



(51) International Patent Classification:
E04F 15/02 (2006.01)

(21) International Application Number:
PCT/SE2016/050019

(22) International Filing Date:
15 January 2016 (15.01.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1550033-3 16 January 2015 (16.01.2015) SE

(71) Applicant: CERALOC INNOVATION AB [SE/SE];
Prästavägen 513, S-263 65 Viken (SE).

(72) Inventor: PERVAN, Darko; Bygatan 30, S-263 61 Viken (SE).

(74) Agent: ENGQUIST, Johan; Ceraloc Innovation AB,
Prästavägen 513, S-263 65 Viken (SE).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,

HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

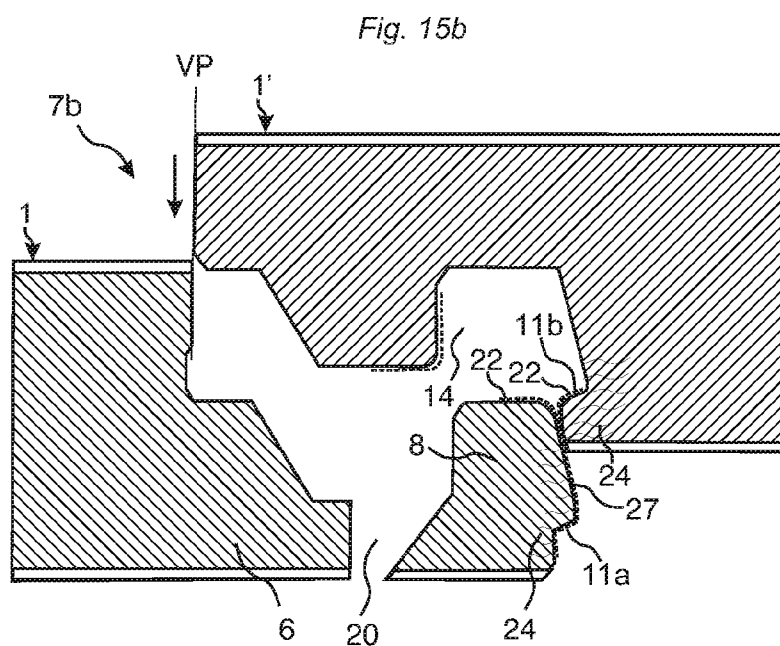
Declarations under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a
patent (Rule 4.17(ii))

Published:

— with international search report (Art. 21(3))
— before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))

(54) Title: MECHANICAL LOCKING SYSTEM FOR FLOOR PANELS



(57) Abstract: Floor panels (1, 1') are shown, which are provided with a mechanical locking system that may be locked with a vertical displacement of a first panel against a second panel. The locking system comprises a first rigid (7a) and a second flexible (7b) joint edge section with different locking functions. The first edge section provides a horizontal locking and the second section provides a vertical locking.

MECHANICAL LOCKING SYSTEM FOR FLOOR PANELS

TECHNICAL FIELD

The disclosure generally relates to the field of mechanical locking systems for floor panels and building panels. The disclosure shows floorboards, furniture components, locking systems and production methods.

FIELD OF APPLICATION OF THE INVENTION

Embodiments of the present invention are particularly suitable for use in floating floors, which are formed of floor panels having of one or more upper layers comprising, e.g., thermoplastic or thermosetting material or wood veneer, an intermediate core of wood-fibre-based material or plastic material and preferably a lower balancing layer on the rear side of the core.

Embodiments of the invention can also be used for joining building panels which preferably contain a board material for instance wall panels, ceilings, furniture components and similar.

The following description of prior-art technique, problems of known systems and objects and features of the invention will therefore, as a non-restrictive example, be aimed above all at this field of application and in particular at laminate floors comprising an HDF core and formed as rectangular floor panels with long and short edges intended to be mechanically joined to each other on both long and short edges.

The long and short edges are mainly used to simplify the description of the invention. The panels may be square. Floor panels are generally produced with the surface layer pointing downwards in order to eliminate thickness tolerances of the core material. Some embodiments and production methods are shown with the surface pointing upwards in order to simplify the description.

It should be emphasized that embodiments of the invention can be used in any floor panel on long and/or short edges and it may be combined with all types of known locking systems on long or short edges that lock the panels in the horizontal and/or vertical direction.

5

BACKGROUND OF THE INVENTION

Relevant parts of this background description are also a part of embodiments of the disclosed invention.

Several floor panels on the market are installed in a floating manner with mechanical locking systems formed at the long and short edges. These systems comprise locking means, which lock the panels horizontally and vertically. The mechanical locking systems are usually formed by machining of the core of the panel. Alternatively, parts of the locking system can be formed of a separate material, for instance aluminium or plastic material, which is integrated with the floor panel, i.e. joined with the floor panel in connection with the manufacture thereof.

Laminate flooring usually comprise a 6-8 mm wood based core, a 0.2 mm thick upper decorative surface layer of laminate and a 0.1 mm thick lower balancing layer. The laminate surface and the balancing layer comprise melamine-impregnated paper. The most common core material is fibreboard with high density and good stability usually called HDF – High Density Fibreboard. The impregnated surface and balancing papers are laminated to the core with heat and pressure. HDF material is hard and has a low flexibility especially in the vertical direction perpendicular to the fibre orientation.

Recently a new type of powder based laminate floors has been introduced. Impregnated paper is replaced with a dry powder mix comprising wood fibres, melamine particles, aluminium oxide and pigments. The powder is applied on an HDF core and cured under heat and pressure. Generally high quality HDF is used with a high resin content and low water swelling. Advanced decors may be formed with digital printing. Water based ink is injected into the powder prior to pressing.

Luxury vinyl tile, LVT, flooring with a thickness of 3-6 mm usually comprises a transparent wear layer which may be coated with an ultraviolet, UV, cured polyurethane, PU, lacquer and a decorative plastic foil under the transparent foil. The wear layer and the decorative foil are laminated to one or several
5 core layers comprising a mix of thermoplastic material and mineral fillers. The plastic core may be rather soft and flexible but also rather rigid depending on the filler content.

Wood Plastic Composite floors generally referred to as WPC floors are similar to LVT floors. The core comprises thermosetting material mixed with wood
10 fibre fillers and is generally stronger and much more rigid than the mineral based LVT core.

Thermoplastic material such as PVC, PP or PE may be combined with a mix of wood fibres and mineral particles and this may provide a wide variety of floor panels with different densities and flexibilities.

15 Moisture resistant HDF with a high resin content, and WPC floors comprise stronger and more flexible core materials than conventional HDF based laminate floors and they are generally produced with a lower thickness.

The above mentioned floor types comprise different core materials with different flexibility, density and strengths. Locking systems formed in one
20 piece with the core must be adapted to such different material properties in order to provide a strong and cost efficient locking function.

DEFINITION OF SOME TERMS

In the following text, the visible surface of the installed floor panel is called "front side" or "floor surface", while the opposite side of the floor panel, facing
25 the sub floor, is called "rear side". The edge between the front and rear side is called "joint edge". By "horizontal plane" is meant a plane, which extends parallel to the front side. Immediately juxtaposed upper parts of two adjacent joint edges of two joined floor panels together define a "vertical plane" perpendicular to the horizontal plane. By "vertical locking" is meant locking
30 parallel to the vertical plane. By "horizontal locking" is meant locking parallel to the horizontal plane.

By “up” is meant towards the front side, by “down” towards the rear side, by “inwardly” mainly horizontally towards an inner and centre part of the panel and by “outwardly” mainly horizontally away from the centre part of the panel.

RELATED ART AND PROBLEMS THEREOF

- 5 For mechanical joining of long edges as well as short edges in the vertical direction and horizontal direction perpendicular to the edges several methods may be used. One of the most used methods is the angle-snap method. The long edges are installed by angling. Horizontal snapping locks the short edges. The vertical connection is generally a tongue and a groove and the
- 10 horizontal connection is a strip with a locking element in one edge that cooperates with a locking groove in the adjacent edge. Locking by snapping is obtained with a flexible strip that during the initial stage of locking bends downwards and during the final stage of locking snaps upwards such that the locking element is inserted into the locking groove.
- 15 Similar locking systems may also be produced with a rigid strip and they are connected with an angling-angling method where both short and long edges are angled into a locked position.

Advanced so-called “fold down locking systems” with a separate and flexible tongue on a short edge generally called “5G systems” have been introduced

20 where both the long and short edges are locked with an angling action. A floor panel of this type is presented in WO 2006/043893. It discloses a floor panel with a short edge locking system comprising a locking element cooperating with a locking groove, for horizontal locking, and a flexible bow shaped so called “banana tongue” cooperating with a tongue groove, for locking in a

25 vertical direction. The flexible bow shaped tongue is inserted during production into a displacement groove formed at the edge. The tongue bends horizontally along the edge during connection and makes it possible to install the panels by vertical movement. Long edges are connected with angling and a vertical scissor movement caused by the same angling action connects

30 short edges. The snapping resistance is low and only a low thumb pressure is

needed to press the short edges together during the final stage of the angling. Such a locking is generally referred to as "vertical folding"

Similar floor panels are further described in WO 2007/015669. This invention provides a fold down locking system with an improved flexible tongue so
5 called "bristle tongue" comprising a straight outer tongue edge over substantially the whole length of the tongue. An inner part of the tongue comprises bendable protrusions extending horizontally along the tongue body.

The above known fold down "5G system" has been very successful and has
10 captured a major market share of the premium world laminate and wood flooring markets. The locking is strong and reliable mainly due to the flexibility and pretension of the separate flexible tongue that allows a locking with large overlapping essentially horizontal locking surfaces. The locking strength and installation is only to a minor extent dependant on the properties of the core
15 since the strength and flexibility is obtained with a well defined tongue made of strong plastic material reinforced with long glass fibres.

The 5G system and similar system have been less successful in the low priced market segments. The major reason is that the cost of the separate tongues and investments in special inserting equipment that is needed to
20 insert a flexible tongue into a displacement groove are still regarded as rather high in relation to the rather low price of the floor panels.

Several attempts have been made to provide a fold down locking system based on a vertical snapping function that may be produced in one piece with the core in the same way as the one piece horizontal snap systems. All such
25 attempts have failed especially when a floor panel comprises an HDF core. This is not a coincidence. The failure is based on major problems related to material properties and production methods. Several of the known locking systems are based on theoretical geometries and designs that have not been tested in industrial applications. One of the main reasons behind the failure is
30 that bending of vertically protruding parts that are used for the vertical locking

of edges is limited to about 50% of the floor thickness or to about 4 mm in an 8 mm thick laminate floor panel. As comparison it may be mentioned that a protruding strip for horizontal snapping may extend over a substantial distance from the upper edge and may protrude 8 – 10 mm beyond the upper edge. This may be used to facilitate a downward bending of the strip and the locking element. In addition a small downward bending of the tongue and upward bending of the upper lip are features that are favourable and may be used to facilitate a horizontal snapping action. Other disadvantages compared to horizontal snapping are that HDF comprises a fibre orientation substantially parallel with the floor surface. The material properties are such that bending of horizontally protruding parts is easier to accomplish than bending of vertically protruding parts. Furthermore, lower parts of an HDF board comprise a higher density and a higher resin content than middle parts and such properties are also favourable for the horizontal snapping systems where the strip is formed in the lower part of the core.

Another circumstance that has supported market introduction of the horizontal one piece snap systems is the fact that a hammer and a knocking block may be used to snap the short edges. Fold down systems are so called tool-less systems and the vertical locking must be accomplished with hand pressure only.

Several attempts have been made to copy the basic principles of the 5G tongue that bends horizontally along its length in an displacement groove during locking and that is very stable in the vertical direction where it is supported over the major part of its width by an upper strong and rigid wall of the displacement groove.

The main problem with one-piece systems based on flexible locking means extending along the joint is the fact that it is difficult to combine a high degree of flexibility in the horizontal direction, that is needed for an easy locking, with a low or preferably non-existent flexibility in the vertical direction that is needed for a high locking strength.

WO 2008/116623 describes a locking system comprising a flexible tongue that bends horizontally along its length. The flexible tongue is formed by jumping tools on an outer or inner part of the fold panel. The jumping tools are used to form cavities above and behind the tongue in order to accomplish flexibility in the length direction of the tongue. The main problem is that the tongue is flexible horizontally but also vertically and the vertical locking strength is very low. The jumping tool forms deep cavities and this reduces the locking strength.

WO 2009/033623 describes a locking system having spring elements that lock adjacent panels vertically. The spring elements are located at an outer part of a locking strip and are formed by a vertical slot located in a locking element at an outer part of the locking strip. During vertical displacement the spring elements are displaced horizontally inwardly by projections formed on the adjacent panel and back again to its initial position. The locking element is used to lock vertically, horizontally and to support the panels such that they are aligned with flat upper edges. Such locking system has several disadvantages. The essentially horizontal contact surfaces located on the locking element may increase the risk for squeaking sound when the panels are moving vertically since the outer part of the strip is not strong enough and is generally much more flexible than the inner part. Locking with a flexible part that moves to its original position cannot create a strong locking and cannot eliminate production tolerances. The forming of a slot in the thicker outer part of the strip is a difficult operation since an unnecessary high amount of material must be removed. Two special tooling stations must be used to form the slots on one short edge and the projections on the other opposite short edge.

WO 2011/001326 describes a one piece locking system where the flexible tongue is formed on the strip panel in a middle section of a core. A deep cut is formed vertically as a cavity with a distance that extends over the major part of the core material and this will reduce the strength of the edge section. Only a few tongues may be formed at an edge and the locking strength is low

especially in HDF material where the middle parts have a rather low density and flexibility.

WO 2013/032391 describes a one piece locking system comprising a slit formed in the locking strip. The locking system is mainly intended to lock very thin LVT panels. The locking surfaces are located at the lower part of strip. Such locking systems are less suitable for thicker laminate panels since the large slit that is used to accommodate a locking protrusion results in low locking strength especially due to the fact that the flexibility in the vertical direction is generally larger than the flexibility in the horizontal direction.

The locking systems described above are also difficult to form in a cost efficient way with known production methods.

A one-piece fold down locking system designed such that it may be formed with high-speed equipment in a cost efficient way and with a quality and locking function similar to the advanced 5G systems may be a major advantage.

SUMMARY OF THE INVENTION

An objective of embodiments of the present invention is to provide an improved and more cost efficient fold down locking system for vertical and horizontal locking of adjacent panels wherein the locking system is produced in one piece with the core.

A first specific objective is to provide a locking system wherein a horizontally extending flexible strip may be used to accomplish the vertical and horizontal locking.

A second specific objective is to provide a locking system with essentially horizontally extending locking surfaces for the vertical locking such that a strong locking force may be obtained in the vertical direction.

A third specific objective is to prevent upward bending of flexible parts that are used to obtain a vertical locking of the edges.

A fourth specific objective is to provide several embodiments of locking systems that may be used to meet the specific material properties of different core materials that are used to produce floor panels and furniture components.

- 5 A fifth specific objective is to provide locking systems that may be produced with cost efficient methods in a double-end tenor comprising a lower chain and an upper belt that displace the panel in relation to several tool stations.

The above objects of the invention may be achieved by embodiments of the invention.

- 10 According to a first aspect of the invention a set of essentially identical floor panels are provided with a mechanical locking system comprising a strip extending horizontally from a lower part of a first edge of a first panel and a downwardly open locking groove formed in an adjacent second edge of a second panel. The strip comprises an upwardly protruding locking element
15 which is configured to cooperate with the locking groove for locking the first edge and the second edge in a horizontal direction parallel to a main plane of the panels and in a vertical direction perpendicularly to the horizontal direction. The locking element and the locking groove comprise an upper and a lower locking surface, which are configured to lock the panels vertically. The
20 strip comprises slits located along the first edge and is configured such that a slit wall is bended horizontally inwardly towards an inner part of the first panel during locking.

- The slits may be located closer to an upper part of the first panel than the locking element. Thereby, the slits may be located between the upper part of
25 the first panel and the locking element in a horizontal direction. In a non-restrictive example, the slits may be provided in a thinnest part of the strip. In another non-restrictive example, the slits may be provided in a portion of the strip inside of the thinnest part of the strip.

- By a first object being located closer to the upper edge than a second object
30 is here and in the following meant that a horizontal distance between the first object and the upper edge is smaller than a horizontal distance between the

second object and the upper edge. This is valid in all aspects and principles of the disclosure, in particular when the object is a locking element, a locking groove, or a slit.

5 The second edge may be displaced vertically downwards towards the first edge during locking. This includes the case when the second edge is displaced towards the first edge by means of a scissor-like movement, wherein the second edge is gradually displaced towards the first edge from one side edge of the second edge to the other.

10 By “during locking” is meant at least during an initial stage of the locking. The bending of the slit wall horizontally inwardly towards an inner part of the first panel may occur during an initial stage of the locking.

15 The slit wall may be further configured to bend horizontally outwardly away from the inner part. The outward bending may occur after the initial stage of the locking. In particular, the outward bending may occur during a final stage of the locking. The slit wall may be configured to be bended at least partly back to an initial position of the slit wall during a final stage of the locking. The initial position of the slit wall may be a position of the slit wall before bending. In a first example, the slit wall is during the final stage bended partly back to the initial position of the slit wall. In a second example, the slit wall is during 20 the final stage bended completely back to the initial position of the slit wall.

The slit wall may be an outer slit wall of the slit. The slit may further comprise an inner slit wall.

25 There may be at least one slit located along the first edge. In one example, there is one slit located along the first edge. In another example, there is a plurality of slits located along the first edge. Here and in the following, reference will be made only to “slits”.

The slits may extend entirely through the strip.

30 Alternatively, some of all of the slits may extend partly through the strip. In this case, the slits may be provided in a front side of the strip, thereby being open upwardly, and/or in a rear side of the strip, thereby being open downwardly.

Each slit may be defined by two sidewalls along the first edge. In a first embodiment, the sidewalls are vertical. This type of slits may be formed by means of cutting, punching or carving. In a second embodiment, the sidewalls are inclined or curved. Thereby, there are transition regions at the side edges of each slit such that a depth of the slit increases from a minimal depth at a centre portion of the slit to a maximal depth at a side edge of the slit. This type of slits may be formed by means of milling.

The inner and/or outer slit walls may be vertical. According to alternative embodiments, the inner and/or outer slit walls are inclined or curved.

According to one embodiment, a height of the slits in a thickness direction of the panel may be between 10% and 40%, more preferably between 20% and 30%, of a maximal thickness of the first panel.

A width of a slit may be constant or vary along the first edge and/or in a vertical direction, i.e. along a thickness direction. By "width of the slit" is here meant a length of the slit in a direction perpendicular to the vertical plane at a given vertical distance from the rear side of the panel and at a given horizontal distance from a side edge of the edge. In a first non-limiting example, the slit may be wider at a centre portion of the slit than at its side edges, close to the sidewalls. In a second non-limiting example, the slit may be tapering in a vertical direction downwards. In a third non-limiting example, the slit may be tapering in a vertical direction upwards. Any of the embodiments of the slit above may be combined.

A cross section of the locking groove or a cross section of the locking element may vary along the first and the second edge.

The locking system may in a locked position and along the edges comprise a first rigid edge section and a second flexible edge section comprising one of the slits. Optionally, the second flexible edge section may comprise at least two of the slits, in particular a plurality of slits.

By rigid or essentially rigid is meant that during locking the locking element is horizontally displaced by a distance that is less than 2%-20%, e.g. 5%, of a maximal width of the locking element. Moreover, by flexible is meant that

during locking the locking element is horizontally displaced by a distance that is larger than 2%-20%, e.g. 5%, of a maximal width of the locking element.

The first rigid edge section may be configured such that the locking element is in contact with the locking groove and the second flexible edge section may
5 be configured such that there is a space between an inner surface of the locking element and an outer groove wall of the locking groove. In particular, in the first rigid edge section, an inner surface of the locking element may be in contact with an outer groove wall of the locking groove. The space may be provided between essentially the entire inner surface of the locking element
10 and the outer groove wall of the locking groove in the second flexible edge section. Alternatively, the space may be provided only along a vertical distance that corresponds to the active locking surfaces located at the first edge section and configured to lock the panels horizontally. The locking element may engage with the locking groove in a locked position of the
15 panels.

According to one embodiment, the edges may be locked with vertical pretension between lower and upper support surfaces and between upper and lower locking surfaces. The locking element with its upper locking surface may only partly snap back to its original position, preferably less than about
20 80% of a first inward displacement, and may in a locked position be displaced upwardly in relation unlocked position due to inclined upper and lower locking surfaces. This may increase the locking strength considerably, even in the case when the locking element in locked position is only pressed inwardly about 0.1 – 0.2 mm.

25 According to one embodiment, the upper locking surface is provided in the second flexible edge section. The upper locking surface may be removed in the first rigid edge section. Instead, there may be a vertical wall or an essentially vertical wall.

According to one embodiment, the lower locking surface is provided at least
30 in the second edge section. Alternatively, the lower locking surface may be provided along the entire edge of the second panel.

The edge of the first panel may comprise upper and lower stabilizing surfaces that in locked position overlap each other and prevent an upward bending of the slit wall. By overlap is meant that the stabilizing surfaces form a non-zero overlap at least in a direction perpendicular to the vertical plane and also at least along a portion of the edges. The stabilizing surfaces may engage with each other in the locked position. In particular, the stabilizing surfaces may engage with each other with pretension. Moreover, the lower and/or upper stabilizing surfaces may be provided in the second flexible edge section. According to one embodiment, the upper stabilizing surface is a wall portion of a slit. The wall portion may be an upper wall portion of a slit. According to one embodiment, the lower stabilizing surface is an upper portion of the strip. Optionally, the upper portion of the strip may be arranged in an inner part of the strip.

According to a second aspect of the invention a set of essentially identical floor panels are provided having a mechanical locking system comprising a strip extending horizontally from a lower part of a first edge and a downwardly open locking groove formed in an adjacent second edge. The strip comprises a first and a second upwardly protruding locking element. The first locking element is located closer to the upper edge than the second locking element. The first locking element comprises an upper locking surface at its upper and outer part. The second edge comprises a downwardly extending protrusion comprising a lower locking surface at its outer and lower part. The second locking element cooperates with the locking groove and locks the first and the second edge in a horizontal direction parallel to a main plane of a first and a second panel and the upper and lower locking surfaces lock the adjacent edges in a vertical direction perpendicularly to the horizontal direction. The first and the second edge in comprise in locked position a first edge section and a second edge section along the first and the second edge, wherein a cross section of the first locking element or a cross section of the protrusion varies along the first and/or the second edge. The second edge section comprises a first and a second slit extending side by side along the edge. The first slit is located closer to the upper part of the first edge than the second

slit. The second slit is formed between the first and the second locking elements. The locking system is configured to be locked with a vertical displacement of the second edge against the first edge wherein a part of the first locking element and a slit wall of the first and the second slits during an
5 initial stage of the vertical displacement is configured to bend horizontally inwards towards an inner part of the first panel and during a final stage of the vertical displacement is configured to bend outwards towards its initial position.

The upper edge may be an upper edge or upper part of the first edge.

10 The first edge and the second edge may be an edge of the first panel and an edge of the second panel, respectively.

The first edge may comprise upper and lower stabilizing surfaces that in the locked position overlap each other and prevent an upward bending of one of the slit walls.

15 Embodiments of the second aspect of the invention are largely analogous to embodiments of the first aspect of the invention, wherein reference is made to the above. In particular, the characteristics of the slits, the upper and lower locking surfaces and the stabilizing surfaces are analogous. In addition, the upper stabilizing surface may be a wall portion of a first slit. The wall portion
20 may be an upper wall portion of a first slit.

There may be one first slit and one second slit. Alternatively, there may be a plurality of first and/or second slits.

According to a third aspect of the invention a set of essentially identical floor panels are provided with a mechanical locking system is provided. The panel
25 edges comprise a strip extending horizontally from a lower part of a first edge and a downwardly open locking groove formed in an adjacent second edge. The strip comprises an upwardly protruding locking element comprising an upper locking surface at its upper and inner part and the locking groove comprises a lower locking surface at its outer and lower part. The locking
30 element cooperates with the locking groove and locks the first and the second edge in a horizontal direction parallel to a main plane of a first and a second

panel. The upper and lower locking surfaces lock the adjacent edges in a vertical direction perpendicularly to the horizontal direction. The first and the second edge comprise in locked position a first edge section and a second edge section along the first and the second edge, wherein a cross section of the locking element or a cross section of the locking groove varies along the first and/or the second edge. The strip of the second edge section comprises a slit extending along the first edge. The slit is located between the locking element and an upper edge, wherein the locking system is configured to be locked with a vertical displacement of the second edge against the first edge wherein a part of the locking element and a slit wall during an initial stage of the vertical displacement is configured to bend horizontally outwardly and during a final stage of the vertical displacement is configured to bend inwardly towards its initial position.

The first panel, in particular the first edge, may comprise upper and lower stabilizing surfaces that in locked position overlap each other and prevent an upward bending of a part of the locking element.

Embodiments of the third aspect of the invention are largely analogous to embodiments of the first aspect of the invention, wherein reference is made to the above. In particular, the characteristics of the slits and the stabilizing surfaces are analogous. In addition, the slit may be a first slit and the upper stabilizing surface may be an upper wall of a second slit provided in the strip. The first slit may be provided closer to an upper part of the first edge than the second slit. It is noted, however, that according to the third aspect the direction of the bending is reversed as compared to the first aspect.

Additionally, according to one embodiment, there is a space formed between an inner groove wall of the locking groove and the locking element in a locked position of the panels. The space may allow for a horizontal displacement outwardly of the locking element. The space may extend along essentially the entire edge. Alternatively, however, the space may extend along a part of the edge, preferably at least along the second edge section.

According to one embodiment, the upper locking surface is provided in the second edge section. The upper locking surface may be removed in the first edge section. Instead, there may be a vertical wall.

5 According to one embodiment, the lower locking surface is provided at least in the second edge section. Alternatively, the lower locking surface may be provided along the entire edge of the second panel.

According to a fourth aspect of the invention a set of essentially identical floor panels are provided with a mechanical locking system comprising a strip extending horizontally from a lower part of a first edge and a downwardly open locking groove formed in an adjacent second edge. The strip comprises an upwardly protruding locking element and the second edge comprises a downwardly extending protrusion comprising a lower locking surface at its lower and outer part. The locking element cooperates with the locking groove and locks the first and the second edge in a horizontal direction parallel to a main plane of a first and a second panel. The first and the second edge in locked position comprise a first edge section and a second edge section along the first and the second edge, wherein a cross section of the protrusion varies along the first and/or the second edge. The second edge section comprises a first and a second slit extending side by side along the edge. The first slit is located closer to the upper part of an edge, in particular the first edge, than the second slit. The second slit is configured to accommodate the protrusion and the lower locking surface such that the lower locking surface locks against an upper locking surface located at a lower and inner part of the second slit and locks the edges in a vertical direction. The locking system is configured to be locked with a vertical displacement of the second edge against the first edge wherein a flexible strip part located between the first and the second slit during an initial stage of the vertical displacement is configured to bend horizontally inwardly and during a final stage of the vertical displacement is configured to bend outwardly towards its initial position.

10 15 20 25 30

The edge of the first panel, in particular the first edge, may comprise upper and lower stabilizing surfaces that in locked position overlap each other and prevent an upward bending of the flexible strip part.

There may be one first slit and one second slit. Alternatively, there may be a plurality of first and/or second slits.

Embodiments of the fourth aspect of the invention are largely analogous to embodiments of the first aspect of the invention wherein reference is made to the above. In particular, the characteristics of the slits and the stabilizing surfaces are analogous. In addition, the upper stabilizing surface may be a wall portion of a first slit. The wall portion may be an upper wall portion of a first slit.

Furthermore, the upper locking surface may be located at an outer and lower part of the flexible strip part. The flexible strip part may be configured to bend horizontally inwardly into the first slit.

According to one embodiment, the lower locking surface is provided in the second edge section. The lower locking surface may be removed in the first edge section. Instead, there may be a vertical wall.

According to one embodiment, the upper locking surface is provided at least in the second edge section. Alternatively, the upper locking surface may be provided along the entire edge of the second panel.

According to a fifth aspect of the invention a set of essentially identical floor panels are provided with a mechanical locking system comprising a strip extending horizontally from a lower part of a first edge and a first and a second downwardly open locking groove formed in an adjacent second edge. The first locking groove is located closer to the upper edge than the second locking groove. The strip comprises a first upwardly protruding locking element and a second locking element. The first locking element is located closer to the upper edge than the second locking element. The second edge comprises a downwardly extending protrusion comprising a lower locking surface at its lower and inner part. The first locking element cooperates with the first locking groove and locks the first and the second edge in a horizontal direction parallel to a main plane of a first and a second panel. The first and the second edge comprise in locked position a first edge section and a second edge section along the first and the second edge, wherein a cross

section of the protrusion varies along the first and/or the second edge. The second edge section comprises a slit configured to accommodate the protrusion and the lower locking surface such that the lower locking surface locks against an upper locking surface located at a lower and inner part of the second locking element and locks the edges in a vertical direction. The locking system is configured to be locked with a vertical displacement of the second edge against the first edge wherein the second locking element during an initial stage of the vertical displacement is configured to bend horizontally and outwardly and during a final stage of the vertical displacement is configured to bend inwardly towards its initial position.

The first panel, in particular the first edge, may comprise upper and lower stabilizing surfaces that in locked position overlap each other and prevent an upward bending of the second locking element.

Embodiments of the fifth aspect of the invention are largely analogous to embodiments of the first aspect of the invention wherein reference is made to the above. In particular, the characteristics of the slits and the stabilizing surfaces are analogous. In addition, in the second edge section the upper locking surface may be provided in an outer and lower part of the slit. It is noted, however, that in the fifth aspect the direction of the bending is reversed as compared to the first aspect.

According to one embodiment, the slit is a first slit and the second edge section further comprises a second slit, wherein the first and the second slit extend side by side along the first edge, the first slit being located closer to an upper part of the first edge than the second slit. If this embodiment is provided with stabilizing surfaces according to any of the embodiments above, the upper stabilizing surface may be a wall portion of the second slit. The wall portion may be an upper wall portion of the second slit.

There may be one first slit and one second slit. Alternatively, there may be a plurality of first and/or second slits.

According to one embodiment, the lower locking surface is provided in the second edge section. The lower locking surface may be removed in the first edge section. Instead, there may be a vertical wall.

5 According to one embodiment, the upper locking surface is provided at least in the second edge section. Alternatively, the upper locking surface may be provided along the entire edge of the second panel.

According to a sixth aspect of the invention, there is provided a set of essentially identical furniture components provided with a mechanical locking system for locking a first edge of a first furniture component and a second edge of a second furniture component essentially perpendicularly to each other. The first edge comprises a strip extending from the first edge, wherein the strip comprises a locking element. The second edge comprises a locking groove. The locking element is configured to cooperate with the locking groove for locking the first edge and the second edge in a vertical direction perpendicular to an outer surface of the first furniture component and in a horizontal direction perpendicular to an outer surface of the second furniture component. The locking element and the locking groove comprise an upper and a lower locking surface that are configured to lock the furniture components in the vertical direction. The strip comprises a slit located along the first edge, wherein a slit wall of the slit is configured to be bended horizontally inwardly towards an inner part of the first furniture component during locking. The locking system comprises a first rigid edge section and a second flexible edge section along the first and second edges. The second flexible edge section comprises the slit. In a locked position, the first rigid edge section is configured such that the locking element is in contact with the locking groove and the second flexible edge section is configured such that there is a space between an inner surface of the locking element and a groove wall of the locking groove.

30 The edge of the first furniture component may comprise upper and lower stabilizing surfaces that in locked position overlap each other and prevent an upward bending of the slit wall.

Embodiments of the sixth aspect of the invention are largely analogous to embodiments of the first aspect of the invention wherein reference is made to the above. In particular, the characteristics of the slits, upper and lower locking surfaces, and the stabilizing surfaces are analogous. It is noted,
5 however, that the sixth aspect is directed to furniture components.

According to a seventh aspect of the invention, there is provided a set of essentially identical floor panels provided with a mechanical locking system comprising a strip formed in one piece with a core of a first panel and extending horizontally from a lower part of a first edge of the first panel. The
10 locking system further comprises a downwardly open locking groove formed in an adjacent second edge of a second panel, the strip comprising an upwardly protruding locking element which is configured to cooperate with the locking groove for locking the first edge and the second edge in a horizontal direction parallel to a main plane of the panels and in a vertical direction
15 perpendicularly to the horizontal direction. The locking element and the locking groove comprise an upper and a lower locking surface that are configured to lock the panels vertically. The strip comprises slits located along the first edge, and a slit wall is configured to be bended horizontally inwardly towards an inner part of the first panel during locking. The core has a higher
20 content of cured resins at a lower and outer part than at a lower and inner part.

The resin may be a thermosetting resin.

The lower and outer part may comprise at least a portion of the strip.
25 Alternatively, or additionally, the lower and outer part may comprise a portion of the second panel located inside of and/or below an outer part of the lower locking surface.

The core may have a higher content of cured resins at an upper and outer
30 part than at an upper and inner part.

The upper and outer part may comprise a portion inside of an upper edge of the first panel. Alternatively, or additionally, the upper and outer part may comprise a portion inside of an upper edge of the second panel.

- 5 Embodiments of the seventh aspect of the invention are largely analogous to embodiments of the first aspect of the invention wherein reference is made to the above. In particular, the characteristics of the slits, upper and lower locking surfaces, and the stabilizing surfaces are analogous. Additionally, it is emphasized that the feature of having a higher content of cured resins at
10 lower/upper and outer parts than at lower/upper and inner parts may be combined with locking systems according to any of the other aspects of the invention described above.

BRIEF DESCRIPTION OF THE DRAWINGS.

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

- | | |
|-------------------|--|
| Figs 1a-d | illustrates main principles according to an embodiment of the invention. |
| 20 Figs 2a-e | illustrate production methods to form locking systems. |
| Figs 3a-b | illustrate production methods to form locking systems. |
| Figs 4a-b | illustrate production methods to form locking systems. |
| Figs 5a-b | illustrates punching and carving of core material. |
| Figs 6a-e | illustrate an embodiment of a first principle of the invention. |
| 25 Figs 7a-f | illustrate locking according to a first principle. |
| Figs 8a-h | illustrate forming a locking system designed according to the first principle. |
| Figs 9a-d | illustrate forming a locking system designed according to the first principle. |

- Figs 10a-d illustrate an edge of a panel comprising a locking system according to an embodiment of the first principle.
- Figs 11a-d illustrate an edge of a panel comprising a locking system according to an embodiment of the first principle.
- 5 Figs 12a-c illustrate an edge of a panel comprising a locking system according to an embodiment of the first principle.
- Figs 13a-c illustrate an edge of a panel comprising a locking system according to an embodiment of the first principle that is formed with punching.
- 10 Figs 14a-g illustrate an embodiment of a locking system according to a second principle of the invention.
- Figs 15a-b illustrate embodiments with increased locking strength and reduced friction.
- 15 Figs 16a-f illustrate an embodiment of a locking system according to a third principle of the invention.
- Figs 17a-g illustrate an embodiment of a locking system according to the third principle of the invention.
- Figs 18a-d illustrate an embodiment of a locking system according to a fourth principle of the invention.
- 20 Figs 19a-b illustrate an embodiment of a locking system according to the fourth principle of the invention.
- Figs 20a-f illustrate an embodiment of a locking of a locking system according to the fourth principle of the invention.
- 25 Figs 21a-d illustrate an embodiment of a locking system according to a fifth principle of the invention.
- Figs 22a-h illustrate a locking and a forming of a locking system according to the fifth principle of the invention.
- Figs 23a-h illustrate embodiments according to the fifth principle of the invention.

- Figs 24a-f illustrate an embodiment of a locking system according to a sixth principle of the invention.
- Figs 25a-f illustrate an embodiment a locking system according to a seventh principle of the invention.
- 5 Figs 26a-d illustrate forming of locking systems with screw cutters, jumping tools, rotating tools and carving according to an embodiment of the invention.
- Figs 27a-b illustrate an embodiment of a locking system for furniture components according to an eighth principle of the invention.
- 10 Figs 28a-d illustrate a method to strengthen edge portions according to an embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION.

The embodiments in figures 1a – 1d are used to explain some main problems related to flexible locking elements made in one piece with a core and some
 15 basic principles of the inventive concept.

Locking systems comprising flexible and bendable parts formed in one piece with the core are to a major extent dependent of the material properties and thickness of the core that may vary between various core materials and between the same type of core materials. Each locking system must be
 20 formed with a specific geometry that is optimized in relation to the properties and thickness of the specific floor panel. This means that a locking system must provide a variety of alternative geometries and principles that could be combined in order to meet the requirements of normal tolerances used in a cost efficient high speed production, locking strength, easy and reliable
 25 installation. The inventive concept provides several principles that may be combined and may be used to form a locking system in a specific floor panel.

Figure 1a is a plan view of an edge of a first 1 and a second 1' panel according to an embodiment. A cutting tool, for example a jumping tool head, a rotating carving tool or a punch, may be used to cut an upwardly and
 30 downwardly open slit 20 in the core material 5 and a flexible tongue 10

comprising a locking surface 11 may be formed adjacent to the slit 20. The flexible tongue 10 is provided outwardly of the slit 20. The slit 20 comprises an outer slit wall 20a, an inner slit wall 20b and two slit sidewalls 20c, 20d. The slit and the tongue have a length direction L along the joint and a

5 thickness T in the vertical direction as shown in figure 1c. The flexible tongue 10 has a width W in a horizontal direction that is perpendicular to the length direction and to the thickness direction. According to the present embodiment, the width W varies along the first edge in an unlocked position of the panels 1, 1'. Indeed, the width W is larger at a location of the locking surface 11,

10 which protrudes outwardly in the horizontal direction, than at a location along the edge next to the locking surface 11. Moreover, the open slit 20 has a width W' in a horizontal direction which is perpendicular to the length direction and to the thickness direction. According to the present embodiment, in an unlocked position the width W' is constant along the first edge as well as in

15 the thickness direction.

Figure 1b shows the flexible tongue 10 in figure 1a in a bended position when an edge of the second panel 1' presses the flexible tongue 10 and the outer slit wall 20a inwardly during locking. During locking the locking surface 11 engages with the edge of the second panel 1'. Tests of various core

20 materials, especially wood based core materials such as HDF, show that the tongue 10 generally comprises three tongue portions P1, P2, P3 with essentially different properties that will be described next in non-limiting embodiments. The two end portions P1 located close to the slit sidewalls 20c, 20d are only possible to bend slightly inwardly and cannot be used to

25 accommodate a locking surface 11 that must be displaced over a specific distance in order to provide a sufficient locking strength. The middle section P3 may accommodate a locking surface but such tongue part is very easy to bend inwardly but also upwardly as shown in the embodiments in figures 1c and 1d and the locking strength in this part of the flexible tongue is generally

30 not sufficient. According to the present embodiment, only the two active portions P2 located between the end portions P1 and the middle portion P3 comprises sufficient flexibility and sufficient locking strengths. Known flexible

tongues are such that only about 20% of the length L of the flexible tongue may be used for a vertical locking of adjacent edges. The major part of the tongue 10 is either not possible to bend or is too weak to provide a sufficient locking strength.

- 5 One solution to this problem would be to form a lot of small flexible tongues along the edge configured such that they are rather easy to bend horizontally inwardly during the vertical folding but hard to bend vertically upwards in locked position. This may be accomplished with several small flexible tongues that are not possible to form with the known production methods and
- 10 especially not tongues which must be formed by rotating tools that form deep cavities in a core material and that are only open in one direction vertically or horizontally. One solution is to form the small tongues with a thickness T that is larger than the width W and this provides a horizontal flexibility that exceeds the vertical flexibility. Removal of material that may be accomplished
- 15 by forming an open slit 20 or just by removing material from an edge provides major advantages related to forming of an appropriate joint geometry.

Another solution to this problem would be to form a locking system comprising a stabilizing edge section 17 as shown in figure 1c that may be used to prevent upward bending of the flexible tongue 10 in locked position.

- 20 This may be accomplished with a locking system comprising a flexible tongue 10 that in a final locked position is slightly bended such that a part of the tongue 10 overlaps a stabilizing part 17 located above a part of the tongue. An advantage is that the stabilizing part will be most active at the weak middle portion P3 that may be most bended in locked position. Such geometry
- 25 makes it possible to form flexible tongues 10 comprising sufficient locking strengths and flexibility along 50% or more of the tongue length L.

- The locking system according to embodiments of the invention is three dimensional and comprises preferably a first rigid edge section 7a having a vertically protruding locking element 8 for horizontal locking and a second
- 30 flexible edge section 7b comprising a flexible slit 20 that may be bended inwardly such that a distance between the outer 20a and inner 20b slit walls decreases during bending and/or outwardly such that the distance between

the slit walls 20a, 20b increases during bending. The distance may be a minimal distance between the outer 20a and inner 20b slit walls. The first rigid edge section 7a and the second flexible edge section 7b are provided along the edges of the first 1 and second 1' panels. In figures 1a-d the second
5 flexible edge section 7b is provided in a centre section of the edges of the panels 1, 1' and first rigid edge sections 7a are provided on both sides of the second flexible edge section 7b. The first rigid edge sections 7a may be provided at corner sections of the edges. According to the present
10 embodiment, there is no locking element 8 provided in the second flexible edge section 7b.

Figures 2 - 5 show production methods that may be used to form three-dimensional locking systems according to embodiments of the invention. In particular, the production methods may be used for producing cavities, protrusions, grooves and slits according to any of the principles of the present
15 disclosure. Figure 2a shows a tool comprising several rotating saw blades 40 that are displaced against a panel edge 1 and back again. Alternatively, the panel 1 may be displaced against the saw blades 40 and back again. This production method may be used to form cavities 37 or protrusions 36 as shown in figures 2b and 2c.

20 Figure 2d shows a top view of a so-called screw cutter 41. This is an advanced production technology that allows high precision and cost efficient forming of protrusions 36 and cavities 37 perpendicular to a panel edge 1 that is displaced in high speed against the screw cutter. WO 2010/087752 provides a detailed description of the screw cutter principle. The resulting
25 protrusions 36 and cavities 37 are shown in figure 2e.

Figure 3a and 3b show a panel 1 with a surface 2 pointing downwards and carving tool 44 that may be used to form an undercut groove 38 that is not possible to form with large rotating tools since a tangent line TL to a part of the undercut groove intersects the panel edge. The carving tool is fixed and
30 the panel 1 is displaced against the carving tool. A more detailed description of carving may be found in WO 2013/191632.

Figure 4a shows a so-called rotating jumping tool head 43 that may be displaced vertically or horizontally against a moving panel edge 1 and that may be used to form a slit 20. Figure 4b is a side view of a jumping tool head that is displaced vertically up and down but also along the feeding direction of a panel 1. The jumping tool head may move horizontally parallel with the panel edge and with a speed that is somewhat lower than the speed of the panel. Several slits 20 may be formed one after each other in the feeding direction and at high speed. Several jumping tools may also be used. One jumping tool may form a first, a third and a fifth slit 20 and another jumping tool may form a second and a fourth slit.

Figure 5a shows a rotating punching tool set 45 comprising a punching wheel 45a and a die wheel 45b. Such tools may be used to punch slits 20 or to remove material from a panel 1 comprising for example LVT, WPC or HDF material. The punching process produces residual material 21 that may be recycled. The punched slits may have various shapes, for example oval, circular or rectangular and the walls are preferably vertical. Figure 5b shows another cost efficient method to form slits 20 with a rotating carving tool 48. The tool rotation is synchronized with the displacement of the panel 1 and each tooth 49 forms one slit at a predetermined position and with a predetermined horizontal extension along an edge of a panel 1. It is not necessary to displace the carving tool vertically. A carving tool 48 may have several sets of teeth 49 and each set may be used to form one cavity. The cavities may have different cross sections depending on the geometry of the teeth. The panel 1 may be displaced along or against the tool rotation.

Figure 6a shows vertical folding of a second panel 1' that is angled against a previously installed panel 1'' in a previous row and wherein this angling action also connect a short edge of the second panel 1' to a short edge of a first panel 1. The short edges of the first 1 and the second 1' panels are locked with a scissor like movement wherein the short edges are gradually locked from one long edge to the other long edge. The adjacent short edges of the first and the second panels 1, 1' have along its edges a first joint edge section 7a that preferably becomes active during a first initial step of the folding action

and a second joint edge 7b section that becomes active during a second stage of the folding action. It is clear that there may be additional joint edge sections 7a, 7b that subsequently become active. For example, the first joint edge sections 7a, 7b that subsequently become active. For example, the first joint edge section 7a and the second joint edge section 7b may be arranged alternately, e.g. as {7a, 7b, 7a, ..., 7a, 7b, 7a} with first joint edge sections 7a at corner sections of the edges. As will be described below, the first joint edge section may be a first rigid edge section 7a and the second joint edge section may be a second flexible edge section 7b.

Figures 6b – 6e show an embodiment according to a first principle of the invention. A set of similar floor panels 1, 1' is provided wherein each floor panel preferably comprises a surface layer 2, a core 5, a balancing layer 3 and a first and a second short edge. As shown in figure 6b, the adjacent edges are initially formed with a geometry that only allows a locking with a sideways sliding action where the panel edges are inserted into each other with a horizontal displacement along the short edges. The panels are not possible to lock with angling, horizontal snapping or vertical snapping.

The edges are in a second step adjusted and a part of the material at the edges is removed as shown in figures 6c and 6d such that a first short edge of a first floor panel 1 may be locked to an adjacent second edge of a similar second floor panel 1' with a vertical displacement of the second edge against the first edge. The vertical displacement is a vertical scissor movement caused by the same angling action that is used to connect the long edges of the panels. The first edge comprises a horizontally protruding strip 6 with a vertically protruding locking element 8 at its outer part that cooperates with a downwardly open locking groove 14 formed in the adjacent second edge.

The locking element comprises an inner surface 8a, an outer surface 8b and an upper surface 8c. The inner surface 8a is closer to the upper edge 25 of the first panel 1 than the outer surface 8b. By upper edge 25 of the first panel 1 is meant an upper part of the first edge of the first floor panel 1. The locking groove 14 comprises an outer groove wall 14a, an inner groove wall 14b and an upper groove wall 14c. The outer groove wall 14a is closer to the upper edge 25' of the second panel 1' than the inner groove wall 14b. By upper

edge 25' of the second panel 1' is meant an upper part of the second edge of the second floor panel 1'. The locking element 8 comprises an upper locking surface 11a formed in the outer surface 8b of the locking element 8 that in a locked position of the panels 1, 1' cooperates with a lower locking surface 11b formed in the inner groove wall 14b and that locks the adjacent edges in a vertical direction. According to the present embodiment, the upper 11a and lower 11b locking surfaces are inclined against a horizontal plane. In non-limiting examples, the inclination angle may be between 0° and 45°, more preferably between 5° and 25°, e.g. 20°. The locking element 8 comprises a first locking surface 12a formed in the inner surface 8a of the locking element 8 that in a locked position cooperates with a second locking surface 12b formed in the outer groove wall 14a and that locks the adjacent edges in a horizontal direction. According to the present embodiment, the first 12a and second 12b locking surfaces are essentially vertical walls. The second edge comprises a projection 26 that is adapted to engage with an indentation 28 in the first edge in a locked position. The edges comprise lower and upper support surfaces 15, 16 that in a locked position cooperate with the upper and lower locking surfaces 11a, 11b and prevent the edges to be displaced vertically downwards and vertically upwards. According to the present embodiment, the lower support surface 15 is provided in the first panel 1 between the upper edge 25 and an inner surface 28a of the indentation 28, and the upper support surface 16 is provided in the second panel 1' between the upper edge 25' and an outer surface 26a of the projection 26. Moreover, the lower support surface 15 is provided adjacent to the upper edge 25 and the upper support surface 16 is provided adjacent to the upper edge 25'. According to the present embodiment, the lower and upper support surfaces 15, 16 are horizontal but it is understood that inclined lower and upper support surfaces are equally conceivable.

Adjacent edges comprise in locked position a first essentially rigid edge section 7a and a second flexible edge section 7b as shown in figure 6c and 6d, respectively. The edge sections are characterized in that a cross section of the locking groove 14 and/or a cross section of the locking element 8 varies

at a horizontal plane H along the adjacent edges 1, 1' which are formed with a basic geometry as shown in figure 6b that is thereafter modified such that the first 7a and the second 7b cooperating edge sections are formed with different geometries and different locking functions as shown in figures 6c and 6d.

It is understood that according to alternative embodiments the geometries according to figures 6c and 6d may be formed directly without first forming a basic geometry as in figure 6b.

The first edge section 7a is preferably a start section that becomes active during a first initial step of the folding action and the second edge section 7b is preferably a section that becomes active during a second step of the folding action.

Figure 6c shows a first cooperating edge section 7a that is used to prevent edge separation during locking and to lock adjacent edges horizontally in the locked position. The first edge section 7a has no vertical locking function since one of the locking surfaces, the upper 11a or as shown in this preferred embodiment the lower locking surface 11a, has been removed. The first 12a and the second 12b locking surfaces are preferably vertical and they are used to guide the second panel 1' during the vertical displacement along a vertical plane VP that intersects the upper and outer edge of the first panel 1.

Figure 6d shows the second edge section 7b that is used to lock the adjacent edges vertically. The second edge 7b section cannot prevent horizontal edge separation and has no horizontal locking function since a part of the locking element 8 and/or the locking groove 14 has been removed in order to form a space S along a horizontal plane H and a slit 20 adjacent to the locking element allows the locking element 8 to be displaced inwardly during locking. The slit 20 is preferably located closer to the upper edge 25 of the first panel 1 than the locking element 8. This inward displacement enables the upper 11a and lower 11b locking surfaces to overlap and lock against each other when the second edge 1' is displaced vertically along the vertical plane VP until a final position where lower 15 and upper 16 support surfaces are in

contact with each other. All shown and described locking systems are primarily intended to be used on the short edges. However, it is not excluded that the disclosed embodiments of locking systems may be used on short and/or long edges and the panels may be locked with a vertical displacement of long and/or short edges.

In figures 6c and 6d the cross section in the first rigid edge section 7a is different from the cross section in the second flexible edge section 7b due to the space S and/or the slit 20 and therefore the cross section varies along the edges.

The panel edges may also comprise a second horizontally extending tongue 50 and a tongue groove 51 formed in the upper part of the panels as shown in figure 6d and inclined first and second locking surfaces 12a, 12b (not shown) such that they may be locked with an angling action wherein the upper and lower locking surfaces 11a, 11b may prevent the strip to bend down when a horizontal separation force is applied after locking. This may be used to increase the locking strength at for example at the long and/or short edges, especially in soft LVT material.

Figure 6e shows that it may be a major advantage to lock the edges with vertical pretension between lower and upper support surfaces 15, 16 and between upper and lower locking surfaces 11a, 11b. The locking element 8 with its upper locking surface 11a at the second edge section 7b will only partly snap back to its original position, preferably less than about 80% of the first inward displacement, and will in locked position be displaced upwardly in relation to an unlocked position due to the inclined upper and lower locking surfaces 11a, 11b. This may increase the locking strength considerably, even in the case when the locking element in locked position is only pressed inwardly about 0.1 - 0.2 mm.

Figures 7a – 7c show locking of the first adjacent edge sections 7a. The second panel 1' is displaced essentially along a vertical plane VP until the first and second locking surface 12a, 12b are in contact with each other and a

horizontal edge separation is prevented until the edges are in a final locked position.

Figures 7d - 7f show locking of the second edge section 7b. A lower part of the second panel slides against a sliding surface 27 formed on the outer surface 8b, which is an outer part of the locking element 8. The separation forces are prevented by the first edge section 7a that is in a locking stage with overlapping first and second locking surfaces 12a, 12b. The locking element 8 adjacent to the slit 20 is pressed inwardly by the lower part of the second panel 1' until the edges are in a final locking position when the locking element 8 snaps back towards its initial position such that the upper 11a and the lower 11b locking surfaces lock against each other and prevent vertical separation of the adjacent panel edges 1, 1'.

Figures 8a - 8c show that a screw cutter 41 may be used to remove the outer part of the locking element 8 from a first panel edge 1 in order to form a part of first edge section 7a.

Figures 8d - 8f show that a jumping tool 43 may be used to form the second flexible section 7b by removing a part of the inner surface 8a of the locking element 8 and a part of the strip 6 in order to create a space S and to form a slit 20. The jumping tool is initially positioned above the strip 6.

Figure 8g and 8h show that similar removal may be obtained with a jumping tool 43 that initially is positioned below the strip. The difference between these two production methods is mainly the fact that more material is removed at the entrance side where the tool initially is positioned than at the exit side. This may be used to form locking systems with a geometry that may be suitable for a strong vertical locking or a strong horizontal locking and the locking system may be adapted to various material properties of the core material. Figure 8h shows that the thickness T of the flexible locking element 8 may be larger than the width W and such a locking element is easier to bend horizontally inwardly than vertically upwards. Low locking resistance during vertical folding may be combined with a strong vertical locking force in locked position.

Figures 9a - 9d show that the first rigid edge section 7a may be formed with a jumping tool 43 or a screw cutter 41 that removes a lower part of the locking groove 14 and the lower locking surface 11b.

Figures 10a - 10b show an embodiment of a first panel 1 comprising two long edges 4a, 4b and a short edge 4c. The panel may be a laminate floor panel comprising an HDF core with a thickness of 6-9 mm. Figure 10a is a plan view of the panel 1. The short edge 4c may have a width of about 18 – 20 cm. Four slits 20-1, 20-2, 20-3, 20-4 may be formed in the strip 6 with a jumping tool head comprising a rotating cutting tool with a diameter of for example 4 – 10 cm. Such rotating cutting tools may have a sufficient capacity to form slits in high speed especially if the vertical displacement of the cutting tool may be as small as about 3 - 5 mm. Figure 10b shows a cross section of a part of the first rigid edge section 7a that is located between the slits 20-1, 20-2, 20-3, 20-4 along the edge and preferably at the end portions of the strip 6 adjacent to the long edges 4a, 4c. The outer part of the locking element 8 is removed by a screw cutter 41. Figure 10c shows a cross section of the second flexible edge section 7b that comprises a slit 20 and an upper locking surface 11a. The shown embodiment comprises five rigid first edge sections 7a and four flexible second edge sections 7b and this is sufficient to provide a strong vertical and horizontal locking especially when the locking element 8 preferably has a thickness that exceeds the width. It is clear, however, that any number of rigid first edge sections 7a and flexible second edge sections 7b may be used. Figures 10c and 10d shows that the slit 20-3 may be formed with a jumping tool head 43 that initially is located above the strip 6. According to the present embodiment, a length L2 of an upper part of the slit 20 is larger than a length L1 of the lower part of the slit 20 and a length L3 of the space S. Such joint geometry may be favourable in some core materials and some core thicknesses.

Figures 11a – 11d show the same basic embodiment as figures 10a -10d. The only difference is that the jumping tool 43 is initially located below the strip 6. The length L2 of the upper part of the slit 20 is smaller than the length L1 of the lower part of the slit 20 and the length L3 of the space S.

A slit 20 that may be formed from above and/or from below provides the advantages that relationships between vertical and horizontal locking surfaces and the flexibility of the flexible edge section may be adjusted in an easy way and adapted to the properties of the core material.

- 5 Figures 12a - 12c show a panel that may be a LVT or WPC floor panel having a core comprising thermoplastic material and fillers with a thickness of about 3-5 mm. The short edge 4c may have a width of about 18 – 20 cm. The small thickness makes it possible to form more than four slits in the strip 6 with a jumping tool head, for example six slits as shown in figure 12a. The shown
10 non-limiting embodiment may comprise preferably up to seven rigid first edge sections 7a and up to six flexible second edge sections 7b and this is sufficient to provide a strong vertical and horizontal locking over essentially the whole short edge 4c in thin core material.

- Figures 13a – 13c show that the number of sections 7a, 7b may be increased
15 further if a punching wheel 45 is used that may remove material such that the slits 20 and protrusions 36 may be formed with essentially vertical walls and with advanced geometries. Such forming is especially suitable for floor panels comprising a core of thermoplastic material such as LVT and WPC core material. Such a locking system may comprise a slit 20 with a length L that is
20 smaller than 2-3 times the floor thickness FT. A short edge may comprise more than ten slits 20.

- Figures 14a – 14g show a second principle of the invention. A locking system is initially formed with a geometry that is not possible to lock even when the edges are displaced sideways along the joint since the horizontal distance
25 from the vertical plane VP to the upper locking surface 11a is larger than the distance from the vertical plane VP to the lower locking surface 11b as shown in figure 14a. Material is thereafter removed from the locking element 8 as in the first principle. According to the present embodiment, the outer surface 8b in the first edge section 7a has a concave shape so that a horizontal
30 extension of an upper and a lower portion of the locking element from the vertical plane VP is larger than a horizontal extension of a middle portion of the locking element between the upper and lower portion. Alternatively,

however, the outer surface 8b may be planar in a vertical direction. Moreover, a slit 20 is formed in the second edge section 7b, preferably with a very small opening 20e that may be as small as for example 0.05-0.5 mm, e.g. 0.1 mm, or practically even non-existent as long as material above the slit may be

5 separated. Figures 14d, 14f show that the first edge section 7a is locked in a similar way as shown in figures 7a – 7c. The upper part of the slit 20 comprises an upper stabilizing surface 18 and the upper part of the strip 6 comprises a lower stabilizing surface 19 as shown in figure 14e. In an

10 unlocked position of the panels 1, 1', the upper stabilizing surface 18 is provided inwardly of the lower stabilizing surface 19. The flexible part of the strip 6 is during locking displaced inwardly and the stabilizing surfaces 18, 19 will overlap each other horizontally as shown in figure 14e. The flexible part of the strip 6 will during the final stage of the vertical displacement slide back partly towards its initial position but not completely until the upper 11a and

15 lower 11b locking surfaces are in contact with each other and the locking system will be locked with a horizontal pretension and with overlapping upper 18 and lower 19 stabilizing surfaces. There is a space S provided in the second flexible edge section 7b into which the locking element is displaced during locking. In a locked position of the panels 1, 1', the space is provided

20 between an inner surface 8a of the locking element 8 and an outer groove wall 14a of the locking groove 14. For example, the space S may be formed by removal of material.

As shown in figure 1b the bending of a flexible tongue is at its maximum position in the middle portion P3 where the vertical locking strength is low and

25 this middle section may be stabilized with stabilizing surfaces that may overlap each other with for example 0.1 – 0.5 mm. This is sufficient to stabilize a flexible part formed by a slit 20.

Stabilizing surfaces allow that the length of the slit may be increased and in some applications only one or two slits may be sufficient.

30 Figures 15a and 15b show that a wax layer 22 may be applied on all parts that are in contact with each other, especially on surfaces adjacent to the upper 11a and lower 11b locking surfaces for example the sliding surface 27

and on first 12a and second 12b locking surfaces. This may reduce friction forces during locking. Core material adjacent to the upper and lower locking surfaces 11a, 11b may also be reinforced with for example resins that are injected into the core or applied on the contact surfaces. The present
5 embodiment may be combined with all principles in the disclosure.

Figure 16a – 16f show an embodiment of a locking system according to a third principle of the invention. Such a locking system may be used when a high horizontal strength is needed for example in a floating floor that is installed in a large commercial area. The slit 20 may be formed in the locking
10 element 8 and the first and the second edge section 7a, 7b may comprise a rigid locking element 8' that is continuous and that extends essentially along the whole edge. Figure 16c shows a slit 20 that is formed with a jumping tool from above and figure 16f shows a slit 20 that is formed from below. Punching may also be used. The present embodiment may be combined with all
15 principles in the disclosure.

Figures 17a - 17c show that a preformed groove 30 may be formed along essentially the whole locking element 8 and a slit 20 may be formed from below in the second edge section. Figures 17d – 17f show that the preformed groove may be formed in the lower part of the strip 6 and the slit 20 may be
20 formed from above the locking element. Figure 17g shows an edge of a first panel 1 comprising a continuous locking element 8' located between the slit 20 and the upper edge 25 of the first panel 1. According to alternative embodiments (not shown) the preformed groove 30 may extend along a part of the locking element 8. In a first non-limiting example, an extension of the
25 preformed groove 30 is the same or larger than an extension of the slit 20. In a second non-limiting example, the preformed groove 30 extends side by side with the slit 20. The present embodiment may be combined with all principles in the disclosure.

Figures 18a – 18d show a locking system according to a fourth principle of
30 the invention. The strip 6 in the first panel 1 comprises a first 8 and a second 8' upwardly protruding locking element. The first locking element 8 is located closer to the upper edge 25 of the first panel 1 than the second locking

element 8'. The edge of the second panel 1' comprises a downwardly extending protrusion 36a. The downwardly extending protrusion 36a is provided outside of a locking groove 14 provided in the second panel 1'. The locking groove 14 is configured to engage with the second locking element 8' in a locked position of the panels 1, 1'. An upper locking surface 11a is formed in an upper and outer part of the first locking element 8 and a lower locking surface 11b is formed at a lower and outer part of the protrusion 36a.

There is provided a first rigid edge section 7a and a second flexible edge section 7b along the edges of the first 1 and second 1' panels. The first 7a and second 7b edge sections may be arranged according to any of the embodiments described in the above. Figure 18b shows that the first rigid edge section 7a may be formed such that the upper 11a or the lower 11b locking surface is removed. The second edge section 7b may be formed with a jumping tool 43 or punching. Figures 18c and 18d show the second edge section 7b that comprises a first and a second slit 20, 20' located horizontally side-by-side. The first slit 20 is located closer to the upper edge 25 of the first panel 1 than the second slit 20'. The slits allow the first locking element 8 and the upper locking surface 11a to be displaced inwardly during locking. The locking system is configured to be locked with a vertical displacement of the second edge against the first edge wherein a part of the first locking element 8 and a slit wall of the first and the second slits during an initial stage of the vertical displacement is configured to bend horizontally inwards towards an inner part of the first panel 1 and during a final stage of the vertical displacement is configured to bend outwards towards an initial position of the part of the first locking element 8.

Preferably, a preformed groove 30 is formed adjacent to the vertical plane VP that intersects the upper edge 25 of the first panel edge 1.

Figures 19a, 19b show a plan and perspective view of a short edge of a first panel 1 comprising a locking system according to the fourth principle of the invention. According to this embodiment, there are a five first rigid edge sections 7a and four second flexible edge sections 7b provided alternately along the edge of the first panel 1. The first 7a and second 7b edge sections

are illustrated in cross-section along a line A-A and a line B-B, respectively, in the enlargements in Figure 19a. Figure 19b illustrates a perspective view of a second edge section 7b. The first 20 and the second 20' slits are provided along portions of the edge of the first panel 1. According to the present
5 embodiment, the first 20 and the second 20' slits are provided side by side and have substantially the same extension along the edge, but it is understood that according to alternative embodiments they may have different extensions. In a first example, the first slit 20 has a longer extension than the second slit 20' along the edge. In a second example, the first slit 20
10 has a smaller extension than the second slit 20' along the edge.

Figures 20a – 20f show that the principles of the invention may be combined, for example the fourth and the second principle. The upper locking surface 11a is formed in an edge of a first panel 1 and is located above the strip 6 and between the locking element 8 and the upper edge 25 of the first panel 1 and
15 the lower locking surface 11b is formed in an edge of a second panel 1' between the locking groove 14 and the upper edge 25' of the second panel 1'. There is provided at least one first rigid edge section 7a and at least one second flexible edge section 7b along the edges of the first 1 and second 1' panels in accordance with any of the embodiment of the disclosure. The
20 second flexible edge section 7b comprises a strip 6 having two slits 20, 20' and the locking is made with pretension and overlapping upper and lower stabilizing surfaces 18, 19 as described above in relation to the second principle of the invention.

Figures 21a – 21d show a locking system of edges of a first 1 and a second 1' panel according to a fifth principle. There is provided at least one first rigid
25 edge section 7a and at least one second flexible edge section 7b along the edges of the first 1 and second 1' panels in accordance with any of the embodiment of the disclosure. The upper locking surface 11a is formed on the inner surface of the locking element 8 in the second flexible edge section 7b and the lower locking surface 11b is formed on the outer groove wall 14a
30 of the locking groove 14 along the entire edge of the second panel 1'. As shown in Figure 21b, the first rigid edge section 7a does not comprise any

upper locking surface 11a and provides horizontal locking of the panels since the edge of the second panel 1' comprises a projection 26 that is adapted to engage with an indentation 28 in the edge of the first panel 1 in a locked position. More specifically, a first locking surface 12a in an inner surface 8a of the locking element 8, which is a vertical wall in the first rigid edge section 7a, engages with a second locking surface 12b in an outer groove wall 14a of the locking groove 14, and an upper edge 25 of the first panel 1 engages with an upper edge 25' of the second panel 1' for providing horizontal locking. The upper 11a and lower 11b locking surfaces provide vertical locking of the panels 1, 1'. A part of the locking element 8 and a slit wall of the slit 20 is during an initial stage of a vertical displacement of the panels 1, 1' configured to bend horizontally outwardly and during a final stage of the vertical displacement configured to bend inwardly towards an initial position of the part of the locking element 8. A space S and a slit 20 are provided in the second flexible edge section(s) 7b as shown in Figure 21c. The space S that preferably extends along essentially the whole edge and that allows a horizontal displacement outwardly of the locking element 8 is formed between an inner groove wall 14b of the locking groove 14 and the locking element 8 in a locked position of the panels 1, 1'. Figure 21d illustrates a perspective view of the first panel 1 in the first rigid edge section 7a and the second flexible edge section 7b. The upper 11a and lower 11b locking surfaces are preferably essentially horizontal and comprises a locking angle against the horizontal plane that is less than 45 degrees, e.g. 10, 15, 20 or 25 degrees. Such locking surfaces are preferably formed with carving tools.

Figures 22a – 22c show locking of the first rigid edge section 7a and figures 22d – 22f show locking of the flexible second edge section 7b when the locking element 8 is initially displaced outwardly, and inwardly during the final stage of the vertical displacement of the edge of the second panel 1' against the edge of the first panel 1. As shown in Figure 22e, the locking element 8 is horizontally displaced outwardly into the space S during locking. Figures 22g and 22h show that the slit 20 may be formed with a jumping tool head from above or below, respectively.

Figures 23a – 23h show embodiments of the invention. Figures 23a – 23d show that the fifth principle may be combined with the second principle and that a crack 23 in the core material may be used to form upper and lower 18, 19 stabilizing surfaces. In a non-limiting example, the core material may
5 comprise an HDF board that comprises an essentially horizontal fibre orientation. Due to the crack 23, an inner and an outer portion of the strip 6 which initially are joined may be separated during locking when the locking element 8 is displaced outwardly. Figures 23e and 23f show that two slits 20, 20' may be formed in a locking system according to the fifth principle. Figures
10 23g and 23h show that as an alternative the lower locking surfaces 11b may be removed with a jumping tool 43 or a screw cutter 41 in a locking system according to the fifth principle in order to form the rigid first edge section 7a. More generally, it is emphasized that embodiments of all the principles of the invention may be combined.

15 Figures 24a - 24f show a sixth principle of the invention. An edge of a first panel 1 comprises a strip 6 with a locking element 8 and an edge of a second panel 1' comprises a downwardly open locking groove 14. The locking element 8 is configured to engage with the downwardly open locking groove 14 in a locked position. Upper 11a and lower 11b locking surfaces that lock
20 the edge of the first panel 1 to the edge of the second panel 1' vertically are located at a lower part of the strip 6 and at an outer and lower part 32 of an downwardly extending protrusion 36a, respectively, wherein the protrusion 36a is formed between the locking groove 14 and the upper edge 25' of the second panel 1' as shown in figure 24a. A part of the protrusion 36a and the
25 lower locking surface 11b is removed by for example a screw cutter or jumping saw blades and a first rigid edge section 7a is formed as shown in figure 24b. A second flexible edge section 7b comprises a first slit 20 and a second slit 20'. The first slit 20 is located closer to the upper edge 25 of the first panel 1 than the second slit 20'. The first slit 20 and the second slit 20'
30 extend along the edge of the second panel 1'. The first 20 and second 20' slit may extend side by side along the edge. An extension of the first slit 20 may be the same as an extension of the second slit 20'. However, it is equally

conceivable that the slits have different extensions along the edge as has been explained above in relation to other principles. The upper locking surface 11a is located at a lower and inner part of the second slit 20'. The first slit 20 provides flexibility such that a flexible strip part 31 located between the first and the second slit may be displaced horizontally inwardly and back again during locking as shown in figures 24d and 24e. The second slit 20' is used to accommodate the protrusion 36a that during a vertical displacement of the edge of the second panel 1' towards the edge of the first panel 1 is inserted into the second slit such that the upper 11a and the lower 11b locking surfaces overlap each other and lock the edges of the first 1 and the second 1' panel vertically. Figure 24f show that the sixth principle may be combined with the second principle and that the locking system may comprise a flexible strip part 31 that is locked with pretension and upper and lower stabilizing surfaces 18, 19 that stabilize the flexible strip part 31 and prevent upward bending. The locking system is particularly suitable for thin LVT and WPC floors but may also be used in HDF floors and other floor types. An advantage is that the protrusion 36a and the locking element 8 may be strong and rigid since no flexibility of such parts is required to lock the edges with a vertical displacement.

Figures 25a - 25f show a seventh principle of the invention that is a modification of the sixth principle. An edge of a first panel 1 comprises a strip 6 with a first 8 and a second 8' locking element 8. The first locking element 8 is located closer to the upper edge 25 of the first panel 1 than the second locking element 8'. An edge of a second panel 1' comprises a first downwardly open locking groove 14 and a second downwardly open locking groove 14'. The first locking groove 14 is located closer to the upper edge 25' of the second panel 1' than the second locking groove 14'. The first locking element 8 and the first locking groove 14 lock the edges horizontally in a locked position of the panels 1, 1'. An upper locking surface 11a is located at a lower and inner part of the second locking element 8' and a lower 11b locking surface is located at a lower and inner part 33 of a downwardly extending protrusion 36a formed on an edge of the second panel 1' between

the first 14 and the second 14' locking groove. The upper 11a and lower 11b locking surfaces lock the edges vertically in a locked position of the panels 1, 1'. A part of the protrusion 36a and the lower locking surface 11b is removed by for example a screw cutter or jumping saw blades and a first rigid edge section 7a is formed as shown in figure 25b. A second flexible edge section 7b comprises a slit 20 that provides flexibility such that the second locking element 8' may be displaced horizontally outwardly and at least partly back again during locking as shown in figures 25d and 25e. The slit 20 is used to provide flexibility and to accommodate the protrusion 36a that during a vertical displacement of the edge of the second panel 1' towards the edge of the first panel 1 is inserted into the slit 20 such that the upper 11a and the lower 11b locking surfaces overlap each other and lock the edges of the first 1 and the second 1' panel vertically. Figure 25f shows that the seventh principle may be combined with the second principle as shown in figure 23e and the locking system may comprise a flexible outer stabilizing strip part 34 and a second locking element 8' that is locked with pretension against the protrusion 36a such that upper and lower stabilizing surfaces 18, 19 overlap each other.

Figure 26a shows an edge of a first panel 1 that is positioned between a chain 46 and a belt 47 of a double-end tenor with its surface 2 pointing downwards. A screw cutter 41 may be used to remove material at an outer part of a strip 6. Figure 26b shows a jumping tool 43 that is used to form slits 20. Figure 26c shows rotating tools 42 that are used to form vertical grooves from above and below and figure 26d shows that essentially horizontal upper 11a and lower 11b locking surfaces may be formed with carving tools 44 in the vertical grooves formed by rotating tools.

Figures 27a and 27b show that all embodiments of the invention disclosed in the above may be used to lock for example furniture components where a second panel 1' comprising a locking groove 14 is locked vertically and perpendicularly to a first panel 1 comprising a strip 6 and with a locking element 8. The locking groove 8 is configured to engage with the locking groove 14 in a locked position of the panels 1, 1'. The panels 1, 1' may have

a first rigid edge section 7a providing horizontal locking of the panels 1, 1' and a second flexible edge section 7b comprising a slit 20 and upper 11a and lower 11b locking surfaces as described in the embodiments above.

According to the embodiment in figures 27a-b there is a space S provided in the second flexible edge section 7b between an inner surface 8a of the locking element 8 and a groove wall 14a of the locking groove 14. In a locked position, a horizontal distance between the groove wall 14a and an upper part 25 of the first panel 1 is smaller than a horizontal distance between an outer surface 8b of the locking element 8 and the upper part 25 of the first panel 1.

Stabilizing surfaces may also be formed according to the embodiments in the above-described principles. An edge of second panel 1' is preferably covered in an edge banding equipment with an edge material prior to the forming of the locking system such that the lower and outer edge 35 of the second panel is covered with an edge material. Such edges may be used in all embodiments of this disclosure but also in other locking system, which are intended to lock a second panel 1' perpendicularly to a first panel 1. It is stressed that any, or any combination, of the principles above which mainly have been described in relation to floor panels also are applicable to furniture components or furniture panels. One difference, however, is that front surfaces of the first 1 and the second 1' panels do not necessarily have to be flush or aligned with each other in a locked position of the panels 1, 1', as preferably is the case in the case of floor panels. Rather, in the case of furniture components, outer surfaces 52, 52' as well as inner surfaces 53, 53' of the panels 1, 1' are preferably arranged perpendicularly to each other in a locked position. In a non-limiting embodiment, a first and a second pair of furniture components are configured to be locked to each other by means of a locking system according to any or any combination of the principles of the invention. The furniture components of each pair may be parallel to each other. The first and the second pair may be arranged perpendicularly to each other in a locked position of the panels. It is equally conceivable, however, that according to alternative embodiments, the first and the second pair are arranged at an angle to each other in a locked position.

Figures 28a - 28d show that a core material 5 of a panel 1 may be locally modified such that it becomes more suitable to form flexible and strong edges portions of a locking system. Figure 28a shows that a resin, for example a thermosetting resin 24 such as for example melamine formaldehyde, urea formaldehyde or phenol formaldehyde resin, may be applied in liquid or dry powder form on for example a melamine formaldehyde impregnated balancing paper 3 or directly on a core material 5. The resin may also be locally injected into the core with high pressure. The resin may also be applied on the upper part of the core 5 in order to improve moisture properties of the upper edges. Figure 28b shows that a core material 5, preferably a wood based panel for example a HDF board or a particle board, may be applied on the impregnated paper 3 with the added resin 24 prior to lamination. Alternatively, a powder layer may be applied on the resin 24. Figure 28c shows a floor board after lamination when the surface layers 2 and the balancing layer 3 have been laminated to the core 5. The resins 24 have penetrated into the core 5 and cured during lamination under heat and pressure. Figure 28d shows an edge of a first panel 1 and a second panel 1' with upper and lower parts that are locally strengthened with increased resin content. The first edge 1 comprises a strip 6 formed in one piece with the core 5. The material of the strip 6 is more flexible and comprises a higher resin content than other parts of the core 5. The increased resin content provides a material that is suitable to form a strong and flexible edge parts. A locking system according to one embodiment of the invention comprises a core 5 having a higher content of cured resins, preferably thermosetting resins, at a lower and outer part than at a lower and inner part. A locking system according to another embodiment of the invention comprises a core 5 having a higher content of cured resins, preferably thermosetting resins, at an upper and outer part than at an upper and inner part. These methods may be used also in other locking systems, preferably locking systems that comprise a horizontally protruding strip with a locking element at a lower part of a panel edge. In particular, the locking systems according to any of the principles in this disclosure may be provided with a higher content of cured resins according to the above.

CLAIMS

1. A set of essentially identical floor panels (1, 1') provided with a mechanical locking system comprising a strip (6) extending horizontally from a lower part of a first edge of a first panel (1) and a downwardly open locking groove (14) formed in an adjacent second edge of a second panel (1'), the strip (6) comprising an upwardly protruding locking element (8) which is configured to cooperate with the locking groove (14) for locking the first edge and the second edge in a horizontal direction parallel to a main plane of the panels and in a vertical direction perpendicularly to the horizontal direction, wherein the locking element (8) and the locking groove (14) comprise an upper (11a) and a lower (11b) locking surface which are configured to lock the panels vertically, wherein
- the strip (6) comprises slits (20) located along the first edge, and
- a slit wall (20a) is configured to be bended horizontally inwardly towards an inner part of the first panel (1) during locking, characterized in that
- the locking system in a locked position and along the edges comprises a first rigid edge section (7a) and a second flexible edge section (7b) comprising one of the slits (20), and that
- the first rigid edge section (7a) is configured such that the locking element (8) is in contact with the locking groove (14) and the second flexible edge section (7b) is configured such that there is a space (S) between an inner surface (8a) of the locking element (8) and an outer groove wall (14a) of the locking groove (14).
2. The set as claimed in claim 1, wherein a cross section of the locking groove (14) or a cross section of the locking element (8) varies along the first and the second edge.
3. The set as claimed in claim 1 or 2, wherein the slit wall (20a) is further configured to be bended at least partly back to an initial position of the slit wall (20a) during a final stage of the locking.

4. The set as claimed in claim in any one of the preceding claims 1 – 3,
wherein the edge of the first panel (1) comprises upper (18) and lower (19)
5 stabilizing surfaces that in the locked position overlap each other and prevent
an upward bending of the slit wall (20a).

5. The set as claimed in any of the preceding claims, wherein the first edge
and the second edge are locked with vertical pretension between upper (16)
and lower (15) support surfaces and between the upper (11a) and lower (11b)
10 locking surfaces.

6. A set of essentially identical floor panels (1, 1') provided with a mechanical
locking system comprising a strip (6) extending horizontally from a lower part
of a first edge and a downwardly open locking groove (14) formed in an
adjacent second edge, wherein the strip (6) comprises a first (8) and a
15 second (8') upwardly protruding locking element, the first locking element (8)
being located closer to an upper edge (25) of the first edge than the second
locking element (8'), wherein the first locking element (8) comprises an upper
locking surface (11a) at its upper and outer part, wherein the second edge
comprises a downwardly extending protrusion (36a) comprising a lower
20 locking surface (11b) at its outer and lower part, the second locking element
(8') being configured to cooperate with the locking groove (14) and to lock the
first and the second edge in a horizontal direction parallel to a main plane of a
first and a second panel (1, 1') and the upper and lower locking surfaces
(11a, 11b) being configured to lock the adjacent edges in a vertical direction
25 perpendicularly to the horizontal direction, characterized in

that the first and the second edge in a locked position comprise a first
edge section (7a) and a second edge section (7b) along the first and the
second edge,

that a cross section of the first locking element (8) or a cross section of
30 the protrusion (36a) varies along the first and/or the second edge,

that the second edge section (7b) comprises a first (20) and a second (20') slit extending side by side along the edge,

that the first slit (20) is located closer to the upper part (25) of the first edge than the second slit (20),

5 that the second slit (20) is formed between the first (8) and the second locking elements (8'),

that the locking system is configured to be locked with a vertical displacement of the second edge against the first edge, and

10 that a part of the first locking element (8) and a slit wall of the first (20) and the second (20') slits during an initial stage of the vertical displacement is configured to bend horizontally inwards towards an inner part of the first panel (1) and during a final stage of the vertical displacement is configured to bend outwards towards an initial position of said part.

15 7. The set as claimed in claim 6, wherein the first edge comprises upper (18) and lower (19) stabilizing surfaces that in the locked position overlap each other and prevent an upward bending of one of the slit walls.

20 8. A set of essentially identical floor panels (1, 1') provided with a mechanical locking system comprising a strip (6) extending horizontally from a lower part of a first edge and a downwardly open locking groove (14) formed in an adjacent second edge, wherein the strip (6) comprises an upwardly protruding locking element (8) comprising an upper locking surface (11a) at its upper and inner part and the locking groove (14) comprises a lower locking surface (11b) at its outer and lower part, the locking element (8) being configured to cooperate with the locking groove (14) and to lock the first and the second
25 edge in a horizontal direction parallel to a main plane of a first and a second panel (1, 1'), the upper and lower locking surfaces (11a, 11b) being configured to lock the adjacent edges in a vertical direction perpendicularly to the horizontal direction, characterized in

30 that the first and the second edge in a locked position comprise a first edge section (7a) and a second edge section (7b) along the first and the second edge,

that a cross section of the locking element (8) or a cross section of the locking groove (14) varies along the first and/or the second edge,

that the strip (6) of the second edge section (7b) comprises a slit (20) extending along at least a part of the first edge, the slit (20) being located
5 between the locking element (8) and an upper edge (25) of the first edge,

that the locking system is configured to be locked with a vertical displacement of the second edge against the first edge, and

that a part of the locking element (8) and a slit wall during an initial stage of the vertical displacement is configured to bend horizontally outwardly
10 and during a final stage of the vertical displacement is configured to bend inwardly towards an initial position of said part.

9. The set as claimed in claim 8, wherein the first edge comprises upper (18) and lower (19) stabilizing surfaces that in the locked position overlap each other and prevent an upward bending of a part of the locking element (8).

15 10. A set of essentially identical floor panels (1, 1') provided with a mechanical locking system comprising a strip (6) extending horizontally from a lower part of a first edge and a downwardly open locking groove (14) formed in an adjacent second edge, wherein the strip (6) comprises an upwardly protruding locking element (8) and the second edge comprises a
20 downwardly extending protrusion (36a) comprising a lower locking surface (11b) at its lower and outer part (32), the locking element (8) being configured to cooperate with the locking groove (14) and to lock the first and the second edge in a horizontal direction parallel to a main plane of a first and a second panel (1, 1'), characterized in

25 that the first and the second edge in a locked position comprise a first edge section (7a) and a second edge section (7b) along the first and the second edge,

that a cross section of the protrusion (36a) varies along the first and/or the second edge,

that the second edge section comprises a first (20) and a second (20') slit extending side by side along the first edge, the first slit (20) being located closer to an upper part (25) of the first edge than the second slit (20'),

5 that the second slit (20') is configured to accommodate the protrusion (36a) and the lower locking surface (11b) such that the lower locking surface locks against an upper locking surface (11a) located at a lower and inner part of the second slit (20') and locks the first and second edges in a vertical direction,

10 that the locking system is configured to be locked with a vertical displacement of the second edge against the first edge, and

that a flexible strip part (31) located between the first (20) and the second (20') slit during an initial stage of the vertical displacement is configured to bend horizontally inwardly and during a final stage of the vertical displacement is configured to bend outwardly towards an initial position of the flexible strip part (31).
15

11. The set as claimed in claim 10 wherein the first edge comprises upper (18) and lower (19) stabilizing surfaces that in locked position overlap each other and prevent an upward bending of the flexible strip part (31).

12. A set of essentially identical floor panels (1, 1') provided with a
20 mechanical locking system comprising a strip (6) extending horizontally from a lower part of a first edge and a first (14) and a second (14') downwardly open locking grooves formed in an adjacent second edge, wherein the first locking groove (14) is located closer to an upper edge (25) of the first edge than the second locking groove (14'), wherein the strip (6) comprises a first
25 upwardly protruding locking element (8) and a second locking element (8'), the first locking element (8) being located closer to the upper edge (25) than the second locking element (8'), wherein the second edge comprises a downwardly extending protrusion (36a) comprising a lower locking surface (11b) at its lower and inner part (33), the first locking element (8) being
30 configured to cooperate with the first locking groove (14) and to lock the first

and the second edge in a horizontal direction parallel to a main plane of a first and a second panel (1, 1'), characterized in

that the first and the second edge in a locked position comprise a first edge section (7a) and a second edge section (7b) along the first and the
5 second edge,

that a cross section of the protrusion (36a) varies along the first and/or the second edge,

that the second edge section comprises a slit (20) configured to accommodate the protrusion (36a) and the lower locking surface (11b) such
10 that the lower locking surface locks against an upper locking surface (11a) located at a lower and inner part of the second locking element (8') and locks the edges in a vertical direction,

that the locking system is configured to be locked with a vertical displacement of the second edge against the first edge, and

15 that the second locking element (8') during an initial stage of the vertical displacement is configured to bend horizontally and outwardly and during a final stage of the vertical displacement is configured to bend inwardly towards an initial position of the second locking element (8').

13. The set as claimed in claim 12, wherein the first edge comprises upper
20 (18) and lower (19) stabilizing surfaces that in locked position overlap each other and prevent an upward bending of the second locking element (8').

14. A set of essentially identical floor panels (1, 1') provided with a mechanical locking system comprising a strip (6) formed in one piece with a core (5) of a first panel (1) and extending horizontally from a lower part of a
25 first edge of the first panel (1) and a downwardly open locking groove (14) formed in an adjacent second edge of a second panel (1'), the strip (6) comprising an upwardly protruding locking element (8) which is configured to cooperate with the locking groove (14) for locking the first edge and the
30 second edge in a horizontal direction parallel to a main plane of the panels and in a vertical direction perpendicularly to the horizontal direction, wherein the locking element (8) and the locking groove (14) comprise an upper (11a)

and a lower (11b) locking surface which are configured to lock the panels vertically, wherein

the strip (6) comprises slits (20) located along the first edge, and

5 a slit wall (20a) is configured to be bended horizontally inwardly towards an inner part of the first panel (1) during locking, characterized in that

the core (5) has a higher content of cured resins at a lower and outer part than at a lower and inner part.

15. The set as claimed in claim 14, wherein the resin is a thermosetting resin.

1/28

Fig. 1a

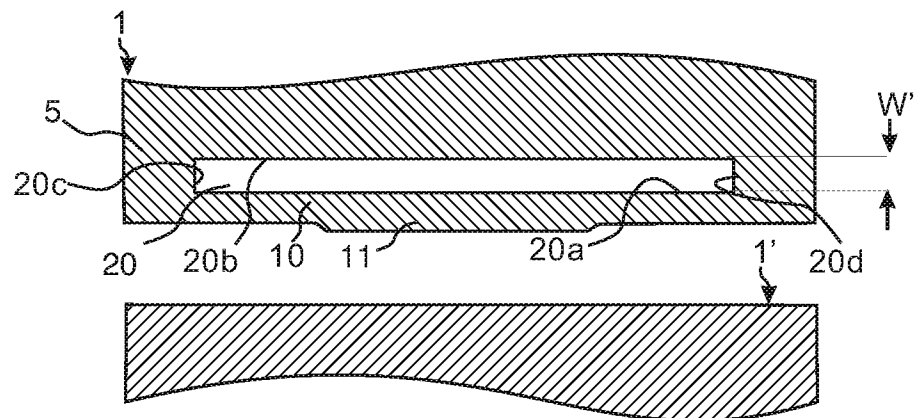


Fig. 1b

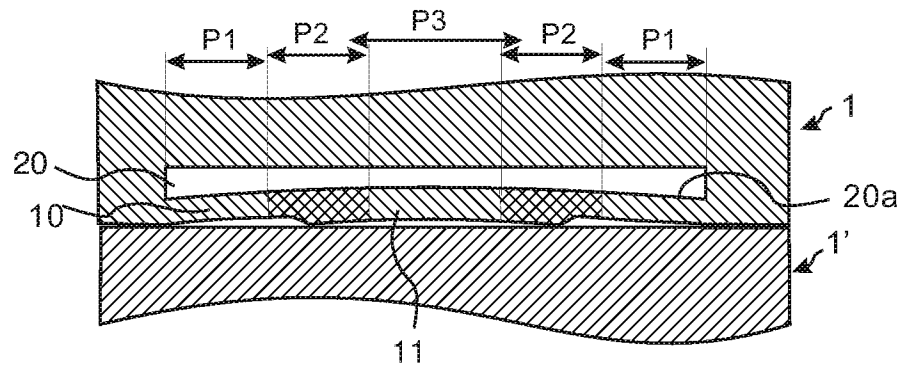


Fig. 1c

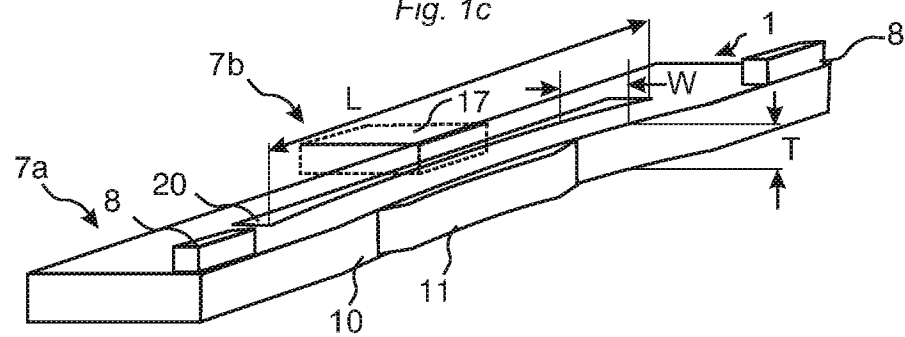
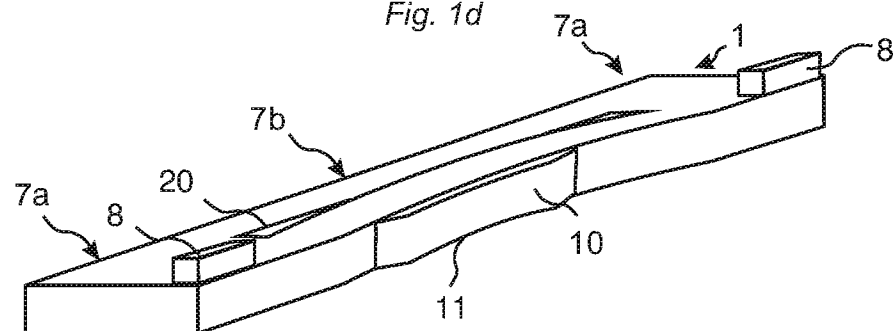
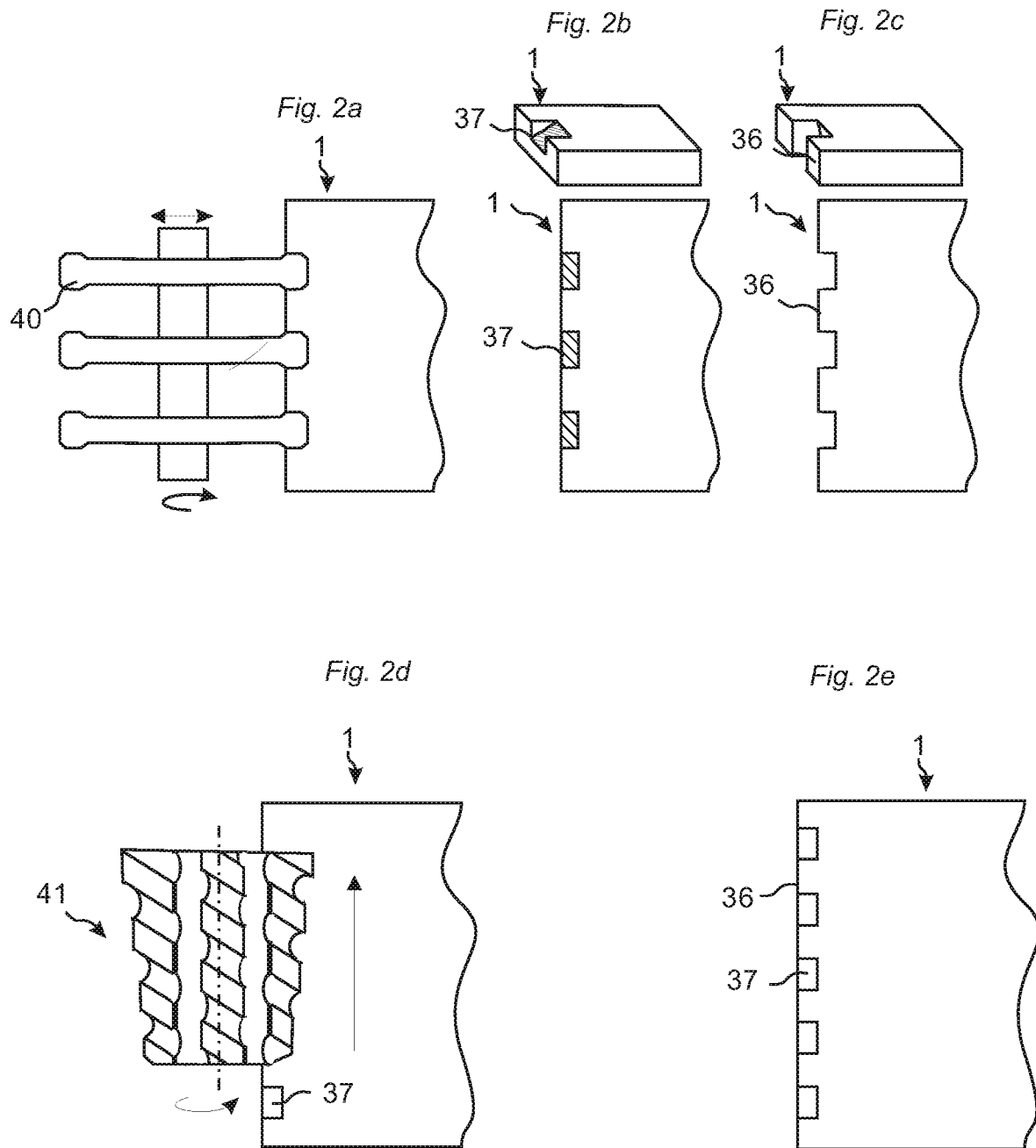


Fig. 1d





3/28

Fig.3a

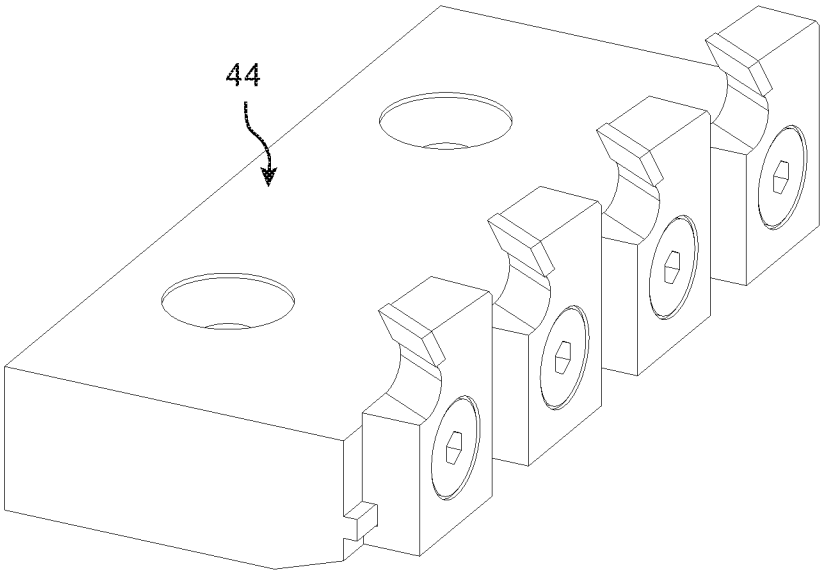
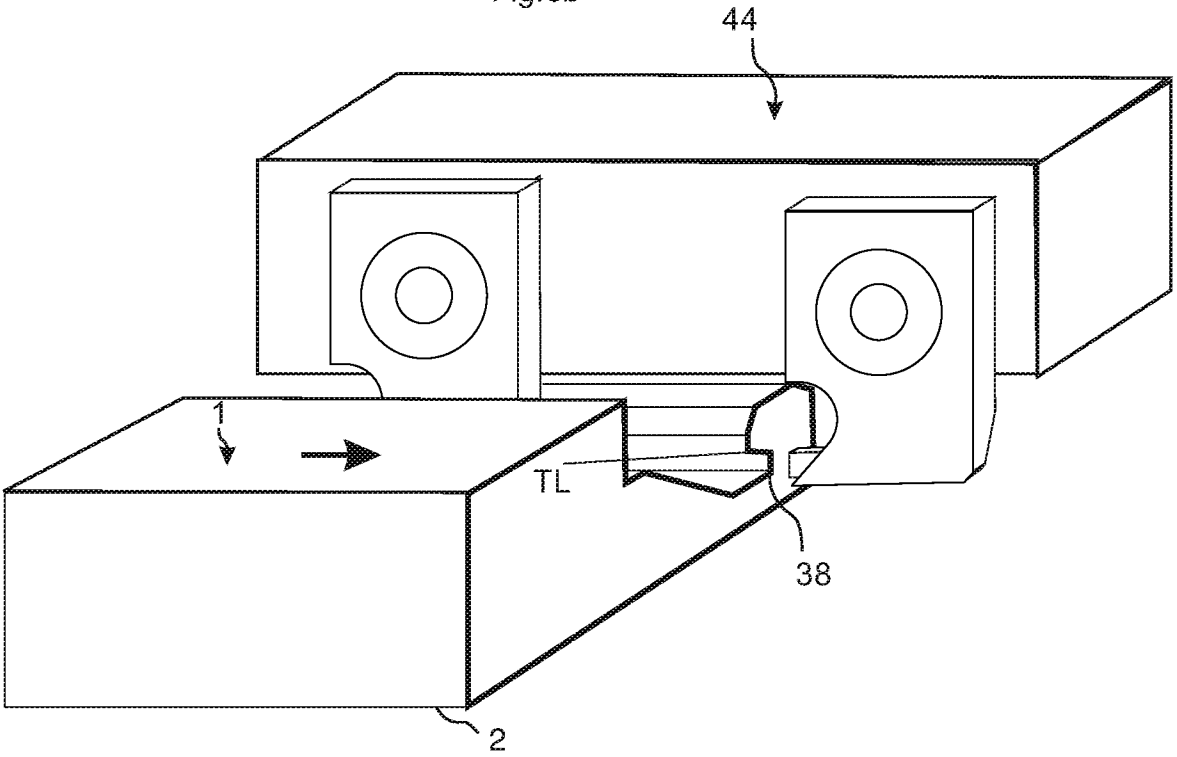


Fig.3b



4/28

Fig. 4a

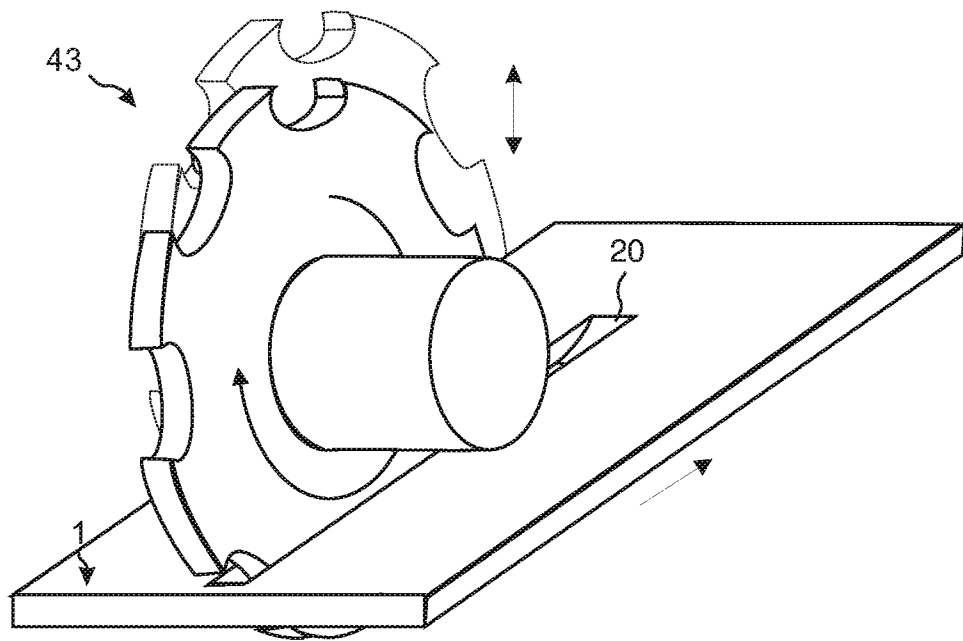
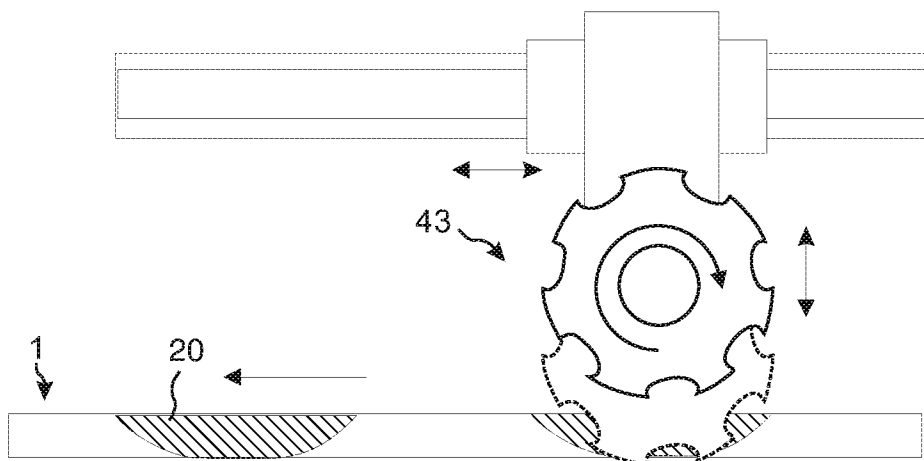


Fig. 4b



5/28

Fig. 5a

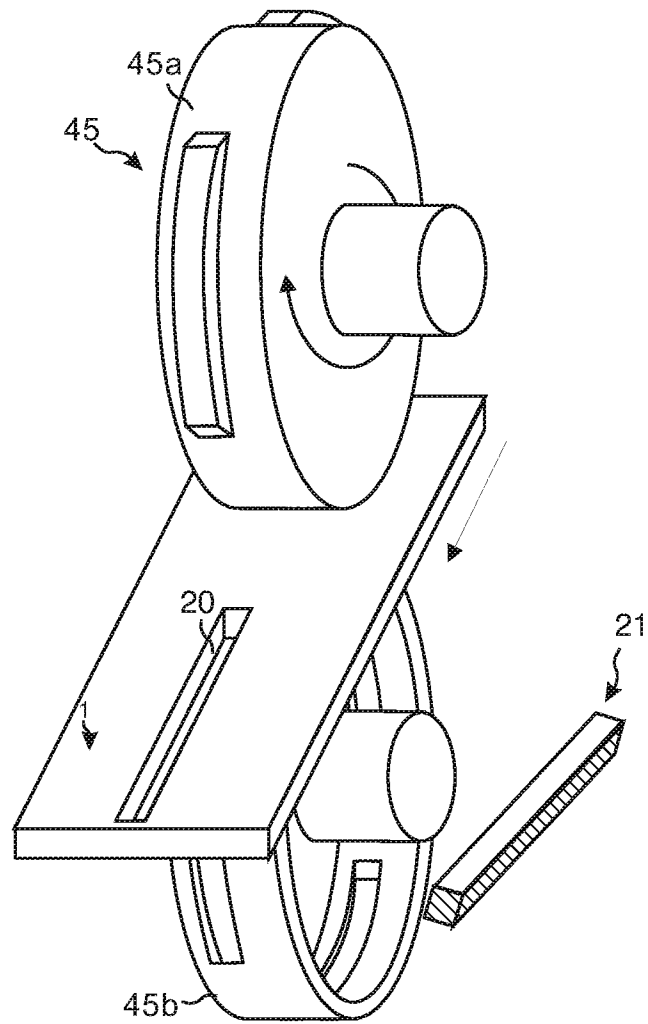
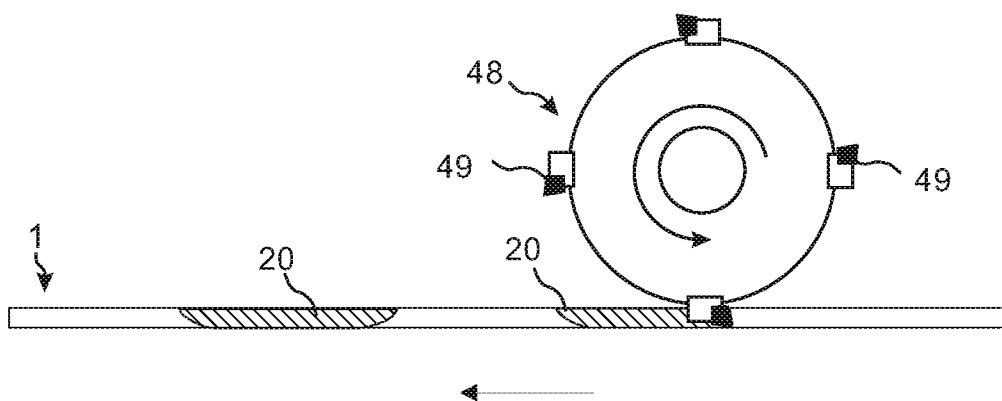


Fig. 5b



6/28

Fig. 6a

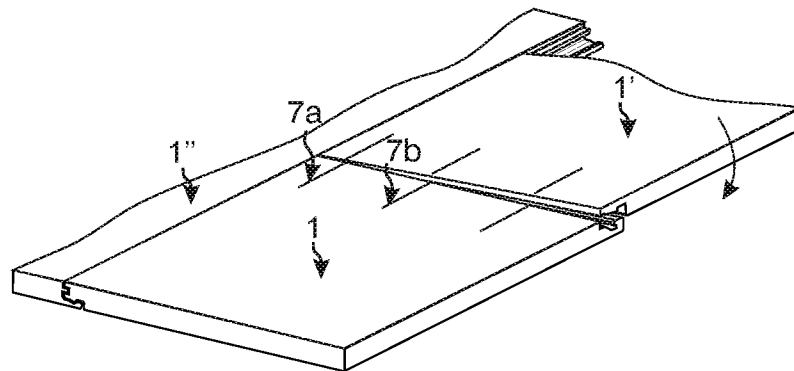


Fig. 6b

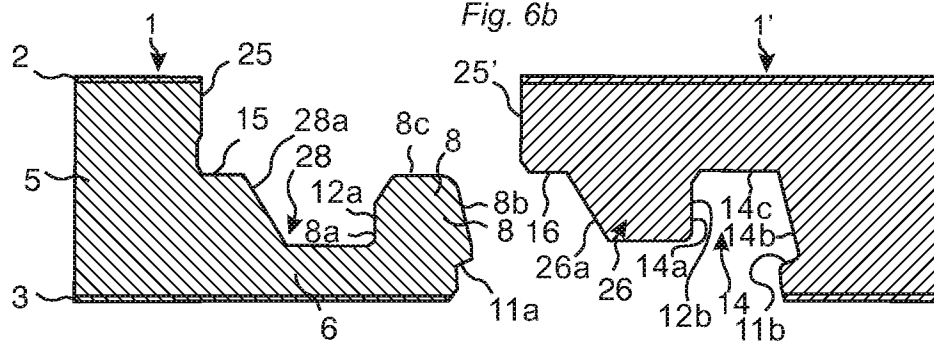


Fig. 6c

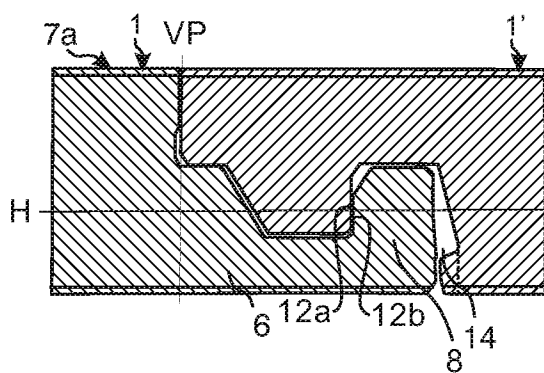


Fig. 6d

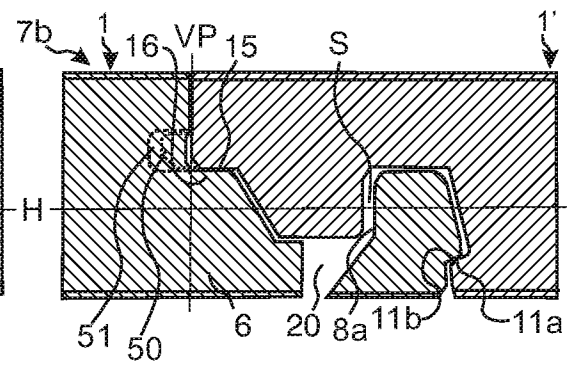
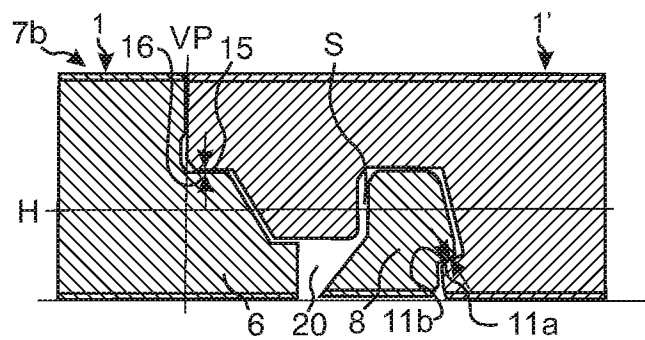
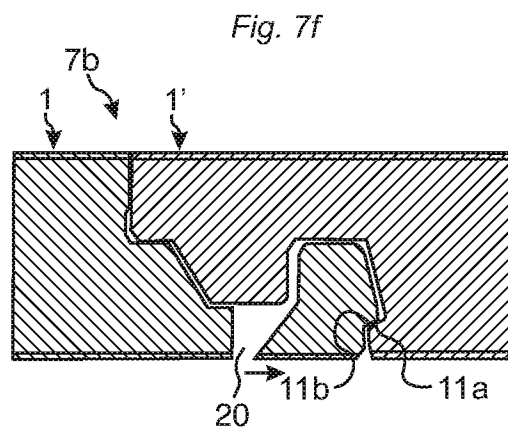
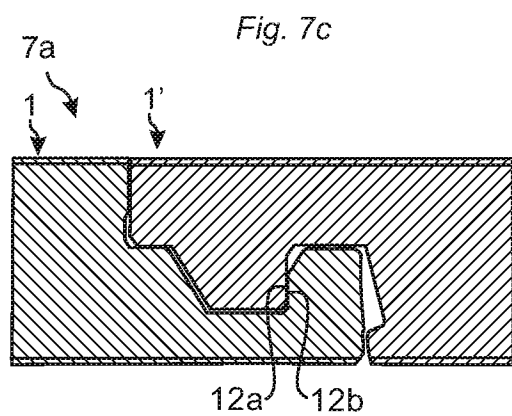
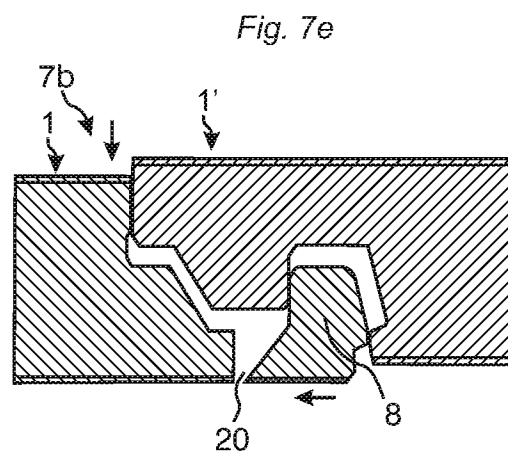
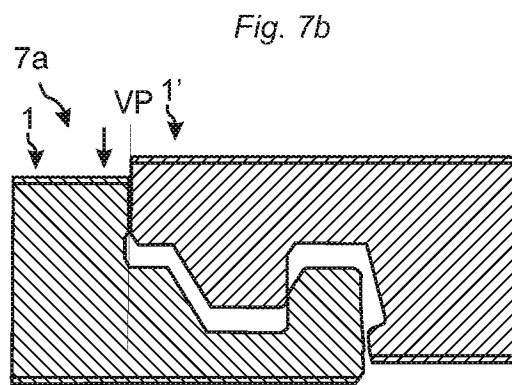
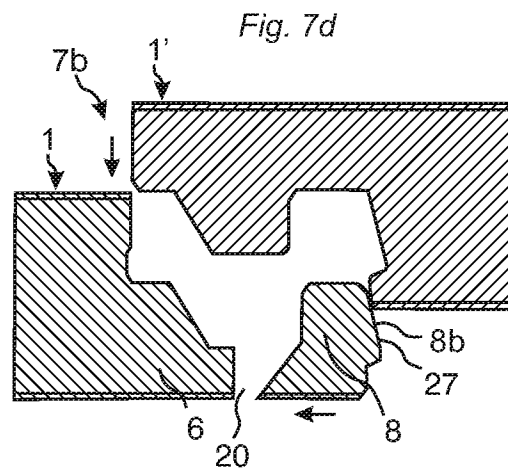
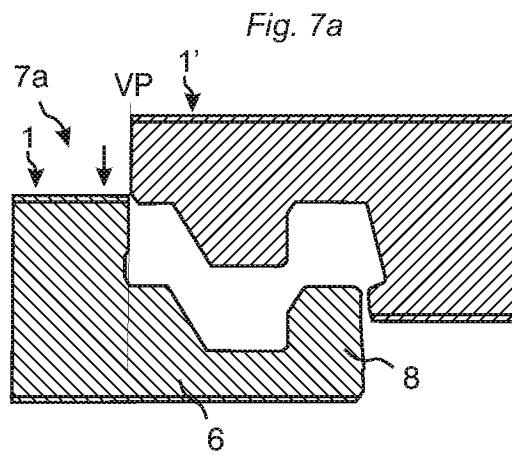


Fig. 6e



7/28



8/28

Fig. 8a

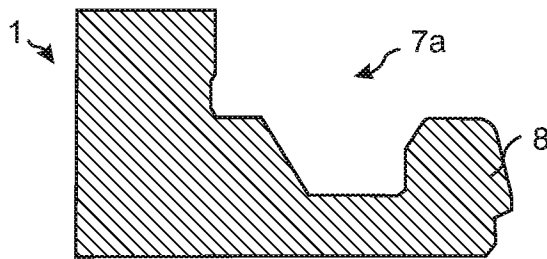


Fig. 8d

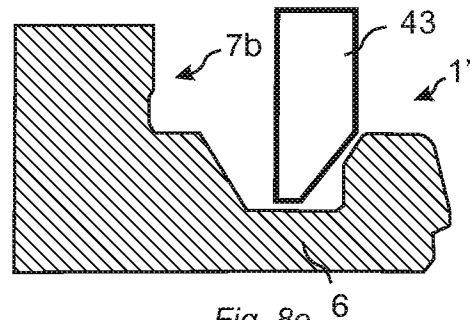


Fig. 8b

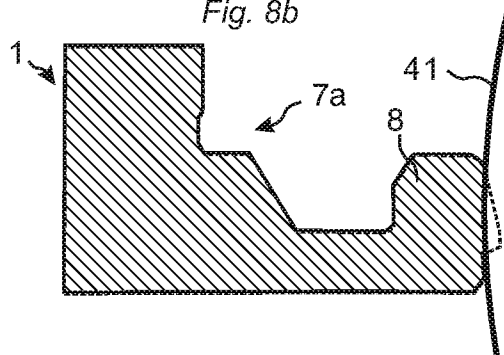


Fig. 8e

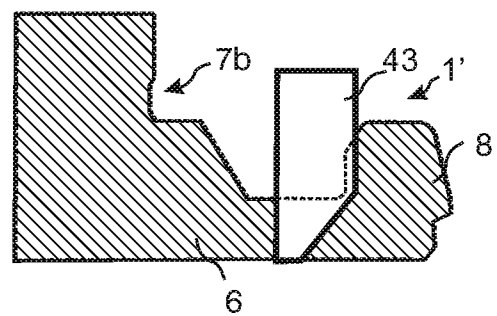


Fig. 8c

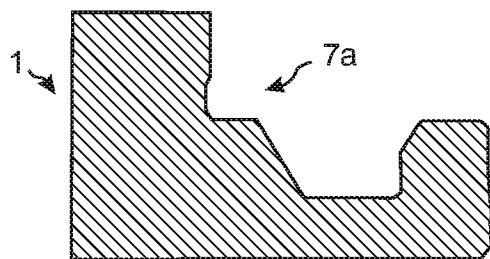


Fig. 8f

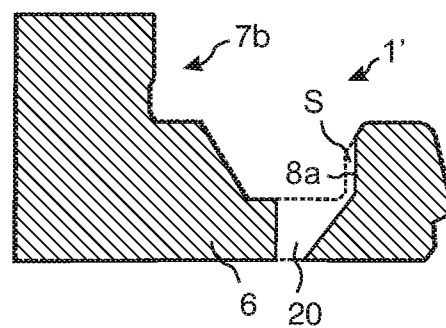


Fig. 8g

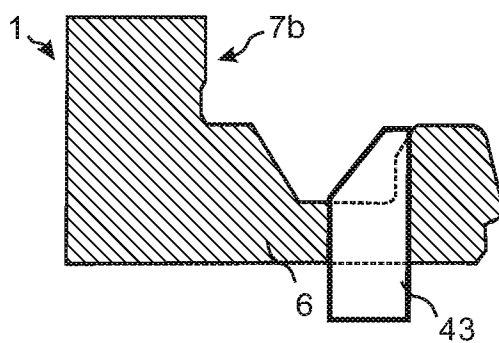
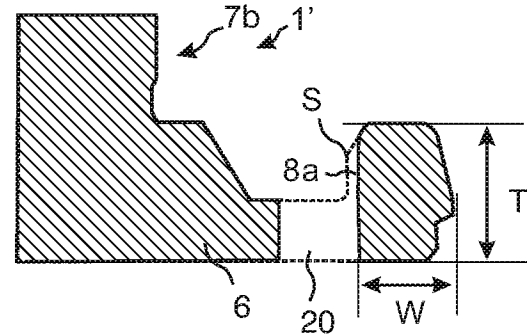


Fig. 8h



9/28

Fig. 9a

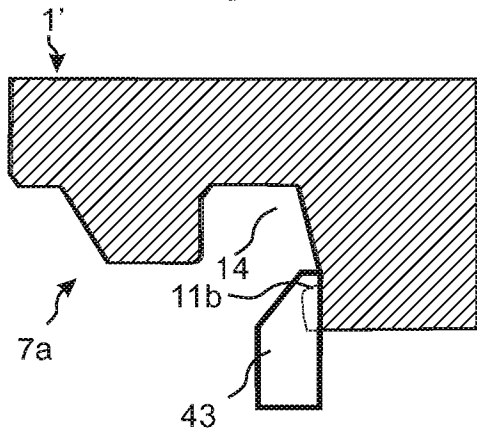


Fig. 9b

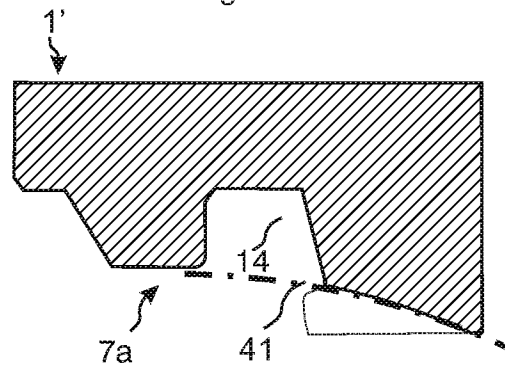


Fig. 9c

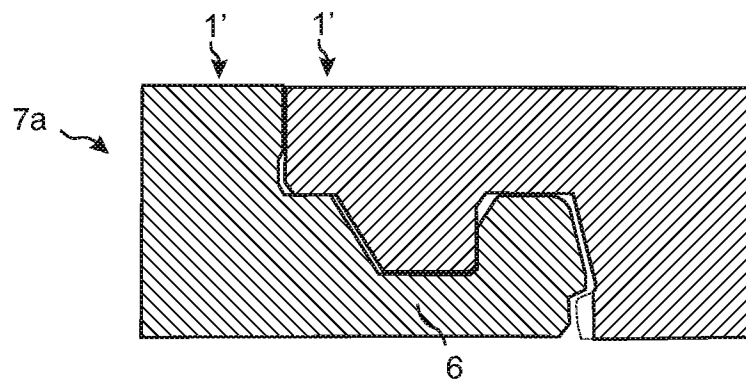
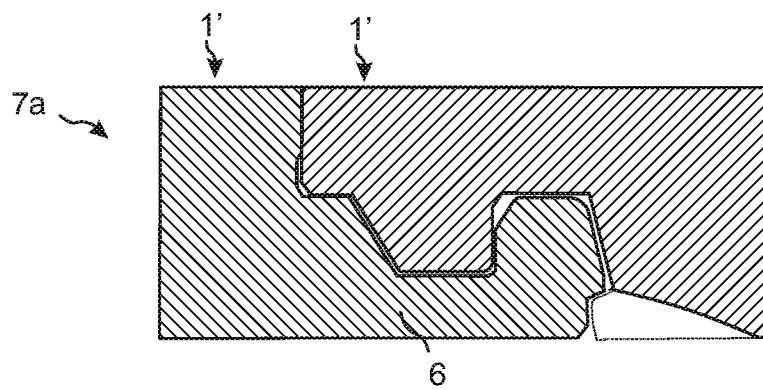
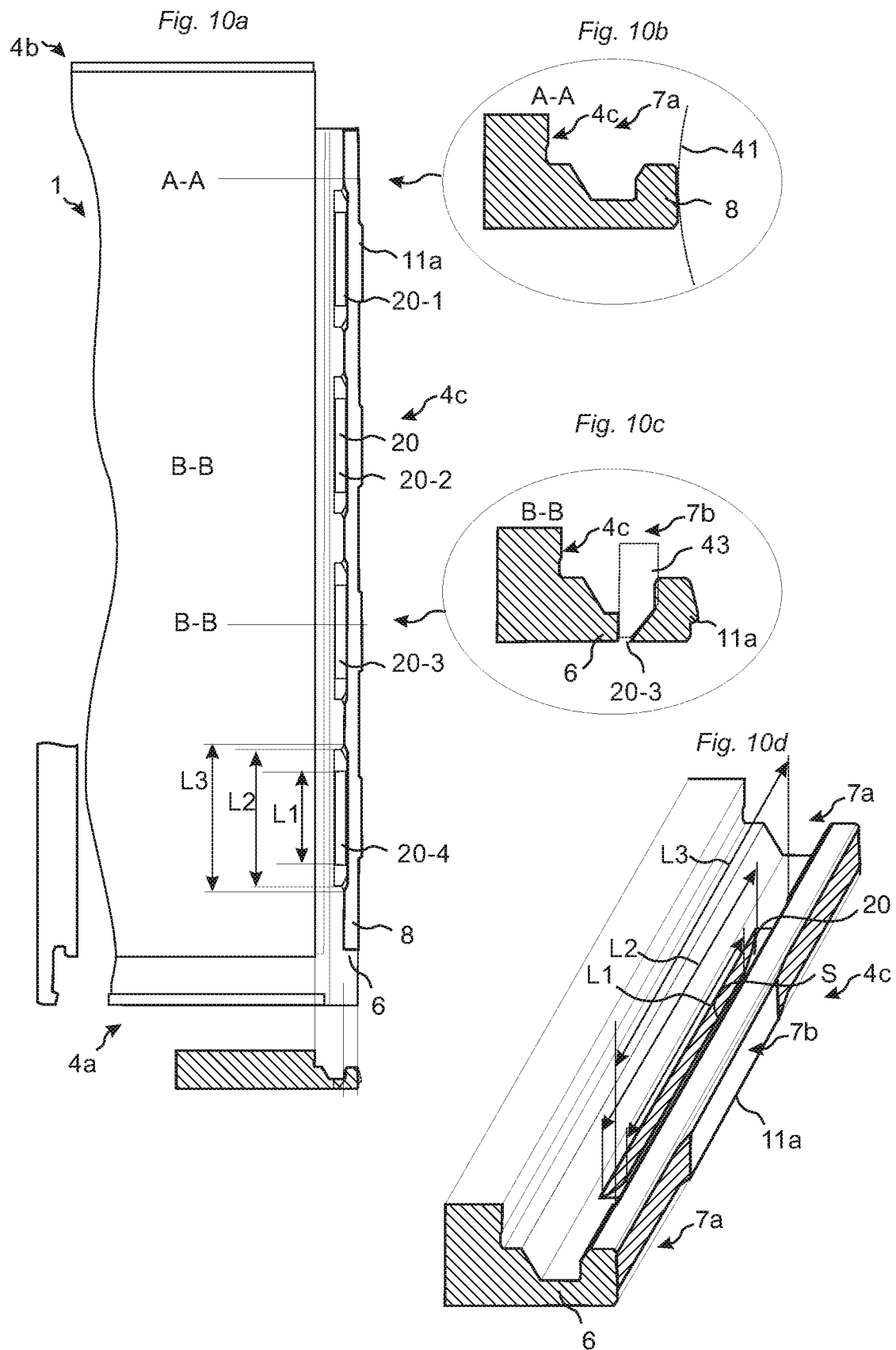


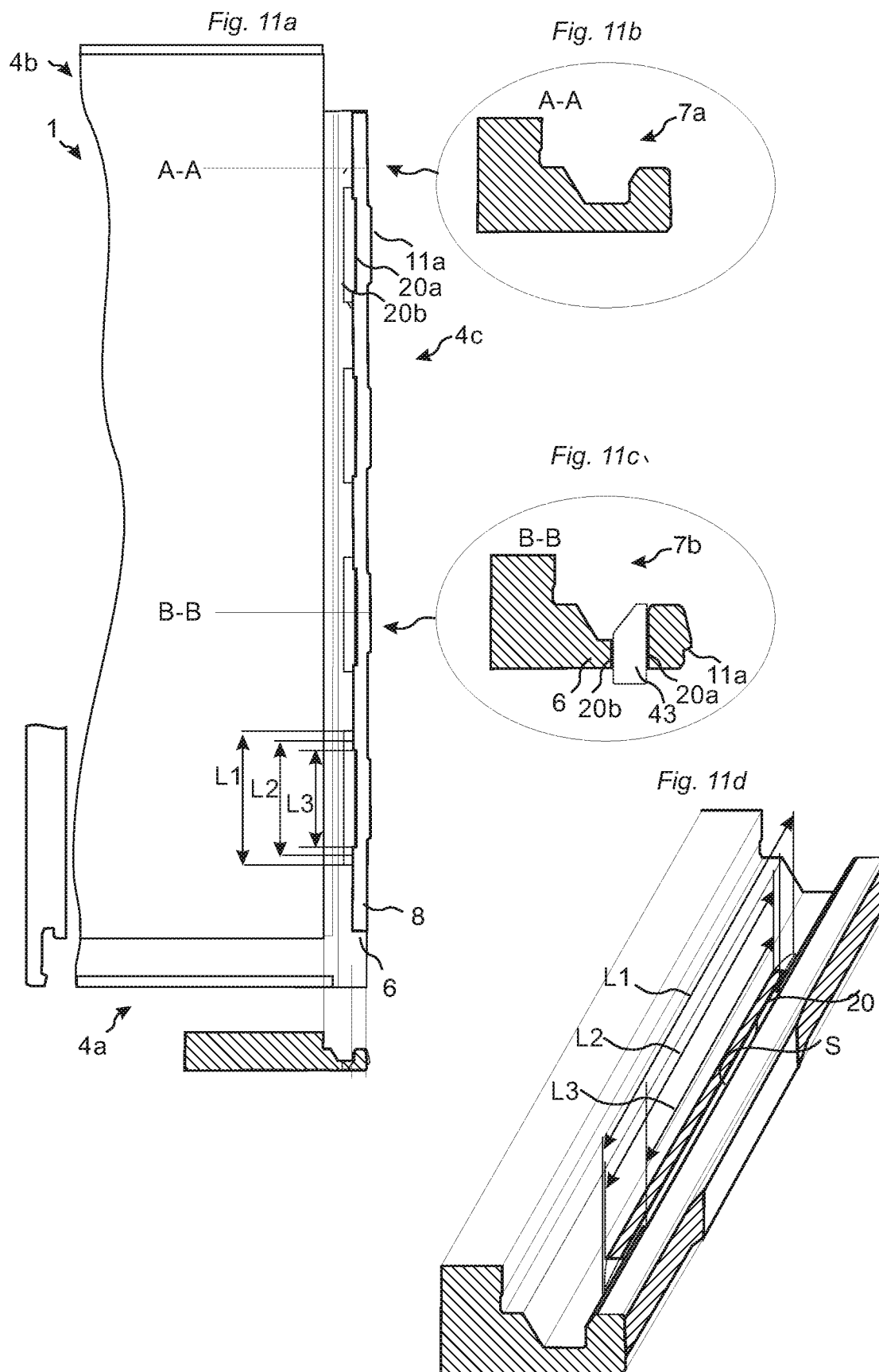
Fig. 9d



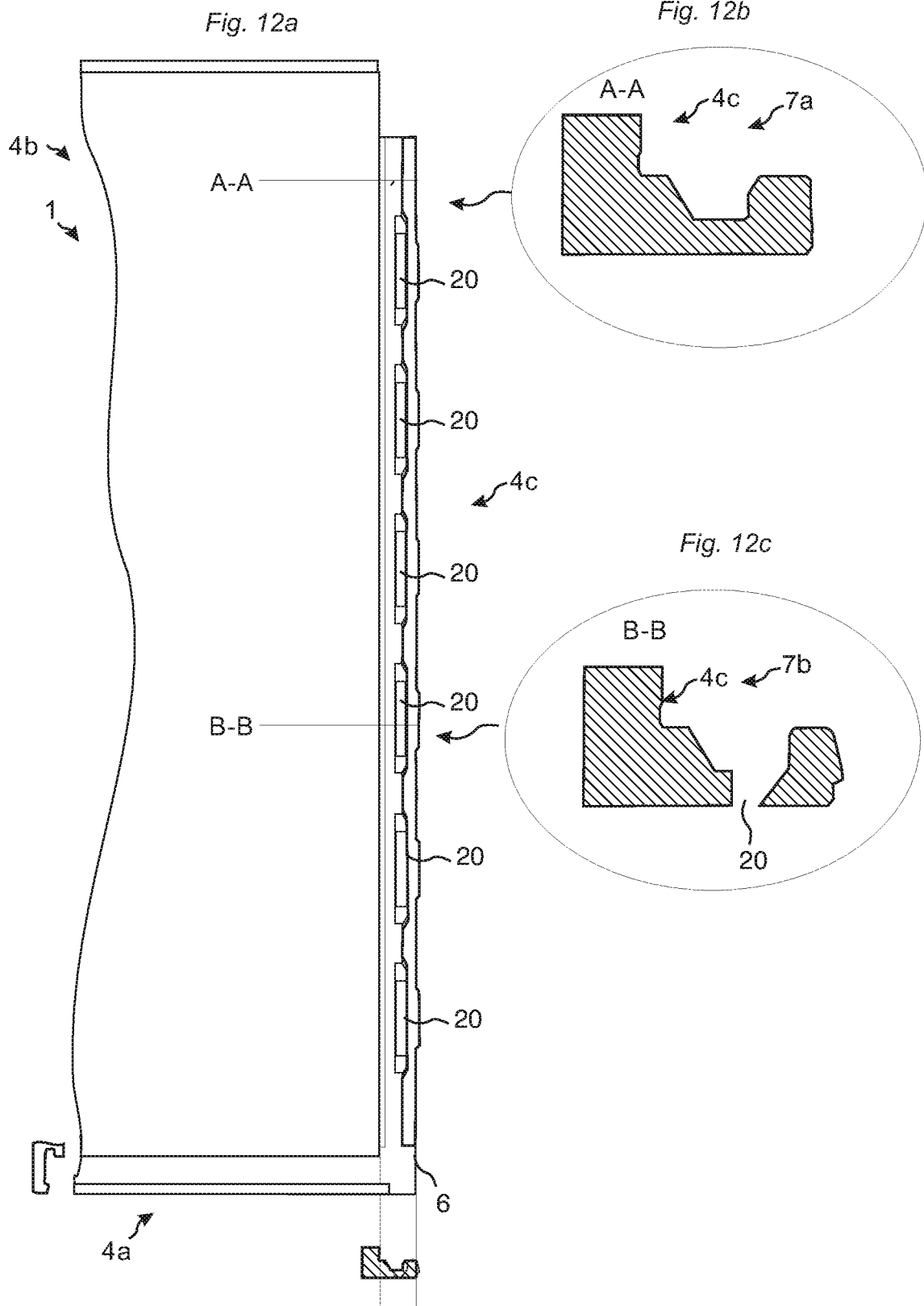
10/28



11/28



12/28



13/28

Fig. 13a

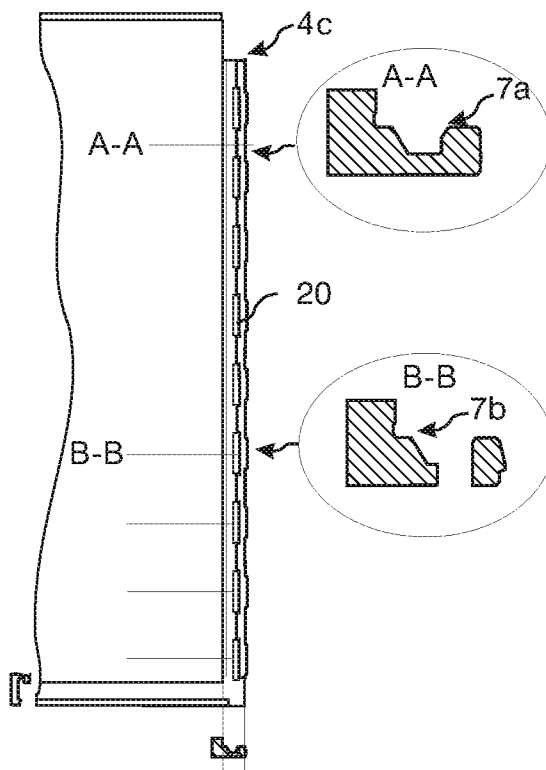


Fig. 13c

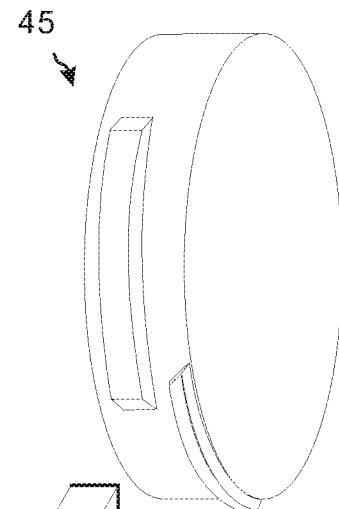
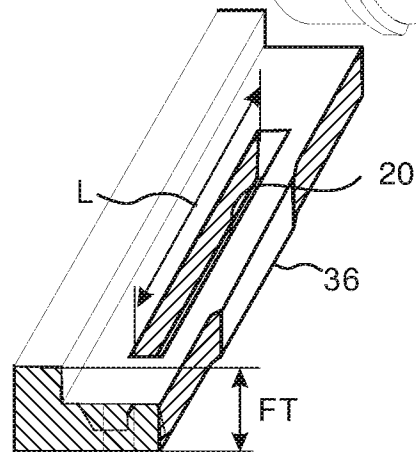
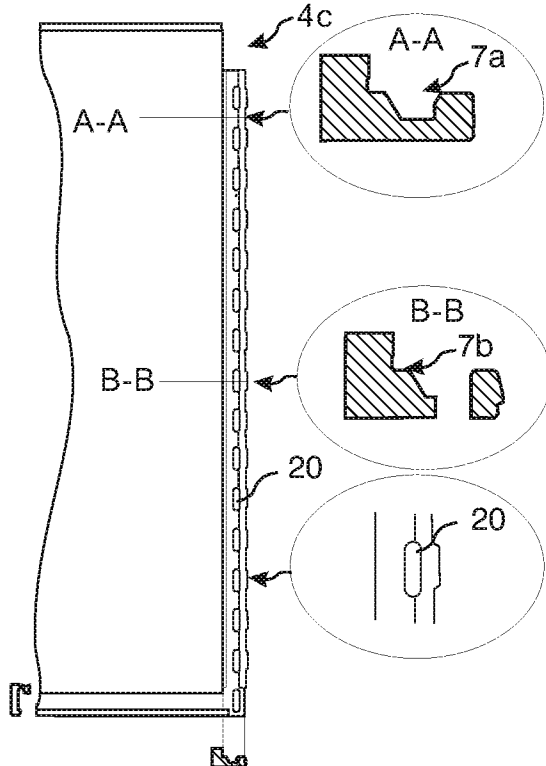
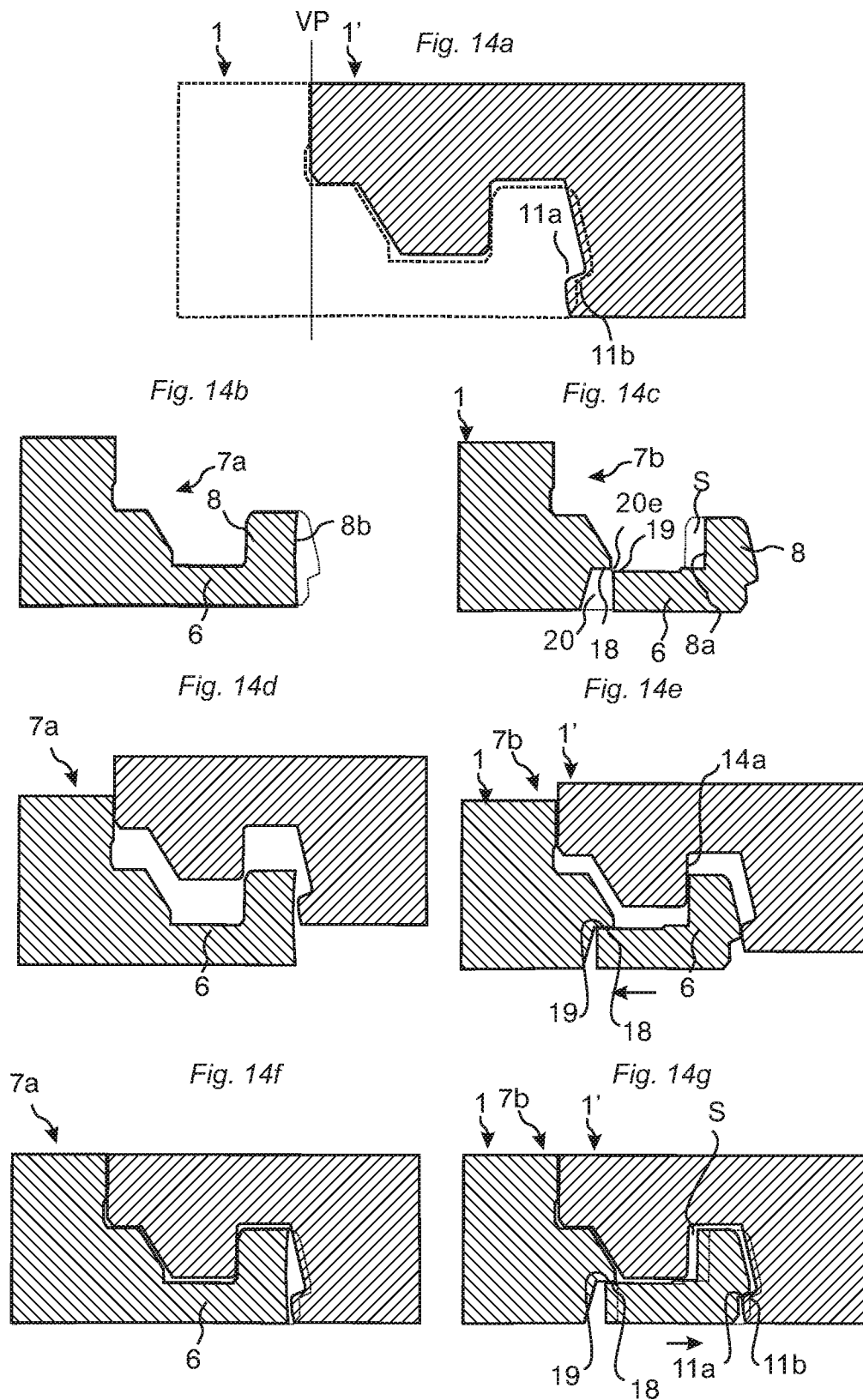


Fig. 13b



14/28



15/28

Fig. 15a

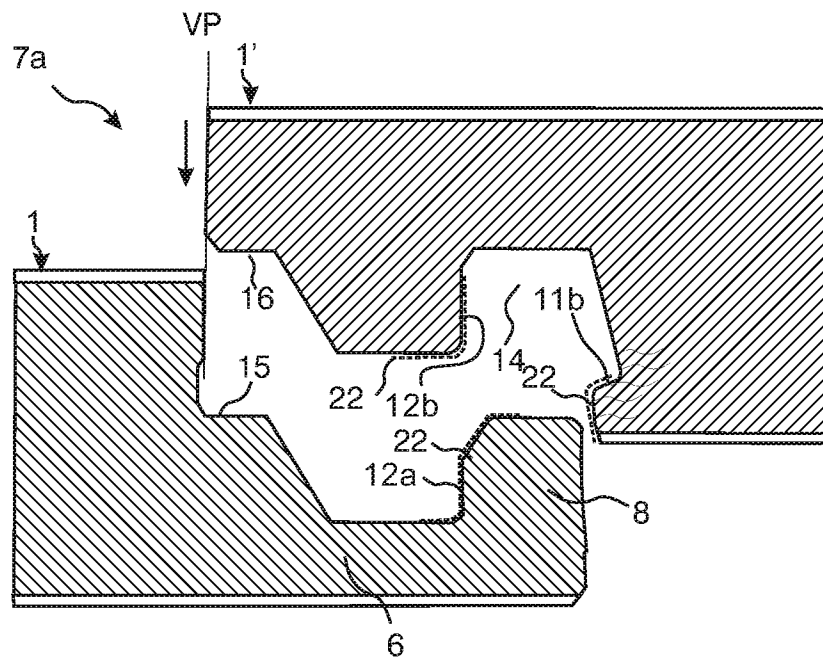
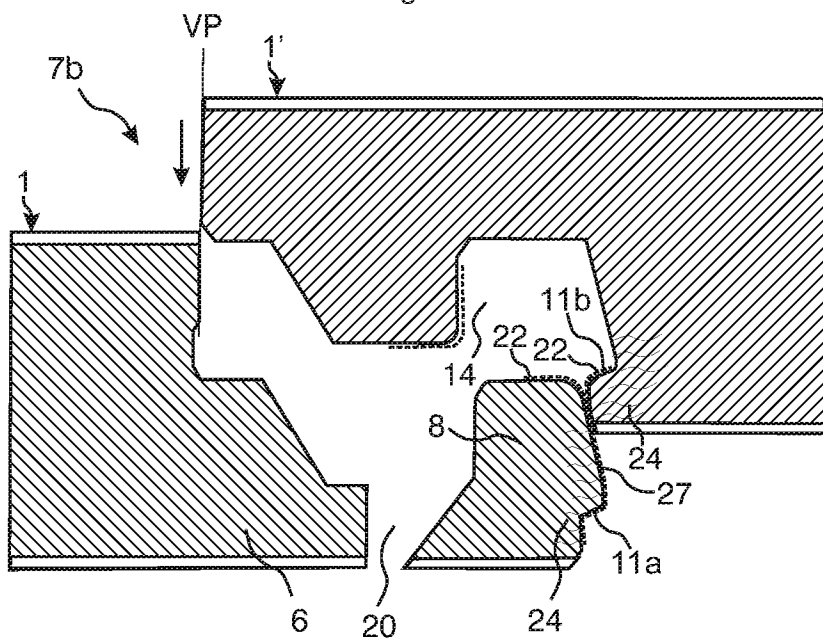


Fig. 15b



16/28

Fig. 16a

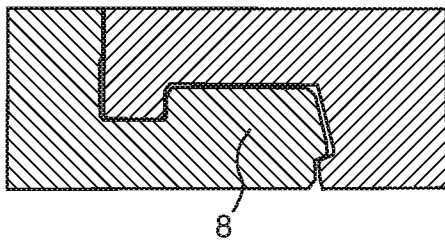


Fig. 16d

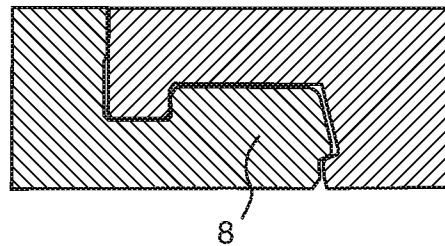


Fig. 16b

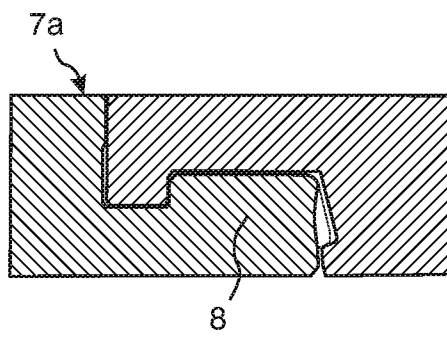


Fig. 16e

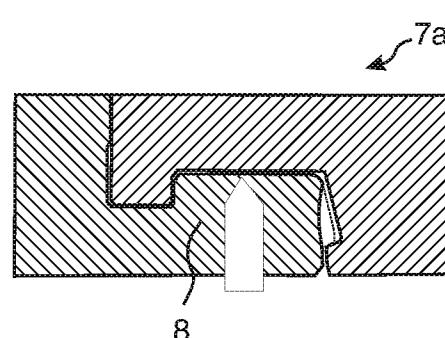


Fig. 16c

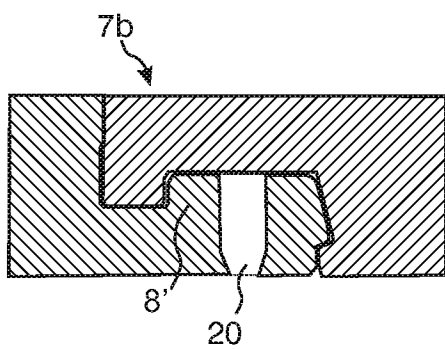
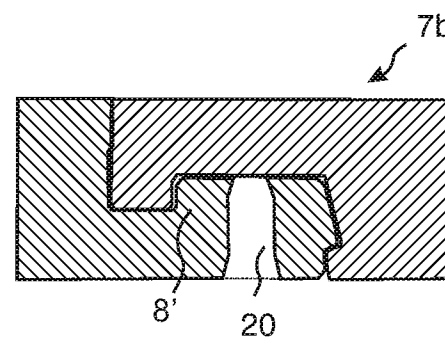
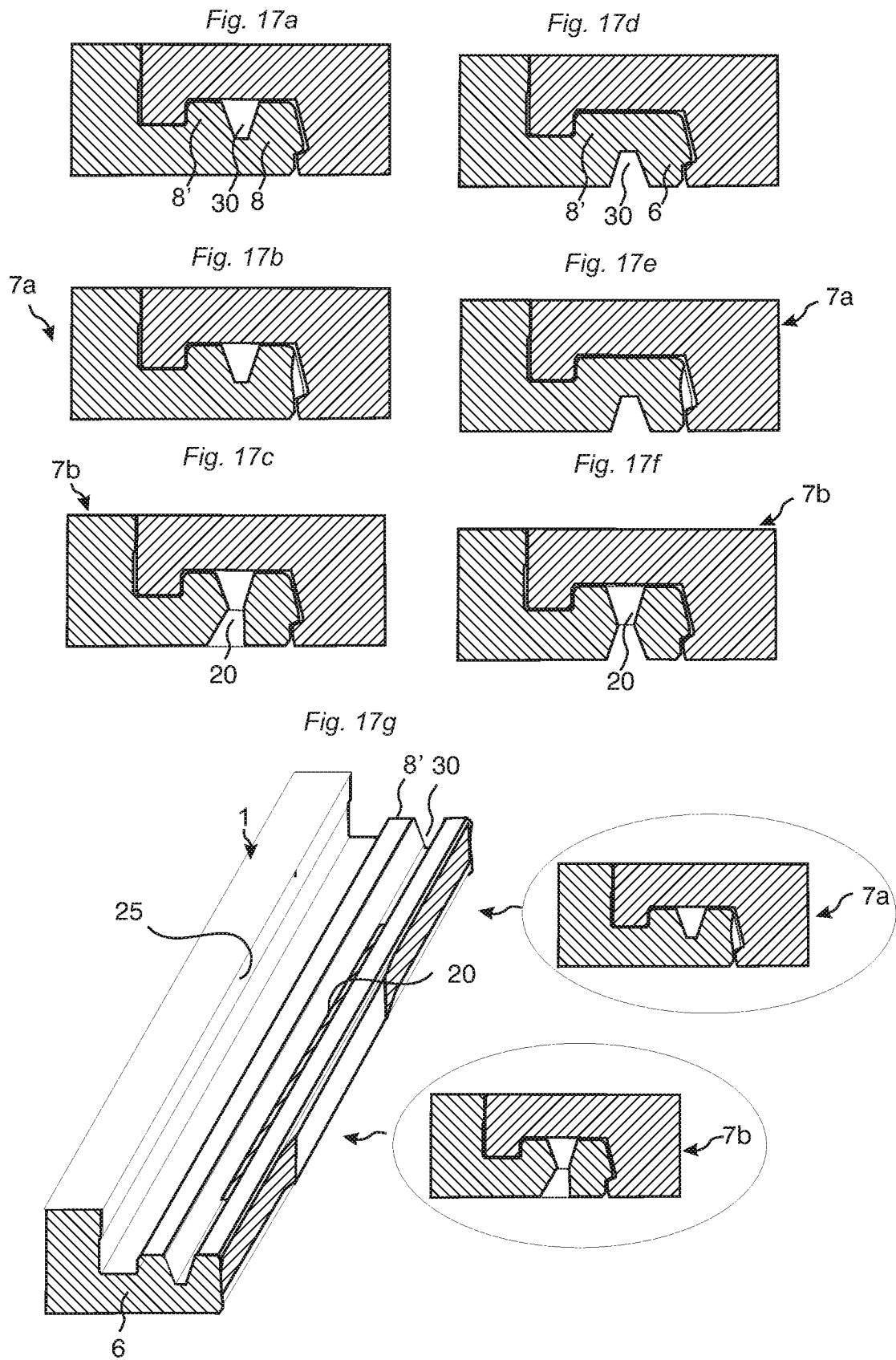


Fig. 16f



17/28



18/28

Fig. 18a

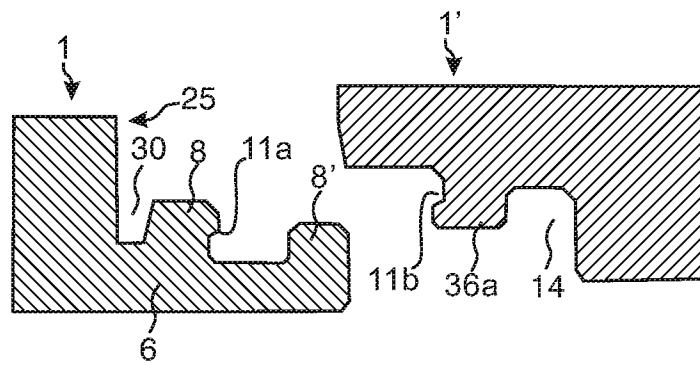


Fig. 18b

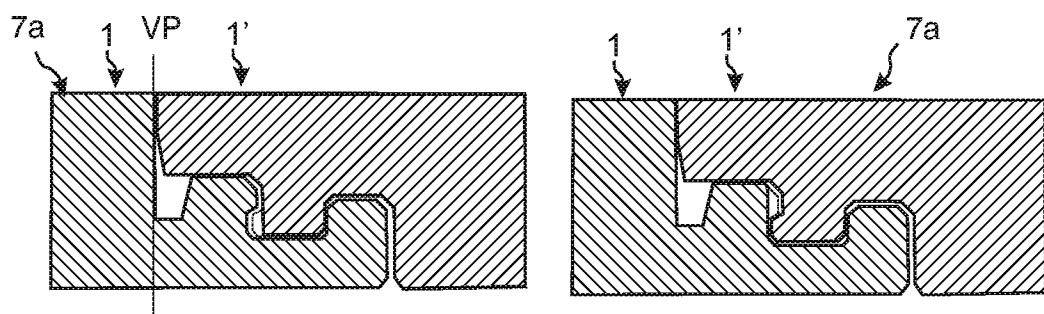


Fig. 18c

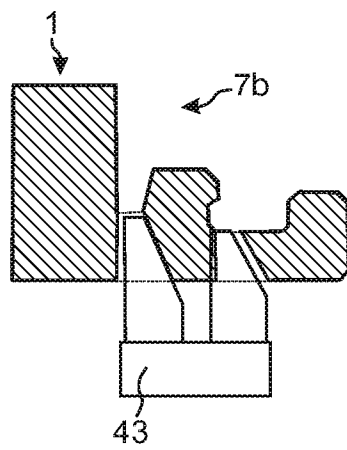
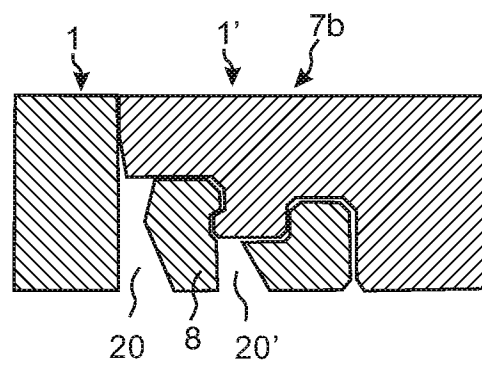


Fig. 18d



19/28

Fig. 19a

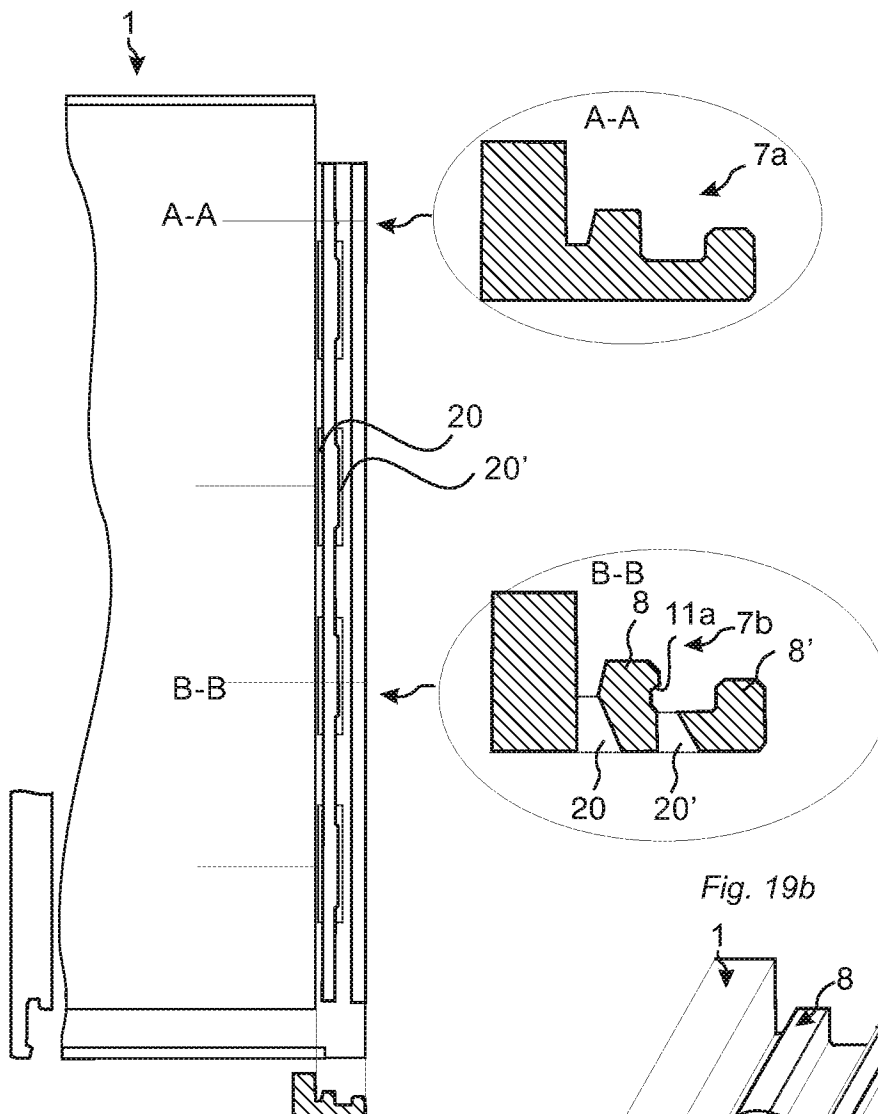


Fig. 19b

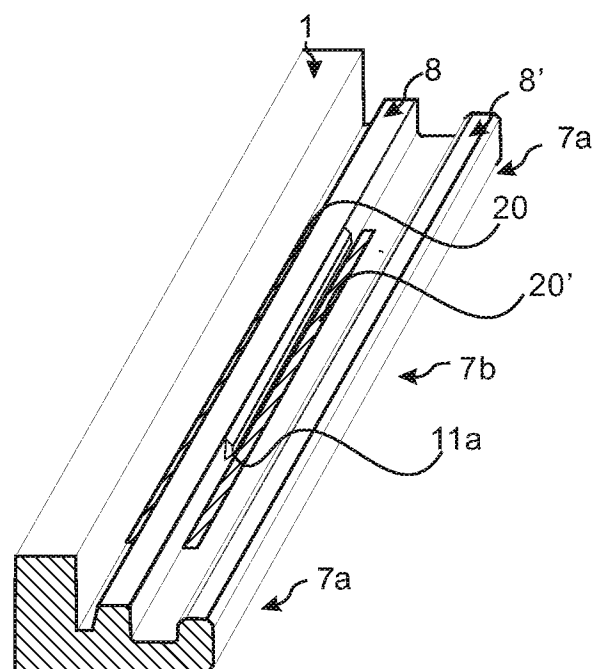


Fig. 20a

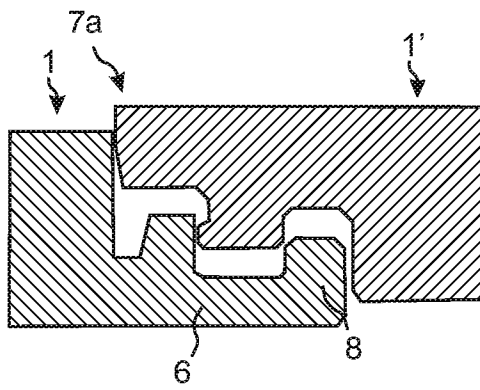


Fig. 20d

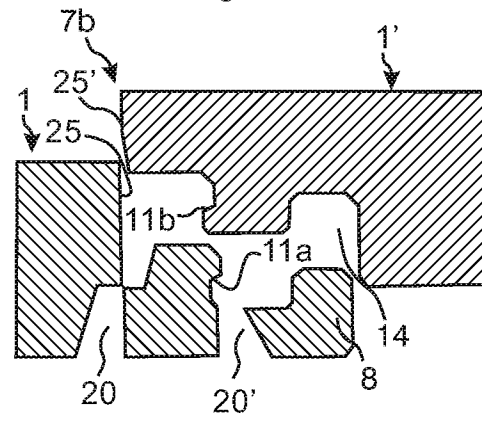


Fig. 20b

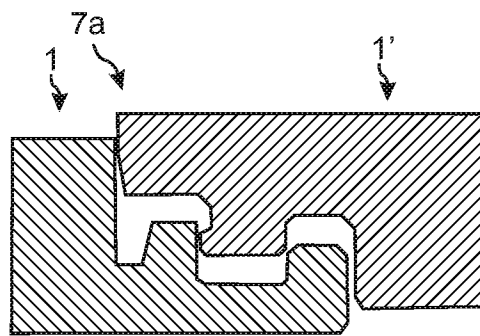


Fig. 20e

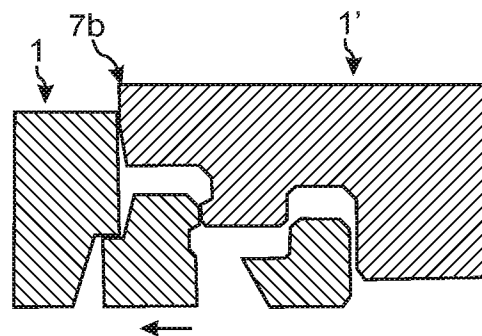


Fig. 20c

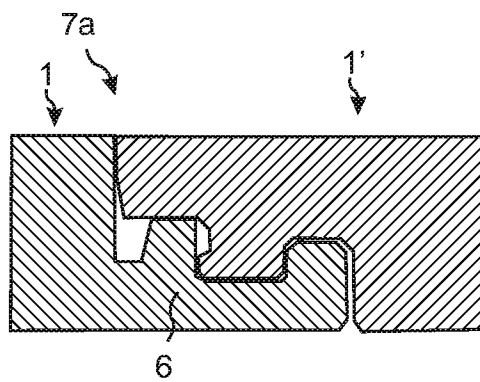
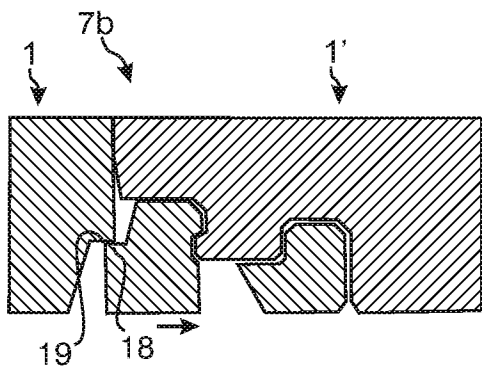


Fig. 20f



21/28

Fig. 21a

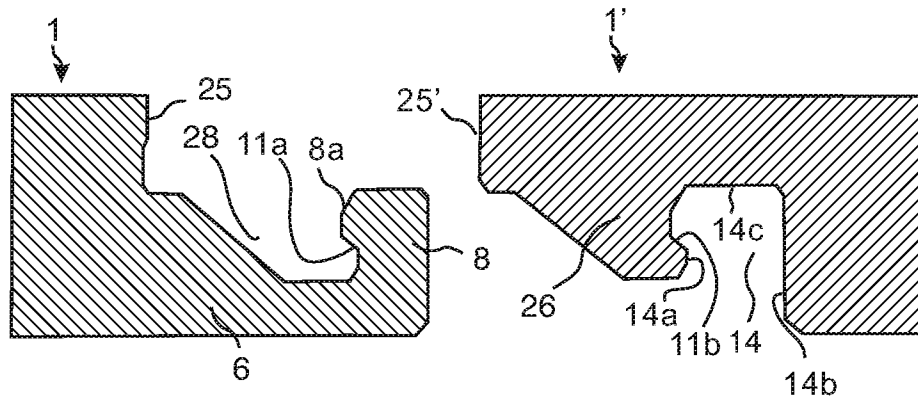


Fig. 21b

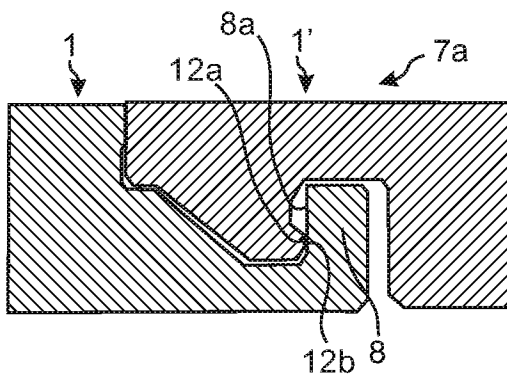


Fig. 21c

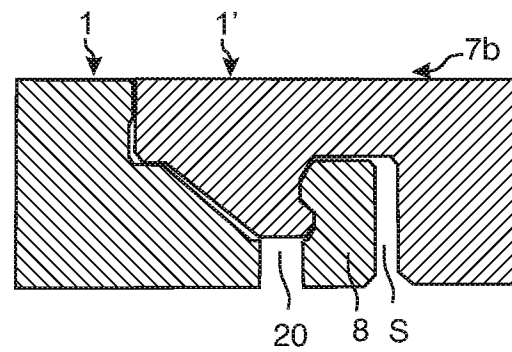


Fig. 21d

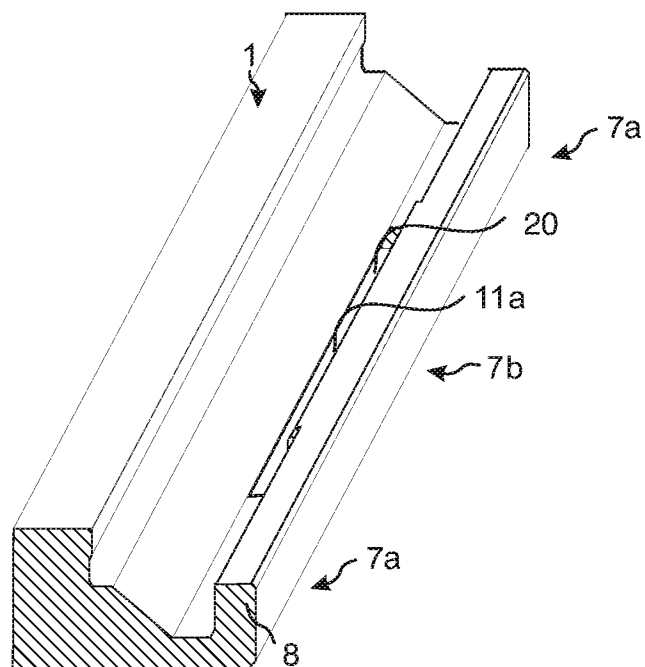


Fig. 22a

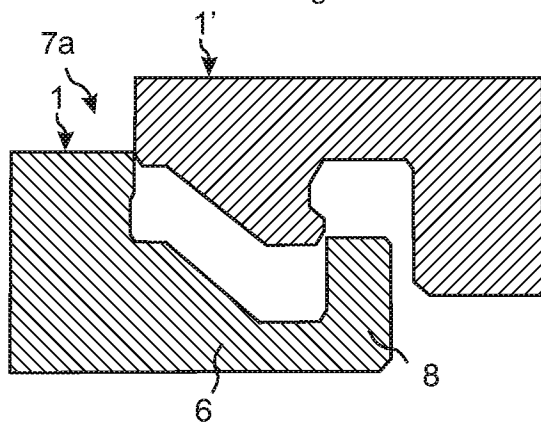


Fig. 22d

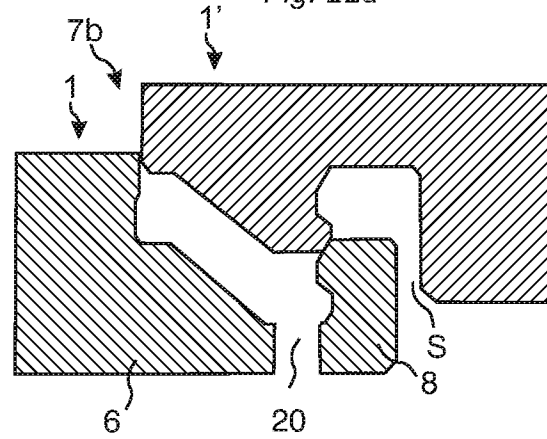


Fig. 22b

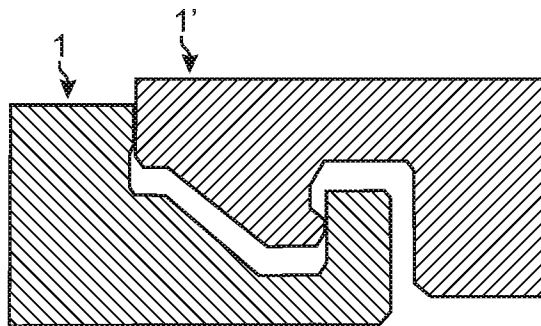


Fig. 22e

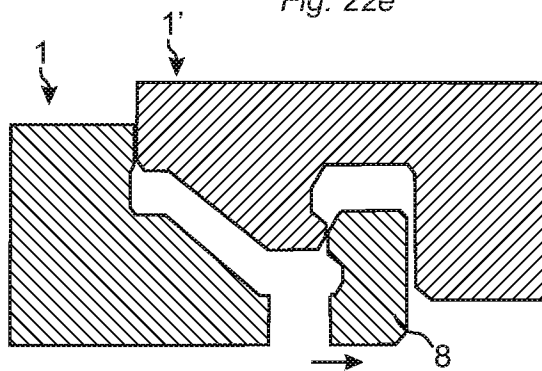


Fig. 22c

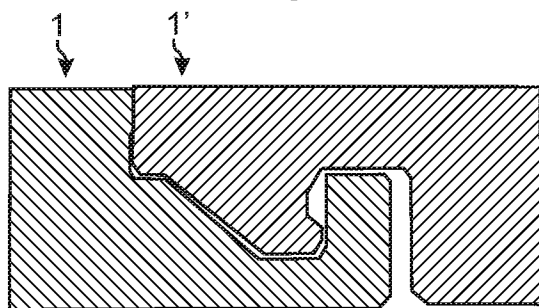


Fig. 22f

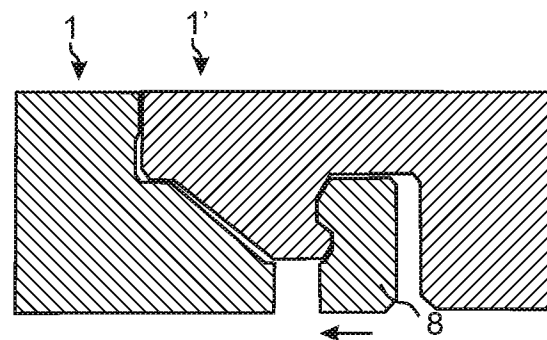


Fig. 22g

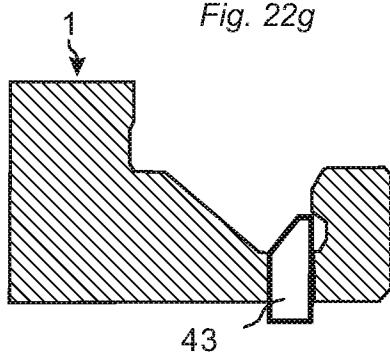


Fig. 22h

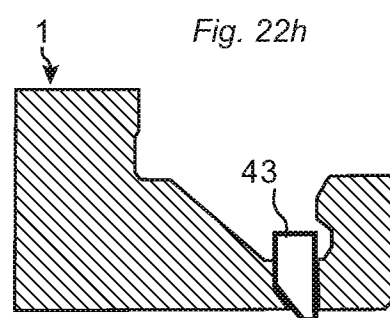


Fig. 23a

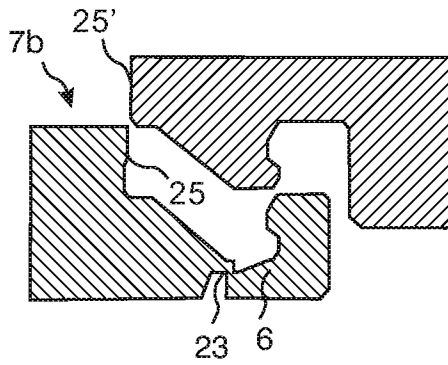


Fig. 23b

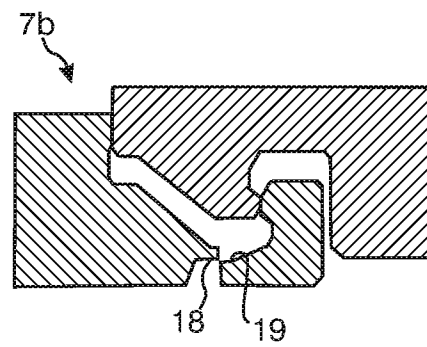


Fig. 23c

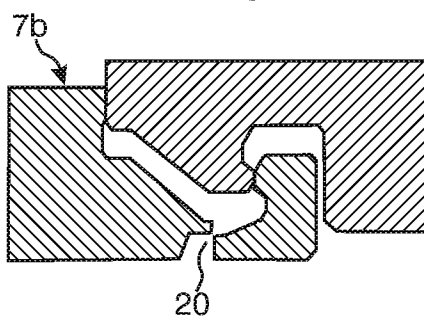


Fig. 23d

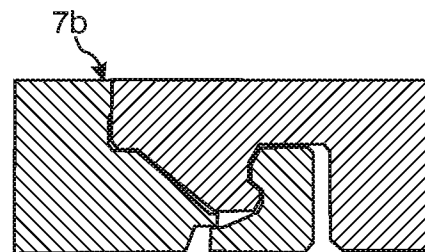


Fig. 23e

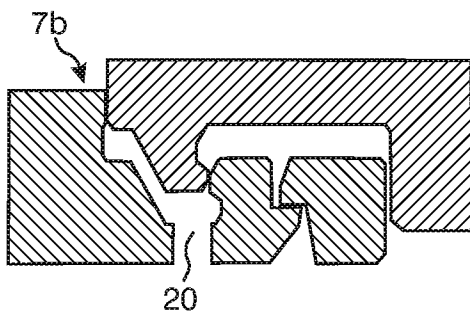


Fig. 23f

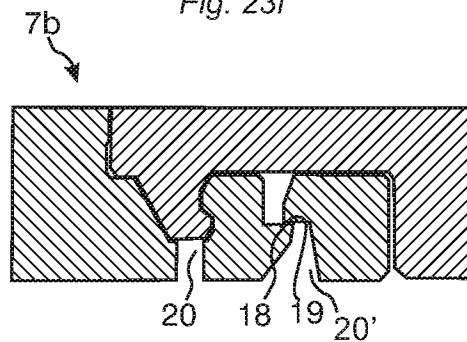


Fig. 23g

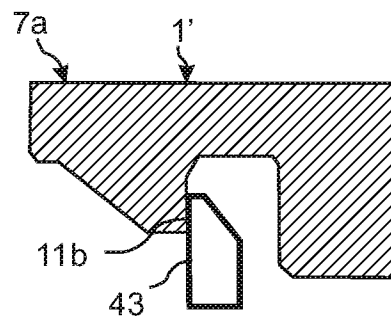
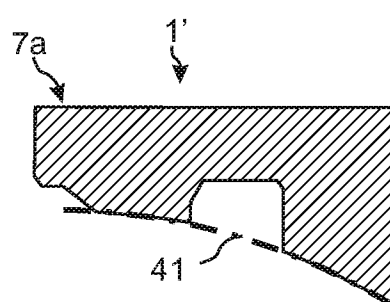


Fig. 23h



24/28

Fig. 24a

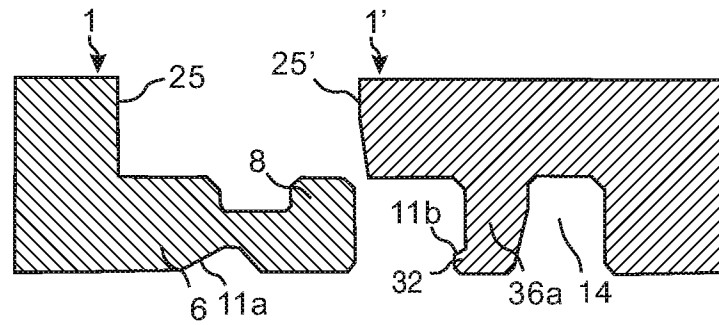


Fig. 24b

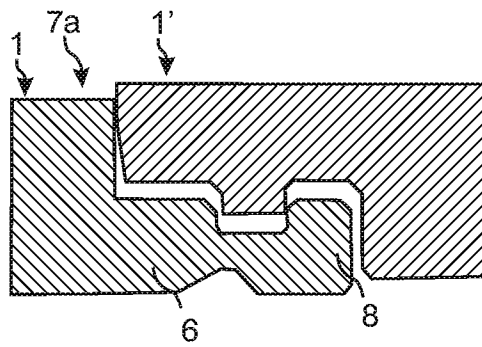


Fig. 24d

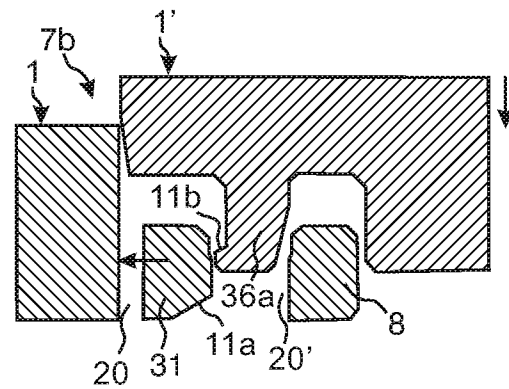


Fig. 24c

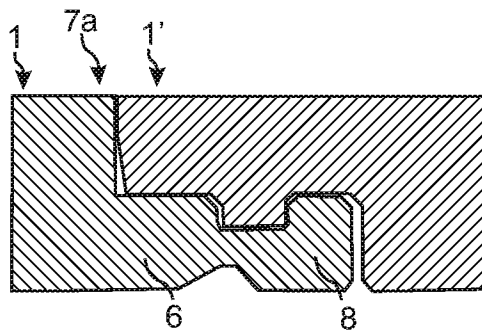


Fig. 24e

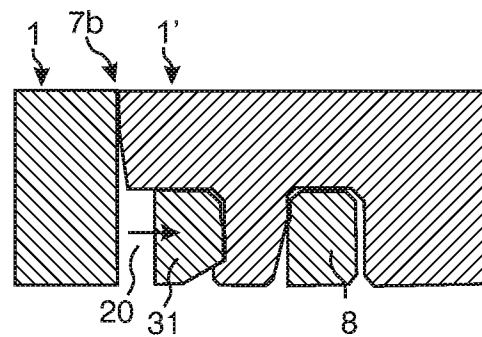
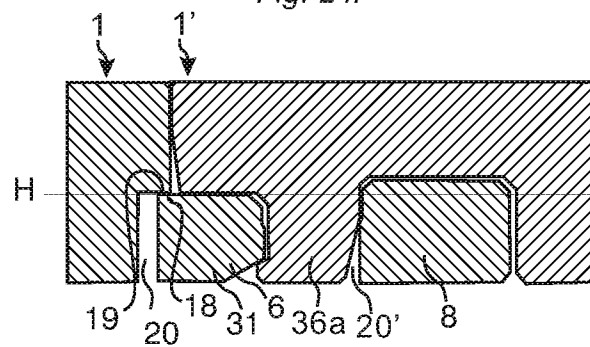


Fig. 24f



25/28

Fig. 25a

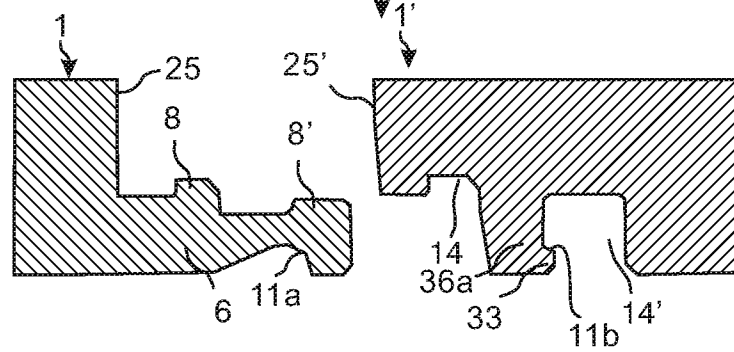


Fig. 25b

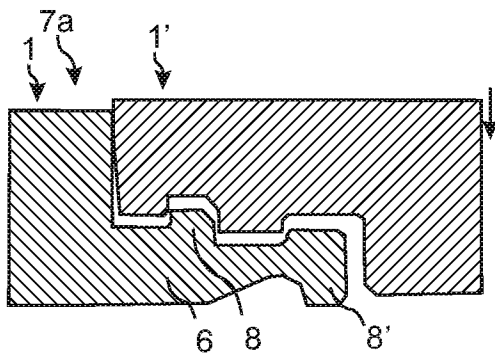


Fig. 25d

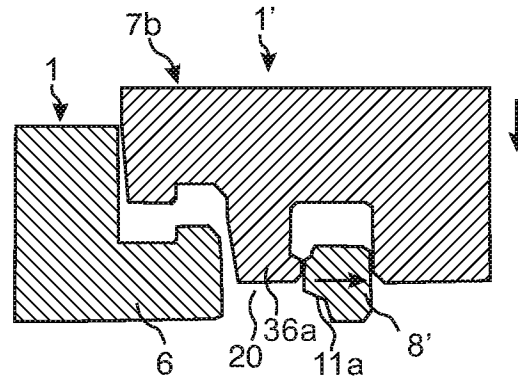


Fig. 25c

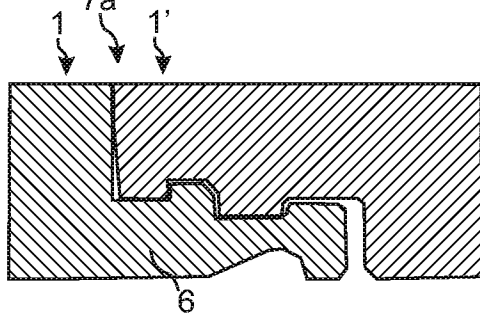


Fig. 25e

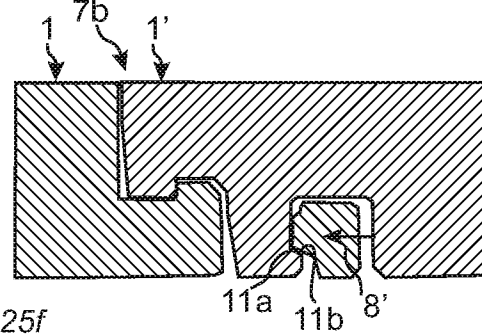
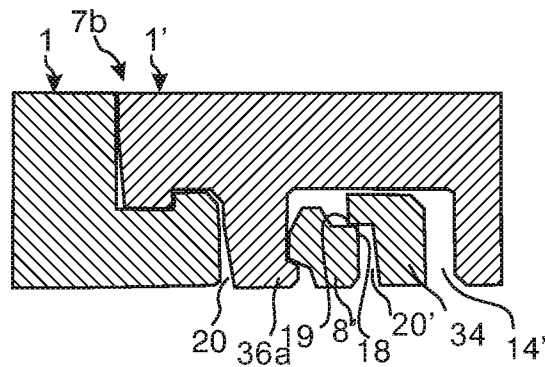


Fig. 25f



26/28

Fig. 26a

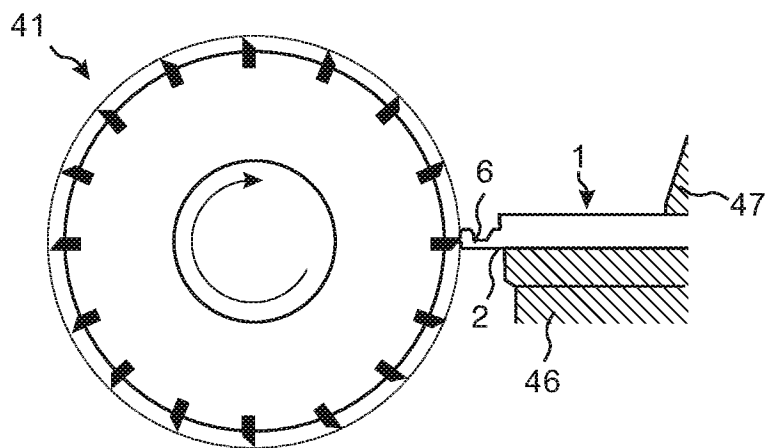


Fig. 26b

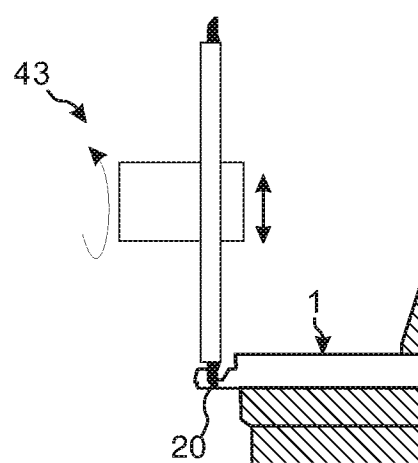


Fig. 26c

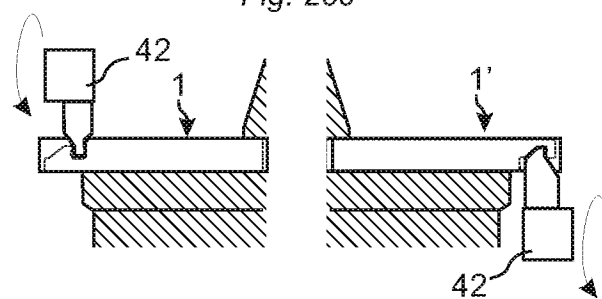
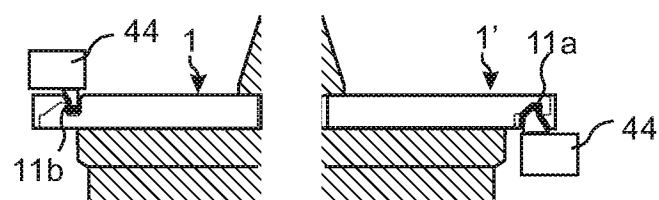


Fig. 26d



27/28

Fig. 27a

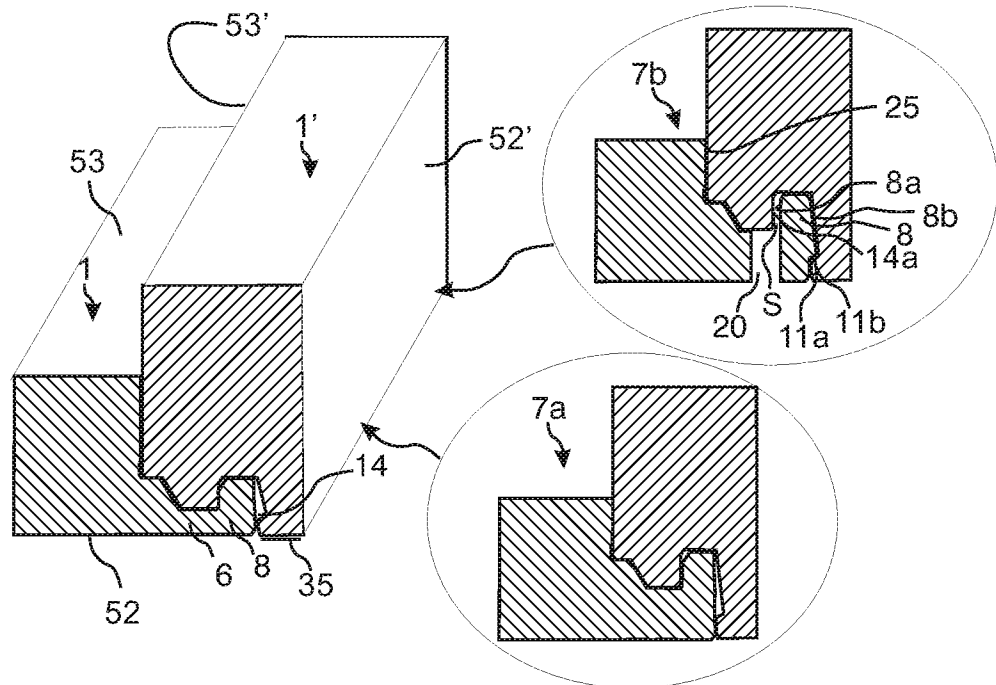
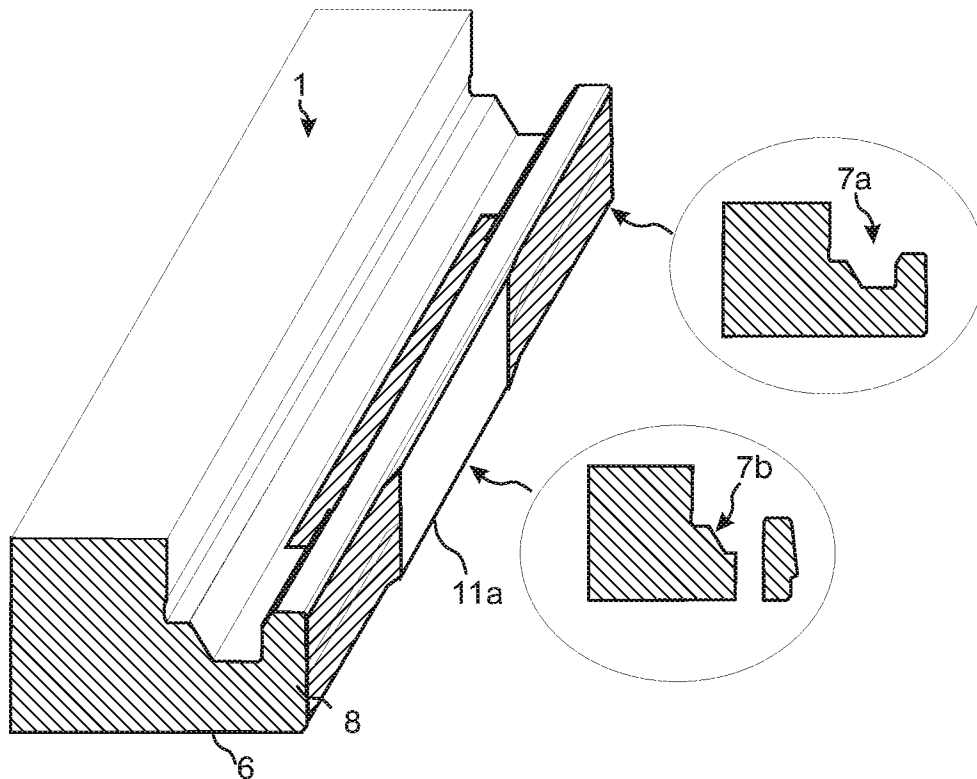


Fig. 27b



28/28

Fig. 28a

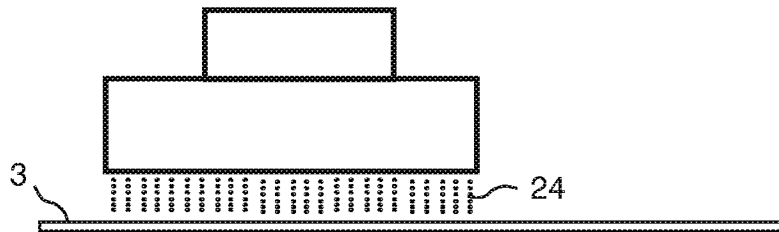


Fig. 28b

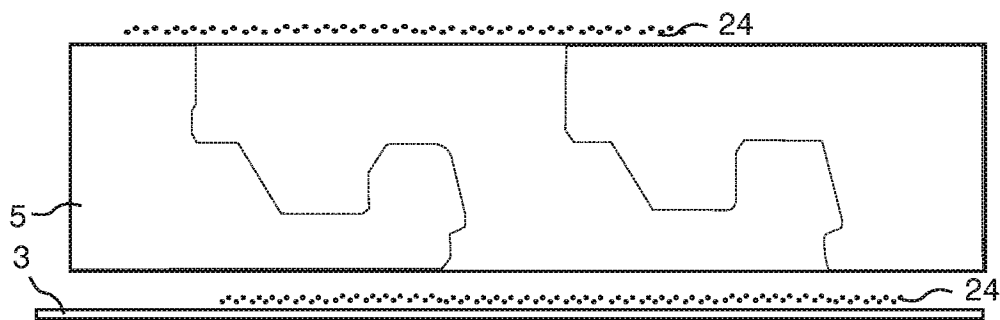


Fig. 28c

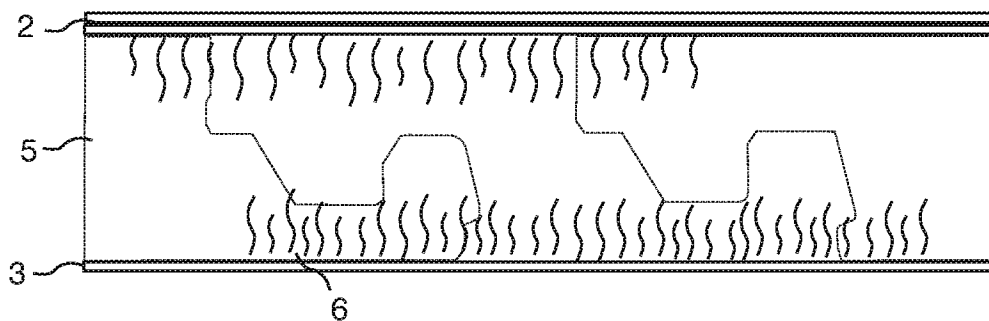
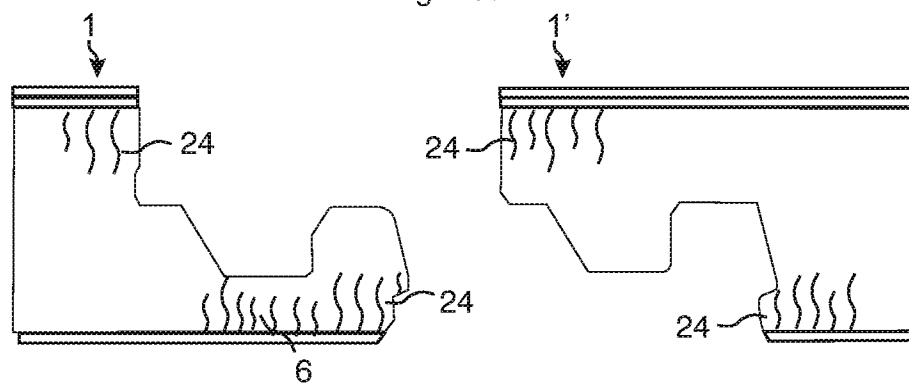


Fig. 28d



INTERNATIONAL SEARCH REPORT

 International application No.
 PCT/SE2016/050019

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

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.
X	US 20100218450 A1 (BRAUN ROGER ET AL), 2 September 2010 (2010-09-02); abstract; paragraphs [0040], [0041], [0042]; figures 1,3,4,7,8 --	1-5
A	US 20110258959 A1 (BRAUN ROGER), 27 October 2011 (2011-10-27); abstract; figures 1a-c; Detail 26 --	1-5
A	US 20100058590 A1 (BRAUN ROGER ET AL), 11 March 2010 (2010-03-11); abstract; figures 1,2,8,9 --	1-5
A	US 20110016822 A1 (BRAUN ROGER), 27 January 2011 (2011-01-27); abstract; paragraph [0037]; figures 7,8,11 --	1-5



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

“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

10-05-2016

Date of mailing of the international search report

10-05-2016

Name and mailing address of the ISA/SE

 Patent- och registreringsverket
 Box 5055
 S-102 42 STOCKHOLM
 Facsimile No. + 46 8 666 02 86

Authorized officer

Örjan Nylund

Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/050019

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1980683 A2 (KRONOTEC AG), 15 October 2008 (2008-10-15); abstract; figures 4,4a,8-11 --	1-5
A	US 20130008127 A1 (BRAUN ROGER ET AL), 10 January 2013 (2013-01-10); abstract; figures 2,3,6,7 -- -----	1-5

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/050019

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:

The following separate inventions were identified:

1. Claims 1-5 directed to a set of essentially identical floor panels (1,1') provided with a mechanical locking system comprising a strip (6) with slits (20) and a slit wall (20a), a locking groove (14), upper (11a) and lower (11b) surfaces.

2. Claims 6-7 directed to a set of essentially identical floor panels (1,1') provided with a .../...

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.: **1-5**

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.

Continuation of: Box No. III

mechanical locking system provided with a strip (6), a second locking element (8'), a protrusion (36a) and a second slit (20').

3. Claims 8-9 directed to a set of essentially identical floor panels (1,1') provided with a mechanical locking system comprising a strip (6) with slits (20) and a slit wall, a locking groove (14), upper (11a) and lower (11b) surfaces placed differently.

4. Claims 10-11 directed to a set of essentially identical floor panels (1, 1') provided with a mechanical locking system provided with a strip (6), a protrusion (36a), and a lower outer part (32).

5. Claims 12-13 directed to a set of essentially identical floor panels (1,1') provided with a mechanical locking system, with a strip (6), a second locking groove (14'), a second locking element (8'), a protrusion (36a), and a slit (20).

6. Claims 14-15 directed to a set of essentially identical floor panels (1, 1') provided with a mechanical locking system, where the core (5) has a higher content of cured resins at a lower and outer part than at a lower and inner part.

A partial search has been carried out, which relates to the invention 1 mentioned above.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2016/050019

US	20100218450 A1	02/09/2010	EP	2226447 A1	08/09/2010
			ES	2389148 T3	23/10/2012
			US	8375674 B2	19/02/2013
US	20110258959 A1	27/10/2011	AU	2009337847 B2	30/08/2012
			BR	PI0911278 A2	06/10/2015
			CA	2722814 A1	22/07/2010
			CN	102016198 A	13/04/2011
			EP	2208835 A1	21/07/2010
			ES	2388644 T3	17/10/2012
			JP	2011526335 A	06/10/2011
			JP	5420650 B2	19/02/2014
			KR	20110028503 A	18/03/2011
			KR	101265878 B1	20/05/2013
			MX	2010011164 A	12/11/2010
			RU	2010140437 A	10/04/2012
			RU	2459057 C2	20/08/2012
			UA	98383 C2	10/05/2012
			US	8484924 B2	16/07/2013
			WO	2010081532 A1	22/07/2010
US	20100058590 A1	11/03/2010	AT	497868 T	15/02/2011
			AU	2008340681 B2	02/12/2010
			BR	PI0809284 A2	02/09/2014
			CA	2687048 A1	02/07/2009
			CN	101687335 A	31/03/2010
			DE	102007062430 B3	02/07/2009
			DE	502008002556 D1	24/03/2011
			EP	2117788 A1	18/11/2009
			ES	2359294 T3	20/05/2011
			JP	2010528897 A	26/08/2010
			JP	5248603 B2	31/07/2013
			KR	20100017940 A	16/02/2010
			KR	101143737 B1	11/05/2012
			MX	2009011057 A	10/11/2009
			RU	2009136945 A	20/04/2011
			RU	2426641 C2	20/08/2011
			UA	95514 C2	10/08/2011
			US	8726513 B2	20/05/2014
			WO	2009080328 A1	02/07/2009

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2016/050019

US	20110016822 A1	27/01/2011	AU	2009270573 A1	21/01/2010
			BR	PI0907564 A2	04/08/2015
			CA	2715964 C	23/04/2013
			CN	101965430 B	05/12/2012
			DE	102008031167 B4	09/07/2015
			EP	2250330 B1	11/12/2013
			ES	2445205 T8	26/03/2014
			JP	2011522982 A	04/08/2011
			JP	5175390 B2	03/04/2013
			KR	20100126730 A	02/12/2010
			KR	101251192 B1	08/04/2013
			MX	2010008746 A	04/10/2010
			RU	2461691 C2	20/09/2012
			RU	2010134599 A	27/02/2012
			UA	98201 C2	25/04/2012
			US	8191334 B2	05/06/2012
			WO	2010006684 A3	29/07/2010
EP	1980683 A2	15/10/2008	AT	499494 T	15/03/2011
			DE	102007017087 B4	25/06/2009
			DE	502008002648 D1	07/04/2011
			ES	2359276 T3	20/05/2011

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2016/050019

US	20130008127 A1	10/01/2013	AT	470031 T	15/06/2010
			AU	2008232024 A1	02/10/2008
			AU	2010202128 A1	17/06/2010
			BR	PI0802606 A2	23/08/2011
			BR	PI0823263 A2	24/09/2013
			CA	2650517 A1	02/10/2008
			CN	101542053 A	23/09/2009
			CN	102888971 A	23/01/2013
			DE	102007015048 A1	09/10/2008
			DE	102007041024 A1	05/03/2009
			DE	502008000733 D1	15/07/2010
			DE	202007018662 U1	19/02/2009
			EP	1994241 B1	02/06/2010
			EP	2146025 B1	18/12/2013
			ES	2346168 T3	11/10/2010
			ES	2444941 T3	27/02/2014
			JP	5602804 B2	08/10/2014
			JP	5069295 B2	07/11/2012
			JP	2013011169 A	17/01/2013
			JP	2009543961 A	10/12/2009
			KR	20090005311 A	13/01/2009
			KR	101054373 B1	04/08/2011
			MX	2008012556 A	28/11/2008
			RU	2445424 C2	20/03/2012
			RU	2396398 C2	10/08/2010
			RU	2010114465 A	20/10/2011
			RU	2008137375 A	10/05/2010
			UA	89589 C2	10/02/2010
			US	8302361 B2	06/11/2012
			US	20100300029 A1	02/12/2010
			US	8511040 B2	20/08/2013
			WO	2008116623 A1	02/10/2008