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**Sheet metal roofing element and method and apparatus for
manufacturing same**

Technical field

The present invention relates to a sheet metal roofing element and a method and apparatus for manufacturing said sheet metal roofing element.

5 Background art

A sheet metal roofing element is for example known from WO 9941471 A1. This known sheet metal roofing element or tile has inter-engageable channels on its opposing longitudinal sides, one channel being on the underside and the channel on the upperside of the tile. A mounting tab extends from adjacent the upperside channel substantially co-planar to the body of the tile. The channels enable two tiles to be joined in an overlapping side by side relationship with their corresponding channel sections engaged. Each tile can be fixed to a supporting structure by their mounting tabs. A third tile can then be joined longitudinally of the first two tiles by engaging its underside channel over and about their joined upperside channel sections. It can also be fixed to the supporting structure and the steps repeated to sheath a desired area.

The manufacturing process of such roofing elements comprises steps of deforming a blank of sheet metal in a sheet metal pressing apparatus, to create strengthening grooves and decorative indentations, and subsequently further deforming the blank by means of a sheet metal folding apparatus to create the folded edges.

Disclosure of the invention

25 It is a first aim of this invention to provide a sheet metal roofing element with enhanced strength.

According to the present invention, the first aim is achieved with a sheet metal roofing element having the technical characteristics of the first independent claim.

It is a second aim of this invention to provide a method and apparatus with which a wide variety of different sheet metal roofing elements having different decorative relief structures can be manufactured in an efficient way.

5 According to the present invention, the second aim is achieved with the method and apparatus according to the further independent claims.

 In a first aspect, the present invention provides a sheet metal roofing element comprising a body, a first folded edge portion at a first longitudinal edge of the body forming a channel on what, in situ, will be an inner face of the roofing element, and a second folded edge portion at a second and opposite longitudinal edge of the body and forming a channel on what, in situ, will be an outer face of the roofing element, the folded edge portions being such that the first folded edge portion of a first such roofing element can be engaged with the second folded edge portion of a second such roofing element, the body being provided with strengthening indentations including a series of transverse strengthening grooves extending in transverse direction of the body and dividing the body up into a plurality of tile portions. The strengthening indentations further include longitudinal strengthening grooves extending in longitudinal direction of the body in between the transverse strengthening grooves without intersecting with the transverse strengthening grooves.

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 It has been found that, even though the longitudinal edges of the sheet metal roofing element are folded to form the first and second folded edge portions, the strength of the sheet metal roofing element can be highly enhanced by the provision of the longitudinal strengthening grooves while avoiding that they intersect with the transverse strengthening grooves.

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 In embodiments according to the present invention, the longitudinal strengthening grooves span at least 75% and preferably at least 80% of the length of the tile portion, and/or the longitudinal strengthening grooves span at most 95% and preferably at most 90% of the length of the tile portion. With said length of the tile portion being the distance between the transverse strengthening grooves adjacent to the tile portion. It has been found that such a span range is optimal for reinforcing the sheet metal roofing element.

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 In embodiments according to the present invention, the transverse strengthening grooves have a depth of at least 2,0 mm and preferably at least

2,5 mm, and/or the transverse strengthening grooves have a depth of at most 4,0 mm and preferably at most 3,5 mm.

In embodiments according to the present invention, the longitudinal strengthening grooves have a depth of at least 1,0 mm and preferably at least 1,5 mm, and/or the longitudinal strengthening grooves have a depth of at most 3,0 mm and preferably at most 2,5 mm.

In embodiments according to the present invention, the transverse strengthening grooves have a W-shaped profile.

In embodiments according to the present invention, the longitudinal strengthening grooves comprise, for each tile portion, a first longitudinal strengthening groove in the vicinity of the first folded edge portion and/or a second longitudinal strengthening groove in the vicinity of the second folded edge portion. The second longitudinal strengthening groove is preferably located underneath a back-folded part of the second folded edge portion, so that in use it is hidden from sight.

Arranging the longitudinal strengthening grooves in such a way, or more generally, in such a way that the transverse strengthening grooves and the longitudinal strengthening grooves together substantially surround each tile portion, offers the advantage that the periphery of the tile portions are strengthened in such a way that further indentations of the tile portions, such as for example the decorative relief structures described below, do not cause any deformations of the roofing element outside of each tile portion.

In embodiments according to the present invention, the tile portions are preferably of substantially the same size, although this is not essential. The transverse grooves are preferably continuous, i.e. extend throughout the entire width or transverse dimension of the roofing element, although this is not essential. The roofing element may be provided with a part at one transverse side which is intended for being overlapped by an adjacent roofing element and may be provided with a mounting tab extending from the second folded edge, by means of which the roofing element can be fixed to a roof structure.

In embodiments according to the present invention, the roofing element may comprise further indentations in the form of decorative relief structures on at least some of the tile portions in between the transverse strengthening grooves. The decorative relief structure may be the same for all the tile

portions of the element, but may also differ. Some of the tile portions may also be left planar, without any relief structure.

In a second aspect, the present invention provides a method for manufacturing a sheet metal roofing element, comprising the steps of:

- 5 (a) providing a blank of sheet metal;
- (b) deforming the blank by means of a sheet metal pressing apparatus, thereby forming indentations in the blank, the indentations including a series of transverse strengthening grooves extending in transverse direction of the blank and dividing the blank up into a plurality of tile portions; and
- 10 (c) further deforming the blank by means of a sheet metal folding apparatus to create a first folded edge portion at a first longitudinal edge of the blank, the first folded edge portion forming a channel on what, in situ, will be an inner face of the roofing element, and a second folded edge portion at a second and opposite longitudinal edge of the body, the second folded edge
- 15 portion forming a channel on what, in situ, will be an outer face of the roofing element, the folded edge portions being made such that the first folded edge portion of a first such roofing element can be engaged with the second folded edge portion of a second such roofing element.

The second aspect of the invention is characterized in that the method

- 20 further comprises the steps, before step (b) of deforming the blank by means of the sheet metal pressing apparatus, of (i) providing a plurality of sets of complementary tile portion deforming inserts with different relief structures, the tile portion deforming inserts being provided for being mounted on mould halves of the sheet metal pressing apparatus; and (ii) selecting, from said
- 25 plurality of sets of complementary tile portion deforming inserts, those sets of complementary tile portion deforming inserts as needed for obtaining the desired relief structures upon deforming the blank in step (b) and placing these sets of complementary tile portion deforming inserts on the mould halves.

By providing the different relief structures by means of the plurality of

- 30 sets of complementary inserts for the mould halves, the pressing apparatus can be quickly and efficiently converted from one configuration (in which the apparatus is provided for manufacturing a first type of roofing element) to another configuration (in which the apparatus is provided for manufacturing a second, different type of roofing element with different decorative relief

structures). Furthermore, by providing separate, interchangeable inserts per tile portion, i.e. the decorative relief structure can be chosen per tile portion, it is clear that a wide variety of roofing elements can be manufactured using the same pressing apparatus by simply placing the appropriate inserts as desired.

5 In embodiments according to the present invention, for at least two of the tile portions sets of complementary tile portion deforming inserts with different relief structures are placed on the mould halves so as to obtain different decorative relief structures on at least two of the tile portions after step (b).

10 In embodiments according to the present invention, for at least one of the plurality of tile portions planar inserts are placed on the mould halves to maintain the respective tile portion planar, without any relief structure.

 In embodiments according to the present invention, the indentations formed in the blank in step (b) further include longitudinal strengthening
15 grooves extending in longitudinal direction of the body in between the transverse strengthening grooves without intersecting with the transverse strengthening grooves.

 In embodiments according to the present invention, the longitudinal strengthening grooves that are created in step (b) comprise, for each tile
20 portion, a first longitudinal strengthening groove in the vicinity of the first longitudinal edge of the manufactured roofing element and a second longitudinal strengthening groove in the vicinity of the second longitudinal edge of the manufactured roofing element.

 In embodiments according to the present invention, the longitudinal
25 strengthening grooves are dimensioned for taking up excess material in case little or no deformation occurs in the respective tile portion.

 In the second aspect, the invention also provides a sheet metal pressing apparatus for use in a method for manufacturing a sheet metal roofing element. The sheet metal pressing apparatus comprises mould halves and
30 means for pressing the mould halves onto each other and thereby deforming a blank of sheet metal to create indentations in the blank. The mould halves comprise complementary transverse parts for forming transverse strengthening grooves extending in transverse direction of the blank and dividing the blank up into a plurality of tile portions. The mould halves are provided for receiving a

plurality of sets of complementary tile portion deforming inserts, provided for forming decorative relief structures on the tile portions of the blank in between the transverse strengthening grooves.

5 In embodiments according to the present invention, the mould halves comprise complementary longitudinal parts for forming longitudinal strengthening grooves extending in longitudinal direction of the blank in between the transverse strengthening grooves without intersecting with the transverse strengthening grooves.

10 In embodiments according to the present invention, the complementary longitudinal parts are positioned for forming the longitudinal strengthening grooves for each tile portion as a first longitudinal strengthening groove in the vicinity of a first longitudinal edge and a second longitudinal strengthening groove in the vicinity of a second longitudinal edge of the blank.

15 In embodiments according to the present invention, the complementary longitudinal parts are dimensioned for forming the longitudinal strengthening grooves such that they take up excess material in case little or no deformation occurs in the respective tile portion.

20 In the second aspect, the invention also provides a roofing element forming device comprising the sheet metal pressing apparatus according to an embodiment of the present invention.

Brief description of the drawings

The invention will be further elucidated by means of the following description and the appended drawings.

25 Figure 1 shows a perspective view on a sheet metal roofing element according to an embodiment of the present invention.

Figure 2 shows a top view on the roofing element of Figure 1.

Figure 3 shows a side view on the roofing element of Figure 1.

30 Figure 4 shows a detailed view on the first transverse edge of the roofing element of Figure 1.

Figure 5 shows a detailed view on the second transverse edge of the roofing element of Figure 1.

Figure 6 shows detailed view on a transverse strengthening groove of the roofing element of Figure 1.

Figure 7 shows a top view on a sheet metal roofing element according to an embodiment of the present invention.

Figure 8 shows a top view on a sheet metal roofing element according to an embodiment of the present invention.

5 Figure 9 shows a perspective view on a roofing element manufacturing device according to an embodiment of the present invention.

Figure 10 shows a perspective view on a mould half of a sheet metal pressing apparatus according to an embodiment of the present invention.

10 Figure 11 shows a perspective view on tile portion deforming inserts for use in a sheet metal pressing apparatus according to an embodiment of the present invention.

Figure 12 shows the different steps of a method according to an embodiment of the present invention for manufacturing a sheet metal roofing element according to an embodiment of the present invention.

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Modes for carrying out the invention

The present invention will be described with respect to particular embodiments and with reference to certain drawings but the invention is not limited thereto but only by the claims. The drawings described are only
20 schematic and are non-limiting. In the drawings, the size of some of the elements may be exaggerated and not drawn on scale for illustrative purposes. The dimensions and the relative dimensions do not necessarily correspond to actual reductions to practice of the invention.

Furthermore, the terms first, second, third and the like in the description
25 and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. The terms are interchangeable under appropriate circumstances and the embodiments of the invention can operate in other sequences than described or illustrated herein.

Moreover, the terms top, bottom, over, under and the like in the
30 description and the claims are used for descriptive purposes and not necessarily for describing relative positions. The terms so used are interchangeable under appropriate circumstances and the embodiments of the invention described herein can operate in other orientations than described or illustrated herein.

The term “comprising”, used in the claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. It needs to be interpreted as specifying the presence of the stated features, integers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression “a device comprising means A and B” should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

Figures 1-6 show a sheet metal roofing element 10 according to an embodiment of the present invention from different views and with different detail, and Figures 7 and 8 show sheet metal roofing elements 10 according to alternative embodiments of the present invention.

The sheet metal roofing element 10 comprises a body having a substantially rectangular shape. A first and second longitudinal edge 101, 102 of the body extend in a longitudinal direction on opposite sides of the body, and a first and second transverse edge 103, 104 of the body extend in a transverse direction on opposite sides of the body, with the transverse direction being substantially perpendicular to the longitudinal direction.

At the first longitudinal edge 101 of the body, the roofing element 10 comprises a first folded edge portion 111 folded downwards underneath the body. As such, the first folded edge portion 111 forms a channel 113 on what, when the roofing element 10 is used for covering a roof structure, will be an inner face 105 of the roofing element 10 facing towards the roof structure. At the second longitudinal edge 102 of the body, the roofing element 10 comprises a second folded edge portion 112 folded upwards over the body. As such, the second folded edge portion 112 forms a channel 114 on what, when the roofing element 10 is used for covering a roof structure, will be an outer face 106 of the roofing element 10, facing away from the roof structure. The folded edge portions 111, 112 of the roofing element 10 have been folded in such a way that the first folded edge portion 111 of a roofing element 10 can be engaged with the second folded edge portion 112 of another roofing element 10 of the same type. At the second longitudinal edge 102 there extends a mounting tab 116 from the second folded edge portion 112, by

means of which the roofing element 10 can be fixed to a roof structure. The mounting tab 116 extends substantially co-planar to the body of the tile.

The body is provided with strengthening indentations 12, 131, 132 including a series of transverse strengthening grooves 12 and a series of longitudinal strengthening grooves 131, 132, which provide additional strength to the roofing element 10.

The transverse strengthening grooves 12 extend in the transverse direction of the body and divide the body up into a plurality of tile portions 14, for example six tile portions 14 in this embodiment. The transverse strengthening grooves 12 have a W-shaped profile, such as for example can be seen in Figure 6.

The longitudinal strengthening grooves 131, 132 extend in the longitudinal direction of the body in between the transverse strengthening grooves 12 without intersecting with the transverse strengthening grooves 12. Two longitudinal strengthening grooves 131, 132 are provided in each tile portion 14, of which a first longitudinal strengthening groove 131 is arranged in the vicinity of the first folded edge portion 111 at the first longitudinal edge 101 of the body, and of which a second longitudinal strengthening groove 132 is arranged in the vicinity of the second folded edge portion 112 at the second longitudinal edge 102. Hereby, the second longitudinal strengthening groove 132 is located underneath a back-folded part 115 of the second folded edge portion 112, such that the second longitudinal strengthening groove 132 is hidden from sight in use.

In the embodiment of Figures 1-6, the tile portions 14 are planar, but according to an embodiment of the present invention the tile portions 14 of the roofing element 10 may be provided with further indentations 15 in the form of decorative relief structures 15, such as shown in Figure 7. The decorative relief structures 15 are for example used to provide the sheet metal roofing element 10 with the look of a wooden or stone roofing element. Each tile portion 14 of the roofing element 10 may be provided with the same decorative relief structures 15, or a combination of different decorative relief structures 15 may be used, possibly in combination with planar tile portions 14.

At the first transverse edge 103 a part of the roofing element 10 is provided with further indentations 16 in the form of a series of parallel ribs 16

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extending along the transverse direction of the body of the roofing element 10. This part of the roofing element 10 is provided for being overlapped by a part of an adjacent roofing element 10, which overlapping part is located at the second transverse edge 104 of said adjacent roofing element 10. The function of the ribs 16 is to prevent water, for example from rain, from flowing between the overlapping roofing elements 10 towards a roofing structure on which the roofing elements 10 are mounted.

At the corner between the second longitudinal edge 102 and the second transverse edge 104, at least the mounting tab 116 is omitted, such that when two adjacent roofing elements 10 are overlapping each other, as described above, the mounting tabs 116 of the overlapping roofing elements 10 do not obstruct each other. In the roofing element 10 of Figures 1-6 only the mounting tab 16 is omitted in said corner of the roofing element 10, but according to alternative aspects of the present invention, shown in Figure 8, also the back-folded part 115 of the second folded edge portion 112 may be omitted completely or partially at said corner of the roofing element 10, such that no channel or only a partial channel 113 is formed by the second folded edge portion 112. In this way possible obstructions between adjacent overlapping roofing elements 10 are further reduced.

A roofing element manufacturing device 20, such as shown in Figure 9, may be used for manufacturing sheet metal roofing elements 10 according to an embodiment of the present invention. The roofing element manufacturing device 20 comprises a lift table 210 for storing blank sheets of metal 30 before being processed in the roofing element manufacturing device 20. The roofing element manufacturing device 20 may, however, also be provided in such a way that blank sheets of metal 30 are provided directly to the roofing element manufacturing device 20.

The roofing element manufacturing device 20 also comprises a sheet metal notching apparatus 220, which is provided for cutting out parts of the blank sheets of metal 30. Such a part being cut out from the blank sheets of metal 30, may for example be the corner part between the second longitudinal edge 102 and the second transverse edge 104, where in the final roofing element 10 the mounting tab 116 and optionally the back-folded part 115 of the second folded edge portion 112 are omitted.

The roofing element manufacturing device 20 also comprises a sheet metal pressing apparatus 230 which is provided for deforming/indenting the blank sheets of metal 30 in order to form the strengthening indentations 12, 131, 132, such as the transverse strengthening grooves 12 and the longitudinal strengthening grooves 131, 132, and the further indentations 15, 16, such as the decorative relief structures 15 and the series of the parallel ribs 16. Furthermore, the sheet metal pressing apparatus 230 is also provided for pre-indenting the blank sheets of metal 30 in preparation of the folding of the blank sheets of metal 30 in the sheet metal folding apparatus 240 following the sheet metal pressing apparatus 230.

The sheet metal pressing apparatus 230 comprises opposing mould halves 231 of complementary shape, of which, for clarity reasons, only the bottom mould half 231 is shown in Figure 9, and in more detail in Figure 10. The sheet metal pressing apparatus 230 also comprises means (not shown) for pressing the mould halves 231 onto each other with a blank sheet of metal 30 positioned in between them, thereby deforming/indenting the blank sheet of metal 30.

The mould halves 231 comprise complementary transverse parts 232 for forming the transverse strengthening grooves 12 of the roofing element 10. The mould halves 231 also comprise complementary longitudinal parts 233 for forming the longitudinal strengthening grooves 131, 132 of the roofing element 10.

The mould halves 231 are provided for receiving a plurality of sets of complementary tile portion deforming inserts 234, of which some examples are shown in Figure 11. The tile portion deforming inserts 234 are provided for forming the decorative relief structures 15 on the tile portions 14 of the roofing element 10. To form a planar tile portion 14, a planar surface tile portion deforming insert 234, such as shown in the bottom right corner of Figure 11, may be used, or, alternatively, no tile portion deforming insert may be used.

The sheet metal folding apparatus 240 of the roofing element manufacturing device 20 is provided for folding the blank sheets of metal 30, thereby creating the first folded edge portion 111 and the second folded edge portion 112 of the roofing element 10 according to an embodiment of the present invention.

The sheet metal folding apparatus 240 comprises opposing mould halves 241 between which the pre-indented blank sheets of metal 30 are pressed before being folded. The sheet metal folding apparatus 240 also comprises means (not shown) for moving said mould halves 241 relative to each other in the transverse direction when a blank sheet of metal 30 is positioned in between them, thereby folding the blank sheet of metal 30.

The method for manufacturing the sheet metal roofing element 10 according to an embodiment of the present invention by means of a roofing element manufacturing device 20 according to an embodiment of the present invention is illustrated in Figure 12, which shows the shape of a blank sheet of metal 30 in the different steps of method. The top row of Figure 12 shows the top view of the blank sheet of metal 30, the bottom row shows a side view of the blank sheet of metal 30.

In a first step A, a substantially rectangular blank sheet of metal 30, showing no deformations, is provided to the roofing element forming device 20, either directly or from the lift table 210, or by any other suitable means known by the skilled person.

In a second step B, the blank sheet of metal 30 is transported to the sheet metal notching apparatus 220 by suitable transportation means. At the sheet metal notching apparatus 220 predetermined parts of the blank sheet of metal 30 are cut out of the blank sheet of metal 30.

In a third step C, the blank sheet of metal 30 is transported from the sheet metal notching apparatus 220 to the sheet metal pressing apparatus 230 by suitable transportation means. In the sheet metal pressing apparatus 230 the blank sheet of metal 30 is deformed between the two mould halves 231 of the sheet metal pressing apparatus 230 for forming the transverse strengthening grooves 12, the longitudinal strengthening grooves 131, 132, the decorative relief structures 15 and the series of the parallel ribs 16. Additionally, the blank sheet of metal 30 is also pre-indented for later folding in a following step D.

Step C is divided in different sub-steps C1, C2, C3 which are applied progressively. This offers the advantage of preventing cracks in the blank sheet of metal 30, which cracks are more likely to occur when the entire blank sheet of metal 30 is deformed at once. In a first sub-step C1 a middle section

of the blank sheet of metal 30 is deformed, after which the adjacent side sections of the blank sheet of metal 30 are deformed in a second sub-step C2. In a third sub-step C3, the blank sheet of metal 30 is then pre-indented in preparation for later folding. It should be clear to the skilled person that sub-

5 steps C1 and C2 may be divided in further sub-steps. It should also be clear to the skilled person that sub-step C3 may also be part of the following step D of folding the blank sheet of metal 30 in the sheet metal folding apparatus 240.

In a fourth step D, the blank sheet of metal 30 is transported from the sheet metal pressing apparatus 230 to the sheet metal folding apparatus 240

10 by suitable transportation means. In the sheet metal folding apparatus 240 the blank sheet of metal 30 is folded by means of the two mould halves 241 of the sheet metal folding apparatus 240 for the first folded edge portion 111 and the second folded edge portion 112 of the roofing element 10.

References

15	10	roofing element
	101, 102	first and second longitudinal edge
	103, 104	first and second transverse edge
	105, 106	inner and outer face
	111, 112	first and second folded edge portion
20	113, 114	channel
	115	back-folded part
	116	mounting tab
	12	transverse strengthening groove
	131, 132	first and second longitudinal strengthening grooves
25	14	tile portion
	15	decorative relief structures
	16	rib
	20	roofing element manufacturing device
	210	lift table
30	220	sheet metal notching apparatus
	230	sheet metal pressing apparatus
	231	mould halves
	232	complementary transverse parts

	233	complementary longitudinal parts
	234	complementary tile portion deforming inserts
	240	sheet metal folding apparatus
	241	mould halves
5	30	blank sheet of metal

Claims

1. A sheet metal roofing element (10), comprising a body, a first folded edge portion (111) at a first longitudinal edge (101) of the body forming a channel (113) on what, in situ, will be an inner face (105) of the roofing element (10), and a second folded edge portion (12) at a second and opposite longitudinal edge of the body and forming a channel (114) on what, in situ, will be an outer face (106) of the roofing element (10), the folded edge portions (111, 112) being such that the first folded edge portion (111) of a first such roofing element (10) can be engaged with the second folded edge portion (112) of a second such roofing element (10), the body being provided with strengthening indentations (12, 131, 132) including a series of transverse strengthening grooves (12) extending in transverse direction of the body and dividing the body up into a plurality of tile portions (14), characterised in that the strengthening indentations (12, 131, 132) further include longitudinal strengthening grooves (131, 132) extending in longitudinal direction of the body in between the transverse strengthening grooves (12) without intersecting with the transverse strengthening grooves (12).
2. The sheet metal roofing element (10) according to claim 1, wherein the longitudinal strengthening grooves (131, 132) span at least 75% and preferably at least 80% of the length of the tile portion (14), and/or the longitudinal strengthening grooves (131, 132) span at most 95% and preferably at most 90% of the length of the tile portion (14).
3. The sheet metal roofing element (10) according to claim 1 or 2, wherein the transverse strengthening grooves (12) have a depth of at least 2,0 mm and preferably at least 2,5 mm, and/or the transverse strengthening grooves (12) have a depth of at most 4,0 mm and preferably at most 3,5 mm.
4. The sheet metal roofing element (10) according to any one of the preceding claims, wherein the longitudinal strengthening grooves (131, 132) have a depth of at least 1,0 mm and preferably at least 1,5 mm, and/or the longitudinal strengthening grooves (131, 132) have a depth of at most 3,0 mm and preferably at most 2,5 mm.

5. The sheet metal roofing element (10) according to any one of the preceding claims, wherein the transverse strengthening grooves (12) have a W-shaped profile.

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6. The sheet metal roofing element (10) according to any one of the preceding claims, wherein the longitudinal strengthening grooves (131, 132) comprise, for each tile portion (14), a first longitudinal strengthening groove (131) in the vicinity of the first folded edge portion (111) and a second longitudinal strengthening groove (132) in the vicinity of the second folded edge portion (112).

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7. The sheet metal roofing element (10) according to claim 6, wherein the second longitudinal strengthening groove (132) is located underneath a back-folded part (115) of the second folded edge portion (112).

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8. The sheet metal roofing element (10) according to any one of the preceding claims, wherein the roofing element (10) comprises further indentations (15) in the form of decorative relief structures (15) on at least some of the tile portions (14) in between the transverse strengthening grooves (12).

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9. The sheet metal roofing element (10) according to claim 8, wherein at least two of the plurality of tile portions (14) have different decorative relief structures (15).

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10. The sheet metal roofing element (10) according to claim 8 or 9, wherein at least one of the plurality of tile portions (14) is planar, without any relief structure.

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11. A method for manufacturing a sheet metal roofing element (10), comprising the steps of:

(a) providing a blank of sheet metal;

(b) deforming the blank by means of a sheet metal pressing apparatus (230), thereby forming indentations in the blank, the indentations including a series of transverse strengthening grooves (12) extending in transverse direction of the blank and dividing the blank up into a plurality of tile portions (14) and decorative relief structures (15) on at least some of the tile portions (15) in between the transverse strengthening grooves (12); and

(c) further deforming the blank by means of a sheet metal folding apparatus (20) to create a first folded edge portion (111) at a first longitudinal edge of the blank, the first folded edge portion (111) forming a channel (113) on what, in situ, will be an inner face (105) of the roofing element (10), and a second folded edge portion (112) at a second and opposite longitudinal edge of the body, the second folded edge portion (112) forming a channel (114) on what, in situ, will be an outer face (106) of the roofing element (10), the folded edge portions (111, 112) being made such that the first folded edge portion (111) of a first such roofing element (10) can be engaged with the second folded edge portion (112) of a second such roofing element (10);

characterised in that the method further comprises the steps, before step (b) of deforming the blank by means of the sheet metal pressing apparatus (230), of (i) providing a plurality of sets of complementary tile portion deforming inserts (234) with different relief structures, the tile portion deforming inserts (234) being provided for being mounted on mould halves (231) of the sheet metal pressing apparatus (230); and (ii) selecting, from said plurality of sets of complementary tile portion deforming inserts (234), those sets of complementary tile portion deforming inserts (234) as needed for obtaining the desired relief structures upon deforming the blank in step (b) and placing these sets of complementary tile portion deforming inserts (234) on the mould halves (231).

12. The method according to claim 11, wherein for at least two of the tile portions (14) sets of complementary tile portion deforming inserts (234) with different relief structures are placed on the mould halves (231) so as to obtain different decorative relief structures (15) on at least two of the tile portions (14) after step (b).

13. The method according to claim 11 or 12, wherein for at least one of the plurality of tile portions (14) planar inserts are placed on the mould halves (231) to maintain the respective tile portion (14) planar, without any relief structure.

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14. The method according to any one of the claims 11-13, wherein the indentations formed in the blank in step (b) further include longitudinal strengthening grooves (131, 132) extending in longitudinal direction of the body in between the transverse strengthening grooves (12) without intersecting with the transverse strengthening grooves (12).

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15. The method according to claim 14, wherein the longitudinal strengthening grooves (131, 132) that are created in step (b) comprise, for each tile portion (14), a first longitudinal strengthening groove (131) in the vicinity of the first longitudinal edge of the manufactured roofing element (10) and a second longitudinal strengthening groove (132) in the vicinity of the second longitudinal edge of the manufactured roofing element (10).

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16. The method according to claim 14 or 15, wherein the longitudinal strengthening grooves (131, 132) are dimensioned for taking up excess material in case little or no deformation occurs in the respective tile portion (14).

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17. A sheet metal pressing apparatus (230) for use in a method for manufacturing a sheet metal roofing element (10), the sheet metal pressing apparatus (230) comprising mould halves (231) and means for pressing the mould halves (231) onto each other and thereby deforming a blank of sheet metal to create indentations in the blank, the mould halves (231) comprising complementary transverse parts (232) for forming transverse strengthening grooves (12) extending in transverse direction of the blank and dividing the blank up into a plurality of tile portions (14), characterised in that the mould halves (231) are provided for receiving a plurality of sets of complementary tile portion deforming inserts (234), provided for forming decorative relief

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structures (15) on the tile portions (14) of the blank in between the transverse strengthening grooves (12).

5 18. The sheet metal pressing apparatus (230) of claim 17, wherein the mould halves (231) comprise complementary longitudinal parts (233) for forming longitudinal strengthening grooves (131, 132) extending in longitudinal direction of the blank in between the transverse strengthening grooves (12) without intersecting with the transverse strengthening grooves (12).

10 19. The sheet metal pressing apparatus (230) of claim 18, wherein the complementary longitudinal parts (233) are positioned for forming the longitudinal strengthening grooves (131, 132) for each tile portion (14) as a first longitudinal strengthening groove (131) in the vicinity of a first longitudinal edge and a second longitudinal strengthening groove (132) in the vicinity of a
15 second longitudinal edge of the blank.

20 20. The sheet metal pressing apparatus (230) according to claim 18 or 19, wherein the complementary longitudinal parts (233) are dimensioned for forming the longitudinal strengthening grooves (131, 132) such that they take up excess material in case little or no deformation occurs in the respective tile
25 portion (14).

21. A roofing element manufacturing device (20) comprising the sheet metal pressing apparatus (230) according to any one of the claims 17-20.

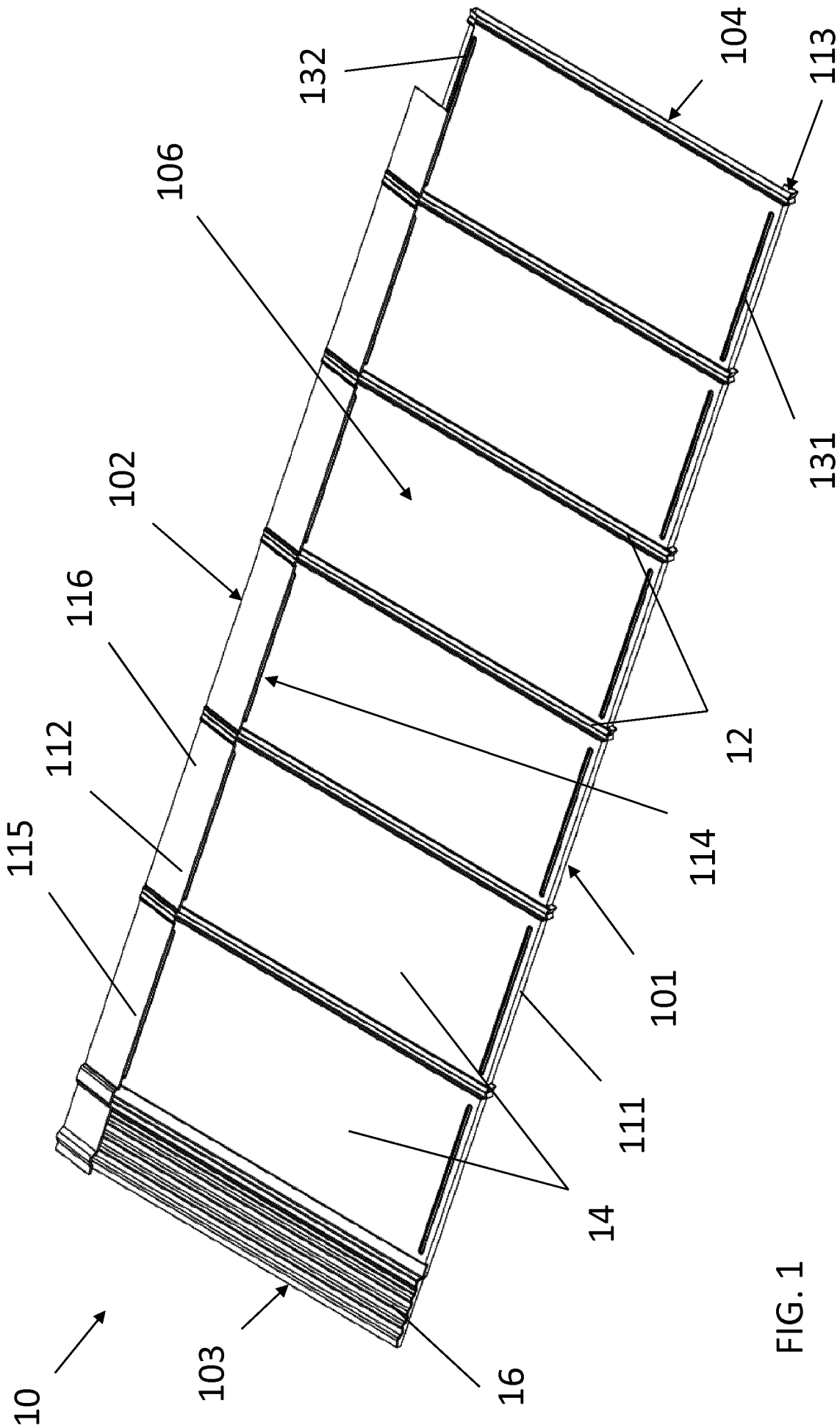
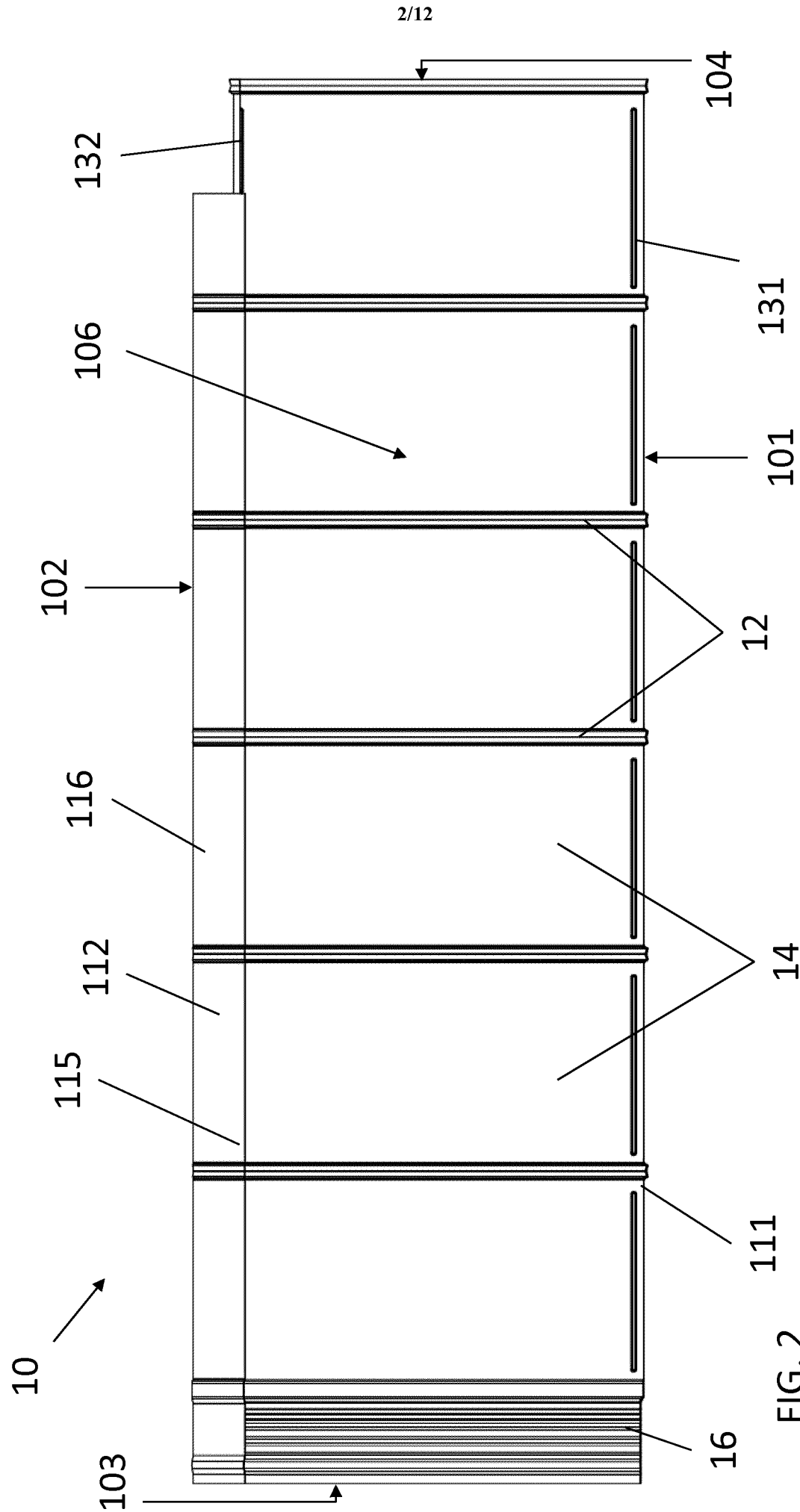


FIG. 1



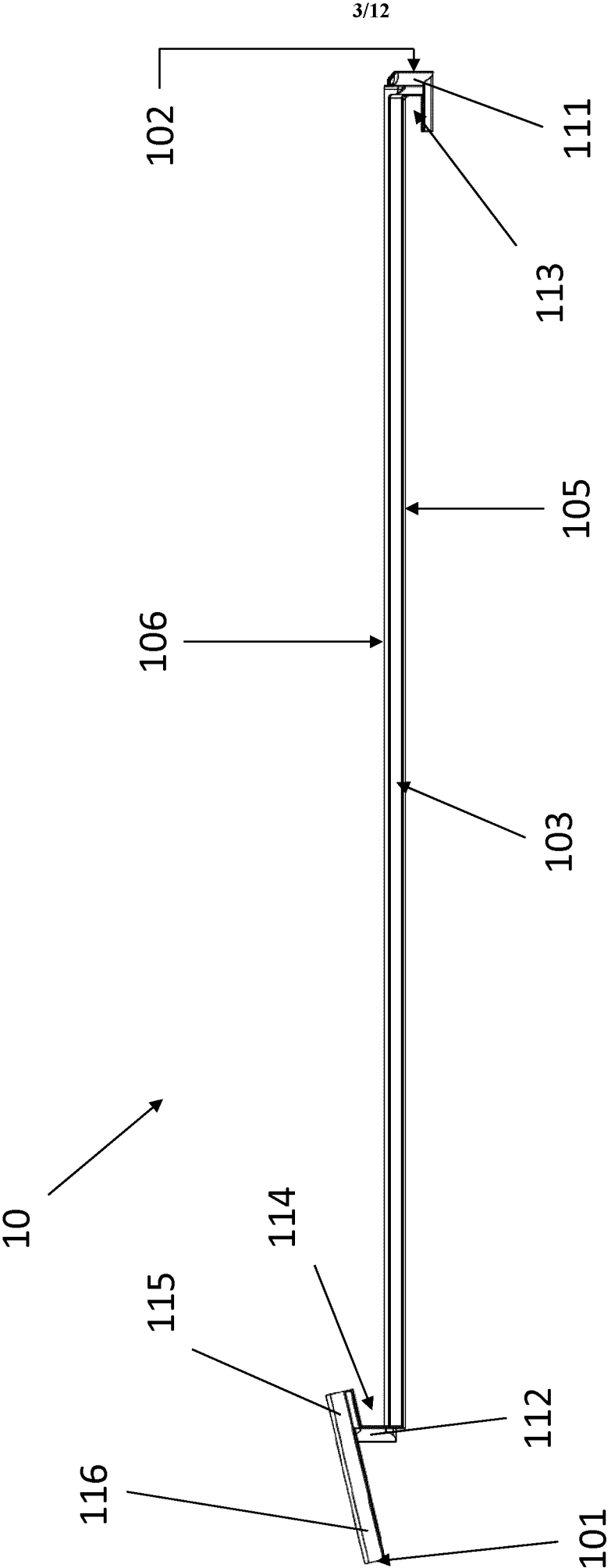


FIG. 3

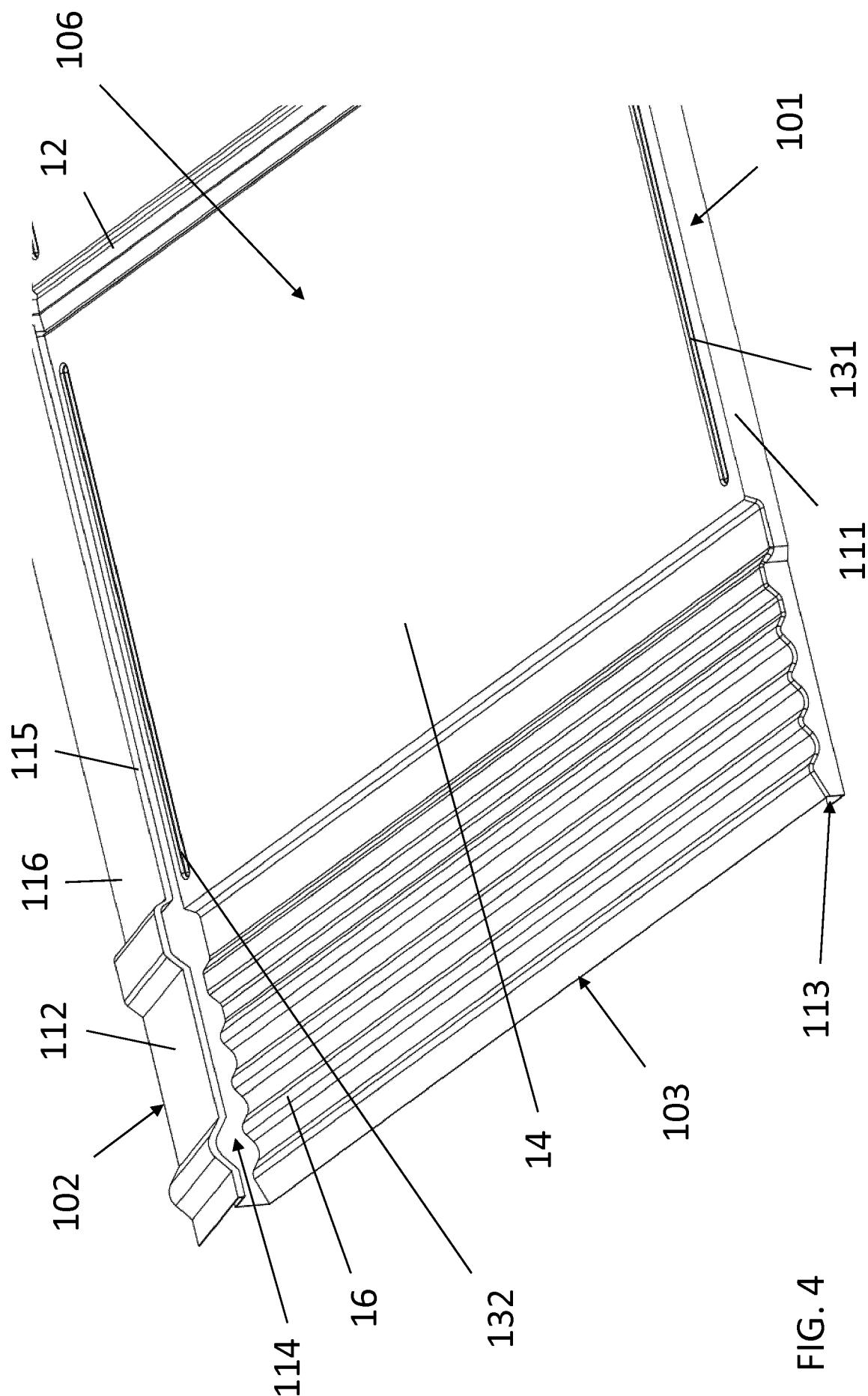


FIG. 4

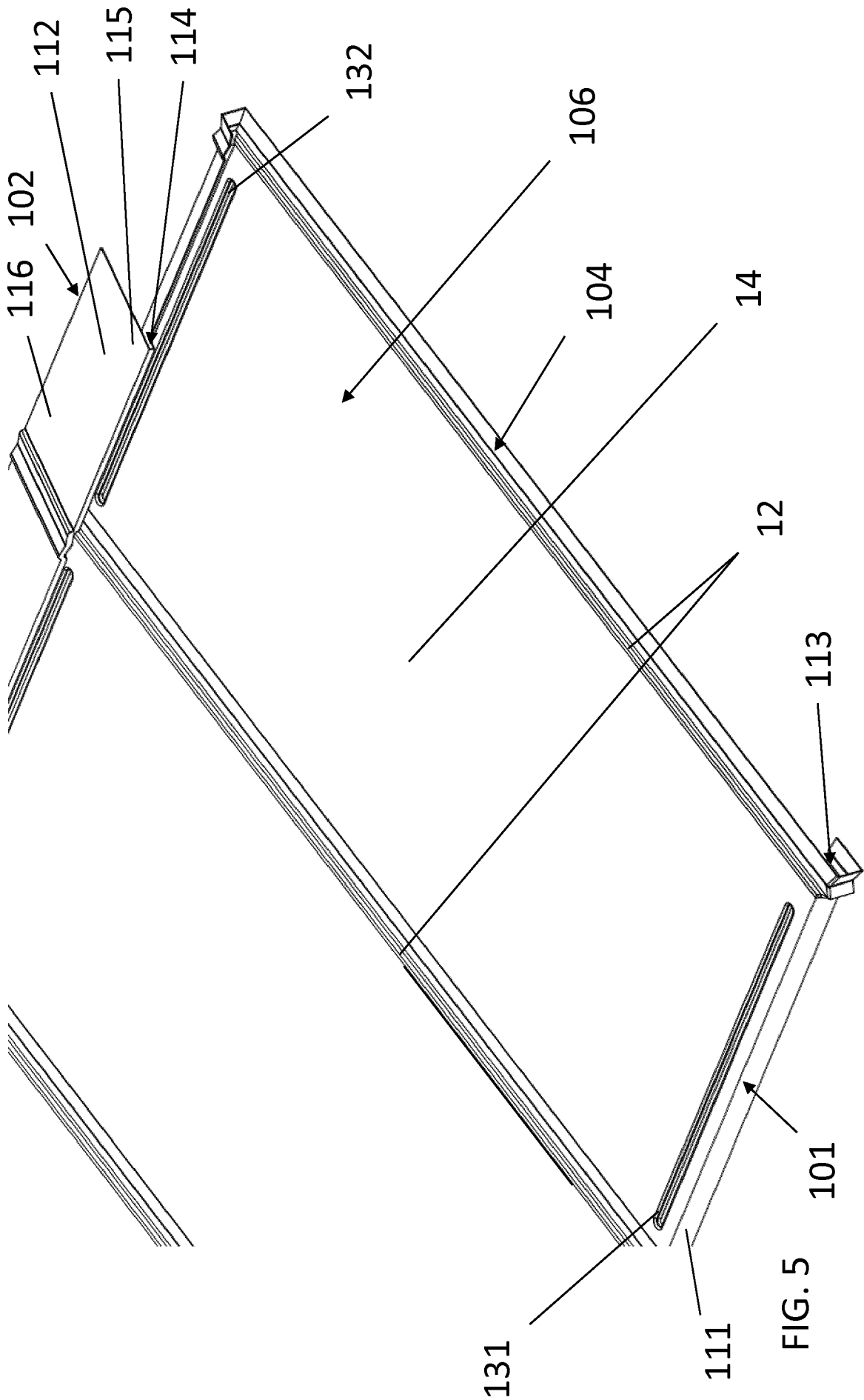


FIG. 5

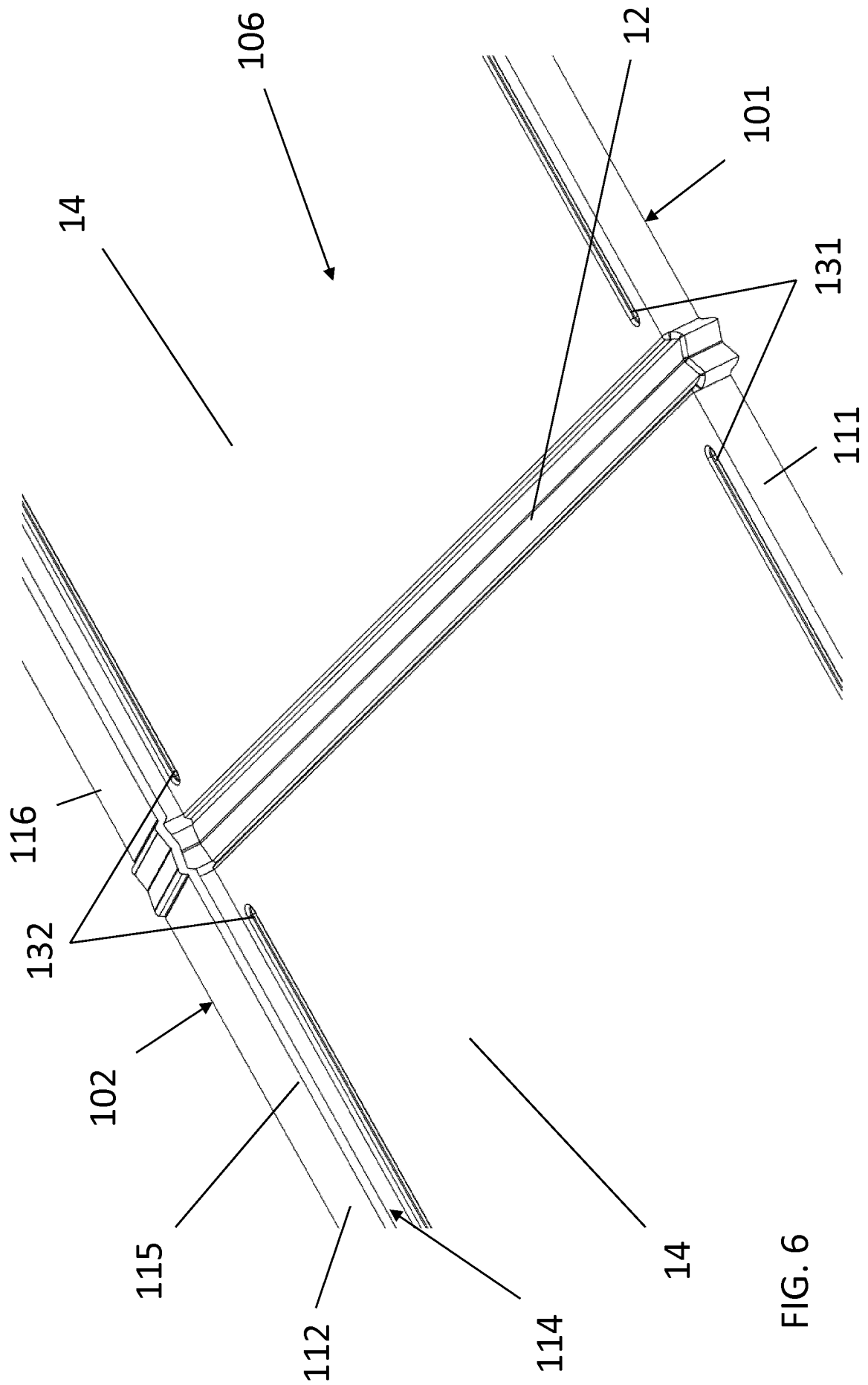


FIG. 6

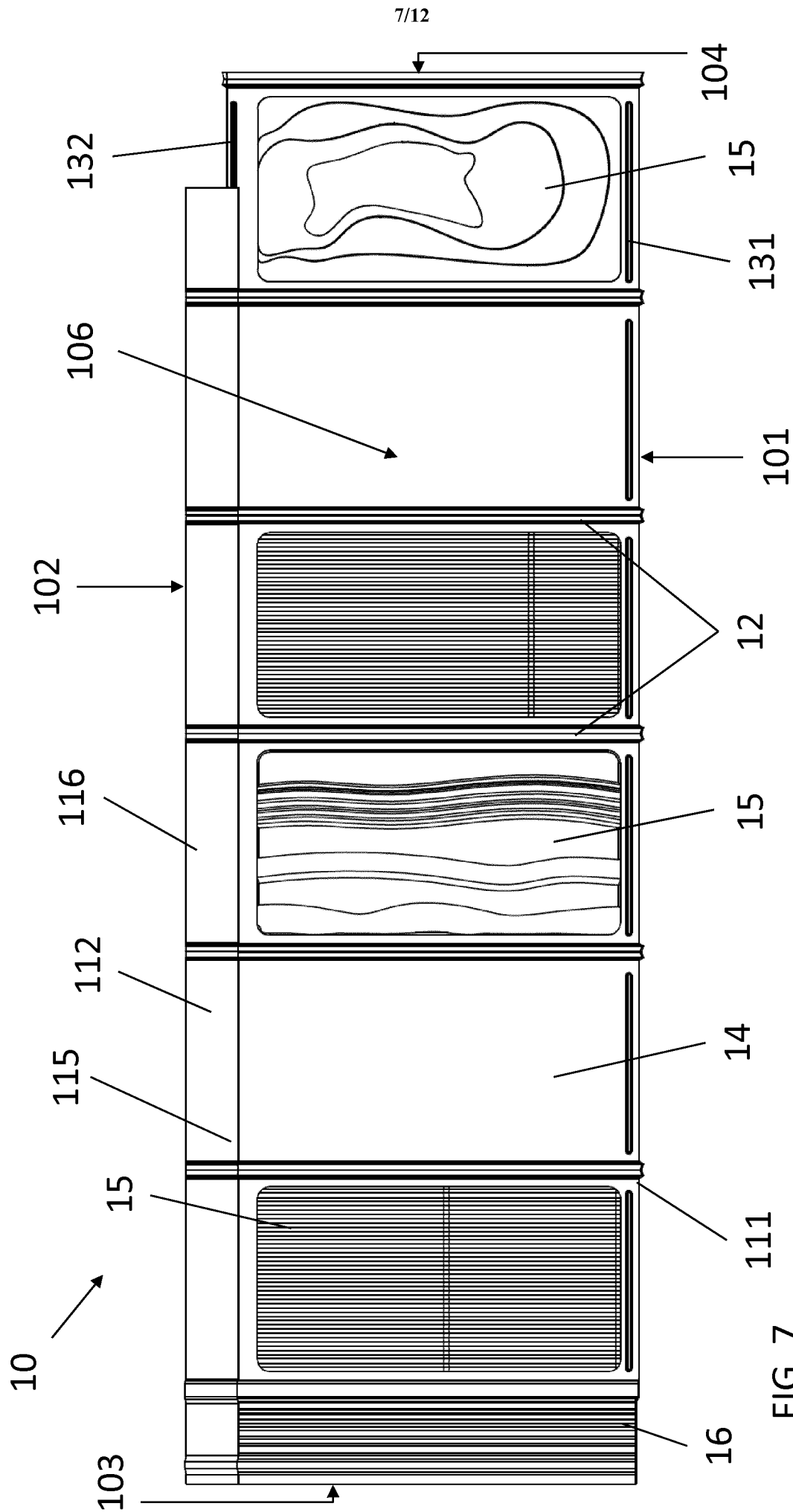


FIG. 7

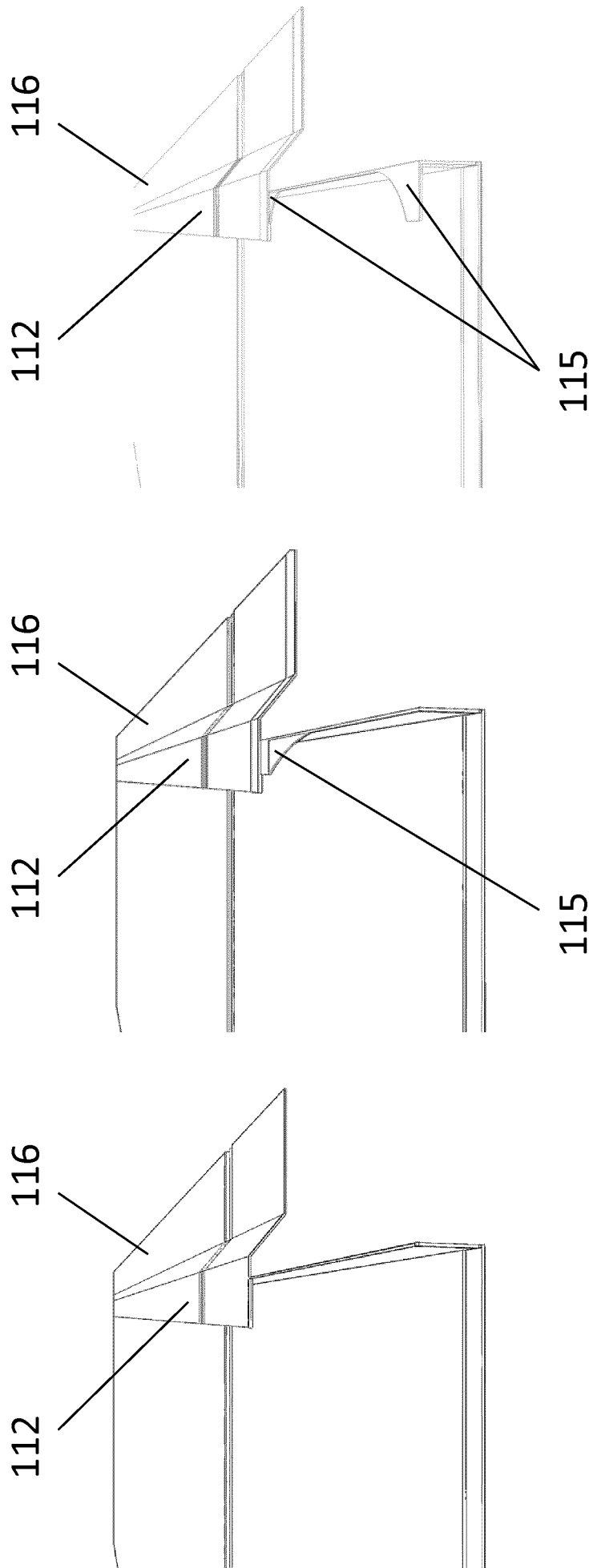


FIG. 8

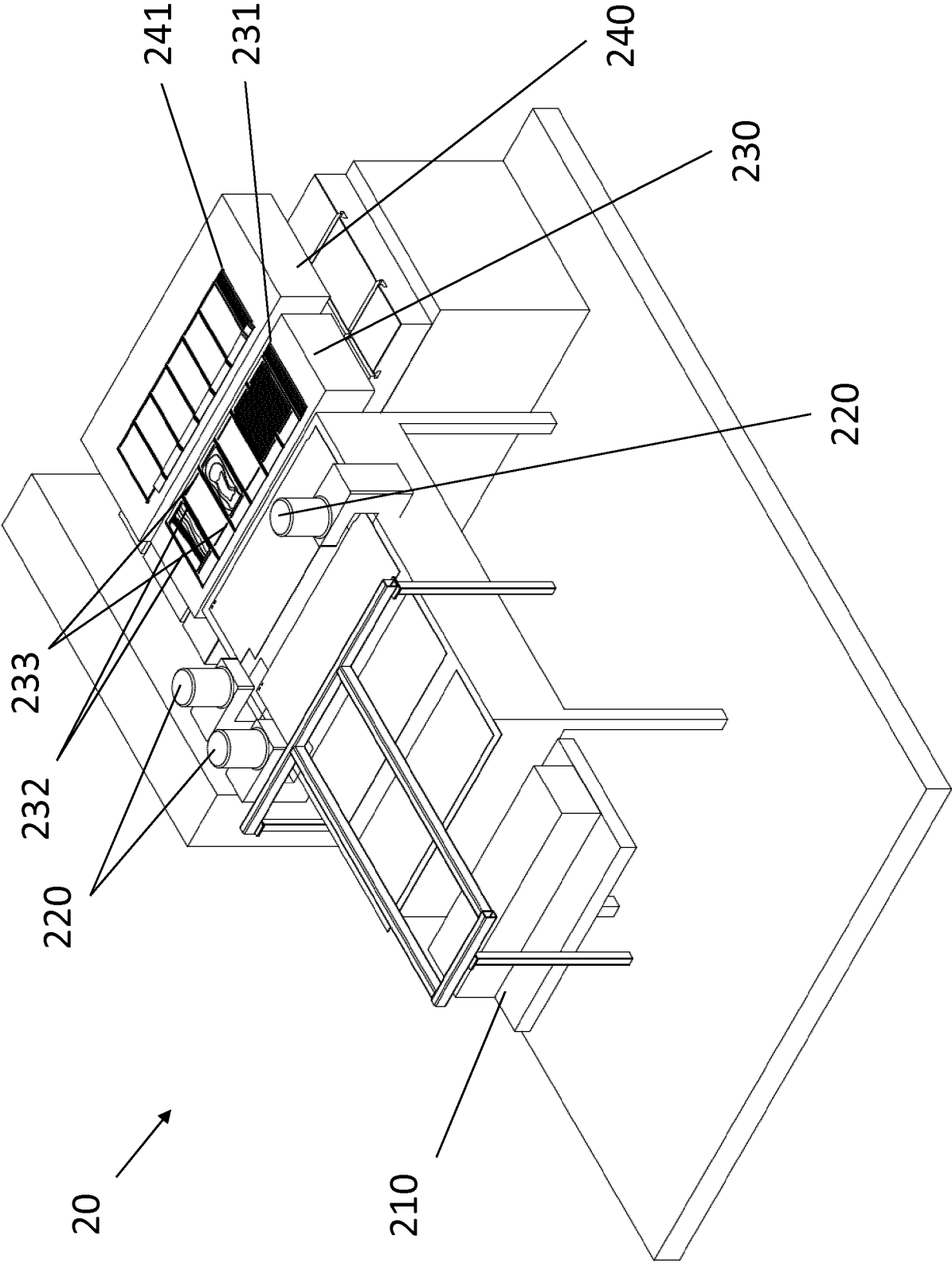


FIG. 9

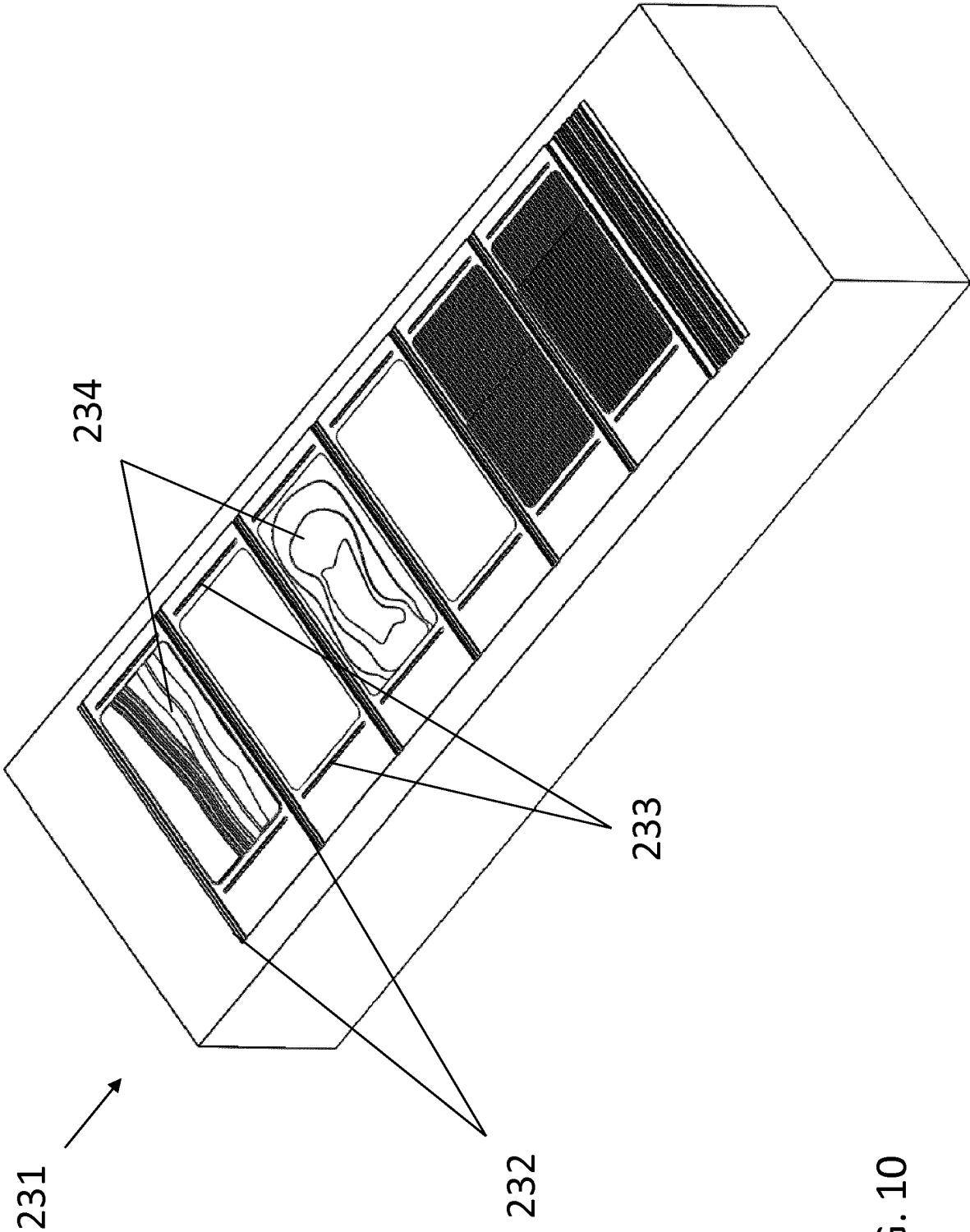


FIG. 10

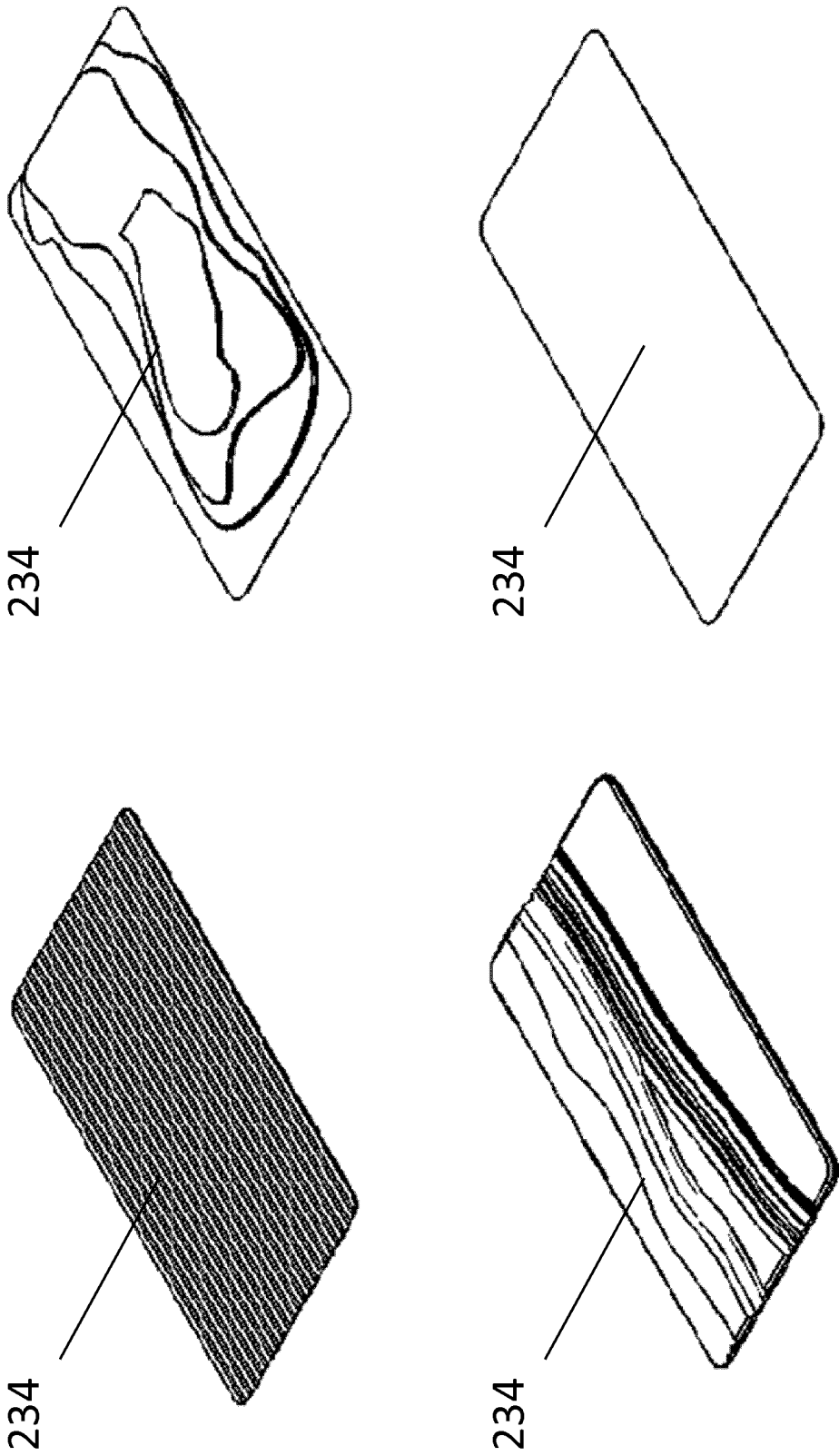
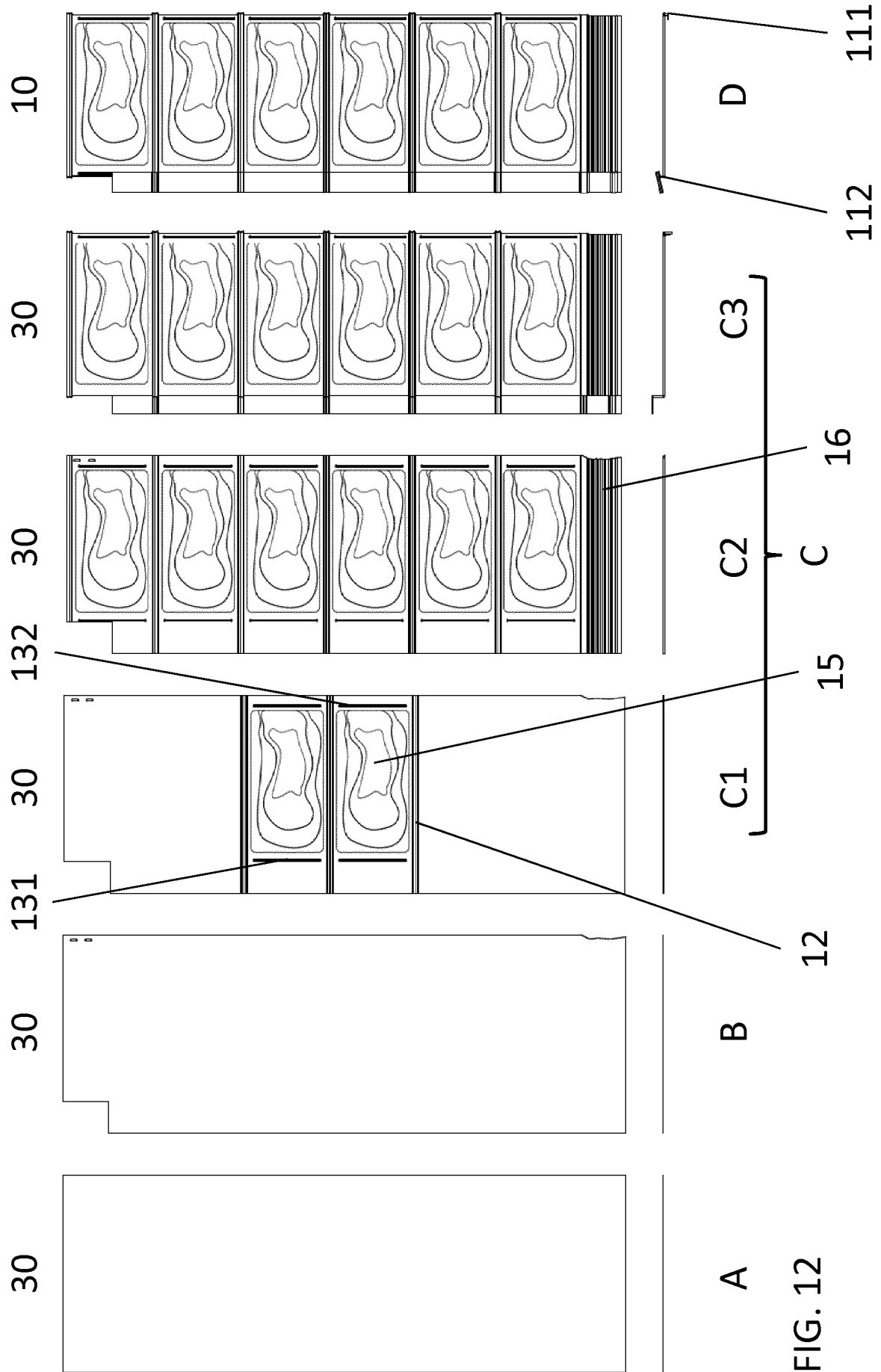


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/062710

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04D1/26 E04D3/30 B21D35/00 B21D37/04
ADD.

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)
E04D B21D

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3 347 001 A (COSDEN BRYAN L) 17 October 1967 (1967-10-17)	1-6, 8-12, 17-21 7
A	figures column 6, lines 40-59 column 7, lines 35-39, 65-70	
Y	US 3 775 925 A (FUJITA K) 4 December 1973 (1973-12-04)	1-6, 8-10, 14-21 7
A	figure 11	
Y	US 256 083 A (C. COOPER) 4 April 1882 (1882-04-04)	1-6, 8-10, 14-16, 18-21 7
A	figures	
	-/-	



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

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"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

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"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

18 January 2017

Date of mailing of the international search report

06/02/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Tran, Kim Lien

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2016/062710

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:

see additional sheet

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 an 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.:

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-8, 10(completely); 9, 17-21(partially)

A sheet metal roofing with longitudinal grooves

2. claims: 11-16(completely); 9, 17-21(partially)

A method for manufacturing a sheet metal roofing element and
an apparatus for use in a method for manufacturing a sheet
metal roofing element

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/062710

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 309 134 A (C. COOPER) 9 December 1884 (1884-12-09) the whole document -----	1
Y	CN 101 952 063 A (KWAN-SUN KIM) 19 January 2011 (2011-01-19) figures 8,9 -----	8-11,13, 17
Y	US 2007/137132 A1 (PLOWRIGHT MARCUS [CA]) 21 June 2007 (2007-06-21) paragraph [0015] -----	11-13,17
A	WO 99/41471 A1 (METRO SHINGLES INTL LIMITED [NZ]; ROSS JAMES CAMERON [NZ]) 19 August 1999 (1999-08-19) cited in the application the whole document -----	1
A	US 1 597 993 A (MEURER GEORGE B) 31 August 1926 (1926-08-31) the whole document -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/062710

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3347001	A	17-10-1967	NONE
US 3775925	A	04-12-1973	NONE
US 256083	A	04-04-1882	NONE
US 309134	A	09-12-1884	NONE
CN 101952063	A	19-01-2011	CN 101952063 A 19-01-2011 KR 100876393 B1 31-12-2008 WO 2009096678 A2 06-08-2009
US 2007137132	A1	21-06-2007	NONE
WO 9941471	A1	19-08-1999	AT 294302 T 15-05-2005 AU 743106 B2 17-01-2002 AU 2554099 A 30-08-1999 CA 2304237 A1 19-08-1999 DE 69924976 D1 02-06-2005 DE 69924976 T2 23-02-2006 EP 1055040 A1 29-11-2000 ES 2242380 T3 01-11-2005 MY 124675 A 30-06-2006 PT 1055040 E 31-08-2005 WO 9941471 A1 19-08-1999
US 1597993	A	31-08-1926	NONE