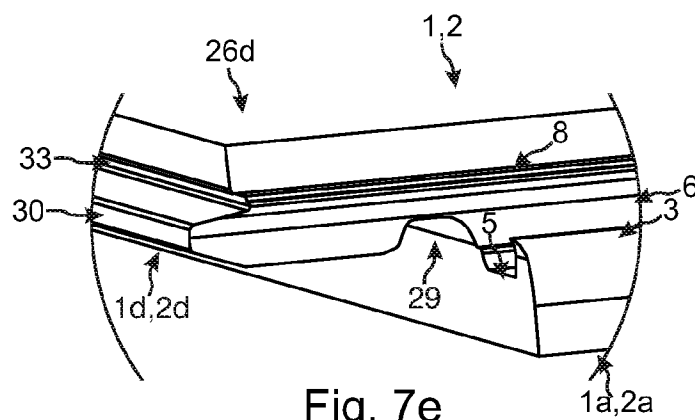


Fig. 7e

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2024/050959

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: E04F, F16B

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 102004001363 A1 (HAMBERGER INDUSTRIEWERKE GMBH), 4 August 2005 (2005-08-04); paragraphs [0032], [0042]-[0044]; figures 1,3 --	1-12
Y	FR 3077027 A1 (INOVAME), 26 July 2019 (2019-07-26); pages 7-12; all figures; claim 1 --	1-12
Y	US 20160326751 A1 (PERVAN DARKO), 10 November 2016 (2016-11-10); paragraphs [0035]-[0045]; figures 6a-6b --	1-12
A	BE 1019395 A3 (KREAFIN GROUP S A), 5 June 2012 (2012-06-05); whole document -- -----	1-12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“D” document cited by the applicant in the international application

“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

27-01-2025

Date of mailing of the international search report

28-01-2025

Name and mailing address of the ISA/SE

Patent- och registreringsverket

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Continuation of: second sheet**International Patent Classification (IPC)*****E04F 15/02*** (2006.01)***F16B 5/00*** (2006.01)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2024/050959**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

- 1: Claims 1-12 related to a set of building panels.
- 2: Claims 13-24 related to a set of building panels.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: **1-12**

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SE2024/050959

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			US	9366036 B2	14/06/2016
			WO	2014081382 A1	30/05/2014
BE	1019395 A3	05/06/2012	NONE		