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

(11) **EP 4 537 952 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
16.04.2025 Bulletin 2025/16

(21) Application number: **23819852.7**

(22) Date of filing: **06.06.2023**

(51) International Patent Classification (IPC):
B21D 24/00 *(2006.01)* ***B21D 22/22*** *(2006.01)*
B21D 24/04 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B21D 22/22; B21D 24/00; B21D 24/04

(86) International application number:
PCT/JP2023/021045

(87) International publication number:
WO 2023/238872 (14.12.2023 Gazette 2023/50)

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

(30) Priority: **06.06.2022 JP 2022091684**

(71) Applicant: **NIPPON STEEL CORPORATION**
Chiyoda-ku
Tokyo 100-8071 (JP)

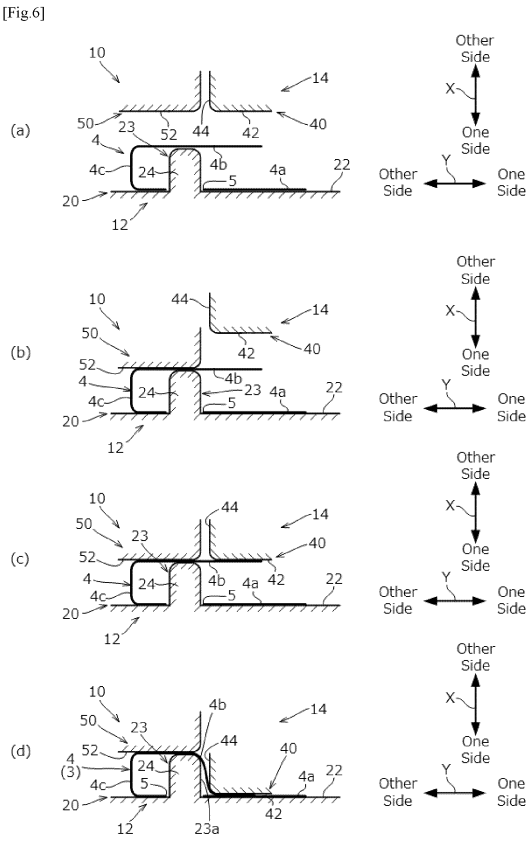
(72) Inventor: **URUSHIBATA, Ryo**
Tokyo 100-8071 (JP)

(74) Representative: **Zimmermann & Partner**
Patentanwälte mbB
Postfach 330 920
80069 München (DE)

(54) PRESSING DEVICE AND METHOD FOR MANUFACTURING PRESSED PRODUCT

(57) A press forming apparatus includes a first die set and a second die set that are in positions to face each other in a press direction and perform relative movement in the press direction. The first die set includes a first support surface and a punch portion that protrudes from the first support surface. The second die set includes a press surface disposed so as to be out of position from a position to face the punch portion in the press direction, and a wall surface that is continuous with the press surface. When viewed from the second die set side in the press direction, the punch portion includes a side surface that faces the wall surface and that includes an opening opened on the wall surface side. At a forming bottom dead center of the relative movement between the first die set and the second die set in the press direction, the wall surface faces the side surface of the punch portion.

[Fig.6]



EP 4 537 952 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a press forming apparatus and a production method for a formed product.

BACKGROUND ART

[0002] From the viewpoint of weight reduction and higher strength of automobiles, formed products made of high-tensile strength steel sheets have been used for structural members of a vehicle body (for example, members that constitute frames). Specifically, for example, a formed product 1 that has a closed sectional shape as illustrated in Figure 1 (a) and a hat-shaped formed product 2 as illustrated in Figure 1 (b) are used.

[0003] The formed product 1 that has a closed sectional shape illustrated in Figure 1 (a) includes plate-like flange portions 1a and 1b, vertical wall portions 1c and 1d, and a top plate portion 1e. The formed product 1 has a closed sectional shape, and the flange portion 1a and the top plate portion 1e are provided to face each other and the vertical wall portion 1c and the vertical wall portion 1d are provided to face each other.

[0004] The formed product 1 described above can be produced by using, for example, roll forming or press forming. However, when roll forming is used as disclosed in Patent Document 1, it is necessary to arrange a plurality of rollers in line, which leads to a large forming apparatus.

LIST OF PRIOR ART DOCUMENT

PATENT DOCUMENT

[0005] Patent Document 1: JP2008-120227A

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] In the meantime, when press forming is used, it is possible to construct a smaller forming apparatus than the case of using roll forming. However, to produce a formed product that includes a flange portion facing a top plate portion as in the formed product 1, a problem of the requirement of a core or an increase in the number of processes arises. In this case, production efficiency for formed products degrades.

[0007] Here, the hat-shaped formed product 2 illustrated in Figure 1 (b) can be produced without using a core through typical bending forming or draw forming using well-known dies. However, as illustrated in Figure 1 (c), in the case in which protruding portions 2c and 2d (for example, hollow cylindrical portions formed by burring) that protrude inward are provided on a pair of vertical wall portions 2a and 2b, the protruding portions 2c and 2d must be prevented from contacting a die during shaping. It is therefore difficult to produce the formed product 2 that includes the protruding portions 2c and 2d through typical bending forming or draw forming using well-known dies. Note that the protruding portions 2c and 2d may also be referred to as recessed portions because they are viewed as recessed portions from outside.

[0008] Accordingly, an objective of the present invention is to provide a press forming apparatus and a production method, with which formed products can efficiently be produced.

SOLUTION TO PROBLEM

[0009]

(1) A press forming apparatus in one aspect of the present invention comprises a first die set and a second die set in positions to face each other in a press direction, the first die set and the second die set performing relative movement in the press direction,

the first die set including a first support surface and a punch portion that protrudes from the first support surface, and
the second die set including a press surface disposed so as to be out of position from a position to face the punch portion in the press direction and a wall surface that is continuous with the press surface, wherein
when viewed from a side of the second die set in the press direction, the punch portion includes a side surface that faces the wall surface and that includes an opening opened on a side of the wall surface, and
at a forming bottom dead center of the relative movement between the first die set and the second die set in the press direction, the wall surface faces the side surface of the punch portion.

(2) **In** the press forming apparatus,

the punch portion may include a plurality of support portions,
the side surface of the punch portion may include side surfaces of the plurality of support portions, and
the side surfaces of two adjacent support portions among the plurality of support portions may be arranged so as to be spaced apart with the opening in between.

(3) **In** the press forming apparatus,

the opening may include a connecting portion that connects two adjacent support portions

among the plurality of support portions, and when viewed from the side of the second die set in the press direction, a distance between a side surface of the connecting portion and the wall surface may be longer than a distance between the side surface of the support portion and the wall surface.

(4) **In** the press forming apparatus,

the opening may include a connecting portion that connects two adjacent support portions among the plurality of support portions, and in the press direction, a position of a top portion of at least one of the support portions may be different from a position of a top portion of the connecting portion that is adjacent to the support portion.

(5) **In** the press forming apparatus, in the press direction, a position of a top portion of at least one support portion among the plurality of support portions may be different from positions of top portions of other support portions.

(6) **In** the press forming apparatus, the second die set may include a pad disposed in a position to face the punch portion in the press direction.

(7) A production method for a formed product in another aspect of the present invention is

a production method for a formed product by a first die set and a second die set facing across a blank in a press direction performing relative movement in the press direction to subject the blank to press forming, wherein
the first die set includes a first support surface and a punch portion that protrudes from the first support surface
the second die set includes a press surface disposed so as to be out of position from a position to face the punch portion in the press direction and a wall surface that is continuous with the press surface, and
the blank includes a first plate-like portion and a second plate-like portion that faces the first plate-like portion in the press direction,
the method comprising:

supporting the first plate-like portion by the first support surface from a side of the first die set and supporting the second plate-like portion by the punch portion crossing the first plate-like portion in the press direction from the side of the first die set; and in this state,
subjecting the second plate-like portion to bending deformation by the press surface that moves relative to the punch portion in the press direction, wherein
at a forming bottom dead center of the relative movement between the first die set and the second die set in the press direction, the wall surface faces a side surface of the punch portion with part of the second plate-like portion in between.

(8) In the production method, when the second plate-like portion is supported by the punch portion, the punch portion may pass through a through-hole formed in the first plate-like portion to cross the first plate-like portion.

(9) A production method for a formed product in a further aspect of the present invention is

a production method for a formed product by a first die set and a second die set facing across a blank in a press direction performing relative movement in the press direction to subject the blank to press forming, wherein
the first die set includes a first support surface and a punch portion that protrudes from the first support surface,
the second die set includes a press surface disposed so as to be out of position from a position to face the punch portion in the press direction and a wall surface that is continuous with the press surface,
when viewed from a side of the second die set in the press direction, the punch portion includes a side surface that faces the wall surface and that includes an opening opened on a side of the wall surface, and
the blank includes a plate-like portion and a protruding portion that protrudes from the plate-like portion in a thickness direction of the plate-like portion,
the method comprising:

supporting the plate-like portion by the punch portion in the press direction from a side of the first die set; and in this state,
subjecting the plate-like portion to bending deformation by the press surface that moves relative to the punch portion in the press direction, wherein
at a forming bottom dead center of the relative movement between the first die set and the second die set in the press direction, the wall surface faces a side surface of the punch portion with part of the plate-like portion in between, and the protruding portion enters the opening without contacting the side surface.

ADVANTAGEOUS EFFECT OF INVENTION

[0010] According to the present invention, it is possible to efficiently produce formed products.

BRIEF DESCRIPTION OF DRAWINGS

[0011]

[Figure 1] Figure 1 shows views illustrating formed products.
[Figure 2] Figure 2 is a view illustrating an example of a formed product produced by using a press forming apparatus according to a first embodiment.
[Figure 3] Figure 3 is a schematic view illustrating a press forming apparatus according to the first embodiment.
[Figure 4] Figure 4 is a schematic view illustrating a positional relationship among a punch, a die, and a pad.
[Figure 5] Figure 5 is a view illustrating a blank used as a starting material in a production method according to the first embodiment.
[Figure 6] Figure 6 shows views for describing the production method according to the first embodiment.
[Figure 7] Figure 7 illustrates another example of the press forming apparatus.
[Figure 8] Figure 8 is a schematic view illustrating a further example of the press forming apparatus.
[Figure 9] Figure 9 is a schematic view illustrating a further example of the press forming apparatus.
[Figure 10] Figure 10 shows schematic views illustrating another example of the production method for a formed product.
[Figure 11] Figure 11 is a schematic view illustrating another example of a formed product.
[Figure 12] Figure 12 shows views for describing a production method for the formed product of Figure 11.
[Figure 13] Figure 13 shows schematic views illustrating a further example of the press forming apparatus.
[Figure 14] Figure 14 shows schematic views illustrating a further example of the press forming apparatus.
[Figure 15] Figure 15 shows views illustrating a further example of the production method for a formed product.
[Figure 16] Figure 16 shows schematic views illustrating a further example of the press forming apparatus.
[Figure 17] Figure 17 shows schematic views illustrating a further example of the press forming apparatus.
[Figure 18] Figure 18 is a schematic view illustrating a further example of a formed product.
[Figure 19] Figure 19 shows schematic views illustrating a further example of the press forming apparatus.
[Figure 20] Figure 20 is a schematic view illustrating a further example of the press forming apparatus.
[Figure 21] Figure 21 is a schematic view illustrating a further example of the press forming apparatus.
[Figure 22] Figure 22 shows schematic views illustrating a further example of the press forming apparatus.
[Figure 23] Figure 23 shows schematic views illustrating a further example of the press forming apparatus.
[Figure 24] Figure 24 is a schematic view illustrating further examples of formed products.
[Figure 25] Figure 25 is a schematic view illustrating a further example of a formed product.
[Figure 26] Figure 26 is a view illustrating a blank used as a starting material in a production method according to a second embodiment.
[Figure 27] Figure 27 shows schematic views illustrating a press forming apparatus according to the second embodiment.
[Figure 28] Figure 28 is a schematic view illustrating a further example of the press forming apparatus.
[Figure 29] Figure 29 is a schematic view illustrating a further example of the press forming apparatus.

DESCRIPTION OF EMBODIMENTS

[0012] A press forming apparatus and a production method for a formed product according to embodiments of the present invention will now be described with reference to drawings.

(First embodiment)

(Formed product)

[0013] First, a formed product produced by using a press forming apparatus according to a first embodiment of the present invention will be briefly described. Figure 2 is a view illustrating an example of a formed product produced by using the press forming apparatus according to the first embodiment of the present invention.

[0014] As illustrated in Figure 2, a formed product 3 has a closed sectional shape. In the embodiment, the formed product 3 includes plate-like flange portions 3a and 3b, plate-like vertical wall portions 3c and 3d, and a top plate portion 3e. The flange portions 3a and 3b and the top plate portion 3e each have a flat plate shape.

[0015] **In** the embodiment, the flange portion 3b is overlaid on the flange portion 3a such that the formed product 3 has a closed sectional shape. The vertical wall portion 3c is provided to extend upward in a bent manner from an edge of the flange portion 3a. The vertical wall portion 3d is provided to extend upward in a bent manner from an edge of the flange portion 3b on the flange portion 3a. The top plate portion 3e is provided to connect an

upper edge of the vertical wall portion 3c with an upper edge of the vertical wall portion 3d.

[0016] **In** the embodiment, the vertical wall portions 3c and 3d and the top plate portion 3e are curved in an arc shape when viewed from above (when viewed from the thickness direction of the top plate portion 3e). **In** the flange portion 3a, four through-holes 5 (see Figure 5) for inserting support portions 24 described later (see Figure 3) are formed in a portion that faces the top plate portion 3e.

(Press forming apparatus)

[0017] Figure 3 is a schematic view illustrating a press forming apparatus according to the first embodiment of the present invention. More specifically, Figure 3 illustrates a press forming apparatus that can produce the formed product 3 illustrated in Figure 2.

[0018] Here, in Figure 3, when a blank is subjected to press forming, a direction in which a first die set (punch) or a second die set (die) moves is indicated by an arrow X (hereinafter, denoted as a "press direction X"), and the width direction of the press forming apparatus is indicated by an arrow Y (hereinafter, denoted as a "width direction Y"). The width direction Y is a direction perpendicular to the press direction X. Furthermore, a direction that intersects the press direction X and the width direction Y is indicated by an arrow Z (hereinafter, denoted as an "intersecting direction Z"). **In** the embodiment, the intersecting direction Z is a direction perpendicular to the press direction X and the width direction Y.

[0019] Although detailed description will be omitted, materials as in well-known dies can be used to produce each component of the press forming apparatus. Each component of the press forming apparatus can be driven by drive mechanisms as in well-known press machines (electric cylinder, hydraulic cylinder, gas cushion apparatus).

[0020] As illustrated in Figure 3, a press forming apparatus 10 according to the embodiment includes a first die set 12 provided on one side in the press direction X and a second die set 14 provided on the other side in the press direction X. That is, the first die set 12 and the second die set 14 are provided in positions to face each other in the press direction X. The first die set 12 and the second die set 14 perform relative movement in the press direction X. In the embodiment, the first die set 12 includes a punch 20, and the second die set 14 includes a die 40 and a pad 50.

[0021] Figure 4 is a schematic view illustrating a positional relationship among the punch 20, the die 40, and the pad 50. Here, Figure 4 is a view of the press forming apparatus 10 viewed from above. As illustrated in Figure 3 and Figure 4, the punch 20 includes a first support surface 22 and a punch portion 23 that protrudes from the first support surface 22. In the embodiment, the first support surface 22 faces the other side (second die set 14 side) in the press direction X. The punch portion 23 protrudes from the first support surface 22 toward the other side in the press direction X. When viewed from the second die set 14 side in the press direction X, the punch portion 23 faces a wall surface 44 of the die 40, which will be described later. In the embodiment, the punch portion 23 includes a plurality of support portions 24 that protrude from the first support surface 22 toward the other side in the press direction X. The support portion 24 may be referred to as a protruding portion.

[0022] The support portions 24 are spaced apart from each other and provided to be aligned in a curved shape when viewed from the second die set 14 side in the press direction X. In the embodiment, each support portion 24 is formed in a circular column shape to have a side surface 24a of a circular section. Note that the shape of the support portion 24 illustrated in Figure 1 is only one example and the shape of the support portion 24 is not limited to the above example. As illustrated in Figure 6 described later, although it is preferable that the top portion of each support portion 24 has a flat shape, it may have a spherical crown shape.

[0023] In the embodiment, the side surface 23a of the punch portion 23 is constituted of a plurality of side surfaces 24a of the plurality of support portions 24. When viewed from the second die set 14 side in the press direction X, the side surface 23a of the punch portion 23 includes an opening 23b opened on the wall surface 44 side of the die 40, which will be described later. In the embodiment, the side surface 23a of the punch portion 23 includes a plurality of openings 23b. In the embodiment, the side surfaces 24a of two adjacent support portions 24 are arranged so as to be spaced apart with the opening 23b in between. In other words, two adjacent support portions 24 are arranged so as to be spaced apart with the opening 23b in between. Here, in the embodiment, the opening 23b is also opened on the second die set 14 side in the press direction X. Furthermore, in the embodiment, the opening 23b is formed to pass through between two adjacent support portions 24 in the width direction Y.

[0024] The first support surface 22 extends on both sides of at least each support portion 24 in the intersecting direction Z. As illustrated in Figure 4, in the embodiment, the first support surface 22 extends at least between the support portions 24 and on both sides of the plurality of support portions 24 in an arrangement direction A of the plurality of support portions 24. Note that, in the present specification, the arrangement direction A refers to a direction along a line (a curve in the example of Figure 4) obtained by connecting the centers of the support portions 24 when viewed from the second die set 14 side (above) in the press direction X.

[0025] As illustrated in Figures 3 and 4, the die 40 includes a press surface 42 and a wall surface 44 that is continuous with the press surface 42. In the embodiment, the press surface 42 faces the one side (first die set 12 side) in the press direction X. The wall surface 44 extends from an edge of the press surface 42 to the other side (opposite to the first die set 12) in the press direction

X. The press surface 42 is provided on one side of the punch portion 23 (the plurality of support portions 24) in the width direction Y. In the embodiment, the press surface 42 is disposed so as to be out of position from a position to face the punch portion 23 in the press direction X. The wall surface 44 is positioned between the punch portion 23 (the plurality of support portions 24) and the press surface 42 in the width direction Y.

[0026] The press surface 42 and the wall surface 44 are provided, with respect to each support portion 24, to extend from the one side to the other side of the support portion 24 in the intersecting direction Z. In the embodiment, as illustrated in Figure 4, the press surface 42 and the wall surface 44 are provided to extend along the arrangement direction A and from one side to the other side of the plurality of support portions 24 in the arrangement direction A. Furthermore, in the embodiment, when viewed from the first die set 12 side in the press direction X, the wall surface 44 is curved in an arc shape to protrude toward the one side in the width direction Y.

[0027] Referring to Figure 3, in the press direction X, the die 40 is provided to be capable of approaching and withdrawing relative to the first support surface 22 of the punch 20. That is, the press surface 42 and the wall surface 44 are capable of approaching and withdrawing relative to the first support surface 22 in the press direction X.

[0028] As illustrated in Figures 3 and 4, the pad 50 is disposed in a position to face the punch portion 23 (the plurality of support portions 24) in the press direction X. In the embodiment, the pad 50 includes a second support surface 52 that faces the punch portion 23 (the plurality of support portions 24) in the press direction X. The second support surface 52 is provided, with respect to each support portion 24, to extend from the one side to the other side of the support portions 24 in the intersecting direction Z. In the embodiment, as illustrated in Figure 4, the second support surface 52 is provided to extend from the one side to the other side of the plurality of support portions 24 in the arrangement direction A.

[0029] Referring to Figure 3, in the press direction X, the pad 50 is provided to be capable of approaching and withdrawing relative to the punch portion 23 (the plurality of support portions 24) of the punch 20. That is, the second support surface 52 is capable of approaching and withdrawing relative to the plurality of support portions 24 in the press direction X.

(Production method for formed product)

[0030] Next, a production method for a formed product will be described. In the production method according to the embodiment, a pre-processed blank is subjected to press forming by using the press forming apparatus 10 described above to produce the formed product 3. The following is a specific description.

[0031] Figure 5 is a view illustrating a blank used as a starting material in the production method according to the embodiment. As illustrated in Figure 5, a blank 4 includes a first plate-like portion 4a, a second plate-like portion 4b, and a third plate-like portion 4c.

[0032] The first plate-like portion 4a has a flat plate shape. A plurality of through-holes 5 is formed in the first plate-like portion 4a. In the embodiment, the plurality of through-holes 5 is provided such that they correspond to the plurality of support portions 24 (see Figure 3) of the first die set 12 (see Figure 3). Here, the through-hole 5 is not limited to circular in shape and may be formed in any size and shape to the extent that the support portion 24 can be inserted. Accordingly, the through-hole 5 may have any other shape such as an elliptic shape or a polygonal shape. The relationship between the through-hole 5 and the support portion 24 will be described later.

[0033] The second plate-like portion 4b has a flat plate shape and is provided to face the first plate-like portion 4a in the thickness direction of the first plate-like portion 4a. Furthermore, the second plate-like portion 4b is provided so as to be spaced apart from the first plate-like portion 4a in the thickness direction of the first plate-like portion 4a. The third plate-like portion 4c is provided to extend in the thickness direction of the first plate-like portion 4a so as to connect an edge of the first plate-like portion 4a with an edge of the second plate-like portion 4b. **In** the embodiment, the third plate-like portion 4c is a portion corresponding to the vertical wall portion 3c (see Figure 2) of the formed product 3 (see Figure 2) and is curved in an arc shape when viewed from the thickness direction of the first plate-like portion 4a.

[0034] Although the material and the dimensions of the blank 4 are not particularly limited, for example, a sheet material (for example, steel sheet) that has a tensile strength of 270 MPa or more and a thickness of 0.5 to 5 mm can be used to produce the blank 4. Although the production method for the blank 4 is not particularly limited, it is possible to produce the blank 4, for example, by using a well-known press forming apparatus to subject a plate material with a plurality of through-holes 5 formed therein to press forming.

[0035] Figure 6 shows views for describing the production method according to the embodiment. Here, in Figure 6, components of the press forming apparatus 10 and the blank 4 are simplified. Furthermore, Figure 6 illustrates the press forming apparatus 10 and the blank 4 as viewed from the intersecting direction Z.

[0036] When the blank 4 is subjected to press forming, as illustrated in Figure 6 (a), the blank 4 is first placed on the first support surface 22 of the first die set 12 such that the punch portion 23 (the plurality of support portions 24) crosses the first plate-like portion 4a from first die set 12 side in the press direction X and supports the second plate-like portion 4b. More specifically, the first plate-like portion 4a is supported by the first support surface 22 such that the third plate-like portion 4c is located on the other side of the punch portion 23 (the plurality of support portions 24) in the width direction Y and the support

portions 24 of the punch portion 23 protrude through the through-holes 5 toward the second plate-like portion 4b side with respect to the first plate-like portion 4a.

[0037] Next, as illustrated in Figure 6 (b), the pad 50 (second support surface 52) is moved to the one side (first die set 12 side) in the press direction X, so that the second plate-like portion 4b is clamped between the punch portion 23 (the plurality of support portions 24) and the second support surface 52. Note that, in the embodiment, the state illustrated in Figure 6 (b) corresponds to the state of "supporting the first plate-like portion by the first support surface from the side of the first die set and supporting the second plate-like portion by the punch portion crossing the first plate-like portion in the press direction from the side of the first die set".

[0038] Next, as illustrated in the views (b), (c), and (d) of Figure 6, the die 40 (press surface 42) is moved from the other side (second die set 14 side) to the one side (first die set 12 side) in the press direction X relative to the top portion of the punch portion 23 (the plurality of support portions 24). Consequently, a portion of the second plate-like portion 4b on the one side with respect to the punch portion 23 (the plurality of support portions 24) in the width direction Y is pressed to the one side (first die set 12 side) in the press direction X. As a result, the second plate-like portion 4b is subjected to bending deformation and the formed product 3 is completed. In the embodiment, at a forming bottom dead center of the relative movement between the first die set 12 and the second die set 14 in the press direction X (the state illustrated in Figure 6 (d)), the wall surface 44 of the die 40 faces the side surface 23a of the punch portion 23 with part of the second plate-like portion 4b in between. Furthermore, at the forming bottom dead center, the wall surface 44 of the die 40 faces at least one opening 23b in the width direction Y. In the embodiment, at the forming bottom dead center, the wall surface 44 faces the plurality of openings 23b in the width direction Y.

[0039] Finally, the second die set 14 (die 40 and pad 50) is moved to the other side in the press direction X, and the formed product 3 is taken out from the press forming apparatus 10.

(Advantageous effects of the embodiment)

[0040] As described above, according to the press forming apparatus 10 according to the embodiment, when the formed product 3, which includes a plate-like portion (flange portion 3a) facing the top plate portion 3e, is to be produced from the blank 4, the portion to be the top plate portion 3e in the second plate-like portion 4b of the blank 4 can be supported by the punch portion 23 (support portions 24) from the first plate-like portion 4a side. This makes it possible to shape the vertical wall portion 3d and the flange portion 3b by simple bending with the press surface 42 and the wall surface 44 of the second die set 14. In this case, it is not necessary to use a core to produce the formed product 3, and it is possible to avoid an increase in the number of processes. As a result, it is possible to efficiently produce the formed product 3.

[0041] Here, when the formed product 3 produced as described above is to be used as a structural member for automobile, the through-hole 5 may be utilized as a drainage hole or may be closed by a patch or the like. Furthermore, to secure sufficient rigidity of surrounding portions of the through-hole 5, the portion at which the through-hole 5 is formed may be subjected to burring, a patch or the like for stiffening may be applied to peripheral edge portions of the through-hole 5, or the wall thickness may be increased in the peripheral edge portions of the through-hole 5.

(Modification)

[0042] The shape of the formed product 3 is not limited to the above example. For example, the vertical wall portions 3c and 3d and the top plate portion 3e may be curved such that they protrude in the opposite direction to the vertical wall portions 3c and 3d and the top plate portion 3e illustrated in Figure 2 when viewed from the thickness direction of the top plate portion 3e. In this case, the shape of any portion of the press forming apparatus 10 may be altered in any way depending on the shape of the formed product 3. Specifically, for example, as illustrated in Figure 7, when viewed from the second die set 14 side in the press direction X, the plurality of support portions 24 is arranged such that they exhibit a curve that protrudes toward the other side in the width direction Y, and the wall surface 44 is provided to protrude toward the other side in the width direction Y.

[0043] Furthermore, the vertical wall portions 3c and 3d and the top plate portion 3e may also be formed to extend in a linear shape when viewed from the thickness direction of the top plate portion 3e. In this case, although not illustrated, for example, when viewed from the second die set 14 side in the press direction X, the plurality of support portions 24 is arranged such that they are aligned in a linear shape along the intersecting direction Z, and the wall surface 44 is provided to extend in parallel along the intersecting direction Z.

[0044] Furthermore, one of the vertical wall portions 3c and 3d may be curved in an arc shape and the other may be formed in a linear shape when viewed from the thickness direction of the top plate portion 3e. Still in this case, the plurality of support portions 24 may be arranged depending on the shape of the vertical wall portions 3c and 3d.

[0045] Note that the distance between adjacent support portions 24, the arrangement of the plurality of support portions 24, the number of support portions 24, and the shape and the dimensions of the support portion 24 are not limited to the above example and may be altered in any way depending on the shape, the dimensions, and the like of the formed product to be produced. For example, as illustrated in Figure 8, the plurality of support portions 24 may be provided to align in the width direction

Y. Furthermore, as illustrated in Figure 9, the punch portion 23 of the first die set 12 may be constituted of one support portion 24. In this case, only one through-hole may be formed in the first plate-like portion 4a of the blank 4 (see Figure 5) for inserting one support portion 24.

[0046] Although in the above-described embodiment, description has been made to the case of producing the formed product 3 that includes the flange portion 3b (see Figure 2), as illustrated in Figure 10, a formed product 3 with no flange portion 3b may be produced. The same applies to embodiments described later. Here, in Figure 10, the view (a) illustrates the press forming apparatus 10 in a state in which the second plate-like portion 4b of the blank 4 is clamped by the punch portion 23 (support portions 24) and the second support surface 52, the view (b) illustrates the press forming apparatus 10 in a state in which a portion of the second plate-like portion 4b on the one side with respect to the punch portion 23 (support portions 24) in the width direction Y is pressed to the one side (first die set 12 side) in the press direction X by the press surface 42, and the view (c) illustrates the press forming apparatus 10 when the formed product 3 is to be taken out (during release).

[0047] Furthermore, while in the above-described embodiment, part of the flange portion 3a and part of the flange portion 3b are overlaid on each other such that the formed product 3 has a closed sectional shape, the formed product 3 may not have a closed sectional shape. For example, a clearance may be formed between the flange portion 3a and the flange portion 3b (vertical wall portion 3d) in a direction in parallel to the width direction of the top plate portion 3e as the formed product 3 illustrated in Figure 11. Here, the formed product 3 illustrated in Figure 11 can be produced as described below, for example.

[0048] Figure 12 shows views for describing a production method for the formed product 3 of Figure 11. When the formed product 3 in Figure 11 is to be produced, as illustrated in Figure 12 (a), the blank 4 is placed on the first support surface 22 of the first die set 12 as in the case of producing the formed product 3 in Figure 2. However, the length in the width direction Y of the first plate-like portion 4a (see Figure 12) of the blank 4 (see Figure 12) used when the formed product 3 in Figure 11 is to be produced is shorter than the length in the width direction Y of the first plate-like portion 4a (see Figure 6) of the blank 4 (see Figure 6) used when the formed product 3 in Figure 2 is to be produced. Furthermore, any through-hole 5 (see Figure 5) may not be formed in the first plate-like portion 4a of the blank 4 (see Figure 12) used when the formed product 3 in Figure 11 is to be produced.

[0049] In the embodiment, the first plate-like portion 4a is supported by the first support surface 22 such that third plate-like portion 4c is located on the other side of the punch portion 23 (the plurality of support portions 24) in the width direction Y and the plurality of support portions 24 protrudes toward the second plate-like portion 4b side with respect to the first plate-like portion 4a on the one side of the first plate-like portion 4a in the width direction Y.

[0050] Next, as illustrated in Figure 12 (b), the pad 50 (second support surface 52) is moved to the one side (first die set 12 side) in the press direction X, so that the second plate-like portion 4b is clamped between the punch portion 23 (the plurality of support portions 24) and the second support surface 52. Note that, in the embodiment, the state illustrated in Figure 12 (b) corresponds to the state of "supporting the first plate-like portion by the first support surface from the side of the first die set and supporting the second plate-like portion by the punch portion crossing the first plate-like portion in the press direction from the side of the first die set".

[0051] Next, as illustrated in the views (b), (c), and (d) of Figure 12, the die 40 (press surface 42) is moved from the other side (second die set 14 side) to the one side (first die set 12 side) in the press direction X relative to the top portion of the punch portion 23 (the plurality of support portions 24). Consequently, a portion of the second plate-like portion 4b on the one side with respect to the plurality of support portions 24 in the width direction Y is pressed to the one side (first die set 12 side) in the press direction X, and the formed product 3 illustrated in Figure 11 is completed.

[0052] Although in the above-described embodiment, description has been made to the case in which the first support surface 22 of the first die set 12 has a flat shape, the shape of the first die set 12 is not limited to the above example. Figure 13 shows schematic views illustrating another example of the press forming apparatus 10. In Figure 13, the view (a) illustrates the blank 4 and the press forming apparatus 10 before shaping, and the view (b) illustrates the blank 4 (formed product 3) and the press forming apparatus 10 after shaping.

[0053] The difference of the press forming apparatus 10 illustrated in Figure 13 from the press forming apparatus 10 illustrated in Figure 3 is the shape of the first die set 12 (punch 20). The difference of the first die set 12 illustrated in Figure 13 from the first die set 12 illustrated in Figure 3 is the shape of the first support surface 22. Specifically, the first support surface 22 of the first die set 12 illustrated in Figure 13 includes a flat surface 22a, a vertical surface 22b extending from the edge on the one side in the width direction Y of the flat surface 22a to the second die set 14 side, and a flat surface 22c extending from the edge on the second die set 14 side in the press direction X of the vertical surface 22b to the one side in the width direction Y. The punch portion 23 (support portions 24) is provided to protrude toward from the flat surface 22a to the second die set 14 side.

[0054] In this case, as illustrated in Figure 13, the blank 4 that includes the first plate-like portion 4a of a bent shape to correspond to the first support surface 22 may be used. In this way, it is possible to produce formed products 3 that have various sectional shapes by altering the shape of the first support surface 22 and the shape of

the blank 4 as necessary. In the example illustrated in Figure 13, the formed product 3 is produced, which includes a flange portion 30a, an vertical wall portion 30b, a bottom plate portion 30c, an vertical wall portion 30d, a top plate portion 30e, an vertical wall portion 30f, and a flange portion 30g formed by the press forming apparatus 10.

[0055] In the description below, a tubular portion formed in the formed product 3 by the press forming apparatus will be referred to as a shaped portion. In the formed product 3 illustrated in Figure 13, the shaped portion 30 is formed to protrude from flange portions 30a and 30g overlaid on each other toward both sides in the thickness direction of the flange portion 30a (30g).

[0056] Although detailed description will be omitted, it is possible to produce formed products 3 of various sectional shapes by altering the shapes of other components of the press forming apparatus 10 as necessary. For example, in the press forming apparatus 10 illustrated in Figure 14 (a), the support portion 24 of the punch portion 23 includes a top surface 240 that is inclined with respect to the press direction X and the second support surface 52 of the pad 50 includes an inclined surface 520 that is substantially parallel to the top surface 240 of the support portion 24. Furthermore, in the press forming apparatus 10 illustrated in Figure 14 (b), the first support surface 22 further includes a support surface 22d that is inclined with respect to the press direction X. The support portion 24 of the punch portion 23 is provided to protrude from the support surface 22d toward the second die set 14 side. In these cases, it is possible to produce formed products 3 depending on the shapes of the first support surface 22 and the support portion 24 by using blanks 4 depending on the shapes of the first support surface 22, the support portion 24, and the second support surface 52.

[0057] In the above-described embodiment, description has been made to the case of producing the formed product 3 from the blank 4 that includes the first plate-like portion 4a, the second plate-like portion 4b, and the third plate-like portion 4c, the shape of the blank 4 is not limited to the above example. For example, as illustrated in Figure 15 (a), the blank 4 may include a fourth plate-like portion 4d and a fifth plate-like portion 4e in addition to the first plate-like portion 4a, the second plate-like portion 4b, and the third plate-like portion 4c. Here, the fourth plate-like portion 4d and the fifth plate-like portion 4e are provided on the opposite side to the second plate-like portion 4b and the third plate-like portion 4c in the thickness direction of the first plate-like portion 4a. In the embodiment, through-holes 5 are formed in a portion of the first plate-like portion 4a that faces the second plate-like portion 4b and in a portion that faces the fourth plate-like portion 4d, respectively.

[0058] In the embodiment, as illustrated in Figure 15 (b), in a way similar to those described in Figure 6, the second plate-like portion 4b is subjected to press forming by the press forming apparatus 10 to form the flange portion 3b, the vertical wall portion 3d, and the top plate portion 3e. In the formed product 3 illustrated in Figure 15, a shaped portion 32 is constituted of the flange portion 3b, the vertical wall portions 3c and 3d, and the top plate portion 3e.

[0059] Next, as illustrated in the views (c) and (d) of Figure 15, the blank 4 is rotated by 180 degrees when viewed from the intersecting direction Z (see Figure 3), and the fourth plate-like portion 4d is subjected to press forming by the press forming apparatus 10. **In** this way, a shaped portion 34 constituted of a flange portion 3f, vertical wall portions 3g and 3h, and a top plate portion 3i is formed. As described above, according to the embodiment, it is possible to produce the formed product 3 that includes a pair of shaped portions 32 and 34 protruding toward mutually opposite directions in the thickness direction of the first plate-like portion 4a. Note that the shaped portion 32 may not include the flange portion 3b or the shaped portion 34 may not include the flange portion 3f.

[0060] Figure 16 shows views illustrating another modification of the press forming apparatus. The difference of the press forming apparatus 10 illustrated in Figure 16 from the press forming apparatus 10 illustrated in Figure 6 is as follows.

[0061] As illustrated in Figure 16, in the embodiment, the die 40 includes wall surfaces 44 on both sides in the width direction Y. Furthermore, the respective pads 50 are provided on the one side and the other side in the width direction Y of the die 40. The punch portion 23 (one or more support portions 24) is provided in a portion on the first die set 12 (punch 20) that faces each second support surface 52 of the die 40 in the press direction X.

[0062] The blank 4 utilized in the embodiment includes a pair of second plate-like portions 4b and a pair of third plate-like portions 4c. One or more through-holes 5 for inserting one or more support portions 24 are formed in the respective portions in the first plate-like portion 4a that face the pair of second plate-like portions 4b.

[0063] Still in the embodiment, as in the above-described embodiment, when the blank 4 is subjected to press forming, as illustrated in Figure 16 (a), the first plate-like portion 4a is supported by the first support surface 22 such that the punch portion 23 (support portions 24) protrudes toward the second plate-like portion 4b side through the through-hole 5 with respect to the first plate-like portion 4a. Next, as illustrated in Figure 16 (b), each pad 50 (second support surface 52) is moved to the one side (first die set 12 side) in the press direction X, so that each of the pair of second plate-like portions 4b is clamped between the punch portion 23 (support portions 24) and the second support surface 52 of each pad 50.

[0064] Next, the die 40 (press surface 42) is moved from the other side (second die set 14 side) in the press direction X to the one side (first die set 12 side) relative to the top portion of the punch portion 23 (support portions 24). Consequently, a portion on the die 40 side of each second plate-like portion 4b from the punch portion 23

(support portions 24) in the width direction Y is pressed to the one side (first die set 12 side) in the press direction X. In this way, the formed product 3 that includes the pair of shaped portions 32 is completed.

[0065] Although detailed description will be omitted, as illustrated in Figure 17, a pair of dies 40 may be provided to be located between a pair of pads 50 in the width direction Y. In this case, as in the production method described in Figure 16, it is possible to produce the formed product 3 that includes the pair of shaped portions 32 by operating the dies 40 and the pads 50. Note that, in the press forming apparatus 10 illustrated in Figure 17, the pair of shaped portions 32 may be formed at the same time by operating the pair of dies 40 at the same time or the pair of shaped portions 32 may be formed sequentially by operating the pair of dies 40 sequentially.

[0066] Furthermore, although detailed description will be omitted, in the press forming apparatus 10 illustrated in Figures 16 and 17, it is possible to produce the formed product 3 that includes a pair of shaped portions 30 as illustrated in Figure 18 by altering the shape of the first support surface 22 as in the press forming apparatus 10 in Figure 13.

[0067] Although in the above-described embodiment, description has been made to the case in which the first die set 12 is constituted of the punch 20, the configuration of the first die set 12 is not limited to the above example. Figure 19 shows views illustrating another modification of the press forming apparatus 10. The difference of the press forming apparatus 10 illustrated in Figure 19 from the press forming apparatus 10 illustrated in Figure 6 is that the first die set 12 includes the punch 20 and a die 26.

[0068] Still in the embodiment, the punch 20 includes the first support surface 22 and the punch portion 23 (one or more support portions 24) as in the above-described punch 20. However, in the embodiment, as illustrated in Figure 19, the die 26 is provided in a portion that faces the press surface 42 of the die 40 in the press direction X, with no first support surface 22 (punch 20) being provided.

[0069] As illustrated in Figure 19, the die 26 includes a press surface 26a facing the other side (second die set 14 side) in the press direction X and a wall surface 26b extending from an edge of the press surface 26a to the one side (opposite to second die set 14) in the press direction X. The press surface 26a is provided on the one side of punch portion 23 (one or more support portions 24) in the width direction Y to face the press surface 42 in the press direction X. The wall surface 26b is positioned between the punch portion 23 (one or more support portions 24) and the press surface 26a in the width direction Y.

[0070] As in the press surface 42 and the wall surface 44, the press surface 26a and the wall surface 26b are provided, with respect to each support portion 24, to extend from the one side to the other side of the support portions 24 in the intersecting direction Z (see Figure 3). In the press direction X, the die 26 is provided to be capable of approaching and withdrawing relative to the first support surface 22 of the punch 20.

[0071] When the blank 4 is subjected to press forming in the embodiment, as illustrated in Figure 19 (a), the blank 4 is first placed on the first support surface 22 and the press surface 26a. More specifically, the first plate-like portion 4a is supported by the first support surface 22 and the press surface 26a such that the punch portion 23 (one or more support portions 24) protrudes toward the second plate-like portion 4b side with respect to the first plate-like portion 4a through one or more through-holes 5.

[0072] Next, as illustrated in Figure 19 (b), the pad 50 is moved so that the second plate-like portion 4b is clamped between the punch portion 23 (one or more support portions 24) and the second support surface 52. Next, the die 26 and the die 40 are moved in the press direction X to approach each other. Consequently, portions in the first plate-like portion 4a and the second plate-like portion 4b on the one side with respect to the punch portion 23 (one or more support portions 24) in the width direction Y are pressed to approach each other in the press direction X. As a result, the formed product 3 that includes the shaped portion 30 is completed.

[0073] Although in the above-described embodiment, description has been made to the case of the punch portion 23 (support portions 24) being provided on the first die set 12, the second die set 14 may be provided with a punch portion (support portion) that has a configuration similar to that of the punch portion 23. Figure 20 is a view illustrating a further example of the press forming apparatus 10. Here, Figure 20 is a schematic view of the punch 20 and the pad 50 of the press forming apparatus 10 and the blank 4 as viewed from the other side in the width direction Y.

[0074] The difference of the press forming apparatus 10 illustrated in Figure 20 from the press forming apparatus 10 illustrated in Figure 6 is that the pad 50 includes a punch portion 53 that protrudes from the second support surface 52. The punch portion 53 protrudes from the second support surface 52 toward the one side (first die set 12 side) in the press direction X. In the embodiment, the punch portion 53 includes a plurality of support portions 54 that protrudes from the second support surface 52 toward the one side in the press direction X. **In** the embodiment, the plurality of support portions 24 and the plurality of support portions 54 are disposed to be aligned alternately along the intersecting direction Z.

[0075] When the blank 4 is subjected to press forming by using the press forming apparatus 10 illustrated in Figure 20, it is possible to perform press forming on the second plate-like portion 4b while the second plate-like portion 4b is clamped between the punch portion 23 (the plurality of support portions 24) and the second support surface 52 and the first plate-like portion 4a is clamped between the punch portion 53 (the plurality of support portions 54) and the first support surface 22. This makes it possible to satisfactorily prevent the blank 4 from moving during press forming, so that more accurate press

forming is made possible.

[0076] Although in the above-described embodiment, the first support surface 22 and the punch portion 23 (support portion 24) are provided integrally to the punch 20, the first support surface 22 and the punch portion 23 (support portion 24) may be provided as separate members. The same applies to a second embodiment described later. Furthermore, although in the above-described embodiment, the second support surface 52 and the punch portion 53 (support portion 54) are provided integrally to the pad 50, the second support surface 52 and the punch portion 53 (support portion 54) may be provided as different members. Figure 21 is a view illustrating a further example of the press forming apparatus 10. Here, Figure 21 is a schematic view of the punch 20 and the pad 50 of the press forming apparatus 10 and the blank 4 as viewed from the other side in the width direction Y.

[0077] The difference of the press forming apparatus 10 illustrated in Figure 21 from the press forming apparatus 10 illustrated in Figure 20 is that the punch 20 includes a base portion 20a provided as a separate member and the punch portion 23 (the plurality of support portions 24) and that the pad 50 includes a base portion 50a provided as a separate member and the punch portion 53 (the plurality of support portions 54).

[0078] In the press forming apparatus 10 according to the embodiment, the first support surface 22 is provided on the base portion 20a. The punch portion 23 (the plurality of support portions 24) is provided such that it can be moved with respect to the first support surface 22 in the press direction X. In addition, the second support surface 52 is provided on the base portion 50a. The punch portion 53 (the plurality of support portions 54) is provided to be movable in the press direction X with respect to the second support surface 52. In the embodiment, each support portion 24 and each support portion 54 are supported to be movable in the press direction X with respect to the base portions 20a and 50a by, for example, a well-known support member 28 (such as a gas cushion).

[0079] Still in the press forming apparatus 10 according to the embodiment, as in the press forming apparatus 10 illustrated in Figure 20, it is possible to perform press forming on the second plate-like portion 4b while the second plate-like portion 4b is clamped between the punch portion 23 (the plurality of support portions 24) and the second support surface 52 and the first plate-like portion 4a is clamped between the punch portion 53 (the plurality of support portions 54) and the first support surface 22. This makes it possible to satisfactorily prevent the blank 4 from moving during press forming, so that more accurate press forming is made possible.

[0080] Although in the above-described embodiment, description has been made to the case in which the first support surface 22 is flat in a section of the punch 20 perpendicular to the width direction Y, the shape of the first support surface 22 is not limited to the above example. The same applies to the second support surface 52. Specifically, as illustrated in the views (a) to (c) of Figure 22, the shapes of the first support surface 22 and the second support surface 52 may be altered as necessary depending on the shape of the blank 4 (formed product 3). In addition, the height of each support portion 24 (position of the tip portion) may be altered as necessary depending on the shape of the blank 4 (formed product 3). Accordingly, in the press direction X, the position of the top portion of at least one of the support portions 24 may be different from the positions of top portions of other support portions 24.

[0081] Although in the above-described embodiment, description has been made to the case in which the second die set 14 includes the die 40 and the pad 50, the configuration of the second die set 14 is not limited to the above example. For example, in place of the die 40 and the pad 50 of the press forming apparatus 10 illustrated in Figure 6, the die 40a may be provided as illustrated in Figure 23. Here, the die 40a includes a press surface 42a, a wall surface 44a, and a second support surface 52a, which have configurations similar to those of the press surface 42, the wall surface 44, and the second support surface 52 in the above-described embodiment.

[0082] Referring to the views (a) and (b) of Figure 23, in the embodiment, when the blank 4 is subjected to press forming, the die 40a is relatively moved to the punch 20 side in the press direction X. Consequently, the press surface 42a, the wall surface 44a, and the second support surface 52a come into contact with the second plate-like portion 4b sequentially, subjecting the second plate-like portion 4b to press forming. In this way, the formed product 3 that includes the shaped portion 32 is completed.

[0083] Although detailed description will be omitted, the second die set may not include the second support surface. Accordingly, for example, in the second die set 14 illustrated in Figure 6, no pad 50 may be provided. In this case, it is also possible to perform press forming on the blank 4 by the punch 20 and the die 40.

[0084] Although detailed description will be omitted, in the press forming apparatus 10 described above, it is possible to obtain formed products of various shapes as illustrated in Figure 24 by adjusting the shape and dimensions of any portion as necessary.

(Second embodiment)

(Formed product)

[0085] Figure 25 is a view illustrating an example of a formed product produced by utilizing a press forming apparatus according to the second embodiment of the present invention.

[0086] As illustrated in Figure 25, a formed product 6 includes a plate-like flange portion 6a, a plate-like vertical wall portion 6b, and a plate-like flange portion 6c. The vertical wall portion 6b is provided to connect an edge of

the flange portion 6a with an edge of the flange portion 6c. The flange portion 6a and the flange portion 6c are provided to extend from the vertical wall portion 6b in the opposite direction to each other in the thickness direction of the vertical wall portion 6b.

[0087] A plurality of protruding portions 7 is formed on the vertical wall portion 6b. The protruding portions 7 are formed to protrude from the vertical wall portion 6b toward the flange portion 6a side in the thickness direction of the vertical wall portion 6b. Note that the protruding portions 7 may also be referred to as recessed portions because they are viewed as recessed portions from outside.

(Blank)

[0088] **In** the embodiment, the formed product 6 is produced by using a blank in which the plurality of protruding portions 7 is formed in advance as a starting material. Figure 26 is a view illustrating an example of the blank used as a starting material in the embodiment. As illustrated in Figure 26, the blank 8 includes a plate-like portion 8a and the plurality of protruding portions 7 protruding from the plate-like portion 8a in a thickness direction of the plate-like portion 8a. Although bottomed protruding portions 7 are formed in the embodiment, for example, protruding portions 7, which include a hole passing through in the thickness direction of the vertical wall portion 6b, may be formed by burring or the like.

(Press forming apparatus and production method)

[0089] Figure 27 shows schematic views illustrating a press forming apparatus according to the second embodiment of the present invention: the view (a) is a view of the press forming apparatus as viewed from the intersecting direction Z, and the view (b) is a view of the press forming apparatus as viewed from above. Still in the embodiment, as in the above-described embodiment, the direction in which the first die set or the second die set move when a blank is subjected to press forming is denoted as the press direction X. The width direction Y of the press forming apparatus is the direction perpendicular to the press direction X. The direction that intersects the press direction X and the width direction Y is denoted as the intersecting direction Z.

[0090] As illustrated in Figure 27, a press forming apparatus 100 according to the embodiment includes a first die set 110 provided on the one side in the press direction X and a second die set 120 provided on the other side in the press direction X. That is, the first die set 110 and the second die set 120 are provided in positions to face in the press direction X. The first die set 110 and the second die set 120 perform relative movement in the press direction X. In the embodiment, the first die set 110 includes a punch 60 and the second die set 120 includes a die 70 and a pad 80.

[0091] The punch 60 includes a first support surface 62 and a punch portion 63 that protrudes from the first support surface 62. In the embodiment, the first support surface 62 faces the other side (second die set 120 side) in the press direction X. The punch portion 63 protrudes from the first support surface 62 toward the other side in the press direction X. When viewed from the second die set 120 side in the press direction X, the punch portion 63 faces a wall surface 74 of the die 70, which will be described later. In the embodiment, the punch portion 63 includes a plurality of support portions 64 that protrude from the first support surface 62 toward the other side in the press direction X. The plurality of support portions 64 are spaced apart from each other and provided to be aligned along the intersecting direction Z. In the embodiment, each support portion 64 is formed in a columnar shape to have side surfaces 64a of a rectangular section. Note that the shape of the support portion 64 illustrated in Figure 27 is only one example and the shape of the support portion 64 is not limited to the above example. Although it is preferable that the top portion of each support portion 64 has a flat shape, it may have a spherical crown shape.

[0092] In the embodiment, the side surface 63a of the punch portion 63 is constituted of a plurality of side surfaces 64a of the plurality of support portions 64. When viewed from the second die set 120 side in the press direction X, the side surface 63a of the punch portion 63 includes an opening 63b opened on the wall surface 74 side of the die 70, which will be described later. In the embodiment, the side surface 63a of the punch portion 63 includes a plurality of openings 63b. In the embodiment, the side surfaces 64a of two adjacent support portions 64 are arranged so as to be spaced apart with the opening 63b in between. In other words, two adjacent support portions 64 are arranged so as to be spaced apart with the opening 63b in between. Here, in the embodiment, the opening 63b is also opened on the second die set 120 side in the press direction X. Furthermore, in the embodiment, the opening 63b is formed to pass through between two adjacent support portions 64 in the width direction Y.

[0093] As in the first support surface 22 of the first embodiment, the first support surface 62 extends at least on both sides of each support portion 64 in the intersecting direction Z. In the embodiment, as in the first support surface 22 of the first embodiment, the first support surface 62 extends at least between the support portions 64 and on both sides of the plurality of support portions 64 in the arrangement direction of the plurality of support portions 64.

[0094] As in the above-described die 40, the die 70 includes a press surface 72 and a wall surface 74 that is continuous with the press surface 72. In the embodiment, the press surface 72 faces the one side (first die set 110 side) in the press direction X. The wall surface 74 extends from an edge of the press surface 72 to the other side in the press direction X. The press surface 72 is provided on the one side of the punch portion 63 (the plurality of support portions 64) in the width direction Y. In the embodiment, the press surface 72 is disposed so as to be out

of position from a position to face the punch portion 63 in the press direction X. The wall surface 74 is positioned between the punch portion 63 (the plurality of support portions 64) and the press surface 72 in the width direction Y.

[0095] As in the press surface 42 and the wall surface 44 described abovbe, the press surface 72 and the wall surface 74 are provided, with respect to each support portion 64, to extend from the one side to the other side of the support portion 64 in the intersecting direction Z. **In the** embodiment, the press surface 72 and the wall surface 74 is provided along the arrangement direction of the plurality of support portions 64 and extend from the one side to the other side of the plurality of support portions 64 in the arrangement direction. In the press direction X, the die 70 is provided to be capable of approaching and withdrawing relative to the first support surface 62 of the punch 60.

[0096] As in the above-described pad 50, the pad 80 is disposed in a position to face the punch portion 63 (the plurality of support portions 64) in the press direction X. In the embodiment, the pad 80 includes a second support surface 82 that faces the punch portion 63 (the plurality of support portions 64) in the press direction X. As in the above-described second support surface 52, the second support surface 82 is provided, with respect to each support portion 64, to extend from the one side to the other side of the support portion 64 in the intersecting direction Z. In the embodiment, the second support surface 82 is provided to extend from the one side to the other side of the plurality of support portions 64 in the arrangement direction of the plurality of support portions 64. In the press direction X, the pad 80 is provided to be capable of approaching and withdrawing relative to the plurality of support portions 64 of the punch 60.

[0097] When the blank 8 is subjected to press forming, the blank 8 is first supported by the punch portion 63 (the plurality of support portions 64). More specifically, the blank 8 is supported by the plurality of support portions 64 such that each protruding portion 7 is in the state of being located on the one side of the plurality of support portions 64 in the width direction Y, being located between two adjacent support portions 64 in the intersecting direction Z, and protruding toward the one side in the press direction X.

[0098] Next, as in the first embodiment, the pad 80 (second support surface 82) is moved to the one side in the press direction X, so that the plate-like portion 8a is clamped between the punch portion 63 (the plurality of support portions 64) and the second support surface 82. Thereafter, as in the first embodiment, the die 70 (press surface 72) is moved from the other side to the one side in the press direction X relative to the top portion of the punch portion 63 (the plurality of support portions 64). Consequently, a portion of the plate-like portion 8a on the one side with respect to the plurality of support portions 64 in the width direction Y is pressed to the one side in the press direction X. As a result, the plate-like portion 8a is subjected to bending deformation and the formed product 6 is completed. In the embodiment, at a forming bottom dead center of the relative movement between the first die set 110 and the second die set 120 in the press direction X, the wall surface 74 of the die 70 faces the side surface 63a of the punch portion 63 with part of the plate-like portion 8a in between, and each protruding portion 7 enters the opening 63b without contacting the side surface 63a. Note that the state of the press forming apparatus 100 at the forming bottom dead center of the relative movement between the first die set 110 and the second die set 120 corresponds to the state in which the punch 20 is replaced with the punch 60, the die 40 is replaced with the die 70, and the pad 50 is replaced with the pad 80 in Figure 6 (d).

(Advantageous effects of the embodiment)

[0099] As described above, according to the press forming apparatus 100 according to the embodiment, when the formed product 6 with the protruding portions 7 formed in the vertical wall portion 6b is to be produced from the blank 8, the protruding portions 7 formed in the blank 8 in advance can be disposed between adjacent support portions 64 in the intersecting direction Z. In this way, when the blank 8 is subjected to press forming, it is possible to prevent the protruding portions 7 from contacting the first die set 110. As a result, it is possible to efficiently produce the formed product 6.

[0100] Note that, as in the plurality of support portions 24 in the above-described embodiment, the height (position of a top portion) of the plurality of support portions 64 may be altered as necessary depending on the shape and the dimensions of the formed product 6. Accordingly, positions of top portions of the plurality of support portions 64 in the press direction X may be different from each other. Although detailed description will be omitted, as in the above-described embodiment, the shapes and the dimensions of other portions of the press forming apparatus 100 may be altered as necessary depending on the shape and the dimensions of the formed product 6. Furthermore, although detailed description will be omitted, the flange portion 6c may not be formed. The same applies to embodiments described later and flange portion may not be formed.

(Modification)

[0101] Although in the above-described embodiment, description has been made to the case in which the second die set 120 includes one die 70, the configuration of the second die set 120 is not limited to the above example. For example, as in the press forming apparatus 100 illustrated in Figure 28, the dies 70 may be provided on both sides of the pad 80 in the width direction Y. In this case, for example, as illustrated in Figure 28, the blank 8 is disposed such that the respective plurality of protruding portions 7 is positioned on either side of the punch portion

63 (the plurality of support portions 64) in the width direction Y and each protruding portion 7 is located between two adjacent support portions 64 in the intersecting direction Z, and the blank 8 is subjected to press forming. In this way, it is possible to produce hat-shaped formed products as illustrated in Figure 1 (c), while each protruding portion 7 is prevented from contacting the first die set 110 during press forming. Although detailed description will be omitted, the pad 80 may not be provided in the press forming apparatus 100 illustrated in Figure 28. In this case, it is also possible to produce hat-shaped formed products while each protruding portion 7 is prevented from contacting the first die set 110 during press forming.

[0102] Although in the above-described embodiment, description has been made to the case in which the punch portion 63 of the first die set 110 is configured such that adjacent support portions 64 are spaced apart with the opening 63b in between, the configuration of the punch portion of the first die set 110 is not limited to the above example. For example, as illustrated in Figure 29, the punch portion 63 of the first die set 110 may further include a connecting portion 65 that connects adjacent support portions 64.

[0103] Referring to Figure 29, in the embodiment, the connecting portion 65 is provided in the opening 63b. In other words, in the embodiment, each opening 63b includes the connecting portion 65. As in the support portion 64, each connecting portion 65 is provided to protrude from the first support surface 62 in the press direction X. In the embodiment, the side surface 63a of the punch portion 63 is constituted of the plurality of side surfaces 64a of the plurality of support portions 64 and the plurality of side surfaces 65a of the plurality of connecting portions 65. Still in the embodiment, the plurality of support portions 64 of the punch portion 63 protrudes from the first support surface 62 toward the other side in the press direction X. The plurality of support portions 64 is provided such that they are spaced apart from each other and aligned along the intersecting direction Z. When viewed from the second die set 120 side in the press direction X (see Figure 27), the distance between the side surface 65a of the connecting portion 65 and the wall surface 74 of the die 70 is larger than the distance between the side surface 64a of the support portion 64 and the wall surface 74. That is, in the width direction Y, the space between the connecting portion 65 and the wall surface 74 is larger than the space between the support portion 64 and the wall surface 74. In the embodiment, in the press direction X, the top portion of the support portion 64 is located on the other side (second die set 120 side) from the top portion of the connecting portion 65.

[0104] When the blank 8 is subjected to press forming, the blank 8 is first supported by the plurality of support portions 64 of the punch portion 63. More specifically, the blank 8 is supported by the plurality of support portions 64 such that each protruding portion 7 is in the state of being located on the one side of the plurality of support portions 64 in the width direction Y, being located between two adjacent support portions 64 in the intersecting direction Z, and protruding toward the one side (first die set 110 side) in the press direction X.

[0105] Next, as in the above-described embodiment, the pad 80 (second support surface 82) is moved to the one side in the press direction X, so that the plate-like portion 8a is clamped between the plurality of support portions 64 and the second support surface 82. Thereafter, the die 70 (press surface 72) is moved from the other side (second die set 120 side) to the one side (first die set 110 side) in the press direction X relative to the top portions of the plurality of support portions 64. Consequently, a portion of the plate-like portion 8a on the one side with respect to the plurality of support portions 64 in the width direction Y is pressed to the one side in the press direction X. As a result, the plate-like portion 8a is subjected to bending deformation and the formed product 6 is completed. Still in the embodiment, at a forming bottom dead center of the relative movement between the first die set 110 and the second die set 120 in the press direction X, the wall surface 74 of the die 70 faces the side surface 63a of the punch portion 63 with part of the plate-like portion 8a in between, and each protruding portion 7 enters the opening 63b without contacting the side surface 63a.

[0106] Still in the embodiment, when the formed product 6 is to be produced from the blank 8, the protruding portions 7 formed in the blank 8 in advance can be disposed between adjacent support portions 64 in the intersecting direction Z. In this way, when the blank 8 is subjected to press forming, it is possible to prevent the protruding portions 7 from contacting the first die set 110. As a result, it is possible to efficiently produce the formed product 6.

[0107] Note that, as in the above-described embodiment, the height of the plurality of support portions 64 (position of a top portion) may be altered as necessary depending on the shape and the dimensions of the formed product 6. Accordingly, positions of top portions of the plurality of support portions 64 in the press direction X may be different from each other. Positions of top portions of the plurality of connecting portions 65 in the press direction X may also be different from each other. Furthermore, in the press direction X, the position of a top portion of at least one of the support portions 64 may be different from the position of a top portion of the connecting portion 65 that is adjacent to the support portion 64, and positions of top portions of the plurality of support portions 64 and positions of top portions of the plurality of connecting portion 65 may be equal to each other.

[0108] Although not illustrated, also in the press forming apparatus 100 including the plurality of connecting portions 65, as in the press forming apparatus 100 illustrated in Figure 28, the dies 70 may be provided on both sides of the pad 80. In this way, it is possible to produce hat-shaped formed products as illustrated in Figure 1 (c),

while each protruding portion 7 is prevented from contacting the first die set 110 during press forming. Although detailed description will be omitted, as in the press forming apparatus 100 illustrated in Figure 28, the pad 80 may not be provided when two dies 70 is provided.

INDUSTRIAL APPLICABILITY

[0109] According to the present invention, it is possible to efficiently produce a formed product that includes a flange portion facing a top plate portion and a formed product with a protruding portion formed in an vertical wall portion.

REFERENCE SIGNS LIST

[0110]

3, 6 formed product
4, 8 blank
5 through-hole
7 protruding portion
10, 100 press forming apparatus
12, 110 first die set
14, 120 second die set
20, 60 punch
22, 62 first support surface
24, 64 support portion
40, 70 die
42, 72 press surface
44, 74 wall surface
50, 80 pad
52, 82 second support surface

Claims

1. A press forming apparatus comprising

a first die set and a second die set in positions to face each other in a press direction, the first die set and the second die set performing relative movement in the press direction,
the first die set including a first support surface and a punch portion that protrudes from the first support surface, and
the second die set including a press surface disposed so as to be out of position from a position to face the punch portion in the press direction and a wall surface that is continuous with the press surface, wherein
when viewed from a side of the second die set in the press direction, the punch portion includes a side surface that faces the wall surface and that includes an opening opened on a side of the wall surface, and
at a forming bottom dead center of the relative movement between the first die set and the second die set in the press direction, the wall surface faces the side surface of the punch portion.

2. The press forming apparatus according to claim 1, wherein

the punch portion includes a plurality of support portions,
the side surface of the punch portion includes side surfaces of the plurality of support portions, and
the side surfaces of two adjacent support portions among the plurality of support portions are arranged so as to be spaced apart with the opening in between.

3. The press forming apparatus according to claim 2, wherein

the opening includes a connecting portion that connects two adjacent support portions among the plurality of support portions, and
when viewed from the side of the second die set in the press direction, a distance between a side surface of the connecting portion and the wall surface is longer than a distance between the side surface of the support portion and the wall surface.

4. The press forming apparatus according to claim 2 or 3, wherein

the opening includes a connecting portion that connects two adjacent support portions among the plurality of support portions, and
in the press direction, a position of a top portion of at least one of the support portions is different from a position of a top portion of the connecting portion that is adjacent to the support portion.

5. The press forming apparatus according to any one of claims 2 to 4, wherein
in the press direction, a position of a top portion of at least one support portion among the plurality of support portions is different from positions of top portions of other support portions.

6. The press forming apparatus according to any one of claims 1 to 5, wherein
the second die set includes a pad disposed in a position to face the punch portion in the press direction.

7. A production method for a formed product by a first die set and a second die set facing across a blank in a press direction performing relative movement in the press direction to subject the blank to press forming,

wherein

the first die set includes a first support surface and a punch portion that protrudes from the first support surface,
the second die set includes a press surface disposed so as to be out of position from a position to face the punch portion in the press direction and a wall surface that is continuous with the press surface, and
the blank includes a first plate-like portion and a second plate-like portion that faces the first plate-like portion in the press direction,
the method comprising:

supporting the first plate-like portion by the first support surface from a side of the first die set and supporting the second plate-like portion by the punch portion crossing the first plate-like portion in the press direction from the side of the first die set; and in this state,
subjecting the second plate-like portion to bending deformation by the press surface that moves relative to the punch portion in the press direction, wherein
at a forming bottom dead center of the relative movement between the first die set and the second die set in the press direction, the wall surface faces a side surface of the punch portion with part of the second plate-like portion in between.

8. The production method for a formed product according to claim 7, wherein
when the second plate-like portion is supported by the punch portion, the punch portion passes through a through-hole formed in the first plate-like portion to cross the first plate-like portion.

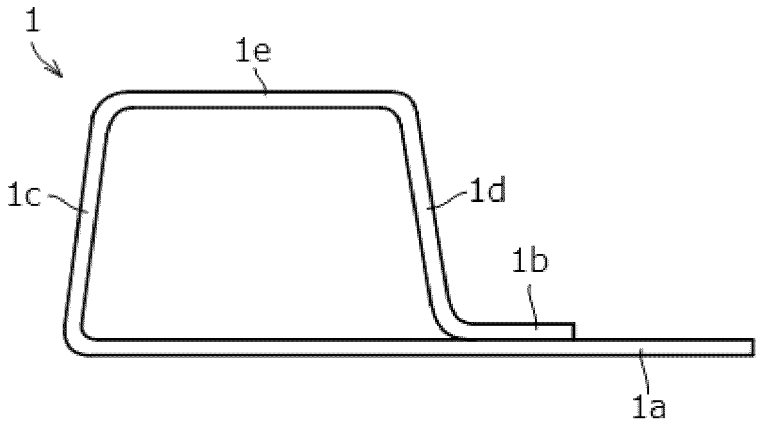
9. A production method for a formed product by a first die set and a second die set facing across a blank in a press direction performing relative movement in the press direction to subject the blank to press forming, wherein

the first die set includes a first support surface and a punch portion that protrudes from the first support surface,
the second die set includes a press surface disposed so as to be out of position from a position to face the punch portion in the press direction and a wall surface that is continuous with the press surface,
when viewed from a side of the second die set in the press direction, the punch portion includes a side surface that faces the wall surface and that includes an opening opened on a side of the wall surface, and
the blank includes a plate-like portion and a protruding portion that protrudes from the plate-like portion in a thickness direction of the plate-like portion,
the method comprising:

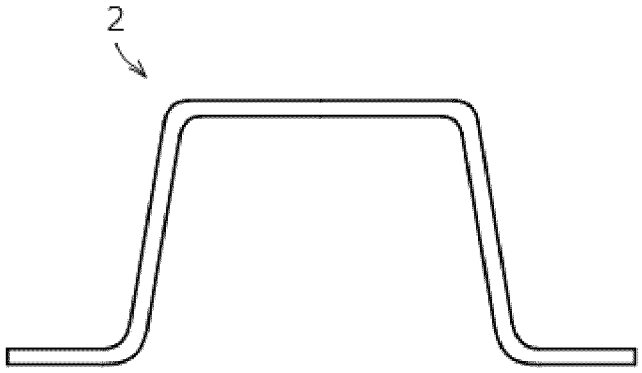
supporting the plate-like portion by the punch portion in the press direction from a side of the first die set; and in this state,
subjecting the plate-like portion to bending deformation by the press surface that moves relative to the punch portion in the press direction, wherein
at a forming bottom dead center of the relative movement between the first die set and the second die set in the press direction, the wall surface faces a side surface of the punch portion with part of the plate-like portion in between, and the protruding portion enters the opening without contacting the side surface.

[Fig.1]

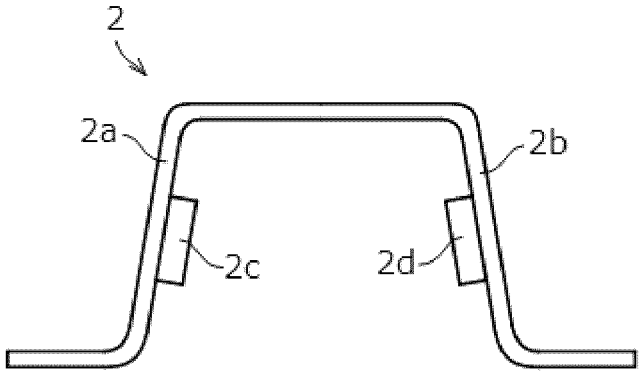
(a)



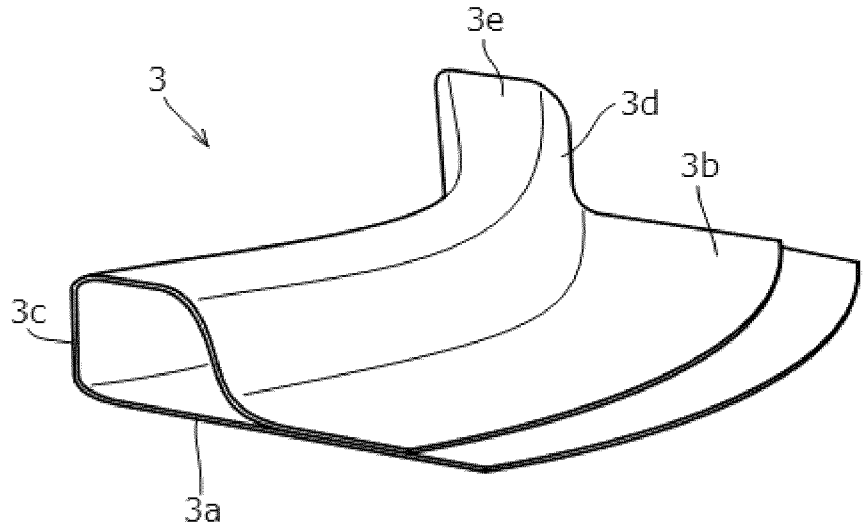
(b)



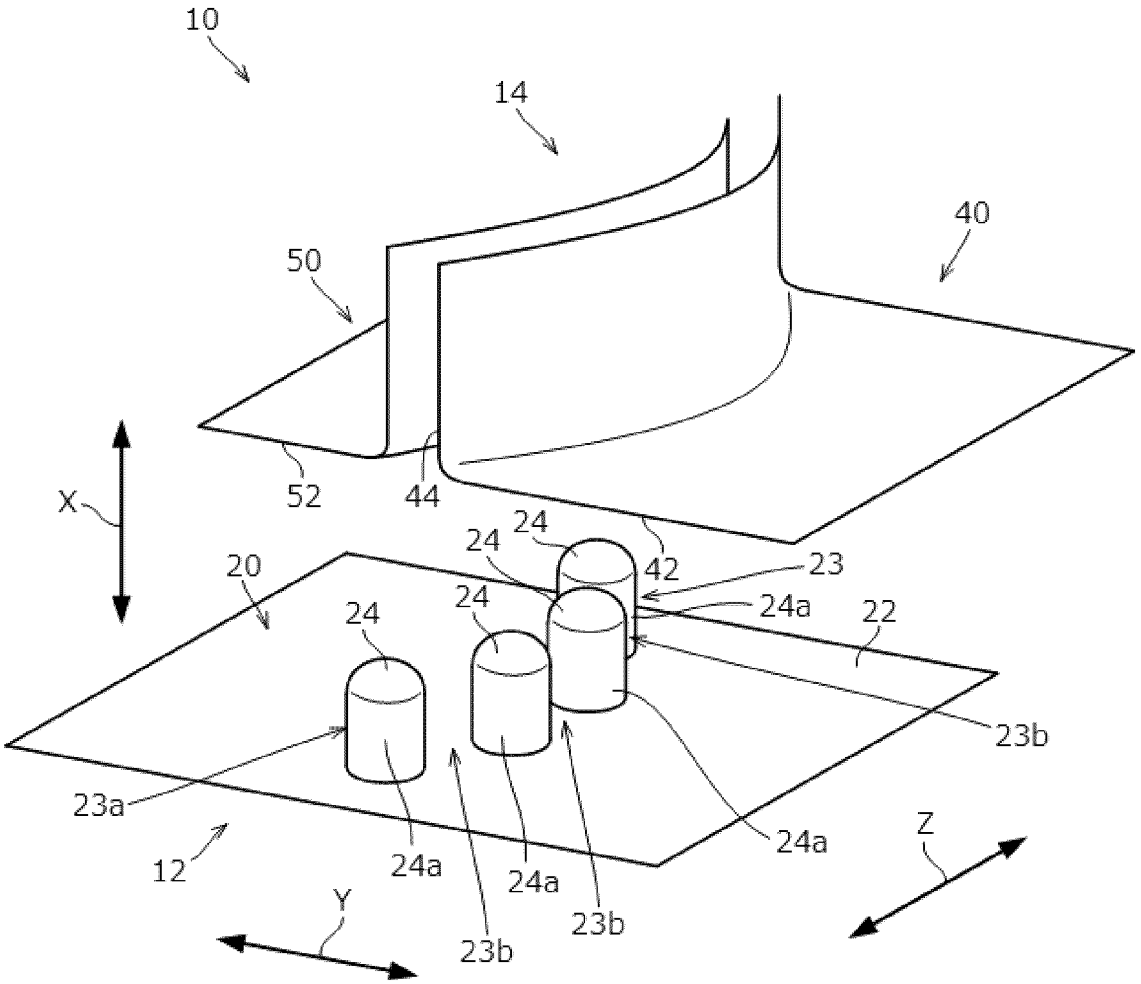
(c)



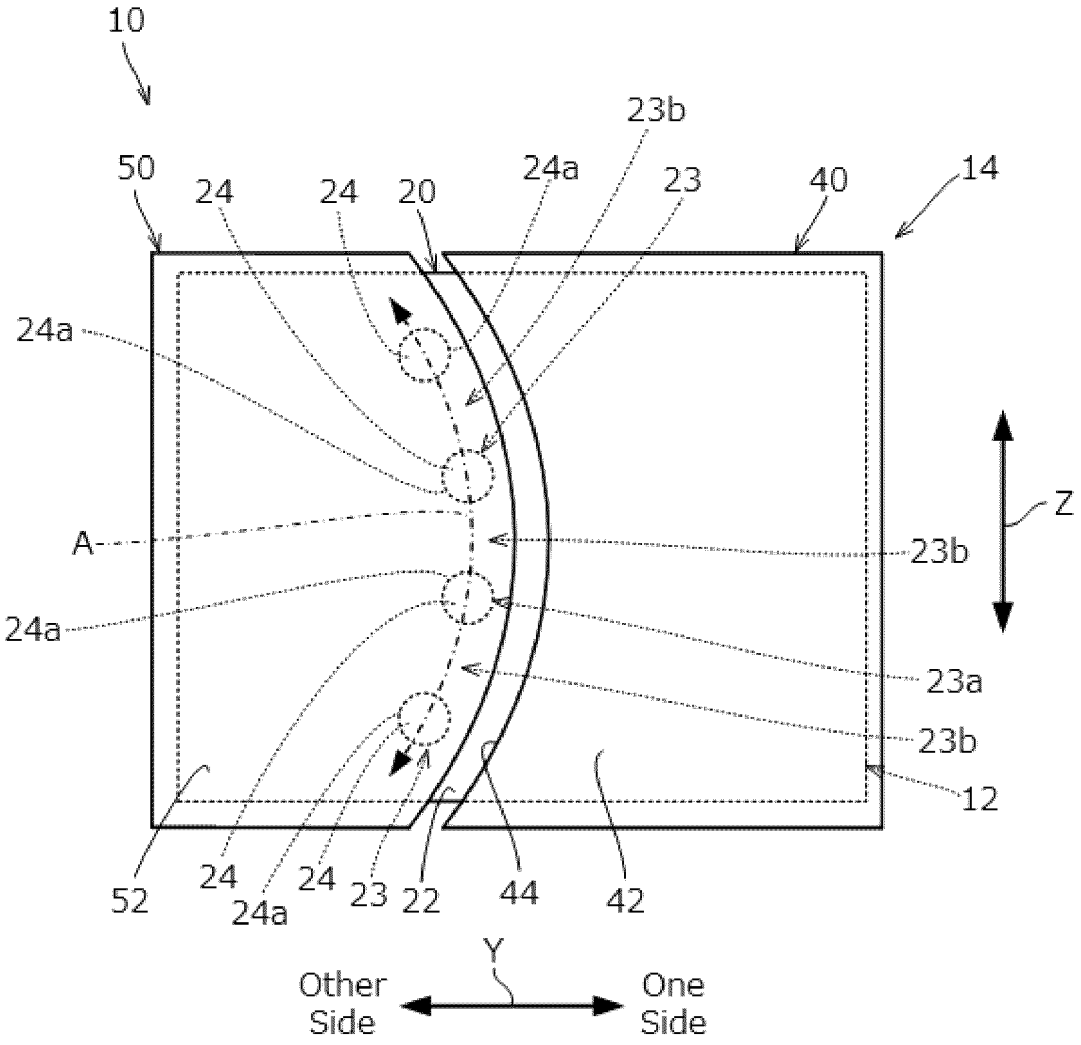
[Fig.2]



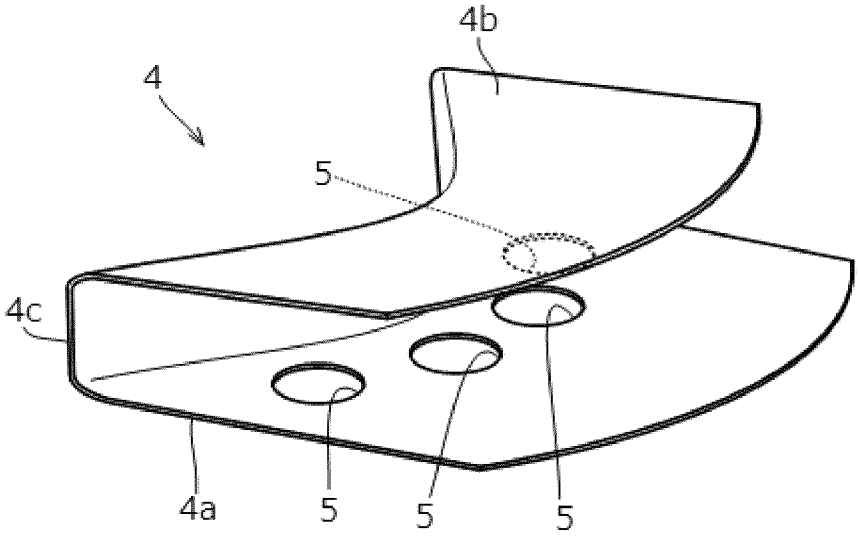
[Fig.3]



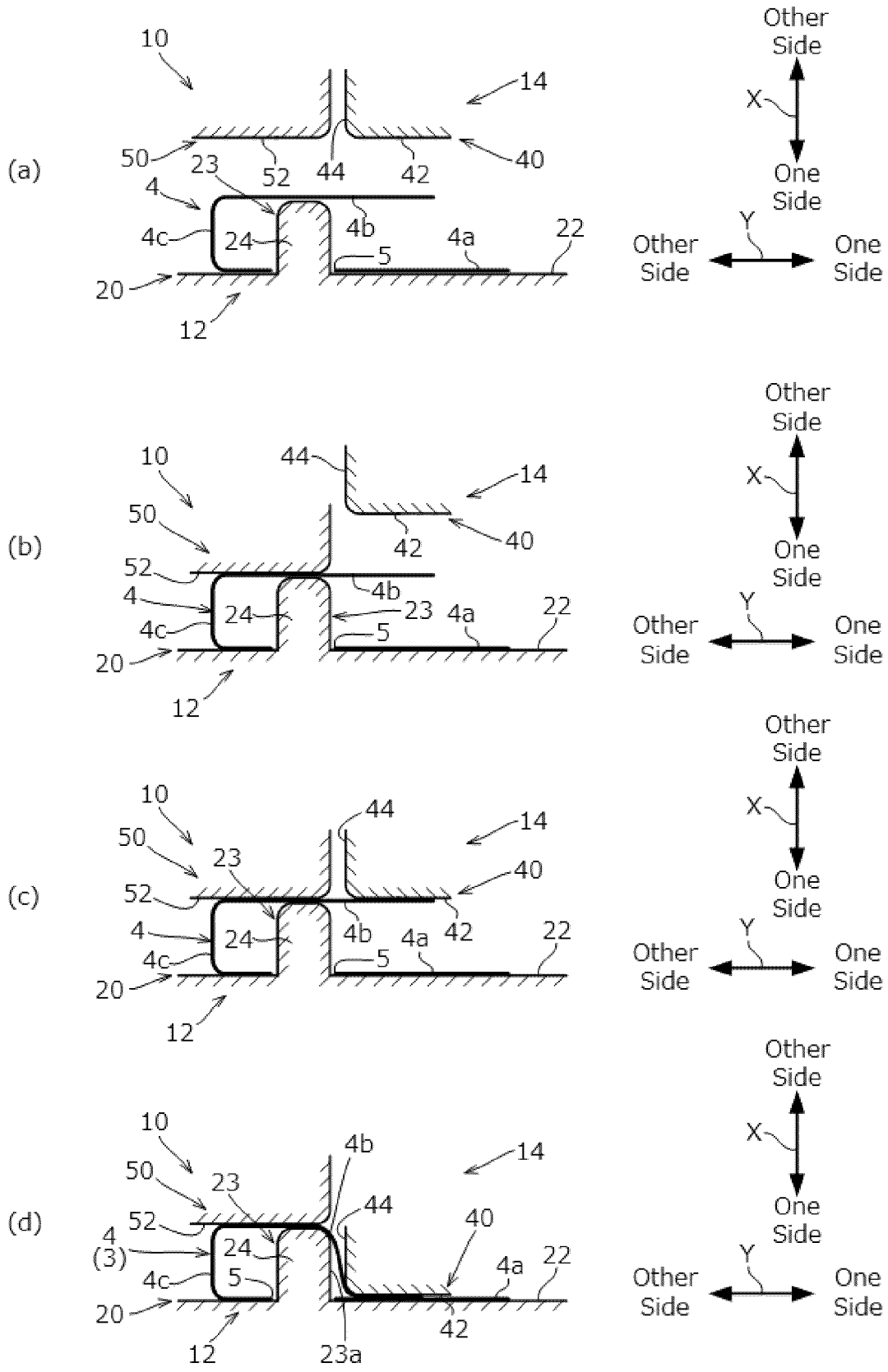
[Fig.4]


10
50
24
24
20
24a
23b
23
40
14
24a
A
24a
23b
Z
23a
23b
12
52
24
24a
24
23
22
44
42
Y
Other Side
One Side

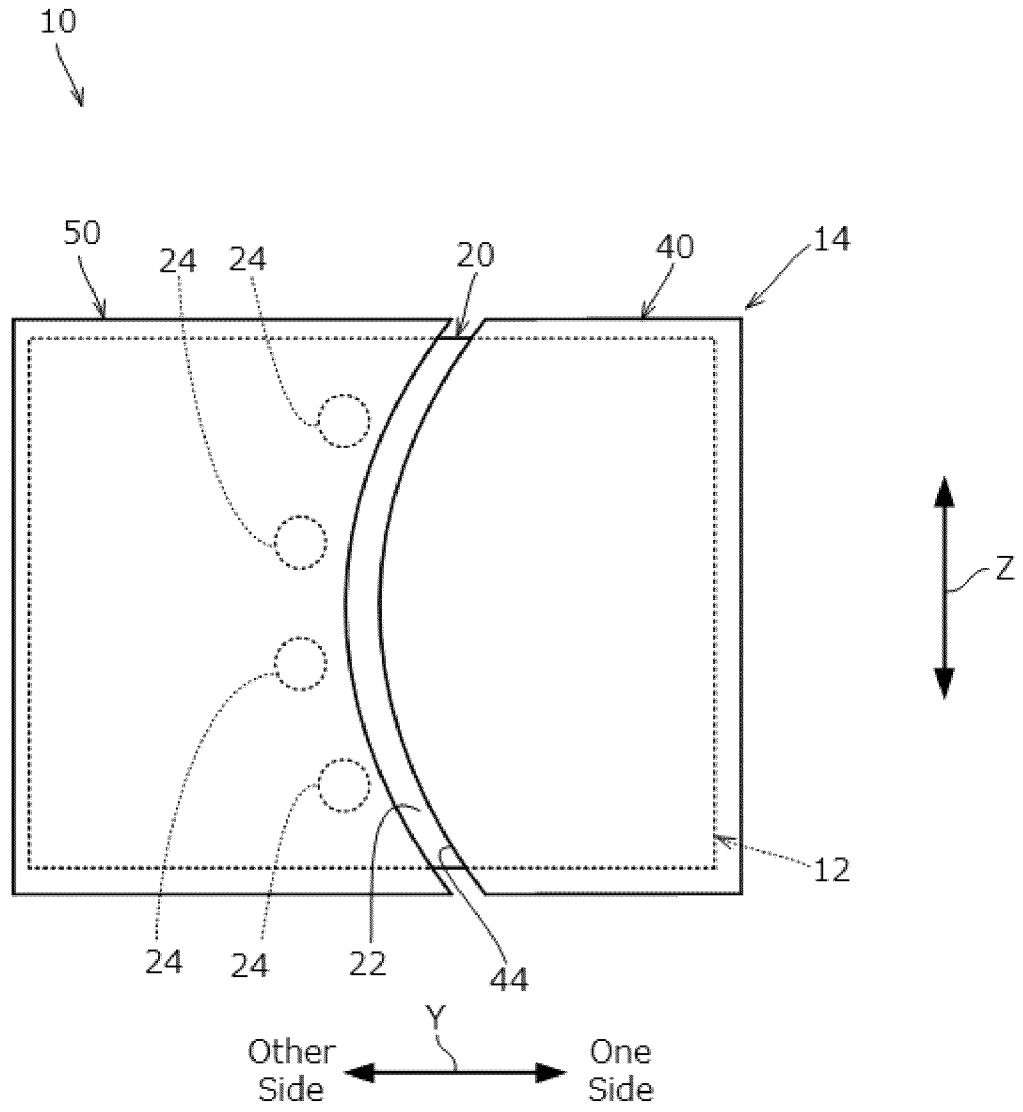
[Fig.5]



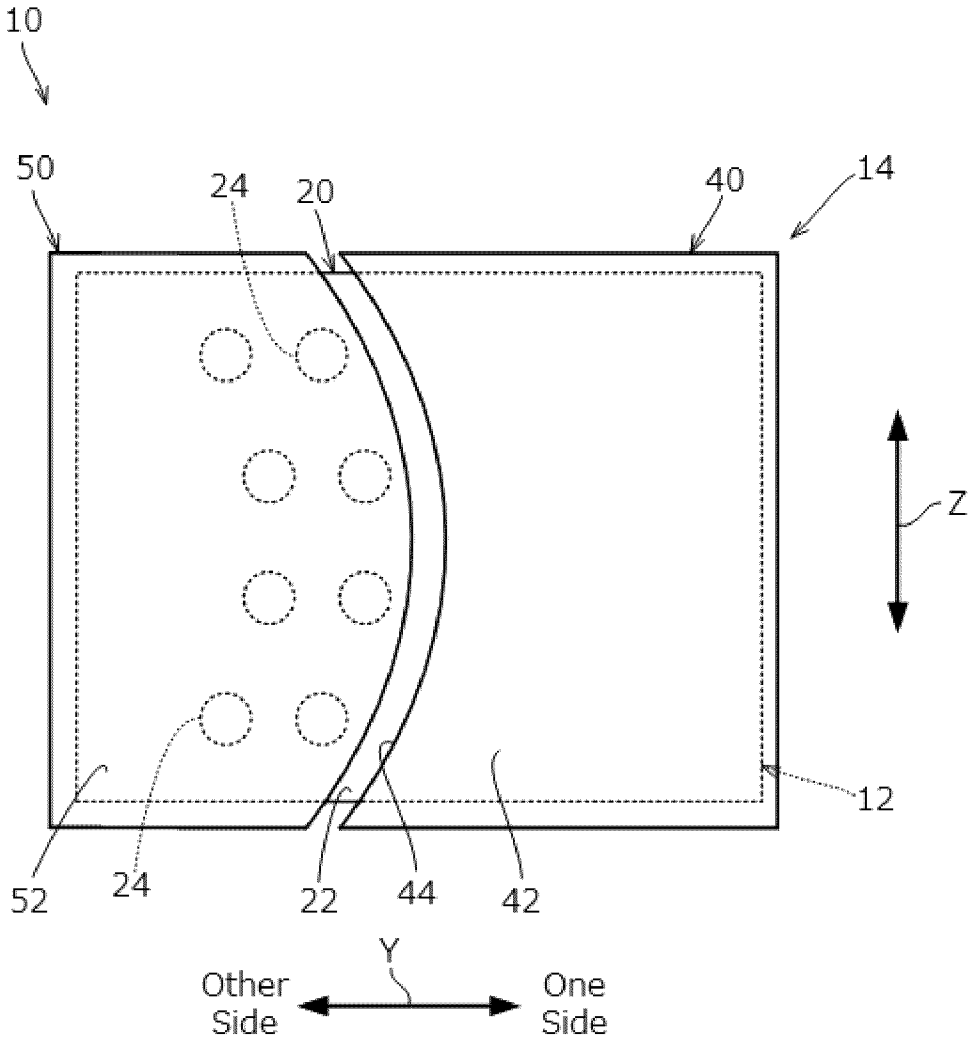
[Fig.6]


(a)
10
14
50
23
52
44
42
40
4
4b
4c
24
5
4a
22
20
12
Other Side
X
One Side
Y
Other Side
One Side
(b)
10
44
14
50
42
40
52
4
4b
24
23
4a
22
4c
5
20
12
Other Side
X
One Side
Y
Other Side
One Side
(c)
10
44
14
50
23
40
52
4
24
4b
42
4a
22
4c
5
20
12
Other Side
X
One Side
Y
Other Side
One Side
(d)
10
4b
14
50
23
44
52
40
4
(3)
24
4a
22
4c
5
20
12
42
23a
Other Side
X
One Side
Y
Other Side
One Side

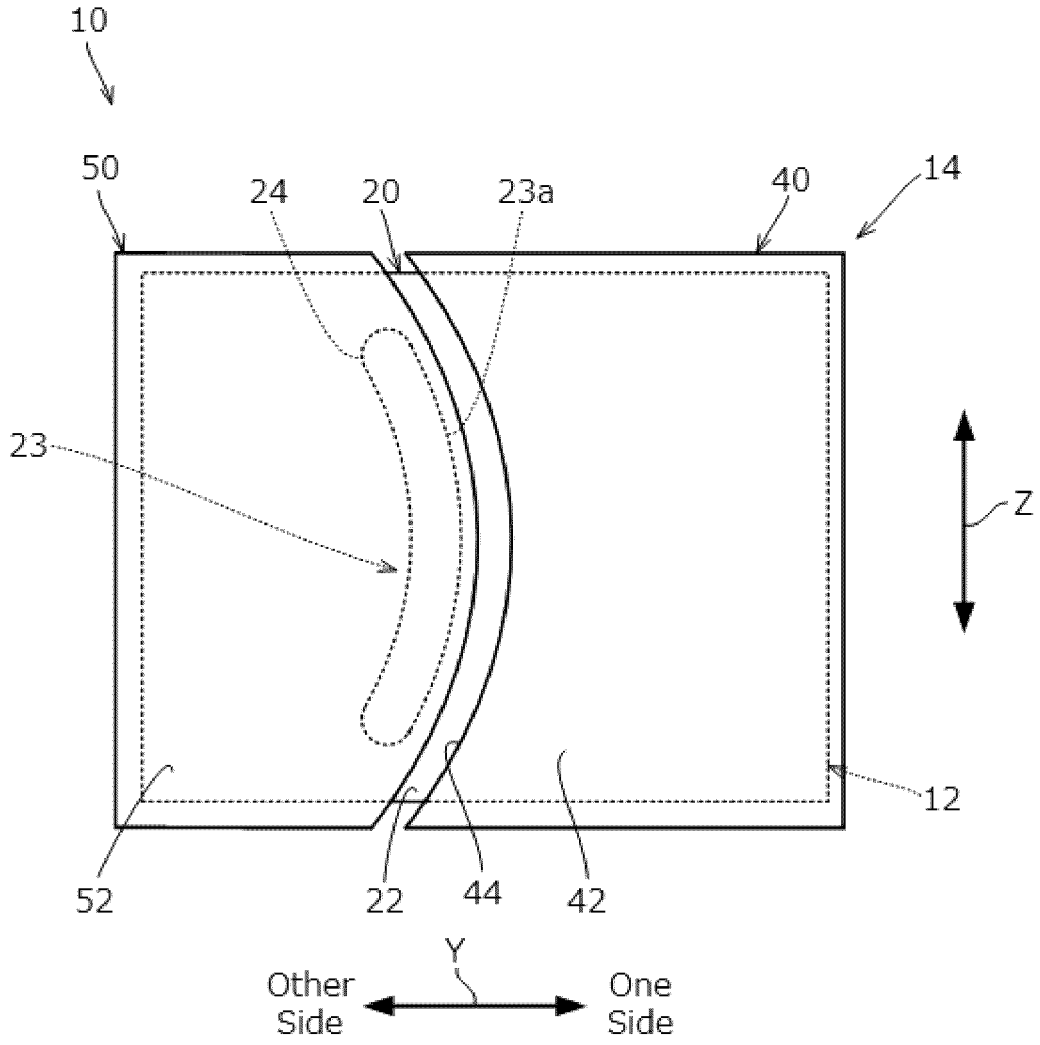
[Fig.7]



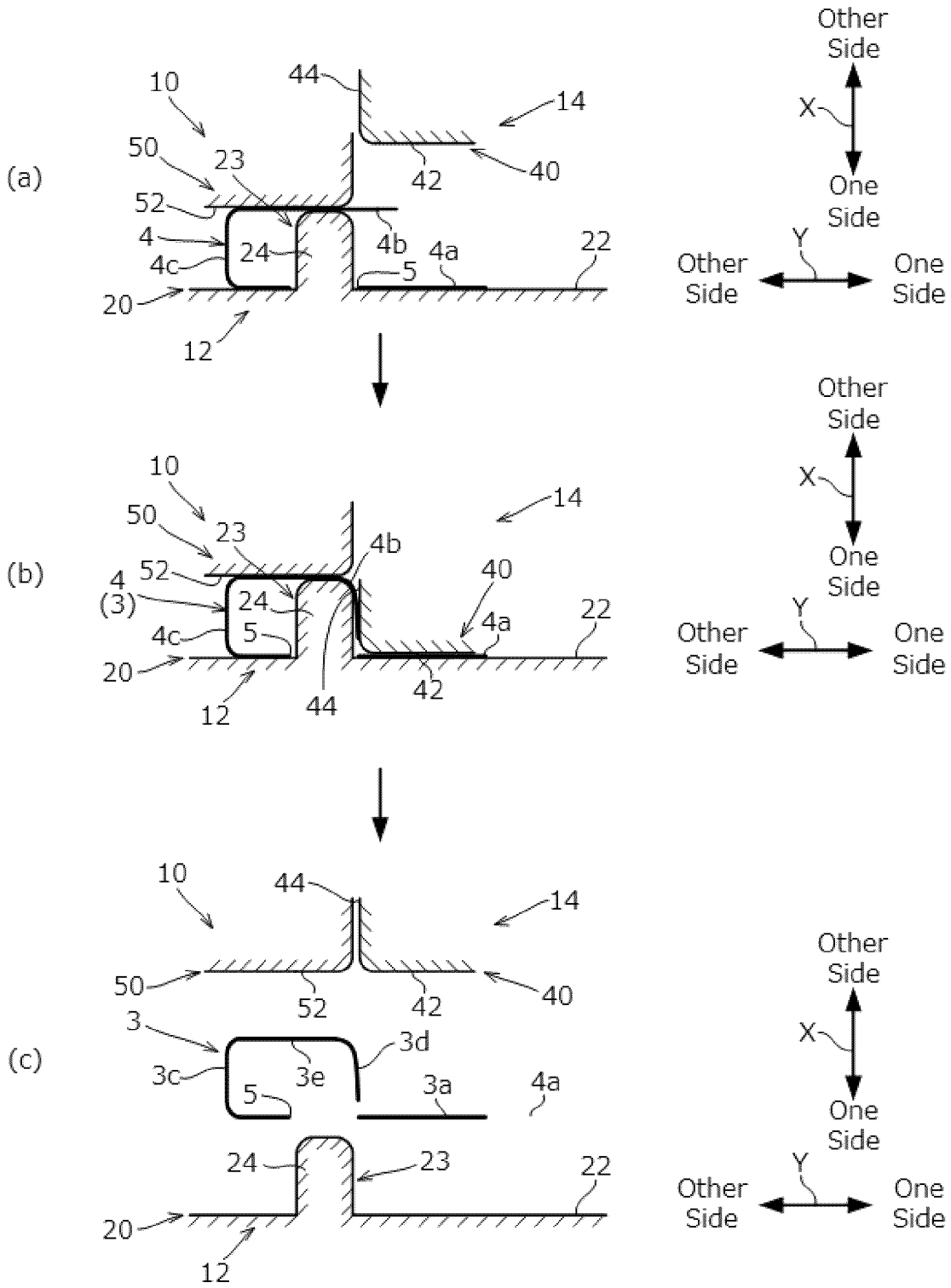
[Fig.8]



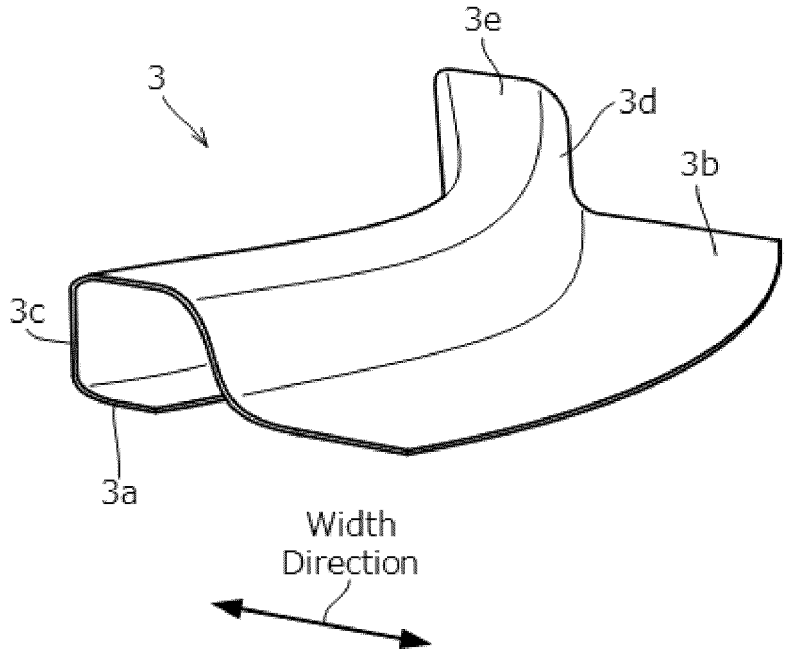
[Fig.9]



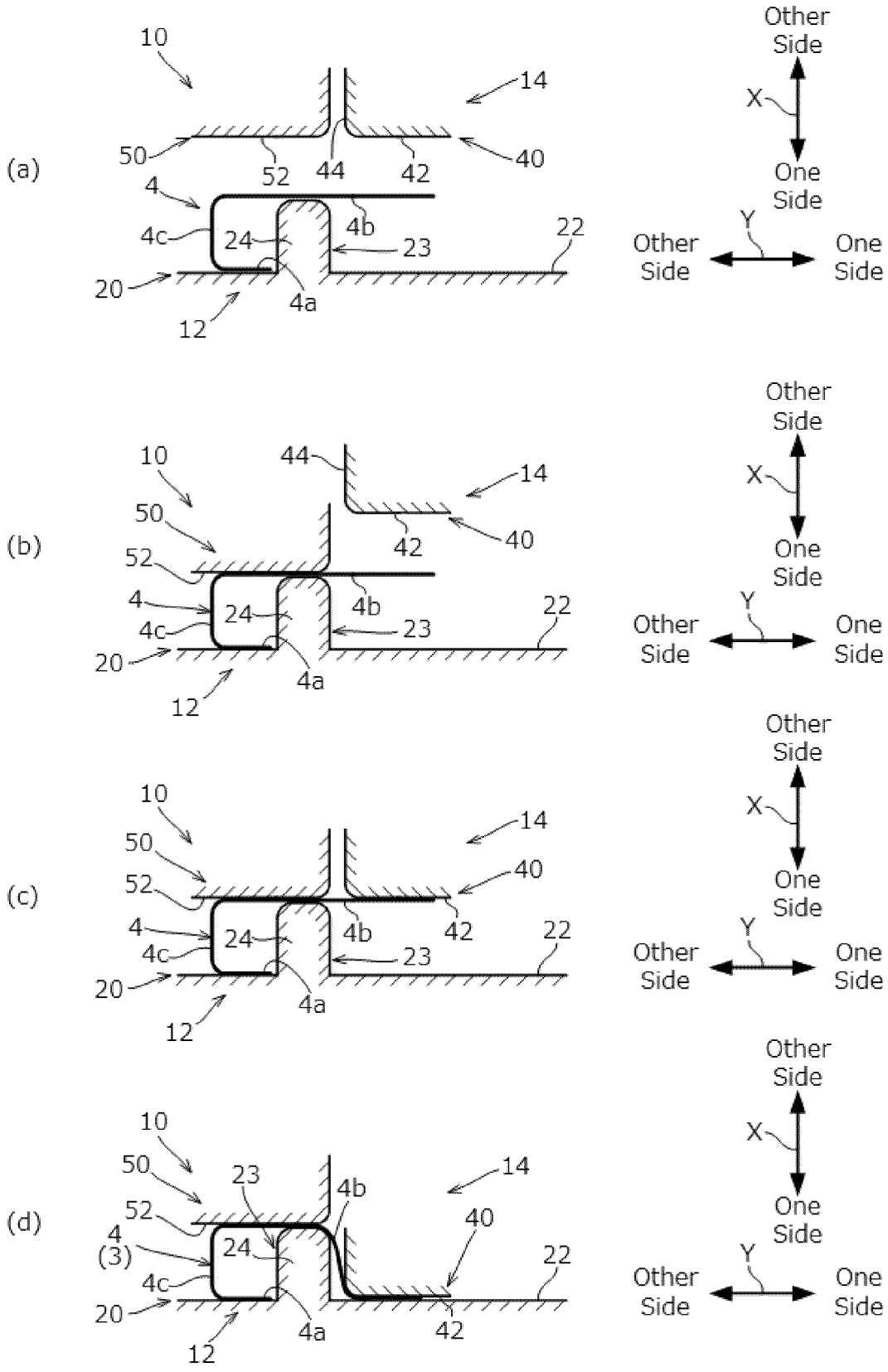
[Fig.10]


(a)
10
44
14
50
23
42
40
52
4
24
4b
4a
22
4c
5
20
12
Other Side
X
One Side
Y
Other Side
One Side
(b)
10
14
50
23
4b
52
40
4
(3)
24
22
4c
5
4a
20
12
44
42
Other Side
X
One Side
Y
Other Side
One Side
(c)
10
44
14
50
52
42
40
3
3d
3c
3e
3a
4a
5
24
23
22
20
12
Other Side
X
One Side
Y
Other Side
One Side

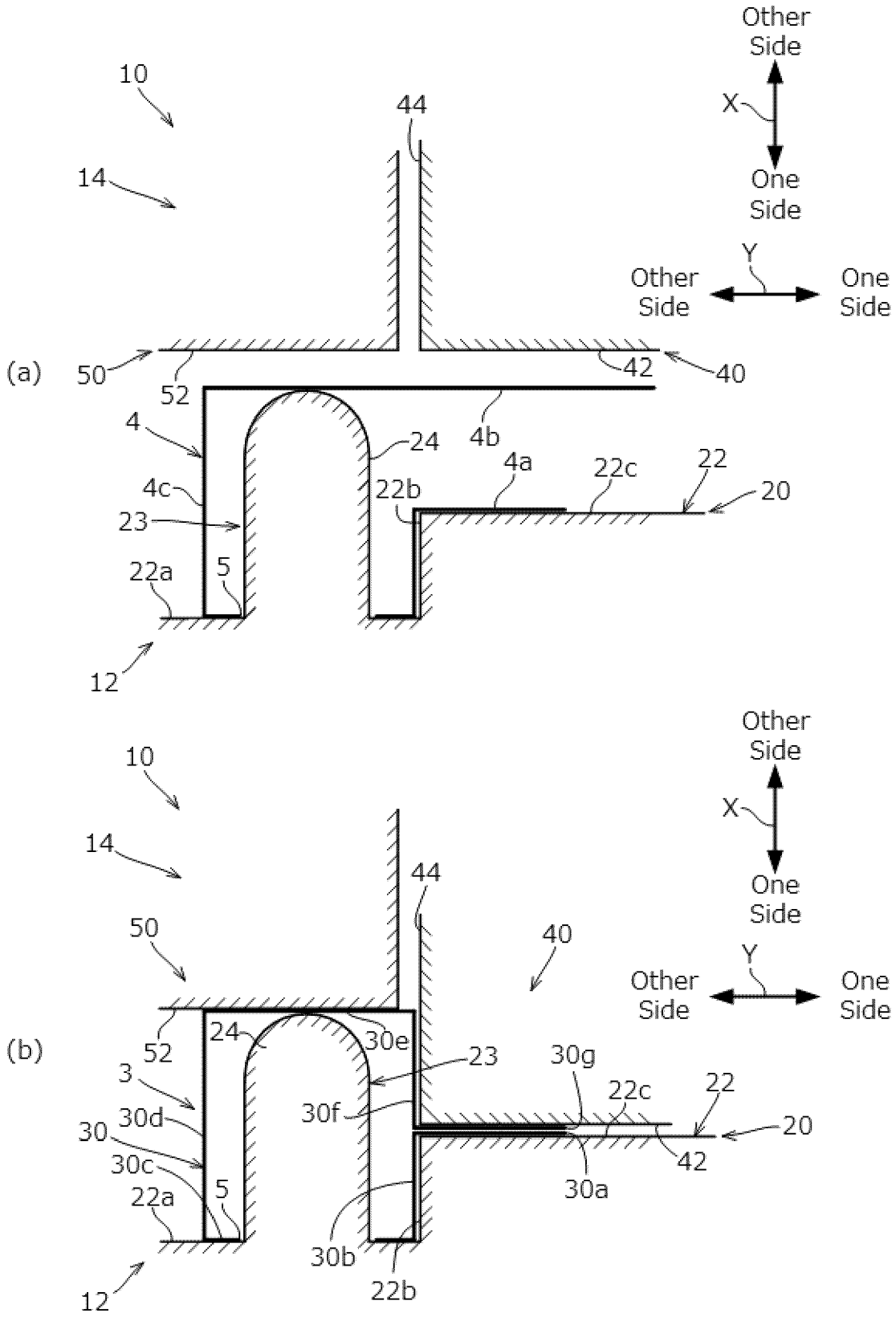
[Fig.11]



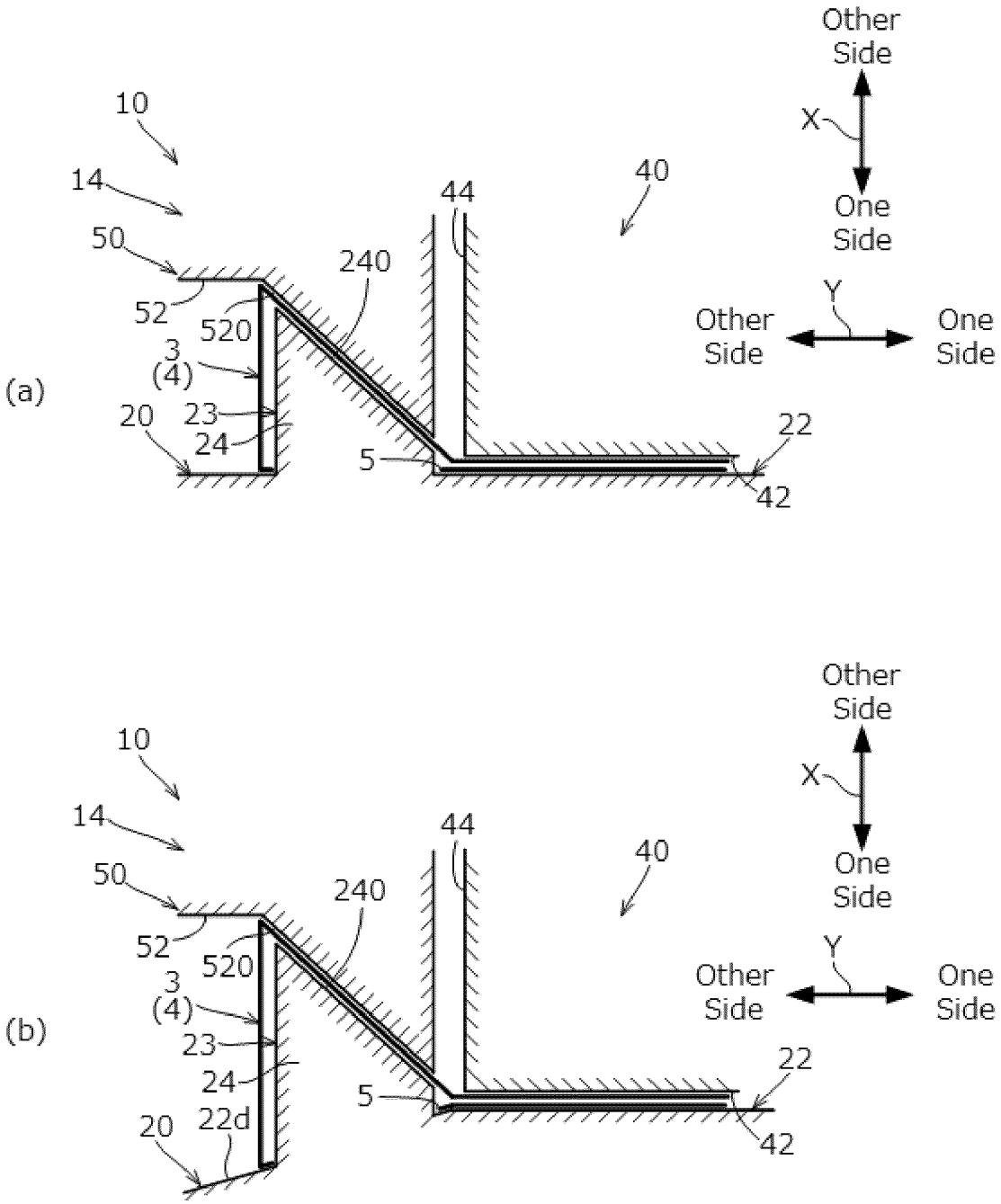
[Fig.12]


(a)
10
14
50
52
44
42
40
4
4b
4c
24
23
22
20
4a
12
Other Side
X
One Side
Y
Other Side
One Side
(b)
10
44
14
50
42
40
52
4
4b
24
4c
23
22
20
4a
12
Other Side
X
One Side
Other Side
Y
One Side
(c)
10
14
50
40
52
4
4b
42
24
4c
23
22
20
4a
12
Other Side
X
One Side
Other Side
Y
One Side
(d)
10
50
23
4b
14
52
40
4
(3)
24
4c
22
20
4a
42
12
Other Side
X
One Side
Other Side
Y
One Side

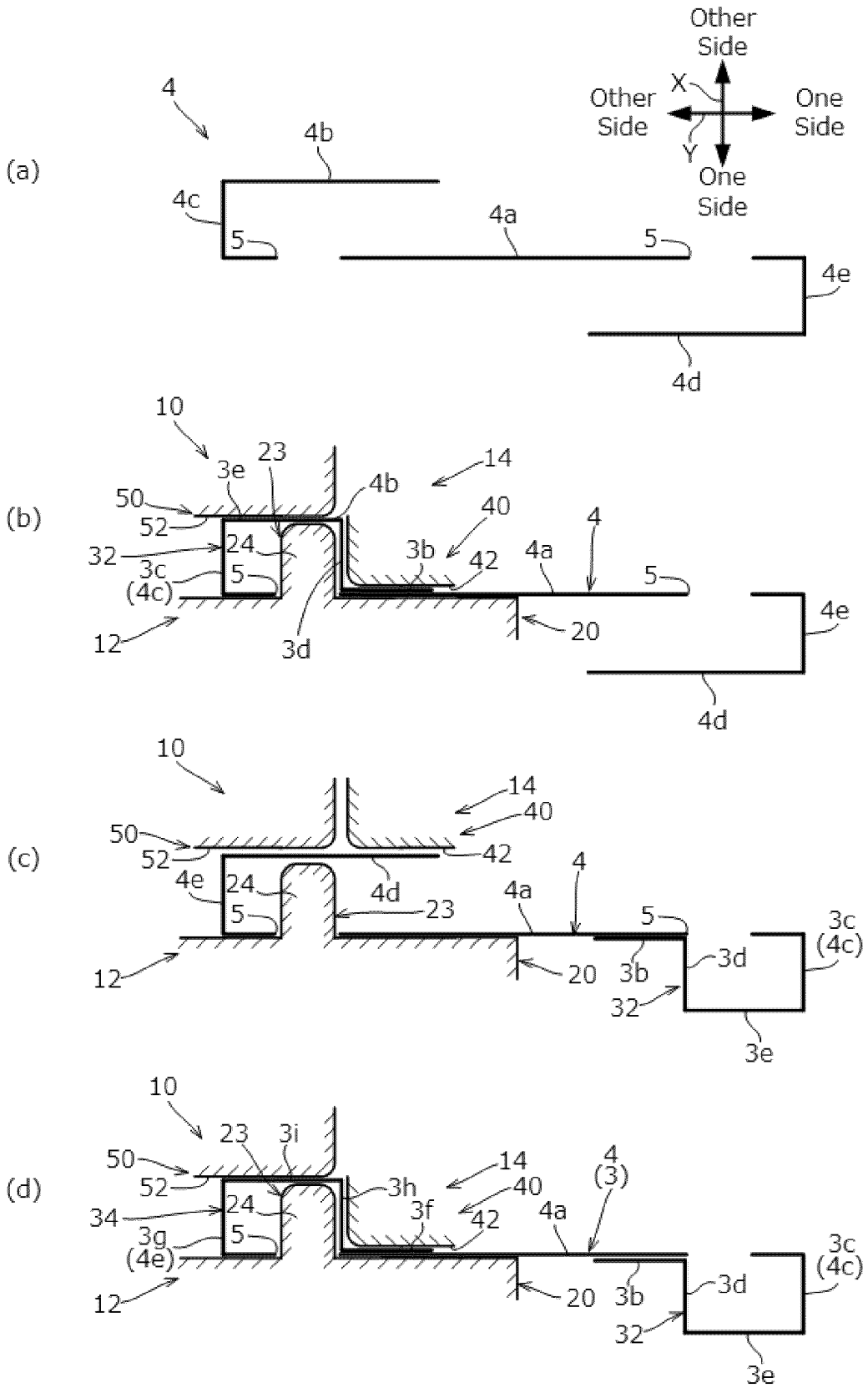
[Fig.13]


(a)
10
14
44
Other Side
X
One Side
Y
Other Side
One Side
50
52
42
40
4
24
4b
4a
22c
22
4c
22b
20
23
22a
5
12
(b)
10
14
44
Other Side
X
One Side
50
40
Y
Other Side
One Side
52
24
30e
23
30g
22c
22
3
30d
30f
20
30
30c
42
5
22a
30a
30b
22b
12

[Fig.14]

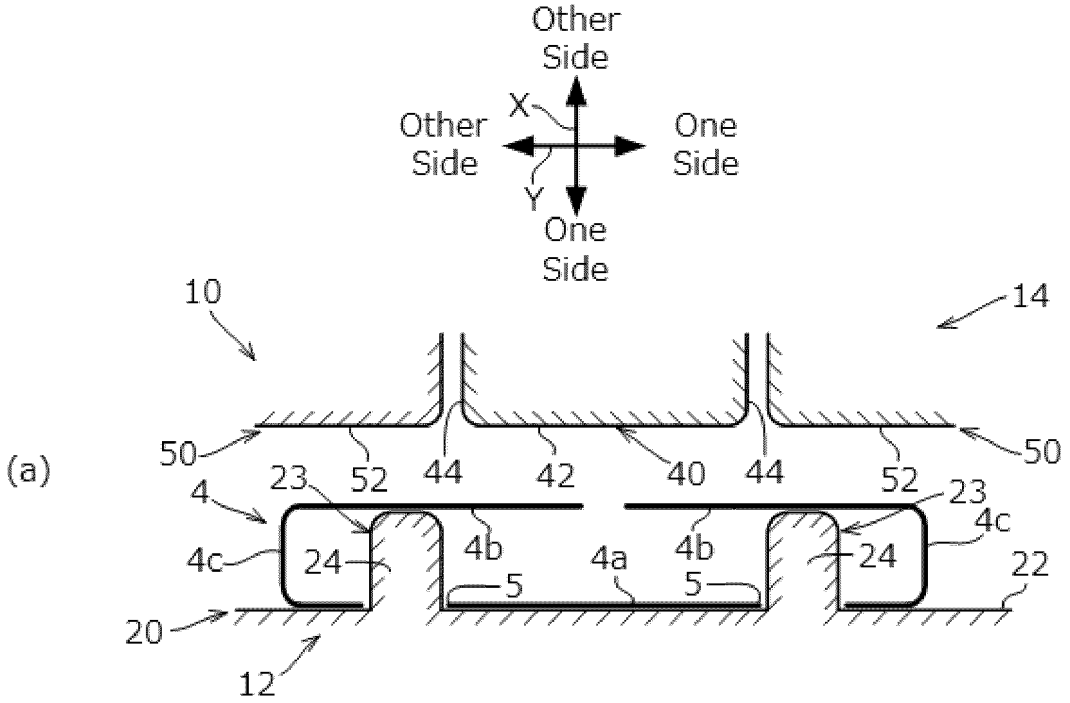

(a)
10
14
50
52
520
240
3
(4)
20
23
24
5
44
40
22
42
Other Side
X
One Side
Y
Other Side
One Side
(b)
10
14
50
52
520
240
3
(4)
23
24
20
22d
5
44
40
22
42
Other Side
X
One Side
Y
Other Side
One Side

[Fig.15]

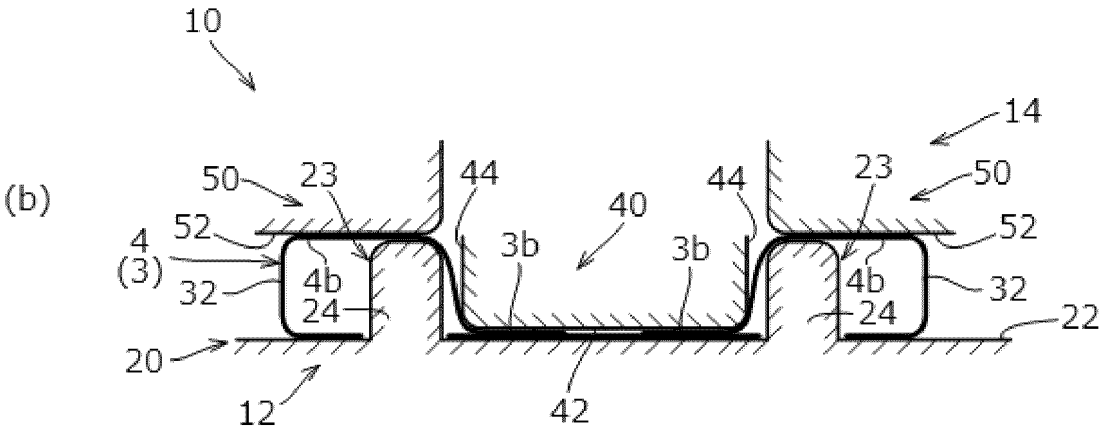

(a)
Other Side
X
Other Side
One Side
Y
One Side
4
4b
4c
5
4a
5
4e
4d
(b)
10
3e
23
14
4b
50
52
40
4
32
24
3b
42
4a
3c
5
5
(4c)
4e
12
3d
20
4d
(c)
10
14
40
50
52
42
4e
24
4d
4
4a
5
3c
(4c)
5
23
12
20
3b
3d
32
3e
(d)
10
23
3i
50
14
4
(3)
52
3h
40
24
3f
42
4a
34
3g
5
3c
(4c)
(4e)
12
20
3b
3d
32
3e

[Fig.16]

(a)

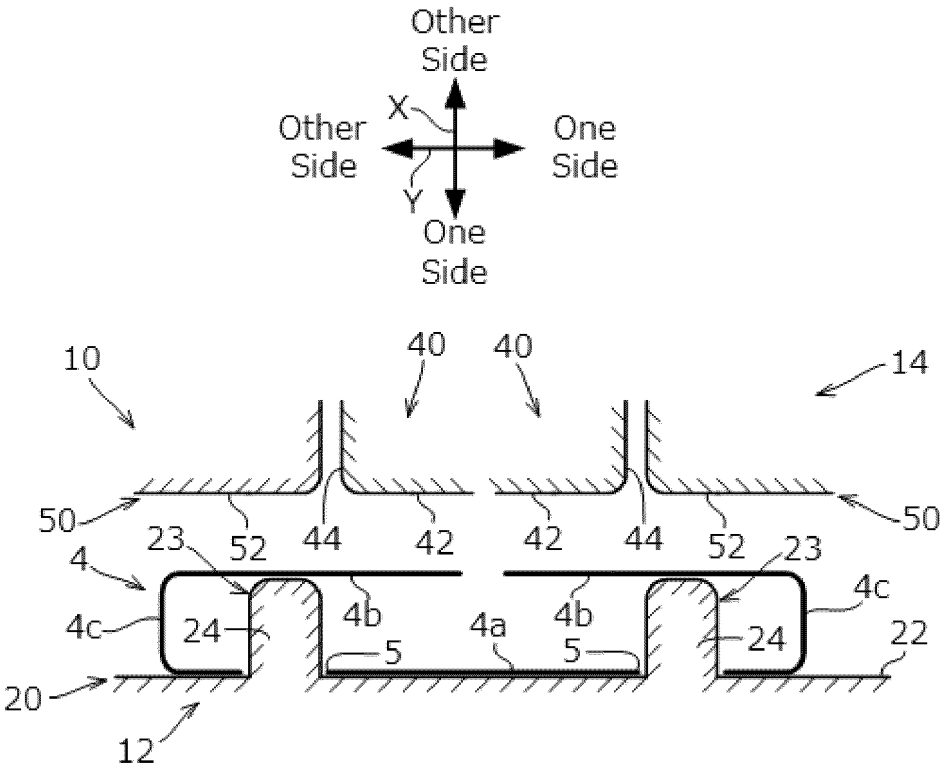

Other Side
X
Other Side
One Side
Y
One Side
10
14
50
52
44
42
40
44
52
50
23
4
4c
24
4b
5
4a
4b
5
24
23
4c
22
20
12

(b)

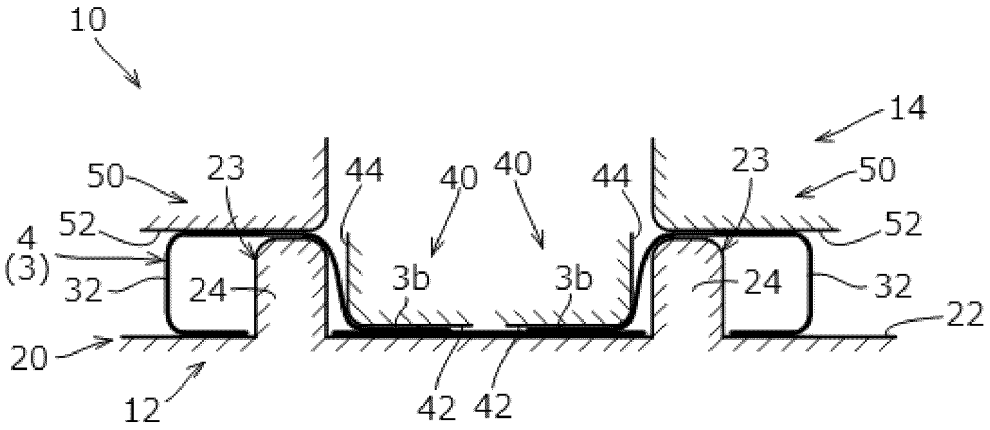

10
14
50
23
44
40
44
23
50
52
4
(3)
32
4b
24
3b
3b
4b
24
52
32
22
20
12
42

[Fig.17]

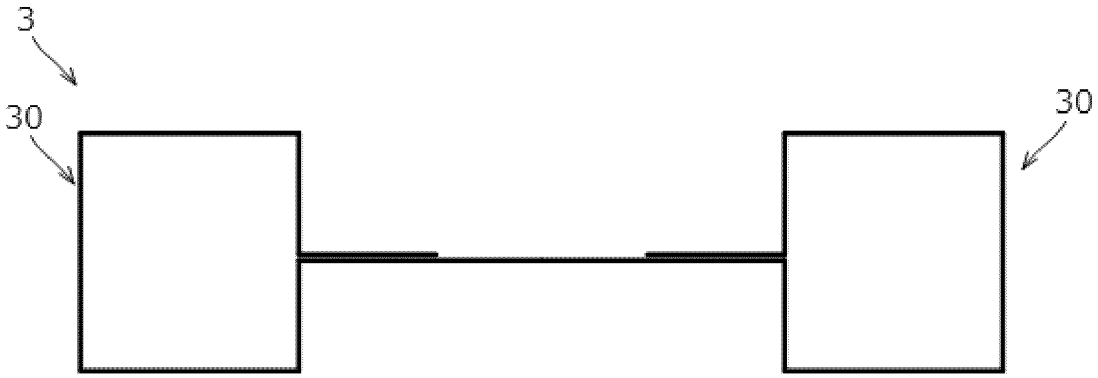
(a)


Other Side
X
Other Side
One Side
Y
One Side
10
40
40
14
50
50
23
52
44
42
42
44
52
23
4
4c
24
4b
5
4a
4b
5
24
4c
22
20
12

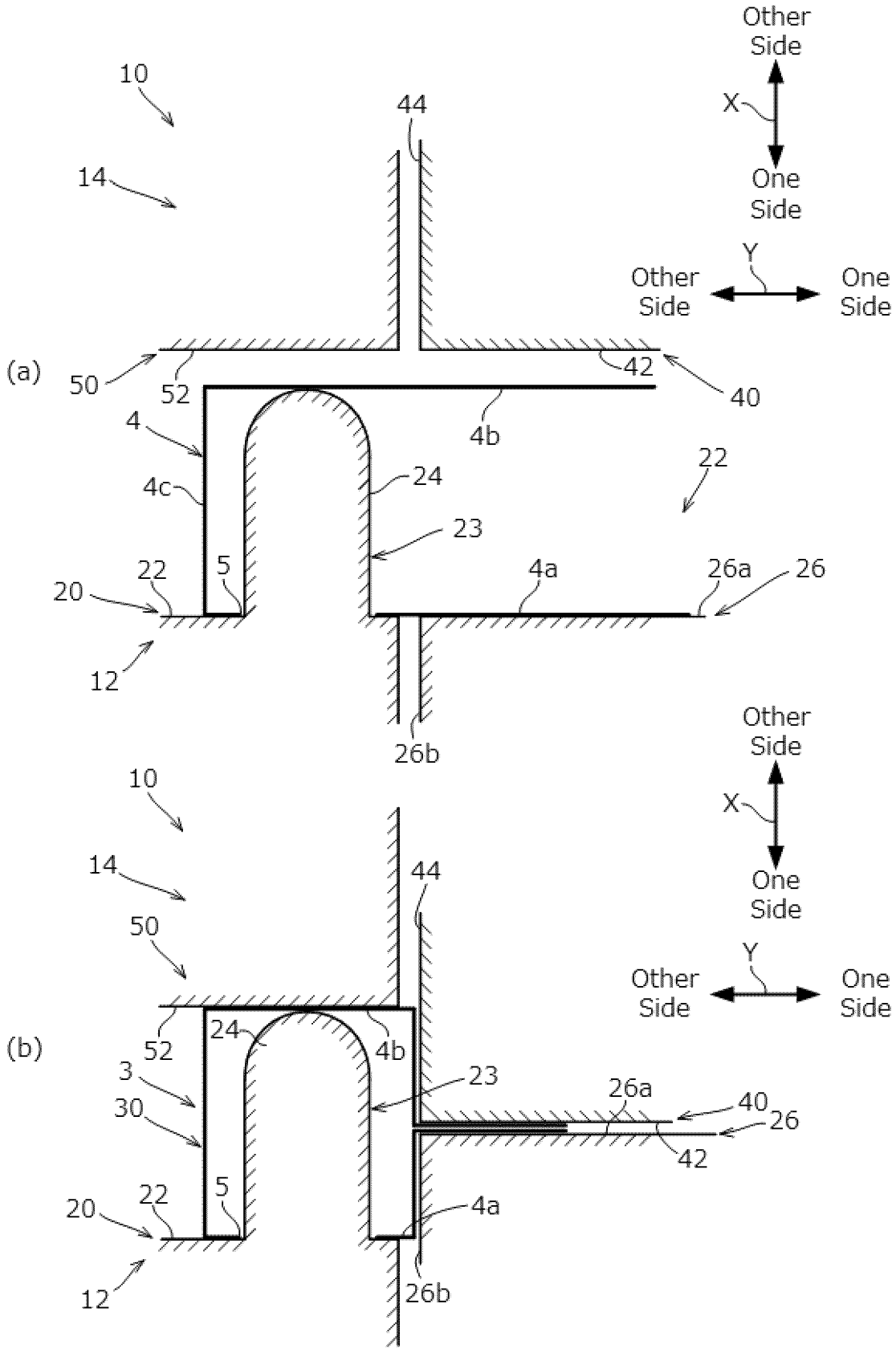
(b)


10
14
50
23
44
40
40
44
23
50
52
52
4
(3)
32
24
3b
3b
24
32
22
20
12
42
42

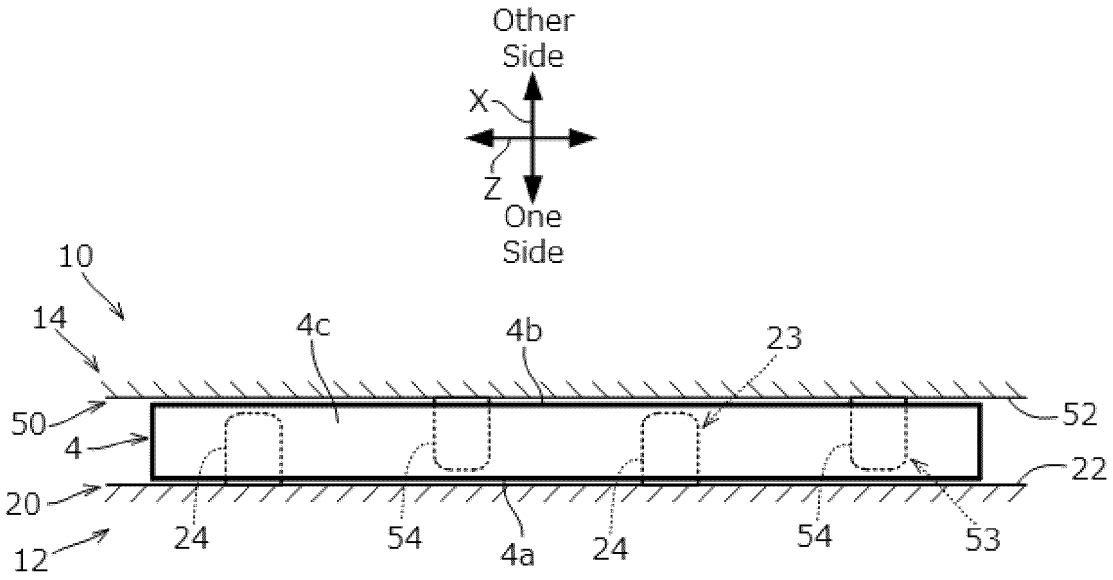
[Fig.18]



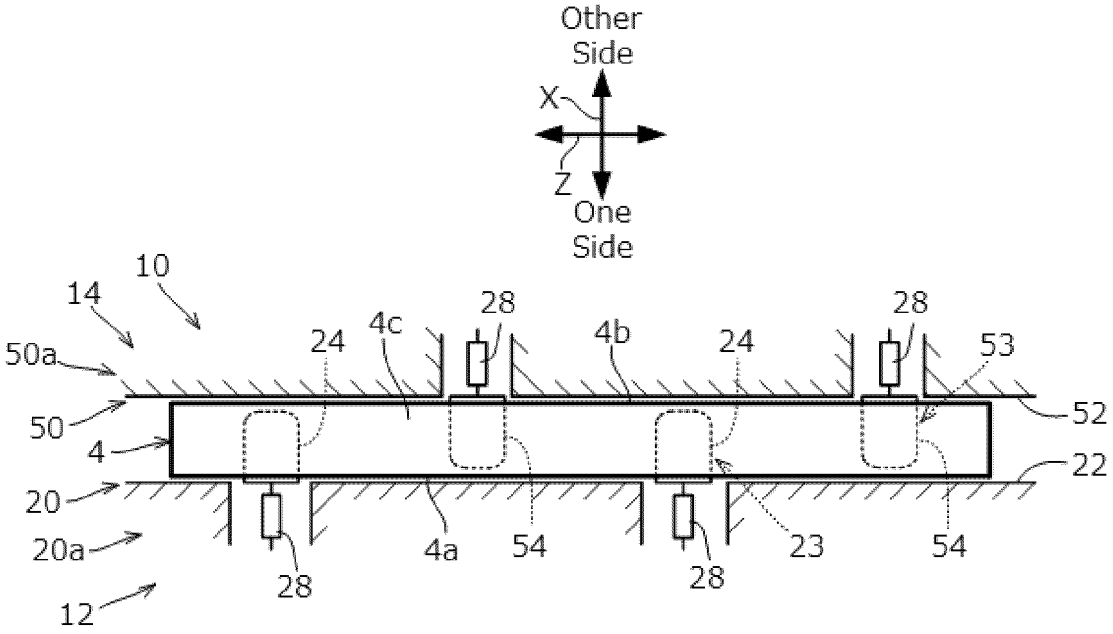
[Fig.19]


(a)
10
14
44
Other Side
X
One Side
Y
Other Side
One Side
50
52
42
40
4
4b
22
4c
24
23
5
22
20
4a
26a
26
12
26b
(b)
10
14
50
44
Other Side
X
One Side
Y
Other Side
One Side
52
24
4b
3
30
23
26a
40
26
42
5
22
20
4a
12
26b

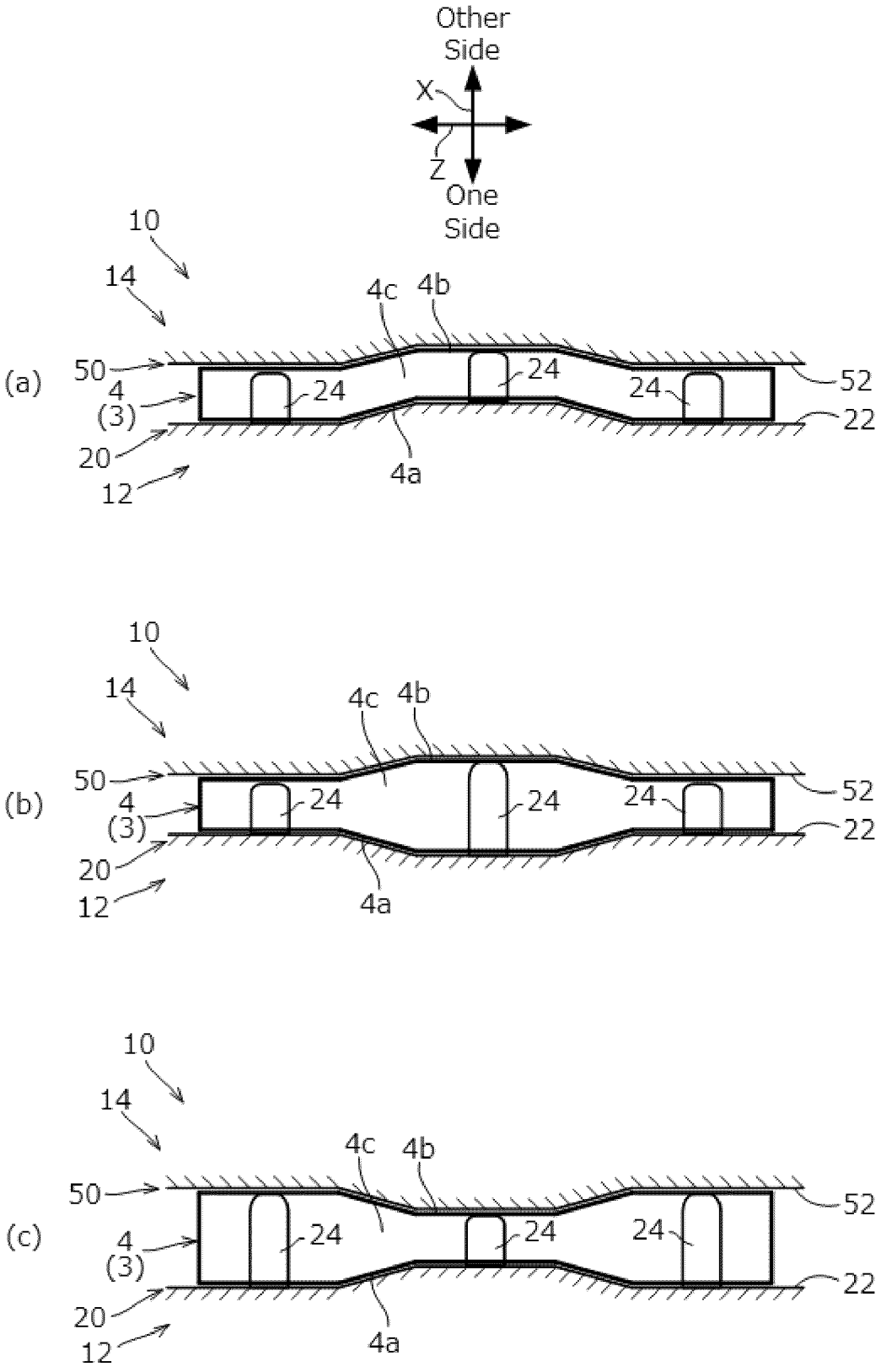
[Fig.20]


Other Side
X
Z
One Side
10
14
4c
4b
23
50
4
52
22
20
12
24
54
4a
24
54
53

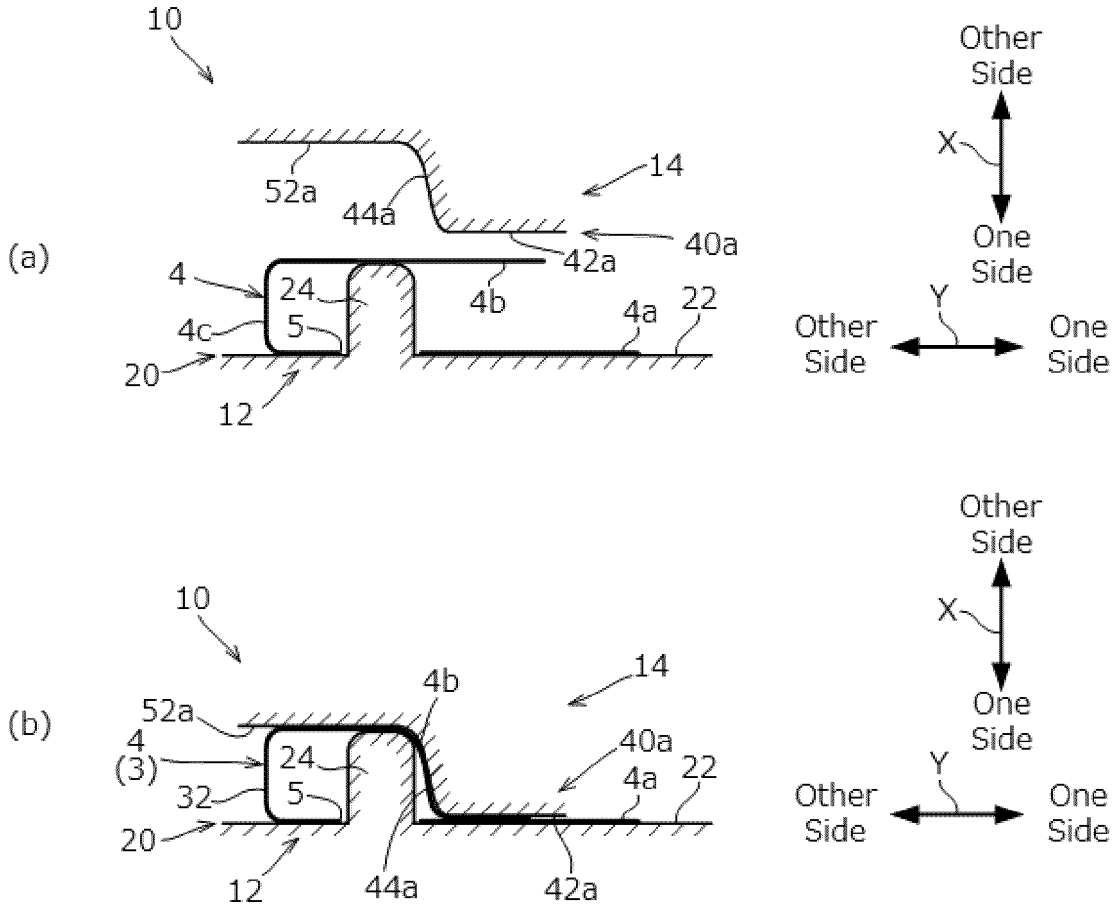
[Fig.21]


Other Side
X
Z
One Side
10
14
50a
50
4
20
20a
12
24
4c
28
4b
24
28
53
52
22
4a
54
28
23
54

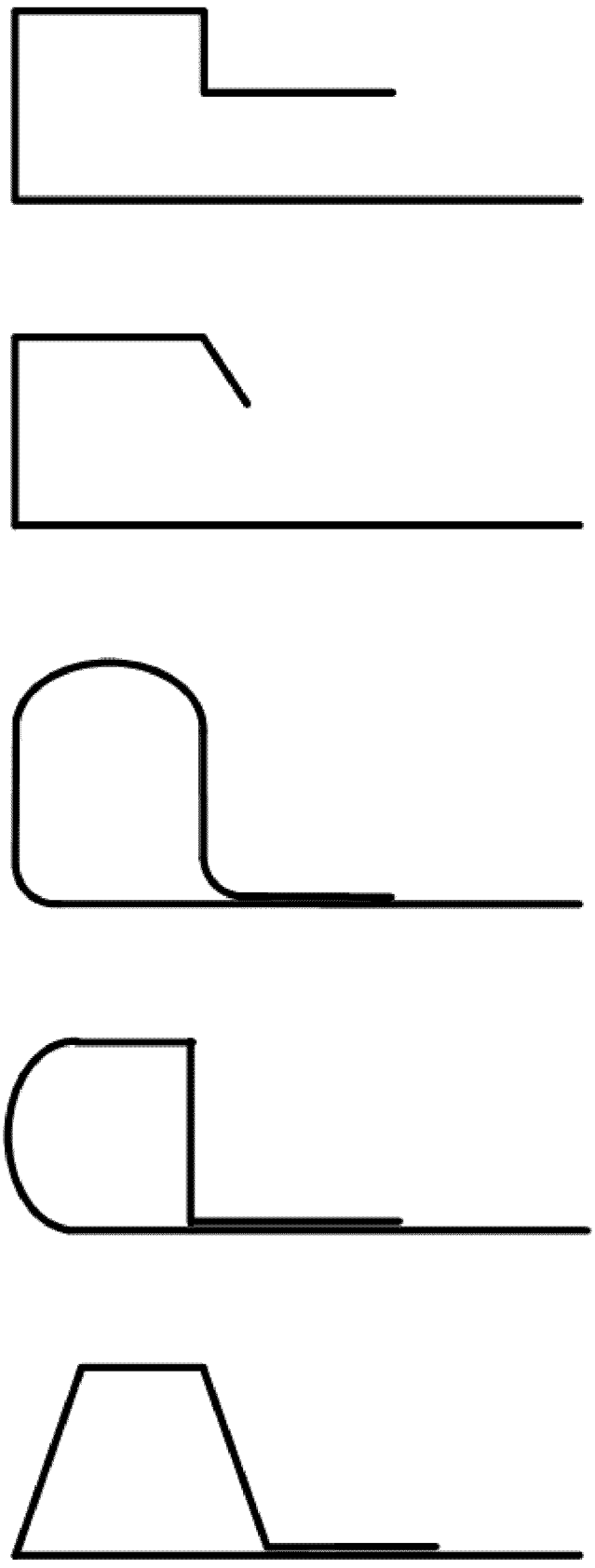
[Fig.22]



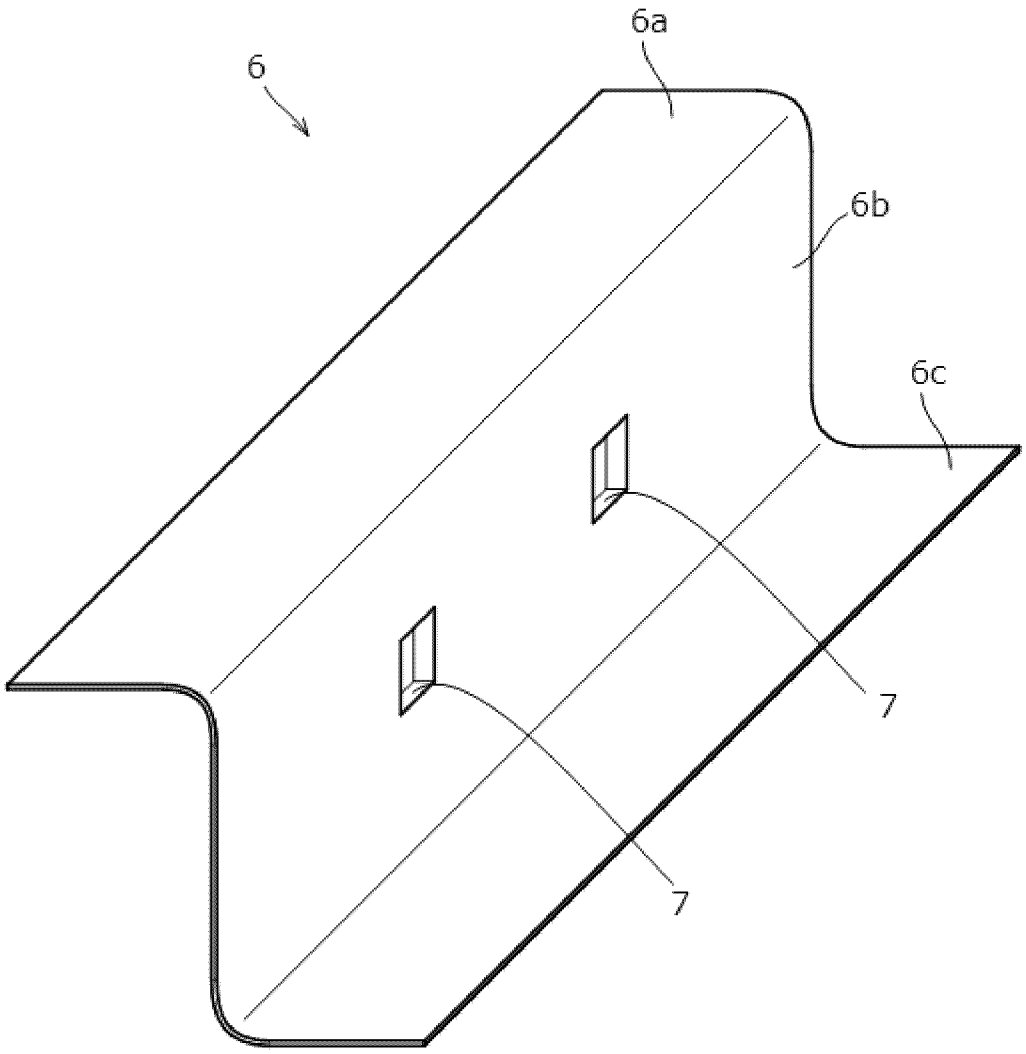
[Fig.23]


(a)
10
52a
44a
14
40a
42a
4
24
4b
4a
22
4c
5
20
12
Other Side
X
One Side
Y
Other Side
One Side
(b)
10
4b
14
52a
4
(3)
24
40a
4a
22
32
5
20
12
44a
42a
Other Side
X
One Side
Y
Other Side
One Side

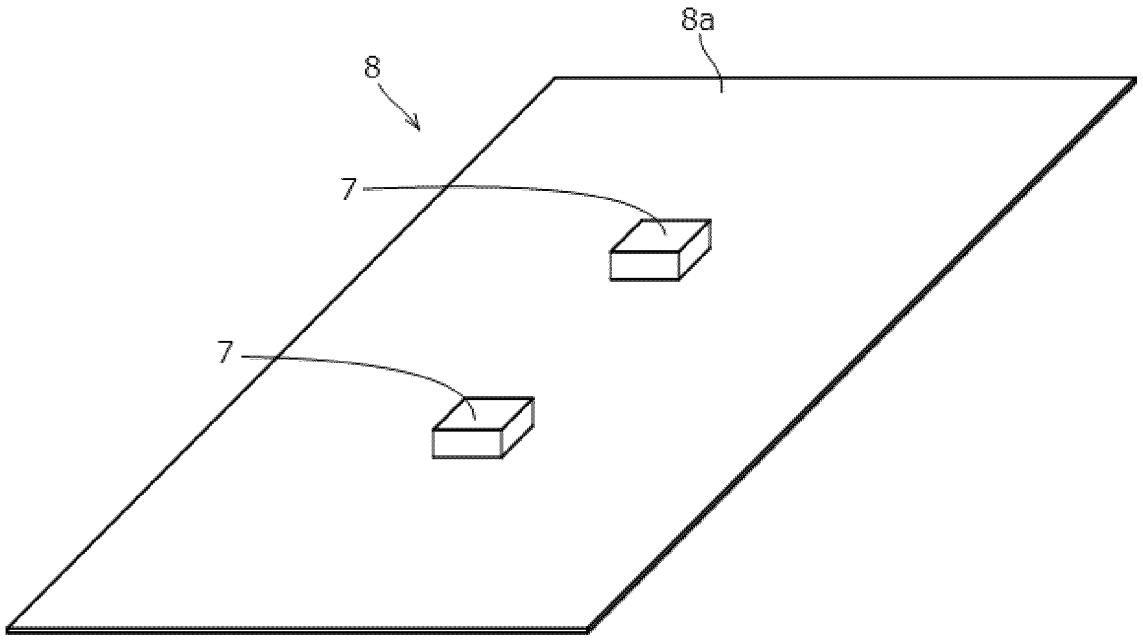
[Fig.24]



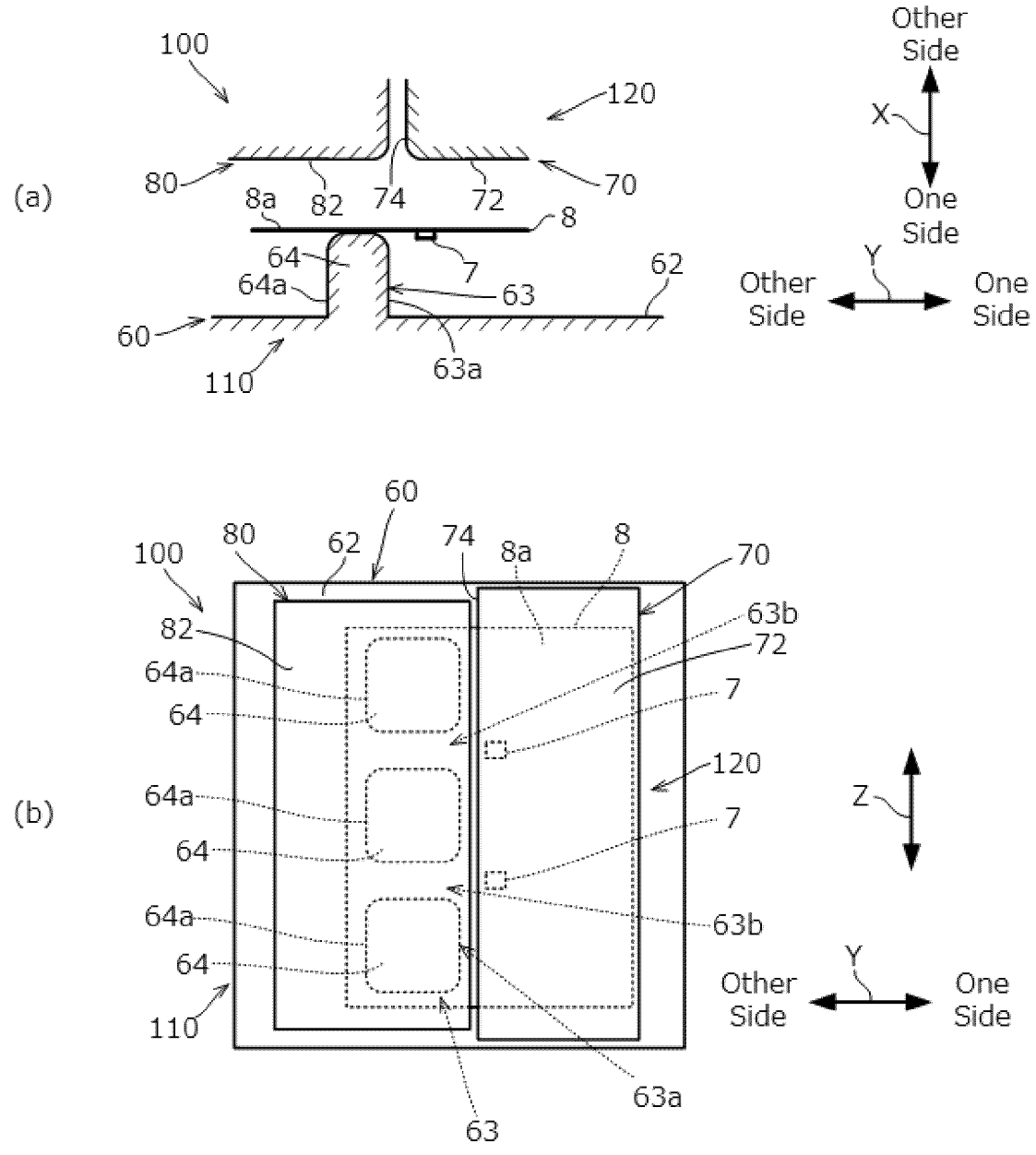
[Fig.25]



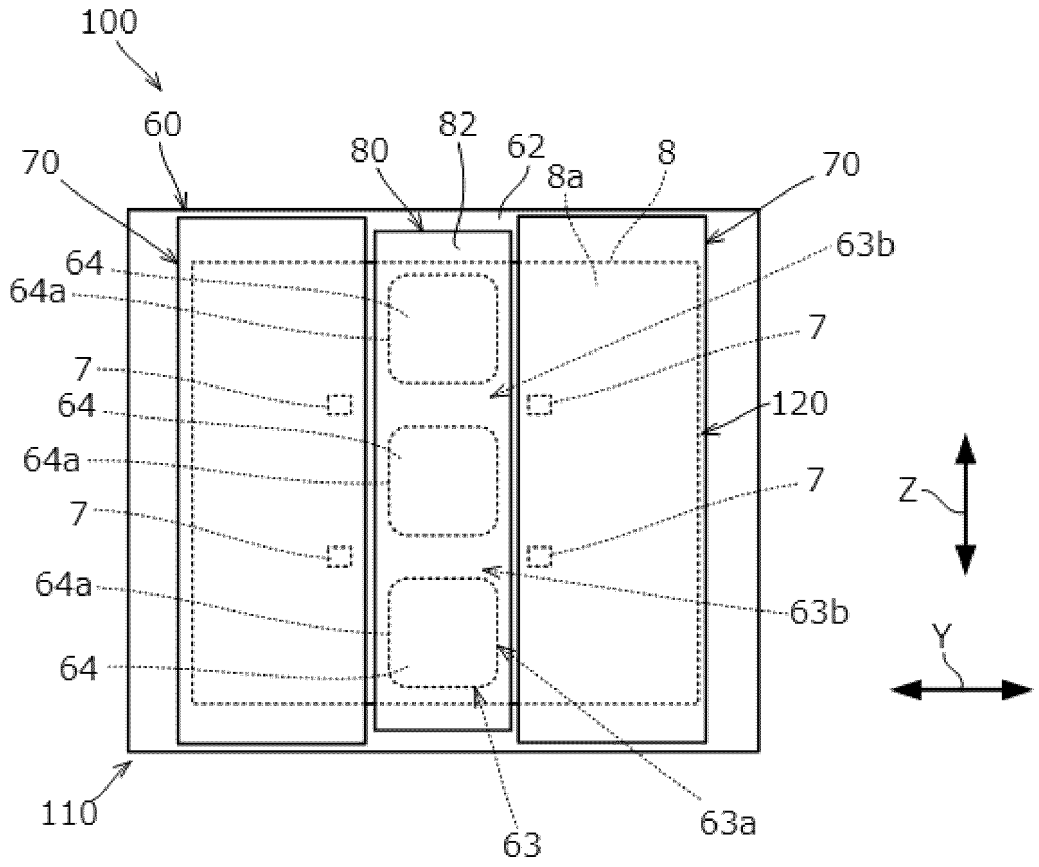
[Fig.26]



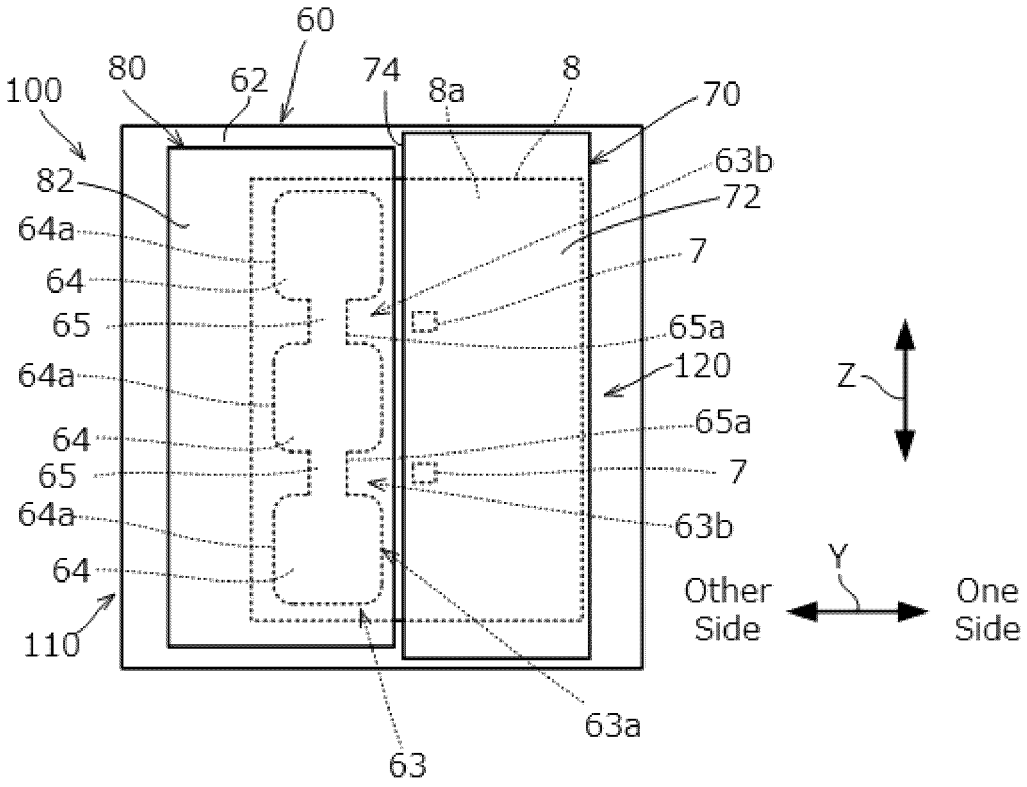
[Fig.27]


(a)
100
120
80
82
74
72
70
8a
8
64
7
64a
63
62
60
110
63a
Other Side
X
One Side
Y
Other Side
One Side
(b)
60
80
62
74
8a
8
70
100
82
63b
72
64a
64
7
120
64a
64
7
64a
63b
64
110
63a
63
Z
Y
Other Side
One Side

[Fig.28]


100
60
70
80
82
62
8a
8
70
63b
64
64a
7
7
64
120
64a
7
7
64a
63b
64
110
63
63a
Z
Y

[Fig.29]


60
80
62
74
8a
8
70
100
82
63b
72
64a
7
64
65
65a
64a
120
Z
64
65a
65
7
64a
63b
Y
64
Other Side
One Side
110
63a
63

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/021045

A. CLASSIFICATION OF SUBJECT MATTER

B21D 24/00(2006.01)i; ***B21D 22/22***(2006.01)i; ***B21D 24/04***(2006.01)i
FI: B21D24/00 H; B21D24/00 F; B21D22/22; B21D24/04 Z

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)

B21D24/00; B21D22/22; B21D24/04

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2016/0354824 A1 (THYSEEN KRUPP STEEL EUROPE AG) 08 December 2016 (2016-12-08)	1-9
A	JP 2021-53651 A (KOBE STEEL LTD) 08 April 2021 (2021-04-08)	1-9
A	JP 6849160 B1 (NIPPON STEEL CORPORATION) 24 March 2021 (2021-03-24)	1-9
A	JP 5470812 B2 (NISSAN MOTOR CO LTD) 16 April 2014 (2014-04-16)	1-9
A	WO 2014/97421 A1 (NIPPON STEEL & SUMITOMO METAL CORPORATION) 26 June 2014 (2014-06-26)	1-9

☐ 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	Date of mailing of the international search report
03 July 2023	**01 August 2023**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/021045

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
US 2016/0354824 A1	08 December 2016	DE 102015108768 A1	
JP 2021-53651 A	08 April 2021	(Family: none)	
JP 6849160 B1	24 March 2021	US 2022/0250132 A1	
		EP 3995223 A1	
		CN 114025894 A	
		KR 10-2022-0018576 A	
JP 5470812 B2	16 April 2014	(Family: none)	
WO 2014/97421 A1	26 June 2014	US 2015/0298197 A1	
		EP 2878392 A1	
		CA 2879808 A1	
		CN 104470651 A	
		KR 10-2015-0018638 A	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2008120227 A **[0005]**