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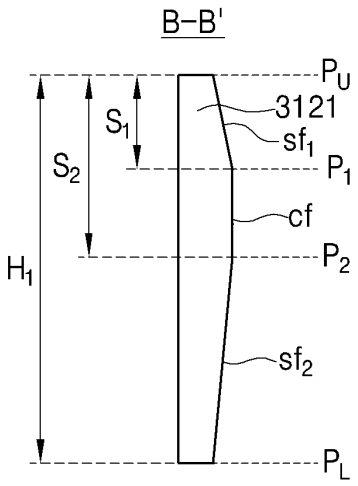
(54) **MOLD**

(57) In accordance with an exemplary embodiment, a mold having an inner space to which molten steel is injected includes a body having the inner space, and an inner surface of the body, which heads toward the inner space, includes a first inclined surface that is inclined to be gradually away from an outer surface opposite to the inner surface in a downward direction and a second inclined surface that is disposed below the first inclined surface and inclined to be gradually close to the outer surface in the downward direction.

In accordance with exemplary embodiments, a compensation rate for shrinkage of a solidified shell is improved. That is, a compensation rate for shrinkage in a long side direction and a short side direction of the solidified shell is improved by a convex member and the inclined surface disposed on the inner surface of the body. Particularly, a compensation rate for shrinkage of the solidified shell at an upper portion of the inner space of the mold is improved. Thus, a gap occurring between the solidified shell and the inner surface of the mold caused by the shrinkage of the solidified shell may be suppressed or prevented, and a solidification delay phenomenon caused by the gap may be suppressed or prevented. Therefore, occurrence of break out and a defect on a surface of a slab may be suppressed or prevented.

FIG. 5



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a mold, and more particularly, to a mold capable of suppressing or preventing a defect of a slab and damage of the mold from occurring.

BACKGROUND ART

[0002] A slab is manufactured by injecting molten steel into a mold having a predetermined inner shape and solidifying the molten steel in the mold. Here, a rectangular mold manufactured by assembling a long side part and a short side part is generally used.

[0003] When the molten steel is supplied into the mold, a solidification shell is formed from a surface of the molten steel in the mold, and a thickness of the solidification shell gradually increases in a downward direction. Also, when the solidified shell is formed as the molten steel is solidified in the mold, solidification shrinkage occurs in the solidified shell. In particular, when the molten steel in a liquid phase is converted into a solid phase at an upper portion of the mold, large shrinkage of the solidified shell occurs. When the shrinkage of the solidified shell is not compensated by the mold, an air layer or a gap is generated between the mold and the solidified shell. When the gap is generated, a heat transfer performance between the mold and the solidified shell or the molten steel is reduced to generate a solidification delay phenomenon, thereby generating break out and damage in the slab.

[0004] In order to solve the above-described problems, the mold was inclined so that a width thereof gradually decreases in the downward direction. That is, the shrinkage of the solidified shell in a long side direction of the mold is compensated by installing a pair of short side parts such that a spaced distance therebetween gradually decreases in the downward direction, and the shrinkage of the solidified shell in a short side direction of the mold is compensated by installing a pair of long side parts such that a spaced distance therebetween gradually decreases in the downward direction. However, even in this case, since the shrinkage of the solidified shell may not be sufficiently compensated, the gap is still generated between the mold and the solidified shell.

[0005] Also, in order to sufficiently compensate the solidification shrinkage at the upper portion in the mold, an installation inclination of the short side part of the mold further increases. In this case, however, since wear between the short side part of the mold and a short side of the slab occurs at a lower portion in the mold, a lifespan of the mold is reduced, and quality of the slab is reduced.

[0006] (Related art document)(Patent document 1) Korean Patent Publication No. KR 10-2000-0008003

DISCLOSURE OF THE INVENTION

TECHNICAL PROBLEM

[0007] The present disclosure provides a mold capable of compensating shrinkage of a solidified shell.

[0008] The present disclosure also provides a mold capable of improving a compensation rate for shrinkage of a solidified shell.

[0009] The present disclosure also provides a mold capable of suppressing or preventing an inner wall of a mold from being worn by a slab.

TECHNICAL SOLUTION

[0010] In accordance with an exemplary embodiment, a mold having an inner space to which molten steel is injected includes a body having the inner space, and an inner surface of the body, which heads toward the inner space, includes a first inclined surface that is inclined to be gradually away from an outer surface opposite to the inner surface in a downward direction and a second inclined surface that is disposed below the first inclined surface and inclined to be gradually close to the outer surface in the downward direction.

[0011] The first inclined surface may extend until a first point P_1 spaced by a first distance S_1 from an upper end Pu of the inner surface of the body, the second inclined surface may extend until a lower end P_L of the inner surface of the body from a second point P_2 disposed below the first point P_1 and spaced by a second distance S_2 from the upper end Pu of the inner surface of the body, and each of the first distance S_1 and the second distance S_2 may be less than a height Hi of the body.

[0012] The first distance S_1 may be approximately 15% or more and approximately 25% or less of the height Hi of the body.

[0013] The first inclined surface may have an inclination that is changed based on a first inflection point IP_1 between the upper end Pu of the inner surface of the body and the first point P_1, and in the first inclined surface, an angle between the outer surface and a lower area of the first inflection point IP_1 may be less than that between the outer surface and an upper area of the first inflection point IP_1.

[0014] The first inflection point IP_1 may be provided in plurality, and a plurality of first inflection points IP_1 may be disposed at different positions between the upper end Pu of the inner surface of the body and the first point P_1.

[0015] The second distance S_2 may be approximately 40% or more and approximately 50% or less of the height Hi of the body.

[0016] The second inclined surface may have an inclination that is changed based on a second inflection point IP_2 between the second point P_2 and the lower end P_L of the inner surface of the body, and in the second inclined surface, an angle between the outer surface and a lower area of the second inflection point IP_2 may be greater

than that between the outer surface and an upper area of the second inflection point IP_2.

[0017] The second inflection point IP_2 may be provided in plurality, and a plurality of second inflection points IP_2 may be disposed at different positions between the second point P_2 and the lower end P_L of the inner surface of the body.

[0018] An intermediate surface spaced by the same distance from the outer surface in a vertical direction may be disposed between the first inclined surface and the second inclined surface.

[0019] The body may include: a pair of long side members each extending in one direction and facing each other in a direction crossing an extension direction thereof; and a pair of short side members each extending to cross the long side member and facing each other to seal a portion between the pair of long side members, and the first and second inclined surfaces may be disposed on the inner surface of at least one of the long side member and the short side member.

[0020] The pair of short side members may be inclined so that a spaced distance therebetween gradually decreases in the downward direction, and a side surface of the short side member, which contacts the long side member, may be gradually inclined toward a center of a width direction of the short side member in the downward direction.

[0021] The body may include a protruding member formed on each of both ends of an extension direction of the short side member to protrude toward the inner space, thereby forming a chamfered surface at an edge of a slab to be cast.

[0022] The mold may further include a convex member that protrudes from the inner surface of at least one of the long side member and the short side member and has a protruding length from the inner surface to the inner space, which gradually decreases in the downward direction.

[0023] A height of the convex member may be less than that of the body.

[0024] The convex member may extend until a third point P_3 spaced by a third distance S_3 from the upper end Pu of the inner surface of the body, and the third distance S_3 may be greater than the first distance S_1 and less than the second distance S_2.

[0025] The convex member may have an inclination by which the protruding length gradually decreases in the downward direction, and the inclination may be changed based on a third inflection point IP_3 between the upper end Pu of the body and the third point P_3. In the convex member, an angle between the outer surface and a lower area of the third inflection point IP_3 may be greater than that between the outer surface and an upper area of the third inflection point IP_3.

[0026] The third inflection point IP_3 may be provided in plurality, and a plurality of third inflection points IP_3 may be disposed at different positions between the upper end Pu of the inner surface of the body and the third point P_3.

ADVANTAGEOUS EFFECTS

[0027] In accordance with the exemplary embodiments, the compensation rate for the shrinkage of the solidified shell is improved. That is, the compensation rate for the shrinkage in the long side direction and the short side direction of the solidified shell is improved by the convex member and the inclined surface disposed on the inner surface of the body. Particularly, the compensation rate for the shrinkage of the solidified shell at the upper portion of the inner space of the mold is improved. Thus, the gap occurring between the solidified shell and the inner surface of the mold caused by the shrinkage of the solidified shell may be suppressed or prevented, and the solidification delay phenomenon caused by the gap may be suppressed or prevented. Thus, the occurrence of the breakout and the defect on the surface of the slab may be suppressed or prevented.

[0028] Also, the friction between the slab and the inner surface of the mold may be reduced by the inclined surface disposed on the inner surface of the mold, and thus the lifespan of the mold may be extended.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

FIG. 1 is a view illustrating a casting apparatus in accordance with exemplary embodiments.

FIG. 2 is a three-dimensional view illustrating a mold in accordance with an exemplary embodiment, and FIG. 3 is an exploded perspective view illustrating the mold.

FIG. 4 is a front view viewed from 'A' side of FIG. 2 to explain an installation state of a pair of short side parts.

FIG. 5 is a cross-sectional view viewed from the 'A' side, which is obtained by cutting the short side part along line B-B'.

FIG. 6 is a front view in which a short side part of FIG. 2 is viewed from 'C' side.

FIG. 7 is a view illustrating the mold in accordance with an exemplary embodiment to explain a solidified shell (refer to (a) of FIG. 7) formed at an upper portion of the mold and a solidified shell (refer to (b) of FIG. 7) formed at a lower portion of the mold.

(a) of FIG. 8 is a three-dimensional view illustrating the short side part in accordance with an exemplary embodiment.

(b) of FIG. 8 is a front view when (a) of FIG. 8 is viewed from 'D' side.

(c) of FIG. 8 is a cross-sectional view when (a) of FIG. 8 is cut along line E-E' and viewed from 'F' side.

(d) of FIG. 8 is a top view of each position ⓐ,

ⓑ, and ⓒ in a vertical direction (Z-axis direction) of (c) of FIG. 8.

FIG. 9 is a view for explaining an extension length of an inner surface of the short side part in accordance with an exemplary embodiment.

FIGS. 10 and 11 are views illustrating the short side part of the mold in accordance with first and second modified examples of an exemplary embodiment.

FIG. 12 is a view illustrating a short side part of a mold in accordance with a third modified example of an exemplary embodiment.

FIGS. 13 to 15 are views illustrating a short side part of a mold in accordance with fourth to sixth modified examples of an exemplary embodiment.

FIG. 16 is a three-dimensional view illustrating the mold in accordance with another exemplary embodiment, and FIG. 17 is an exploded perspective view of the mold.

FIG. 18 is a three-dimensional view illustrating the mold in accordance with yet another exemplary embodiment.

FIG. 19 is a three-dimensional view illustrating a short side part of the mold in accordance with yet another exemplary embodiment.

MODE FOR CARRYING OUT THE INVENTION

[0030] Hereinafter, exemplary embodiments will be described in more detail with reference to the accompanying drawings. The present invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the present invention to those skilled in the art. In the figures, the dimensions of layers and regions are exaggerated for clarity of illustration. Like reference numerals refer to like elements throughout.

[0031] FIG. 1 is a view illustrating a casting apparatus in accordance with exemplary embodiments.

[0032] Referring to FIG. 1, a casting apparatus includes a tundish 20 that receives molten steel from a ladle 10 and stores the molten steel, a mold 3000 that receives the molten steel from the tundish 20 and initially solidifies the molten steel into a predetermined shape, and a nozzle(22) that supplies the molten steel of the tundish 20 to the mold 3000.

[0033] Also, the casting apparatus includes a cooling unit 40 disposed below the mold 3000 and spraying cooling water to an unsolidified slab 1 drawn from the mold 3000 to completely solidify the slab1. Here, the cooling unit 40 includes a plurality of segments 41. Also, each of the plurality of segments 41 may include a plurality of rolls that are rotatable by movement force of the slab 1 and nozzles disposed between the plurality of rolls to spray cooling water to the slab 1.

[0034] Hereinafter, a mold in accordance with an exemplary embodiment will be described with reference to FIGS. 2 to 7.

[0035] FIG. 2 is a three-dimensional view illustrating the mold in accordance with an exemplary embodiment, and FIG. 3 is an exploded perspective view illustrating the mold. FIG. 4 is a front view viewed from 'A' side of FIG. 2 to explain an installation state of a pair of short side parts. FIG. 5 is a cross-sectional view viewed from the 'A' side, which is obtained by cutting the short side part along line B-B'. FIG. 6 is a front view in which the short side part of FIG. 2 is viewed from 'C' side. FIG. 7 is a view illustrating the mold in accordance with an exemplary embodiment to explain a solidified shell (refer to (a) of FIG. 7) formed at an upper portion of the mold and a solidified shell (refer to (b) of FIG. 7) formed at a lower portion of the mold.

[0036] Here, FIG. 5 illustrates a state in which the short side part stands perpendicularly to the ground for a detailed description on an inner surface of the short side part.

[0037] Referring to FIGS. 2 and 3, the mold 3000 includes a body 3100 having an inner space IS and having an inner surface if including a first inclined surface sf_1 that is gradually inclined to be away from an outer surface of in an downward direction and a second inclined surface sf_2 that is disposed below the first inclined surface sf_1 and gradually inclined to be close to the outer surface of in an downward direction.

[0038] Also, the mold 3000 includes a convex member 3122 protruding from the inner surface if of the body 3100 to the inner space IS and has a protruding length P_L (refer to FIG. 5) from the inner surface if of the body 3100 to the inner space IS, which gradually decreases in the downward direction.

[0039] As illustrated in FIGS. 2 and 3, the body 3100 includes a pair of long side members 3111 (hereinafter, referred to as first and second long side members 3111) each extending in one direction (X-axis direction) and spaced apart from each other in a direction (Y-axis direction) crossing the extension direction and a pair of short side members 3121 (hereinafter, referred to as first and second short side members 3121) each extending in a direction (Y-axis direction) crossing or perpendicular to the extension direction (X-axis direction) of the long side member 3111 and spaced apart from each other in the extension direction of the long side member 3111.

[0040] The convex member 3122 is disposed on the inner surface if of the body 3100. As illustrated in FIGS. 2 and 3, the convex member 3122 may be disposed on an inner surface of the short side member 3121. Hereinafter, a configuration including the short side member 3121 and the convex member 3122 disposed on the short side member 3121 is defined as a short side part 3120. In this case, the mold 3000 may include the first and second long side members 3111 and the first and second short side members 3120 including the convex member 3122.

[0041] As the first and second long side members 3111

and the first and second short side members 3121, which are described above, are connected or coupled to each other, the body 3100 having the inner space IS is provided. For example, based on the Y-axis direction, one end of each of the first and second short side members 3121 is connected to an inner surface of the first long side member 3111, and the other end is connected to an inner surface of the second long side member 3111. Also, the first short side member 3121 and the second short side member 3121 are spaced apart from each other in the X-axis direction. Here, a spaced distance between the first short side member 3121 and the second short side member 3121 is greater than that between the first long side member 3111 and the second long side member 3111. Thus, the body 3100 having the inner space IS having a rectangular shape is provided. More specifically, the body 3100 having the inner space IS having the rectangular shape in which a length in the X-axis direction is greater than a length in the Y-axis direction is provided.

[0042] Hereinafter, the extension direction of each of the long side member 3111 and the short side member 3121 is defined as a width direction. Accordingly, a length in the extension direction of each of the long side member 3111 and the short side member 3121 may be defined as a 'width'. Thus, a width of the long side member 3111 is a length in the X-axis direction, and a width of the short side member 3121 is a length in the Y-axis direction. Also, in a horizontal direction of each of the long side member 3111 and the short side member 3121, a length in a direction crossing the width direction is defined as a 'thickness'. Thus, a thickness of the long side member 3111 is a length in the Y-axis direction, and a thickness of the short side member 3121 is a length in the X-axis direction.

[0043] As illustrated in FIGS. 2 and 4, when the first short side member 3121 and the second short side member 3121 are installed to face each other, the first and second short side members 3121 are inclined so that a spaced distance SL therebetween gradually decreases in the downward direction. More specifically, the first and second short side members 3121 are installed to be inclined so that the spaced distance SL between at least second inclined surfaces sf_2 among the inner surfaces if of the first and second short side members 3121 gradually decreases in the downward direction. Accordingly, a length in a long side direction of the inner space IS of the mold 3000 gradually decreases in the downward direction. The above-described feature in which the spaced distance SL between the first and second short side members 3121 gradually decreases in the downward direction is provided for compensating shrinkage in a long side direction of a solidified shell C. More specifically, the above-described feature is provided for compensating shrinkage occurring when a solidified shell (hereinafter, referred to as a long side solidified shell LC (refer to FIG. 7)) formed as a molten steel M is solidified along the first and second long side members 3111 is contracted in the extension direction of the first and second long side members 3111.

[0044] Also, as illustrated in FIG. 6, an extension length, i.e., a width SW, of each of the first and second short side members 3121 decreases in the downward direction. In other words, the extension length SW of each of the first and second short side members 3121 in the Y-axis direction that is a short side direction of the mold 3000 gradually decreases in the downward direction. Thus, both side surfaces corresponding to one end and the other end of each of the first and second short side members 3121 are inclined in the Y-axis direction.

[0045] That is, the side surfaces of each of the first and second short side members 3121 are inclined to be gradually close to a center of the width direction in the downward direction. Also, the first and second long side members 3111 are connected to the side surfaces of each of the first and second short side members 3121. Thus, a spaced distance between the first and second long side members 3111 gradually decreases in the downward direction.

[0046] The above-described feature in which the distance between the pair of long side members 3111 contacting the short side member 3121 gradually decreases in the downward direction by forming the side surface of the short side member 3121 to be inclined is provided for compensating shrinkage in a short side direction of the solidified shell C. That is, the above-described feature is provided for compensating shrinkage occurring when a solidified shell (hereinafter, referred to as a short side solidified shell SC (refer to FIG. 7)) formed as the molten steel M is solidified along the first and second long side members 3121 is contracted in the extension direction of the first and second long side members 3121.

[0047] Hereinafter, the inner surface of the body of the mold in accordance with an exemplary embodiment will be described with reference to FIGS. 3 to 6.

[0048] The inner surface of the body 3100 includes the above-described first and second inclined surfaces sf_1 and sf_2. Here, as illustrated in FIGS. 3 to 6, among the long side member 3111 and the short side member 3121 of the body 3100, the inner surface if of the short side member 3121 includes the first and second inclined surfaces sf1 and sf_2. Here, since the first and second short side members 3121 have the same shape, all of the first and second short side members 3121 will be referred to as the short side member 3121 .

[0049] As described above, the body 3100 includes the long side member 3111 and the short side member 3121. Accordingly, the inner surface if of the body 3100 represents the inner surfaces of the long side member 3111 and the short side member 3121. Thus, the inner surface if of the body 3100 and the inner surface if of each of the long side member and the short side member will be described with the same reference numeral 'if'. Also, an outer surface of the body and an outer surface of each of the long side member and the short side member will be described with the same reference numeral 'of'. Also, since the mold 3000 includes the body 3100,

the inner and outer surfaces of each of the short side member 3121 and the long side member 3111 may represent the inner and outer surfaces of the mold 3000.

[0050] The short side member 3121 is provided so that the inner surface if heading toward the inner space of the mold 3000 includes an inclined surface. That is, the inner surface if of the mold 3000 includes an inclined surface, and the inclined surface includes the first inclined surface sf_1 inclined to be gradually away from the outer surface of in the downward direction and the second inclined surface sf_2 inclined to be gradually close to the outer surface of in the downward direction as illustrated in FIGS. 4 and 5. Also, the inner surface if may include an intermediate surface cf disposed between the first inclined surface sf_1 and the second inclined surface sf_2. That is, the inner surface if of the short side member 3121 includes the first inclined surface sfi, the intermediate surface cf, and the second inclined surface sf_2, and the first inclined surface sfi, the intermediate surface cf, and the second inclined surface sf_2 are sequentially and consecutively arranged.

[0051] Referring to FIGS. 4 and 5, the first inclined surface sfi, the intermediate surface cf, and the second inclined surface sf_2 have different inclinations. That is, the inner surface if of the short side member 3121 may have a multi-step inclination, more particularly a three-step inclination.

[0052] In the inner surface if of the short side member 3121, a connection point between the first inclined surface sf_1 and the intermediate surface cf is a point at which the inclination begins to change, and a connection point between the intermediate surface cf and the second inclined surface sf_2 is a point at which the inclination begins to change. Thus, hereinafter, for convenience of explanation, the point between the first inclined surface sf_1 and the intermediate surface cf is referred to as a first point P_1, and the point between the intermediate surface cf and the second inclined surface sf_2 is referred to as a second point P_2. Also, a length from an upper end Pu to a lower end P_L of the short side member 3121 is referred to as a height Hi of the short side member 3121.

[0053] The first inclined surface sf1 that is an inclined surface formed on an upper portion of the inner surface if of the body 3100 extends by a predetermined length from the upper end P_U of the inner surface if of the short side member 3121 in the downward direction. Here, as described above, the first inclined surface sf1 is inclined or slanted to be gradually away from the outer surface of in the downward direction. In other words, the first inclined surface sf_1 is inclined to be gradually close to a center of the inner space IS of the mold 3000 in the downward direction. Thus, in the short side members 3121, a portion in which the first inclined surface sf_1 is disposed may have a shape having a thickness that gradually increases in the downward direction.

[0054] Referring to FIG. 5, the first inclined surface sf_1 extends from the upper end Pu of the short side member 3121 to the first point P_1. Here, the first inclined surface sf1 may have a constant inclination from the upper end Pu of the short side member 3121 to the first point P_1. That is, the first inclined surface sf_1 may have a constant inclination without change of the inclination or without an inflection point.

[0055] The first point P_1 may be a point spaced by a first distance S1 from the upper end P_U of the short side member 3121 in the downward direction. Thus, the first inclined surface sf_1 extends from the upper end Pu of the short side member 3121 to the first point P_1 spaced by the first distance S_1 in the downward direction. The first distance S_1 may be 15% or more and 25% or less of the height H_1 of the short side member 3121. Thus, the first point P_1 may be a point spaced by a length of 15% or more and 25% or less of the height Hi of the short side member 3121 from the upper end Pu of the short side member 3121 in the downward direction. Thus, the first inclined surface sf1 extends so that the spaced distance S_1 from the upper end Pu of the short side member 3121 to the first point P_1 is 15% or more and 25% or less of the height Hi of the short side member 3121.

[0056] The second inclined surface sf_2 that is an inclined surface disposed on a lower portion of the inner surface if is disposed below the first inclined surface sf_1. Here, as described above, the second inclined surface sf_2 is inclined to be gradually close to the outer surface of in the downward direction. Thus, in the short side members 3121, a portion in which the second inclined surface sf_2 is disposed may have a shape having a thickness that gradually decreases in the downward direction.

[0057] As illustrated in FIG. 5, the second inclined surface sf_2 extends from the second point P_2 below the first point P_1 to the lower end P_L of the short side member 3121. Here, the second inclined surface sf_2 may have a constant inclination from the second point P_2 to the lower end P_L of the short side member 3121. That is, the second inclined surface sf_1 may have a constant inclination without change of the inclination or without an inflection point.

[0058] The second point P_2 may be a point spaced by a second distance S_2 that is greater than the first distance S_1 from the upper end Pu of the short side member 3121 in the downward direction. Thus, the second inclined surface sf_2 extends from the second point P_2 spaced by the second distance S_2 from the upper end Pu of the short side member 3121 in the downward direction to the upper end Pu of the short side member 3121. The second distance S_2 may be greater than 40% and equal to or less than 50% of the height H1 of the short side member 3121. Thus, the second inclined surface sf_2 extends from the second point P_2 spaced by the second distance S_2 that is greater than 40% and equal to or less than 50% of the height Hi of the short side member 3121 in the downward direction from the upper end Pu of the short side member 3121 to the lower end P_L of the short side member 3121.

[0059] The intermediate surface cf that is a surface disposed between the first inclined surface sf1 and the second inclined surface sf_2 is spaced by the same distance from the outer surface of in a vertical direction. Thus, in

the short side member 3121, a portion in which the intermediate surface cf is disposed may have a shape having a thickness that is constant or not changed in the vertical direction.

[0060] The intermediate surface cf extends from the first point P1 to the second point P2. In other words, the intermediate surface cf extends from a point (first point P1) spaced apart by the first distance S_1 from the upper end Pu of the short side member 3121 in the downward direction to a point (second point P_2) spaced by the second distance S2 from the same. When the short side member 3121 is disposed perpendicularly to the ground as illustrated in FIG. 5, the intermediate surface cf is not inclined, i.e., perpendicular to the ground.

[0061] As described above, the first inclined surface sf1 that is an upper inner surface of the short side member 3121 is inclined to be gradually away from the outer surface of in the downward direction. This is to additionally compensate the shrinkage in the long side direction of the solidified shell C at the upper portion in the mold 3000, at which solidification shrinkage occurs relatively large. That is, when the first and second short side members 3121 are installed to face each other, the first and second short side members 3121 are inclined so that the spaced distance therebetween gradually decreases in the downward direction as described above to compensate the solidification shrinkage in the long side direction. Here, the solidification shrinkage in the long side direction may be additionally compensated by providing the first inclined surface sf_1 on the inner surface (if) of the short side member 3121. This is because, in a decrease rate in which the length of the inner space IS of the mold 3000 in the long side direction gradually decreases in the downward direction, a decrease rate caused by the first inclined surface sf_1 is further added to a decrease rate generated by installing the short side member 3121 to be inclined.

[0062] Thus, when the first inclined surface sf_1 is disposed on the short side member 3121, the decrease rate in which the length of the inner space IS of the mold 3000 in the long side direction (X-axis direction) gradually decreases in the downward direction is greater than that when the first inclined surface sf_1 is not disposed on the short side member 3121. Thus, a compensation rate of solidification shrinkage of the mold 3000 in the long side direction when the first inclined surface sf_1 is disposed on the short side member 3121 is improved than that when the first inclined surface sf_1 is not disposed on the short side member 3121. Particularly, the compensation rate at the upper portion in the mold 3000 at which the solidification shrinkage occurs largely is improved. As a result, a gap occurring between the long side solidified shell LC (refer to FIG. 7) and the short side member 3121 may be suppressed or prevented, and occurrence of a surface crack and break out caused by the shrinkage of the solidified shell LC may be suppressed or prevented.

[0063] Also, the second inclined surface sf_2 is inclined to be gradually close to the outer surface of in the downward direction. This is to suppress the friction between the inner surface of the short side member 3121 and the cast steel 1 formed by solidifying the molten steel in the lower part of the mold 3000. That is, the first and second short side members 3121 are inclined so that the distance therebetween decreases in the downward direction in order to compensate the solidification shrinkage in the long side direction. Thus, the spaced distance between the first short side member 3121 and the second short side member 3121 at the lower portion in the mold 3000 may remarkably decrease to cause friction between the slab 1 and the short side member 3121 when the slab 1 is drawn from the mold 3000 in the downward direction. However, the friction between the slab 1 and the short side member 3121 may be suppressed or prevented by forming the second inclined surface sf_2 on the short side member 3121.

[0064] As illustrated in FIGS. 4 and 5, this is because the spaced distance between the center of the inner space IS of the mold 3000 and the second inclined surface sf_2 may increase when the second inclined surface sf_2 is gradually close to the outer surface in the downward direction in comparison with when the second inclined surface sf_2 is not gradually close to the outer surface in the downward direction to reduce close contact force between the slab 1 and the short side member 3121. Also, as the friction force between the slab 1 and the short side member 3121 is reduced, wear of the short side member 3121 may be reduced to extend a lifespan of the short side member 3121, i.e., the mold 3000.

[0065] In the inner space IS of the mold 3000, an amount of shrinkage of the solidified shell is greatest at the upper portion, and the amount of shrinkage gradually decreases in the downward direction. Also, a position at which the intermediate surface cf is disposed is a central portion of the mold 3000, and an amount of shrinkage of the central portion is smaller than that of the upper portion and greater than that of the lower portion. Thus, the amount of shrinkage of the central portion is necessary to be compensated.

[0066] However, when the second inclined surface sf_2 is continuously formed from the first point P_1 without the intermediate surface cf, a decrease rate in which a length in the long side direction gradually decreases in the downward direction may be reduced in the central portion of the inner space of the mold 3000. Thus, solidification shrinkage at the central portion of the inner space IS of the mold 3000 may not be sufficiently compensated.

[0067] Also, when the first inclined surface sf_1 extends until the second point P_2, the solidification shrinkage at the central portion of the inner space IS of the mold 3000 may be excessively compensated in comparison with an amount of shrinkage of the solidified shell.

[0068] Thus, the intermediate surface cf without change of the spaced distance with the outer surface of or without change of the inclination may be preferably provided between the first inclined surface sf_1 and the second inclined surface sf_2.

[0069] The convex member 3122 is disposed on the inner surface if of the body 3100. That is, the convex member 3122 protrudes from the inner surface if of the body 3100 to the inner space IS. Here, as illustrated in FIGS. 2, 3, and 6, the convex member 3122 may be disposed on the inner surface if of the short side member 3121.

[0070] Hereinafter, the short side part including the short side member and the convex member will be described with reference to FIGS. 2, 3,

(a) of FIG. 8 is a three-dimensional view of the short side part in accordance with an exemplary embodiment. (b) of FIG. 8 is a front view when (a) of FIG. 8 is viewed from 'D' side. (c) of FIG. 8 is a cross-sectional view when (a) of FIG. 8 is cut along line E-E' and viewed from 'F' side. (d) of FIG. 8 is a top view of each position ⓐ, ⓑ, and ⓒ in a vertical direction (Z-axis direction) of (c) of FIG. 8.

[0071] FIG. 9 is a view for explaining an extension length of the inner surface of the short side part in accordance with an exemplary embodiment.

[0072] Referring to FIGS 2 and 3 and (a) of FIG. 8, the convex member 3122 is disposed on the inner surface if of the short side member 3121. That is, the convex member 3122 protrudes from the inner surface if of the short side member 3121 to the inner space IS of the mold 3000.

[0073] The convex member 3122 extends in the extension direction of the short side member 3121, that is, in the width direction (Y-axis direction). Here, the convex member 3122 has a shape in which the protruding length P_L gradually increases in a direction from both ends to a center of the extending direction. In other words, the convex member 3122 may have a shape in which the protruding length P_L gradually decreases in a direction from the center to the both ends in the width direction. Thus, in the width direction of the convex member 3122, a position having the maximum protruding length P_L may be the center of the convex member 3122 in the width direction. Here, the center of the convex member 3122 in the width direction may correspond to the center of the short side member 3121 in the width direction.

[0074] Also, the convex member 3122 may have a shape in which the protruding length P_L in the width direction is constant or the same.

[0075] As illustrated in (a) and (b) of FIG. 8, the convex member 3122 has a width PW less than the width SW of the short side member 3121. Thus, as illustrated in (b) of FIG. 8, the inner surface if of the short side member 3121 is exposed to an outer side of the width direction of the convex member 3122. Also, the convex member 3122 may have the width PW that is constant in the vertical direction as illustrated in (b) and (d) of FIG. 8. Thus, as illustrated in (b) of FIG. 8, a line (hereinafter, referred to as a boundary line DL) connecting an uppermost end and a lowermost end of the convex member 3122 may be a straight line without curvature.

[0076] The convex member 3122 extends downward from the upper end Pu of the inner surface if of the short side member 3121, and here, the protruding length P_L gradually decreases in the downward direction as illustrated in (c) and (d) of FIG. 8. That is, in the convex member 3122, the protruding length P_L of the upper portion is less than that of the lower portion. Also, as illustrated in (c) of FIG. 8, the convex member 3122 may have a constant decrease inclination in which the protruding length P_L of the convex member 3122 gradually decreases in the downward direction.

[0077] An extension length of the convex member 3122 in the vertical direction is less than the height Hi of the short side member 3121. That is, the convex member 3122 extends from the upper end Pu to one point (hereinafter, referred to as a third point P_3) of the short side member 3121. Here, a distance (hereinafter, referred to as a third distance S_3) between the upper end Pu to the third point of the short side member 3121 is greater than the first distance S_1 and less than the second distance S_2. More specifically, the third distance S_3 may be 30% or more and 40% or less of the height H1 of the short side member 3121. Thus, the third point P_3 may be a point spaced by a length of 30% or more and 40% or less of the height Hi of the short side member 3121 from the upper end Pu of the short side member 3121 in the downward direction. That is, the convex member 3122 extends so that the spaced distance S_3 between the upper end P_U and the third point P_3 of the short side member 3121 is 30% or more and 40% or less of the height Hi of the short side member 3121.

[0078] As described above, since the convex member 3122 is formed on the inner surface if of the short side member 3121 to protrude or be convex toward the inner space of the mold 3000, an extension length of the inner surface of the short side part 3120 increases more than that of the related art. Here, the inner surface of the short side part 3120 refers to a surface including the other surface that is opposite to one surface of the convex member 3122 connected to the short side member 3121 and the inner surface if of the short side member 3121 disposed at an outer side of the width direction of the convex member 3122. Also, as illustrated in (a) of FIG. 9, an extension length SIL of the inner surface if of the short side part 3120 represents a length of a path from one end E_1 that is one of both ends of the inner surface of the short side part 3120 in the Y-axis direction to the other end E_2.

[0079] The inner surface of the short side part 3120 has a shape of a curve bent at least one time instead of a straight line. Also, a length (refer to (a) of FIG. 9) of a path from the one end to the other end of the curve is greater than that (refer to (b) of FIG. 9) of a path from one end to the other end of the straight line. Thus, since the extension length SIL of the inner surface of the short side part 3120 has a path from the one end E_1 to the other end E_2 of the inner surface, which increases as the protruding length P_L of the convex member 3122 increases, the extension length SIL of the inner surface of the short side part 3120 increases. Also, the protruding length P_L of the convex member 3122 gradually decreases in the downward direction. Thus, the extension length

of the inner surface of the short side part 3120 gradually decreases in the downward direction.

[0080] The width of the short side member 3121 gradually decreases in the downward direction. Thus, a length of a short side direction of the inner space of the mold 3000 gradually decreases in the downward direction. Here, a decrease rate in which the length of the inner space IS of the mold 3000 in the short side direction gradually decreases in the downward direction is greater when the convex member 3122 is provided on the short side member 3121 than when the convex member 3122 is not provided on the short side member 3121. This is because, in the decrease rate in which the length of the inner space IS of the mold 3000 in the short side direction gradually decreases in the downward direction, a decrease rate caused by the convex member 3122 is further added to a decrease rate generated by reducing the width of the short side member 3121.

[0081] Thus, the mold 3000 may additionally compensate solidification shrinkage in the short side direction through the convex member 3122. That is, as the convex member 3122 is installed on the short side member 3121, the solidification shrinkage in the short side direction may be additionally compensated. Thus, a compensation rate of the solidification shrinkage in the short side direction of the mold 3000 is improved. Accordingly, a gap occurring between the short side solidified shell SC and the long side member 3111 may be suppressed or prevented, and occurrence of a surface crack and break out caused by the shrinkage of the solidified shell may be suppressed or prevented.

[0082] FIGS. 10 and 11 are views illustrating the short side part of the mold in accordance with a first modified example and a second modified example of an exemplary embodiment. FIG. 12 is a view illustrating a short side part of a mold in accordance with a third modified example of an exemplary embodiment.

[0083] In the above-described exemplary embodiment, the first inclined surface sf_1 has the constant inclination until the first point P_1, i.e., a constant inclination degree. However, the exemplary embodiment is not limited thereto. As illustrated in the first modified example of FIG. 10, the first inclined surface sf_1 may have a multi-step inclination. That is, the first inclined surface sf_1 may be inclined to be gradually away from the outer surface of in the downward direction, and the inclination may be changed at least one time. In other words, the first inclined surface sf_1 may have the inclination that is changed based on one point (first inflection point IP_1) between the upper end Pu of the short side member 3121 and the first point P_1. Here, an inclination of an upper area of the first inclined surface sf_1 is less than that of a lower area of the first inclined surface sf_1 based on the first inflection point IP_1. As described above, when one first inflection point IP_1 is provided between the upper end Pu of the short side member 3121 and the first point P_1, the first inclined surface sf_1 may have a two-step inclination. However, the exemplary embodiment is not limited to the two-step inclination of the first inclined surface sf_1. For example, the first inclined surface sf_1 may have a three or more-step inclination. To this end, two or more first inflection points IP_1 may be provided.

[0084] Also, in the above-described exemplary embodiment, the second inclined surface sf_2 has a constant inclination or a constant inclination degree from the second point P_2 to the lower end of the short side member 3121. However, the exemplary embodiment is not limited thereto. As illustrated in second modified example of FIG. 11, the second inclined surface sf_2 may have a multi-step inclination. That is, the second inclined surface sf_2 may be inclined to be gradually close to the outer surface of in the downward direction, and the inclination may be changed at least one time. In other words, the inclination of the second inclined surface sf_2 is changed based on one point (second inflection point IP_2) between the second point P_2 and the lower end P_L of the short side member 3121. Here, an inclination of an upper area of the second inclined surface sf_2 is greater than that of a lower area of the second inclined surface sf_2 based on the second inflection point IP_2. As described above, when one second inflection point IP_2 is provided between the second point P_2 and the lower end P_L of the short side member 3121, the second inclined surface sf_2 has a two-step inclination. However, the exemplary embodiment is not limited to the two-step inclination of the second inclined surface sf_2. For example, the second inclined surface sf_1 may have a three or more-step inclination. To this end, two or more second inflection points IP_2 may be provided.

[0085] Also, in the above-described exemplary embodiment, the convex member 3122 has the protruding length P_L that decreases with a constant rate from the upper end Pu of the short side member 3121 to the third point P_3. That is, the convex member 3122 in accordance with an exemplary embodiment has a constant inclination from the upper end Pu of the short side member 3121 to the third point P_3.

[0086] However, the exemplary embodiment is not limited thereto. As illustrated in third modified example of FIG. 12, the convex member 3122 may have a multi-step inclination. That is, the convex member 3122 has the protruding length P_L that gradually decreases in the downward direction, and a degree of decrease may be changed at least one time. In other words, when the convex member 3122 extends from the upper end of the short side member 3121 to the third point P3, the inclination of the convex member 3122 may be changed at least one time. That is, the inclination of the convex member 3122 is changed based on one point (third inflection point IP_3) between the upper end Pu of the short side member 3121 and the third point P_3. Also, an inclination of a lower area of the convex member 3122 is greater than that of an upper area of the convex member 3122 based on the third inflection point IP_3.

[0087] As illustrated in FIG. 12, the third inflection point IP_3 may be the same as, e.g., the first point P_1. Alternatively, the third inflection point IP_3 may be any point be-

tween the upper end Pu of the short side member 3121 and the third point P_3.

[0088] As described above, when one third inflection point IP_3 is provided between the third point P_3 and the lower end P_L of the short side member 3121, the convex member 3122 has a two-step inclination in the vertical direction. However, the exemplary embodiment is not limited to the two-step inclination of the convex member 3122. For example, the convex member 3122 may have a three or more-step inclination. To this end, two or more third inflection points IP_3 may be provided.

[0089] FIGS. 13 and 15 are views illustrating the short side part of the mold in accordance with fourth modified example and sixth modified example of an exemplary embodiment. Here, (a) to (d) of each of FIGS. 13 to 15 are illustrated by the same method as (a) to (d) of FIG. 8.

[0090] In the above-described first to third modified examples, and an exemplary embodiment, the width PW of the convex member 3122 is constant in the vertical direction instead of being changed. However, the exemplary embodiment is not limited thereto. The width PW of the convex member 3122 may gradually decreases in the downward direction as with the fourth to sixth modified examples. That is, the convex member 3122 may have a shape in which the protruding length P_L gradually decreases in the downward direction, and the width PW gradually decreases in the downward direction at the same time.

[0091] As described above, when the width PW of the convex member 3122 gradually decreases in the downward direction, a decrease rate thereof may be constant as with FIG. 13. Thus, as illustrated in FIG. 13, the line connecting the uppermost end and the lowermost end of the convex member, i.e., the boundary line DL, may be a straight line without curvature.

[0092] However, the exemplary embodiment is not limited thereto. For example, the boundary line DL may have curvature as with the fifth and sixth modified examples. Here, the boundary line DL may have a shape protruding to the outside of the convex member 3122 or a shape having positive curvature as with the fifth modified example of FIG. 14. Also, as with the sixth modified example of FIG. 15, the boundary line DL of the convex member may have a shape protruding to the inside of the convex member 3122 or a shape having negative curvature. As described above, the feature in which the boundary line DL has the positive curvature or the negative curvature represents that the width PW of the convex member 3122 gradually decreases in the downward direction, and a decrease rate thereof is not constant.

[0093] FIG. 16 is a three-dimensional view illustrating the mold in accordance with another exemplary embodiment, and FIG. 17 is an exploded perspective view of the mold.

[0094] In the above-described exemplary embodiment, the inner surface if of the short side member 3121 includes the first and second inclined surfaces sf_1 and sf_2 and the intermediate surface cf, and the convex member 3122 is disposed on the short side member 3121. However, the exemplary embodiment is not limited thereto. For example, as with another exemplary embodiment illustrated in FIGS. 16 and 17, the inner surface if of the long side member 3111 may include the first and second inclined surfaces sf1 and sf_2 and the intermediate surface cf, and the convex member 3122 may be disposed on the long side member 3111. Here, a component including a long side member 3111 and a convex member 3112 disposed on the long side member 3111 may be defined as a long side part 3110. In this case, a mold 3000 may include first and second long side members 3111 including the convex member 3112 and first and second short side members 3120 including a convex member 3122.

[0095] Also, the first and second modified examples and an exemplary embodiment may be applied to first and second inclined surfaces sf_1 and sf_2 of the long side member 3111. Also, an exemplary embodiment and the third to sixth modified examples may be applied to the convex member 3112 disposed on the long side member 3111.

[0096] FIG. 18 is a three-dimensional view illustrating a mold in accordance with yet another exemplary embodiment. FIG. 19 is a three-dimensional view illustrating a short side part of the mold in accordance with yet another exemplary embodiment.

[0097] Hereinafter, the mold in accordance with yet another exemplary embodiment will be described with reference to FIGS. 18 to 19. Here, overlapped contents described in the above-described exemplary embodiments will be omitted or simply described.

[0098] A mold 3000 in accordance with yet another exemplary embodiment may be a chamfered mold. That is, the mold 3000 includes a body 3100 in which first and second inclined surfaces sf_1 and sf_2 and an intermediate surface cf are disposed on an inner surface if, and a protruding member 3123 is disposed on a corner thereof and a convex member 3122 protruding from the inner surface if of the body 3100 toward an inner space IS and having a protruding length that gradually decreases from the inner surface if of the body 3100 to the inner space in the downward direction.

[0099] Here, the first and second inclined surfaces sf_1 and sf_2 and the intermediate surface cf may be disposed on the inner surface if of the short side member 3121. Also, the convex member 3122 may be disposed on the inner surface if of the short side member 3121. Here, the first and second modified examples and an exemplary embodiment may be applied to the first and second inclined surfaces sf_1 and sf_2, and an exemplary embodiment and the third to sixth modified examples may be applied to the convex member 3122.

[0100] When the protruding member 3123 protrudes from the inner surface if of the body 3100 to the inner space, the protruding member 3123 may protrude from the inner surface if of the short side member 3121 as with FIGS. 18 and 19. Here, the protruding member 3123 is disposed on each of both edges in an extension direction

of the short side member 3121. That is, the protruding member 3123 protrudes from the inner surface if of the both edge of the short side member 3121 to the inner space IS of the mold 3000. The protruding member 3123 that is a component forming a chamfered shape may be referred to as the chamfered protruding member 3123.

[0101] In the above-described chamfered mold, the convex member 3112 may be additionally provided on a long side part 3110.

[0102] In the above-described exemplary embodiments, the mold 3000 has the approximately rectangular shape in which the long side member 3111 and the short side member 3121 have different lengths from each other. However, the exemplary embodiments are not limited thereto. For example, the mold 3000 may have a square shape.

[0103] The above-described mold 300 in accordance with the exemplary embodiments has the improved compensation rate for the shrinkage of the solidified shell C. That is, all of the compensation rates for the shrinkage in the long side direction and the short side direction of the solidified shell are improved by the convex member and the inclined surface disposed on the inner surface if of the body 3100. Particularly, the compensation rate for the shrinkage of the solidified shell at the upper portion of the inner space IS of the mold 3000 is improved. Thus, the gap occurring between the solidified shell and the inner surface of the mold 3000 caused by the shrinkage of the solidified shell may be suppressed or prevented, and a solidification delay phenomenon caused by the gap may be suppressed or prevented. Thus, occurrence of break out and a defect on a surface of the slab may be suppressed or prevented.

[0104] Also, the friction between the slab and the inner surface if of the mold 3000 may be reduced by the inclined surface disposed on the inner surface if of the mold 3000 to extend the lifespan of the mold 3000.

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[0105] In accordance with the exemplary embodiments, the compensation rate for the shrinkage of the solidified shell is improved. That is, the compensation rate for the shrinkage in the long side direction and the short side direction of the solidified shell is improved by the convex member and the inclined surface disposed on the inner surface of the body. Particularly, the compensation rate for the shrinkage of the solidified shell at the upper portion of the inner space of the mold is improved. Thus, the gap occurring between the solidified shell and the inner surface of the mold caused by the shrinkage of the solidified shell may be suppressed or prevented, and the solidification delay phenomenon caused by the gap may be suppressed or prevented. Thus, occurrence of the break out and the defect on the surface of the slab may be suppressed or prevented.

Claims

1. A mold having an inner space to which molten steel is injected, comprising

   a body having the inner space,
   wherein an inner surface of the body, which heads toward the inner space, comprises a first inclined surface that is inclined to be gradually away from an outer surface opposite to the inner surface in a downward direction and a second inclined surface that is disposed below the first inclined surface and inclined to be gradually close to the outer surface in the downward direction.

2. The mold of claim 1, wherein the first inclined surface extends until a first point (P_1) spaced by a first distance (S_1) from an upper end (Pu) of the inner surface of the body,

   the second inclined surface extends until a lower end (P_L) of the inner surface of the body from a second point (P_2) disposed below the first point (P_1) and spaced by a second distance (S_2) from the upper end (Pu) of the inner surface of the body, and
   each of the first distance (S_1) and the second distance (S_2) is less than a height (H_1) of the body.

3. The mold of claim 2, wherein the first distance (S_1) is approximately 15% or more and approximately 25% or less of the height (Hi) of the body.

4. The mold of claim 2, wherein the first inclined surface has an inclination that is changed based on a first inflection point (IP_1) between the upper end (Pu) of the inner surface of the body and the first point (P_1), and
   in the first inclined surface, an angle between the outer surface and a lower area of the first inflection point (IP_1) is less than that between the outer surface and an upper area of the first inflection point (IP_1).

5. The mold of claim 4, wherein the first inflection point (IP_1) is provided in plurality, and a plurality of first inflection points (IP_1) are disposed at different positions between the upper end (Pu) of the inner surface of the body and the first point (P_1).

6. The mold of claim 2, wherein the second distance (S_2) is approximately 40% or more and approximately 50% or less of the height (Hi) of the body.

7. The mold of claim 6, wherein the second inclined surface has an inclination that is changed based on a second inflection point (IP_2) between the second

point (P_2) and the lower end (P_L) of the inner surface of the body, and
in the second inclined surface, an angle between the outer surface and a lower area of the second inflection point (IP_2) is greater than that between the outer surface and an upper area of the second inflection point (IP_2).

8. The mold of claim 7, wherein the second inflection point (IP_2) is provided in plurality, and a plurality of second inflection points (IP_2) are disposed at different positions between the second point (P_2) and the lower end (P_L) of the inner surface of the body.

9. The mold of claim 2, wherein an intermediate surface spaced by the same distance from the outer surface in a vertical direction is disposed between the first inclined surface and the second inclined surface.

10. The mold of any one of claims 2 to 9, wherein the body comprises:

a pair of long side members each extending in one direction and facing each other in a direction crossing an extension direction thereof; and
a pair of short side members each extending to cross the long side member and facing each other to seal a portion between the pair of long side members,
wherein the first and second inclined surfaces are disposed on the inner surface of at least one of the long side member and the short side member.

11. The mold of claim 10, wherein the pair of short side members are inclined so that a spaced distance therebetween gradually decreases in the downward direction, and
a side surface of the short side member, which contacts the long side member, is gradually inclined toward a center of a width direction of the short side member in the downward direction.

12. The mold of claim 10, wherein the body comprises a protruding member formed on each of both ends of an extension direction of the short side member to protrude toward the inner space, thereby forming a chamfered surface at an edge of a slab to be cast.

13. The mold of claim 10, further comprising a convex member that protrudes from the inner surface of at least one of the long side member and the short side member and has a protruding length from the inner surface to the inner space, which gradually decreases in the downward direction.
wherein a width of the convex member is less than that of the body.

14. The mold of claim 13, wherein a height of the convex member is less than that of the body.

15. The mold of claim 13, wherein the convex member extends until a third point (P_3) spaced by a third distance (S_3) from the upper end (Pu) of the inner surface of the body, and
the third distance (S_3) is greater than the first distance (S_1) and less than the second distance (S_2).

16. The mold of claim 15, wherein the convex member has an inclination by which the protruding length gradually decreases in the downward direction, and the inclination is changed based on a third inflection point (IP_3) between the upper end (Pu) of the body and the third point (P_3),
wherein in the convex member, an angle between the outer surface and a lower area of the third inflection point (IP_3) is greater than that between the outer surface and an upper area of the third inflection point (IP_3).

17. The mold of claim 16, wherein the third inflection point (IP_3) is provided in plurality, and a plurality of third inflection points (IP_3) are disposed at different positions between the upper end (Pu) of the inner surface of the body and the third point (P_3).

FIG. 1

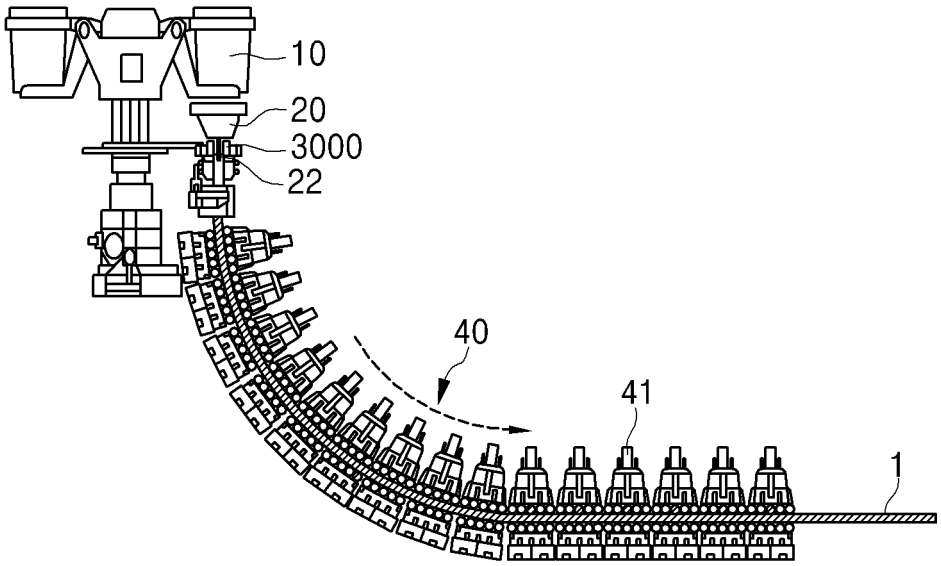

10
20
3000
22
40
41
1

FIG. 2

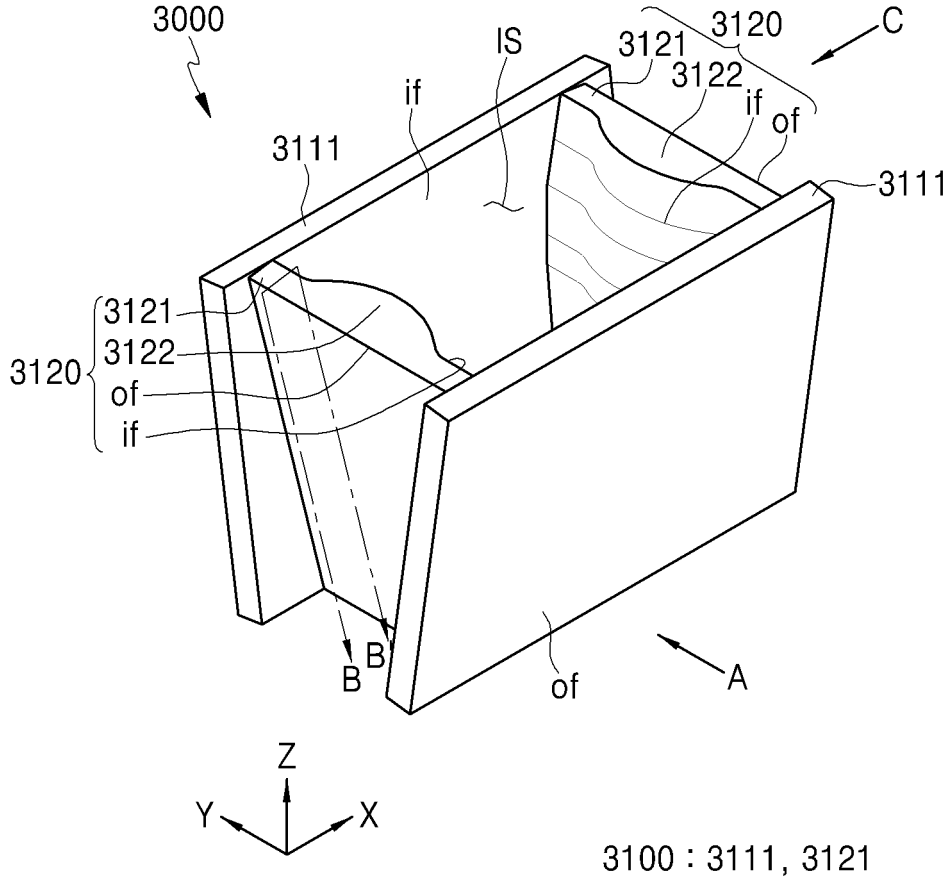

3000
IS
3121
3120
C
3122
if
of
3111
3111
3121
3122
3120
of
if
B
B
of
A
Z
Y
X
3100 : 3111, 3121

FIG. 3

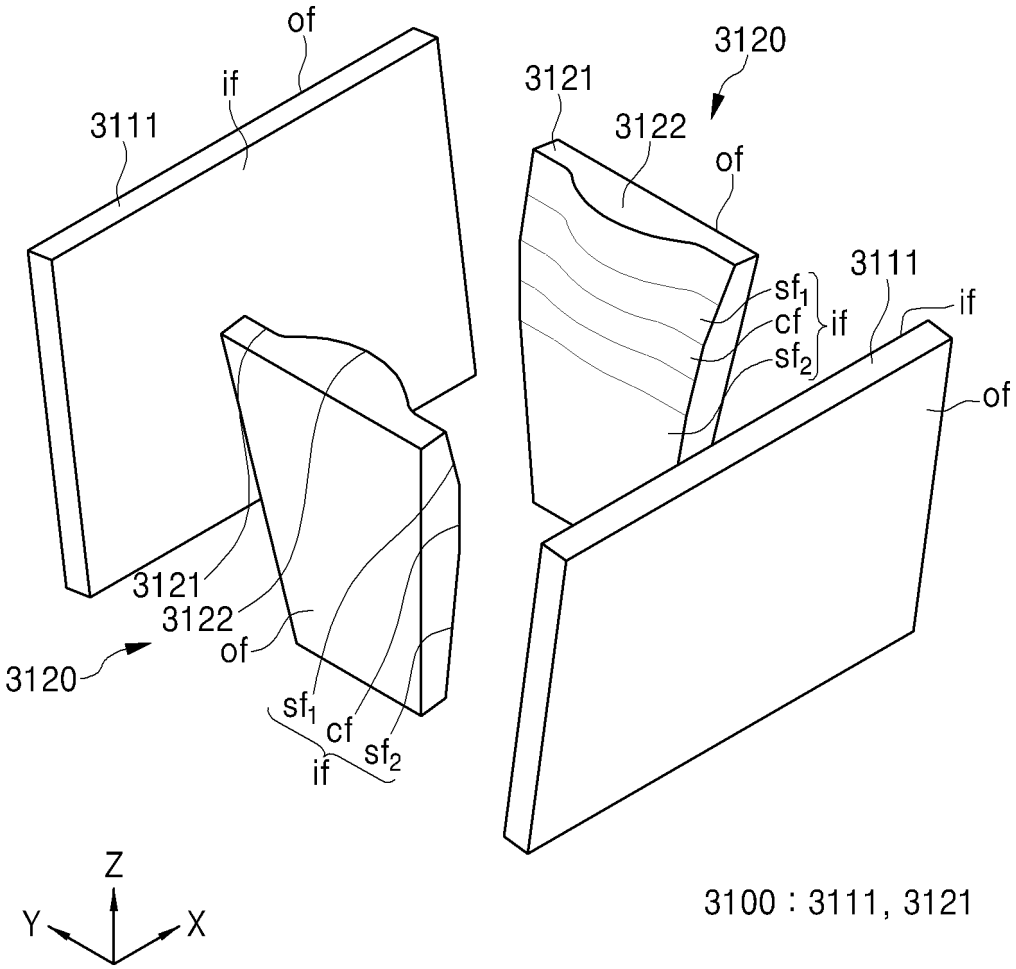

of
if
3111
3121
3122
3120
of
3121
3122
of
3120
sf1
cf
sf2
if
3111
if
of
sf1
cf
sf2
if
Z
Y
X
3100 : 3111, 3121

FIG. 4

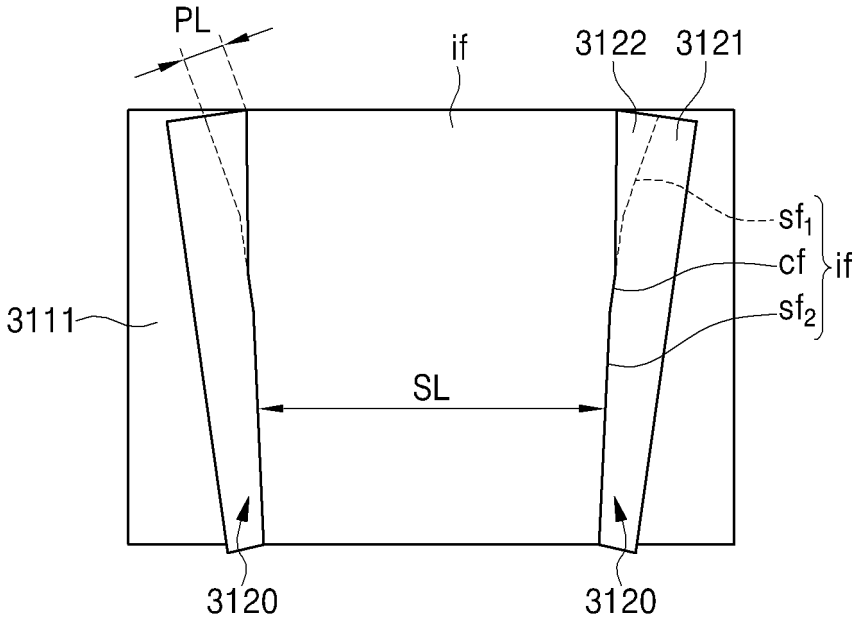

PL
if
3122
3121
sf1
cf
if
sf2
3111
SL
3120
3120

FIG. 5

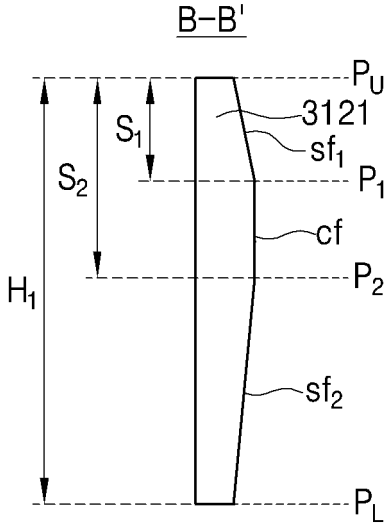

B-B'
PU
3121
S1
sf1
P1
S2
cf
P2
H1
sf2
PL

FIG. 6

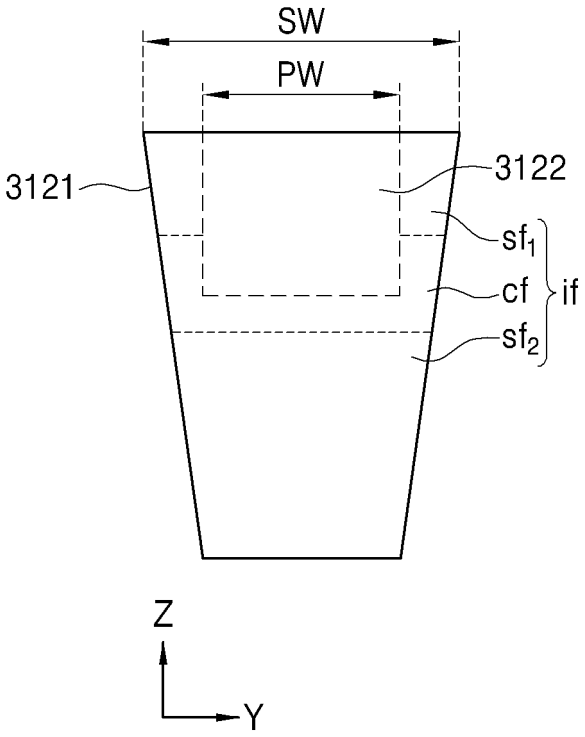
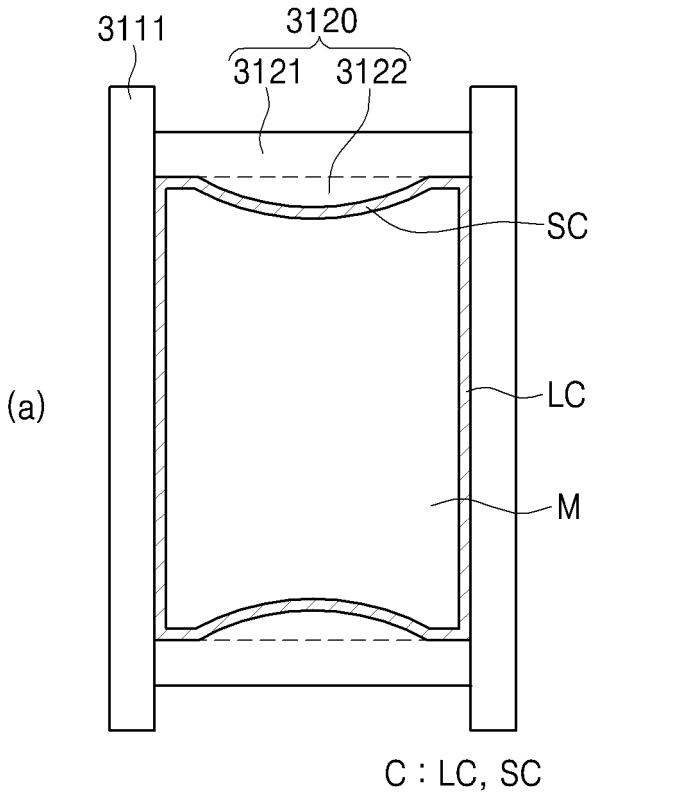


FIG. 7


3111
3120
3121
3122
SC
LC
M
(a)
C : LC, SC

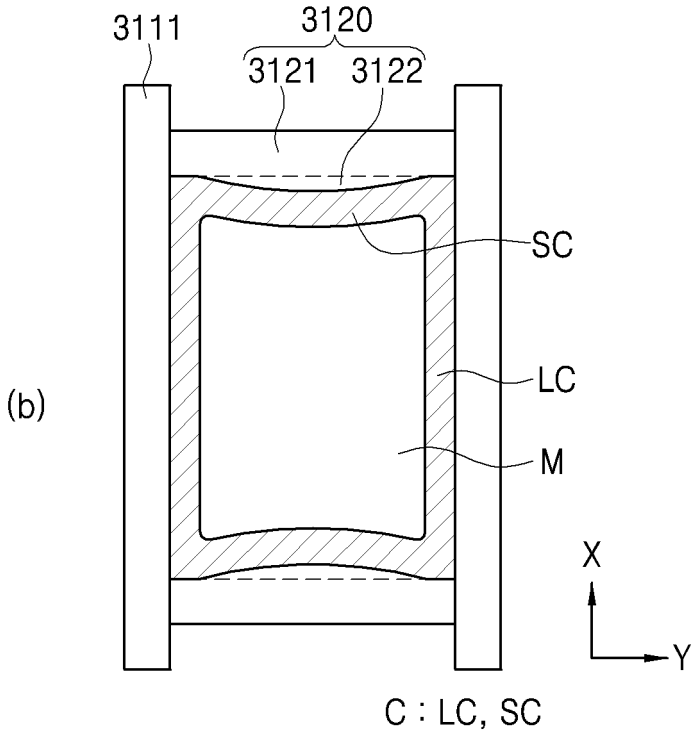

3111
3120
3121
3122
SC
LC
M
X
Y
(b)
C : LC, SC

FIG. 8

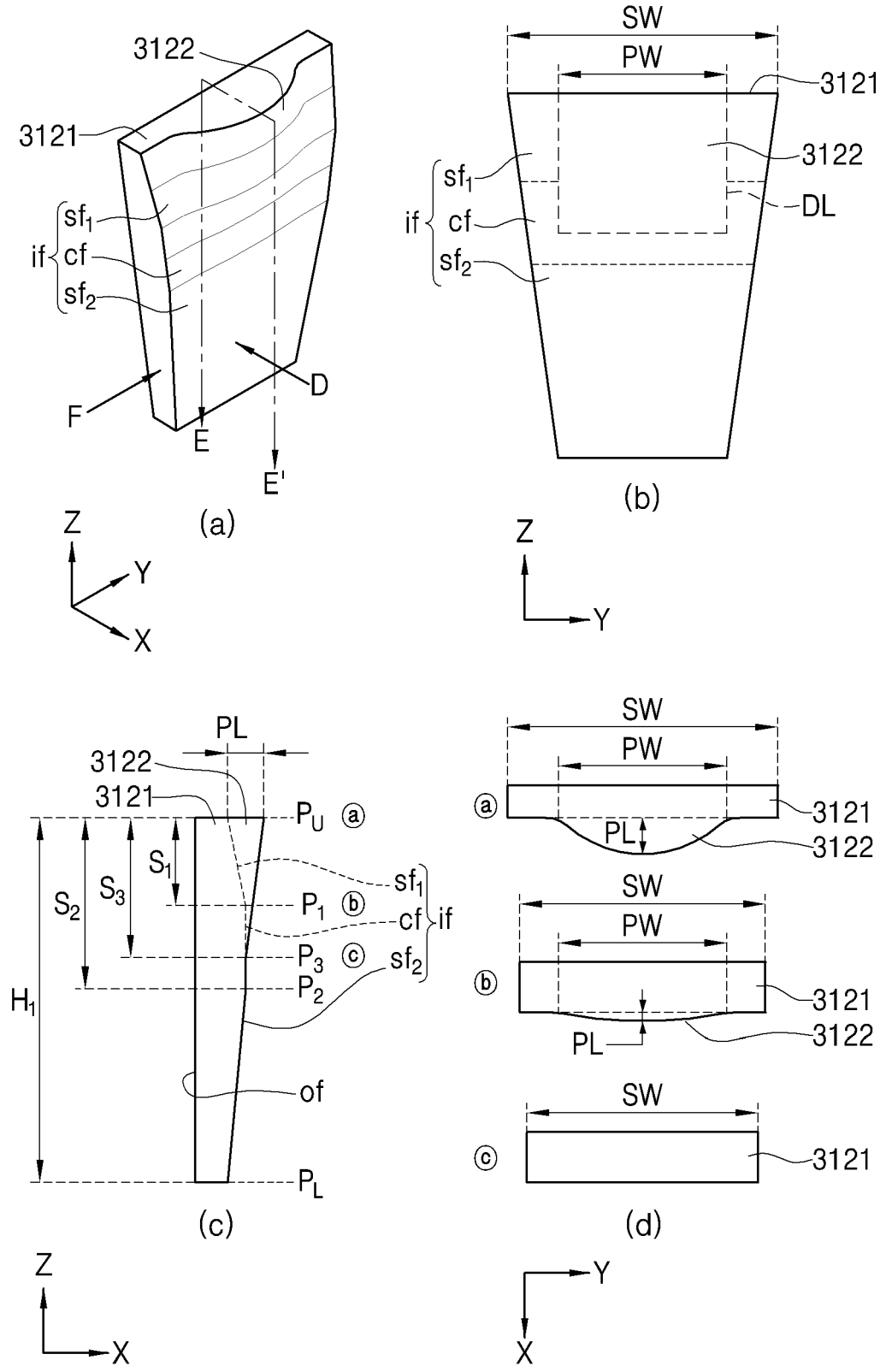

3122
3121
sf1
if
cf
sf2
F
E
E'
D
(a)
Z
Y
X
SW
PW
3121
3122
sf1
if
cf
sf2
DL
(b)
Z
Y
PL
3122
3121
PU
ⓐ
S1
S2
S3
sf1
P1
ⓑ
cf
if
P3
ⓒ
sf2
P2
H1
of
PL
(c)
Z
X
SW
PW
ⓐ
3121
PL
3122
SW
PW
ⓑ
3121
PL
3122
SW
ⓒ
3121
(d)
Y
X

FIG. 9

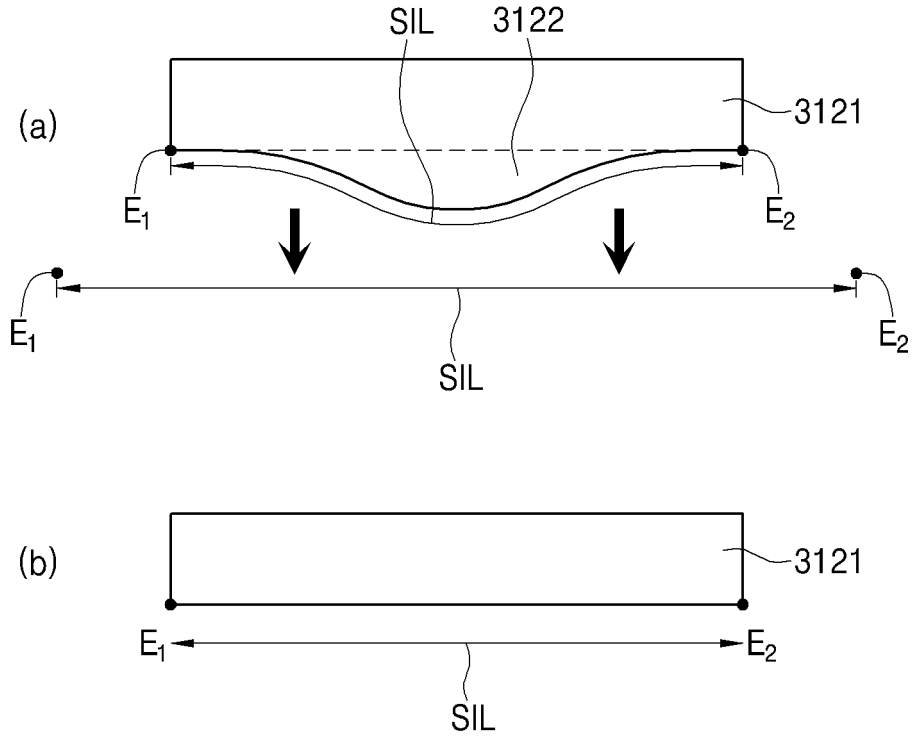

SIL
3122
(a)
3121
E1
E2
E1
E2
SIL
(b)
3121
E1
E2
SIL

FIG. 10

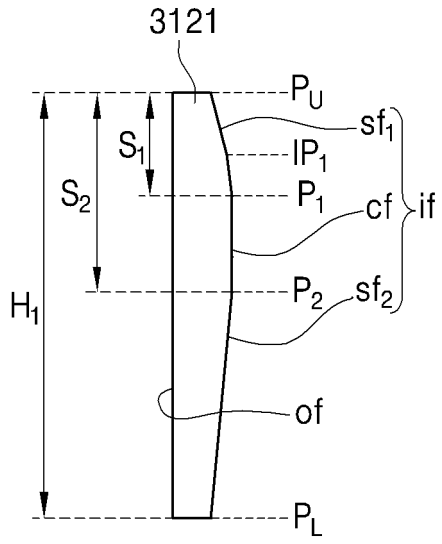

3121
PU
sf1
S1
IP1
S2
P1
cf
if
H1
P2
sf2
of
PL

FIG. 11

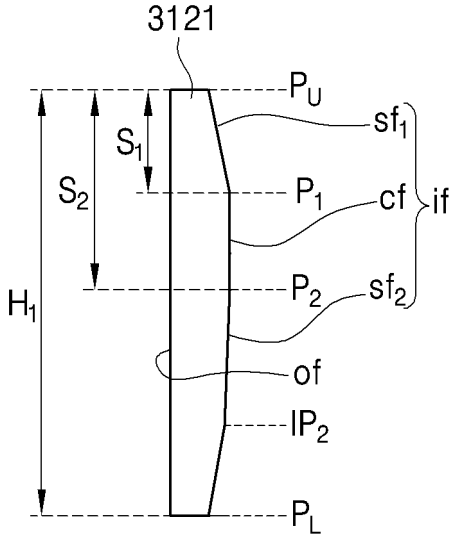

3121
P_U
sf_1
S_1
S_2
P_1
cf
if
H_1
P_2
sf_2
of
IP_2
P_L

FIG. 12

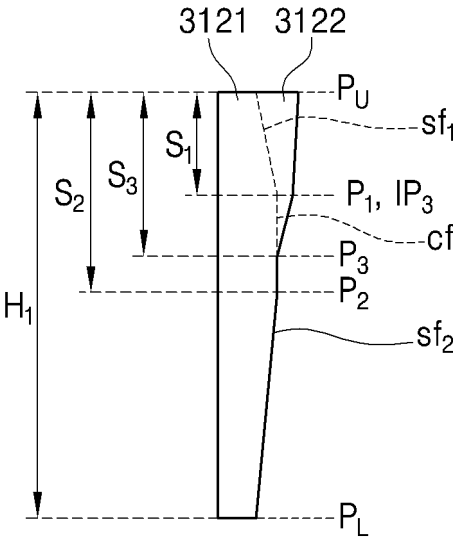

3121
3122
P_U
sf_1
S_1
S_2
S_3
P_1, IP_3
cf
P_3
P_2
H_1
sf_2
P_L

FIG. 13

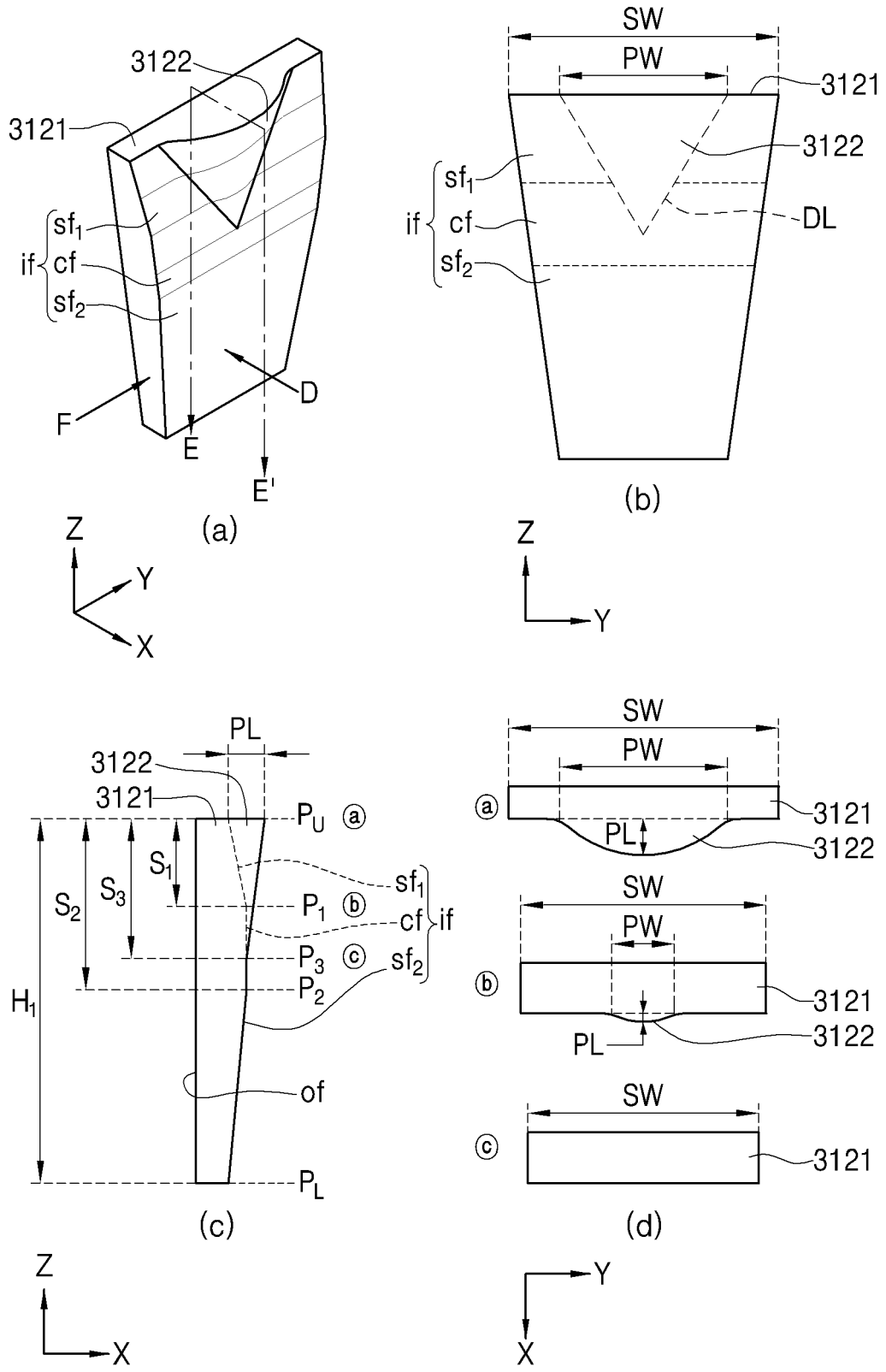

3122
3121
sf1
if
cf
sf2
F
E
E'
D
(a)
Z
Y
X
SW
PW
3121
3122
sf1
if
cf
sf2
DL
(b)
Z
Y
PL
3122
3121
PU
ⓐ
S1
S2
S3
sf1
P1
ⓑ
cf
if
P3
ⓒ
sf2
P2
H1
of
PL
(c)
Z
X
SW
PW
ⓐ
3121
PL
3122
SW
PW
ⓑ
3121
PL
3122
SW
ⓒ
3121
(d)
Y
X

FIG. 14

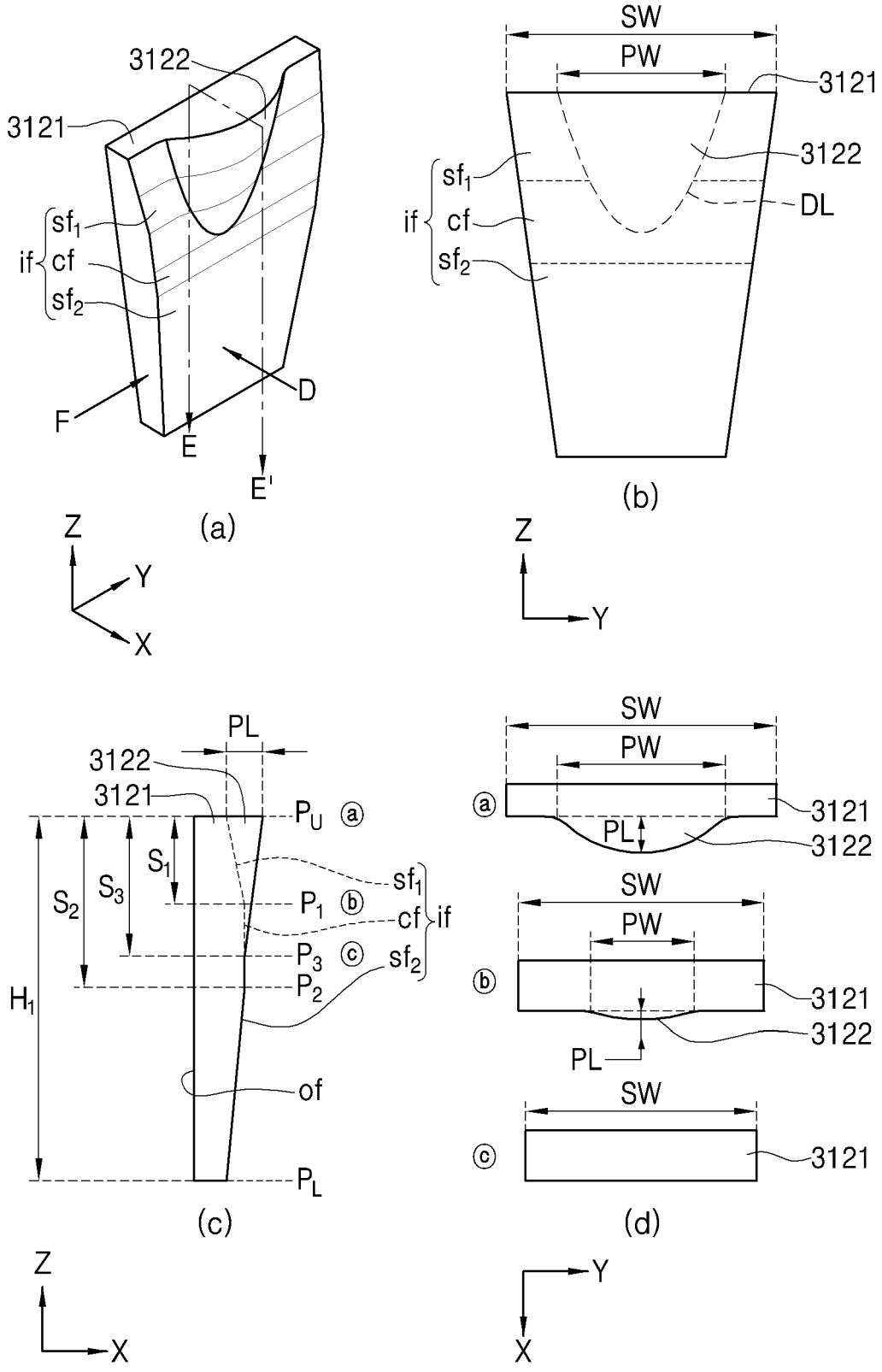

3122
3121
sf1
if
cf
sf2
F
E
E'
D
(a)
Z
Y
X
SW
PW
3121
3122
sf1
if
cf
sf2
DL
(b)
Z
Y
PL
3122
3121
PU
ⓐ
S1
S2
S3
sf1
P1
ⓑ
cf
if
P3
ⓒ
sf2
P2
H1
of
PL
(c)
Z
X
SW
PW
ⓐ
3121
PL
3122
SW
PW
ⓑ
3121
PL
3122
SW
ⓒ
3121
(d)
Y
X

FIG. 15

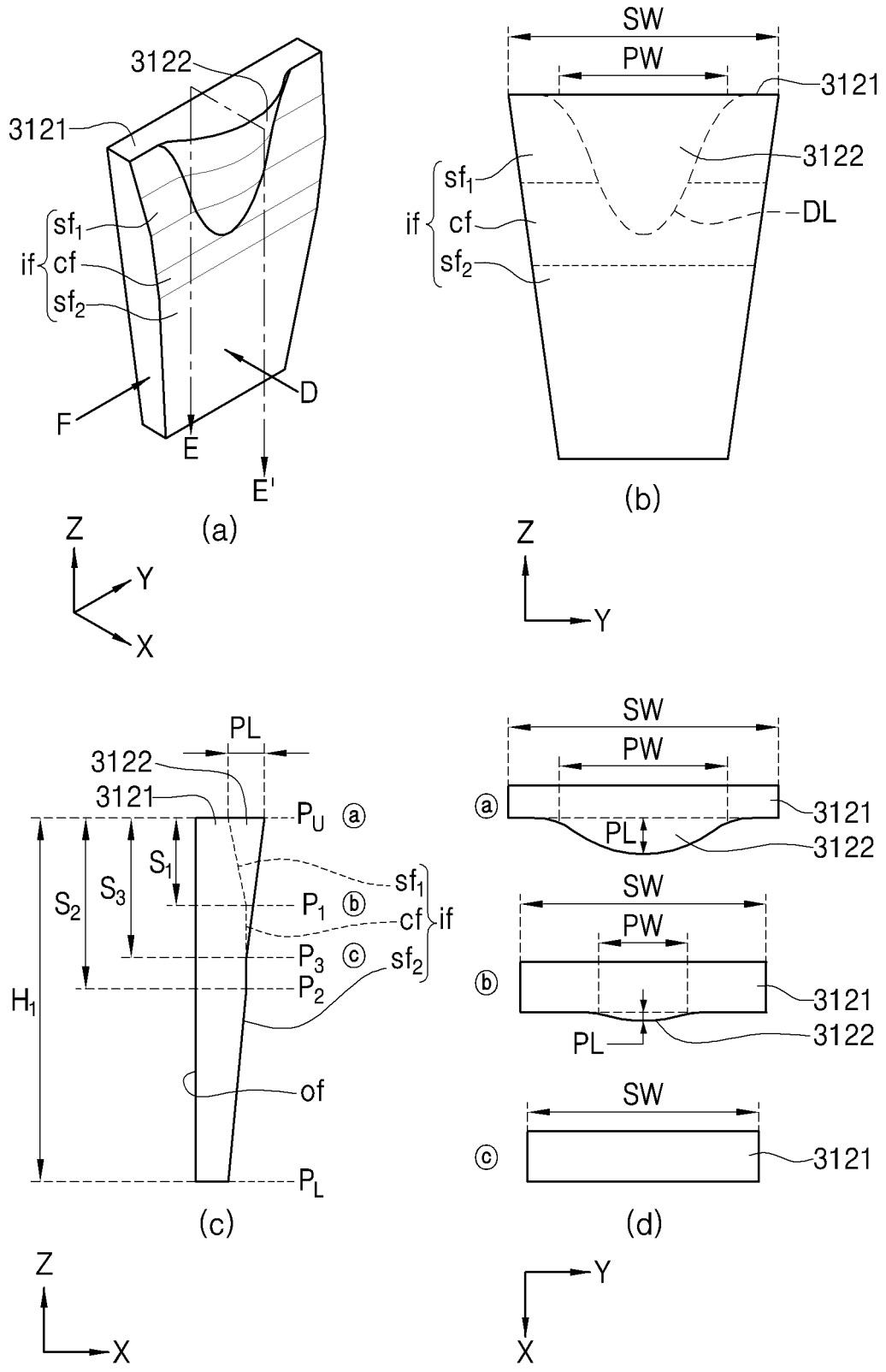

3122
3121
sf1
if
cf
sf2
F
E
E'
D
(a)
Z
Y
X
SW
PW
3121
3122
sf1
if
cf
sf2
DL
(b)
Z
Y
PL
3122
3121
PU
ⓐ
S1
S2
S3
sf1
P1
ⓑ
cf
if
P3
ⓒ
sf2
P2
H1
of
PL
(c)
Z
X
SW
PW
ⓐ
3121
PL
3122
SW
PW
ⓑ
3121
PL
3122
SW
ⓒ
3121
(d)
Y
X

FIG. 16

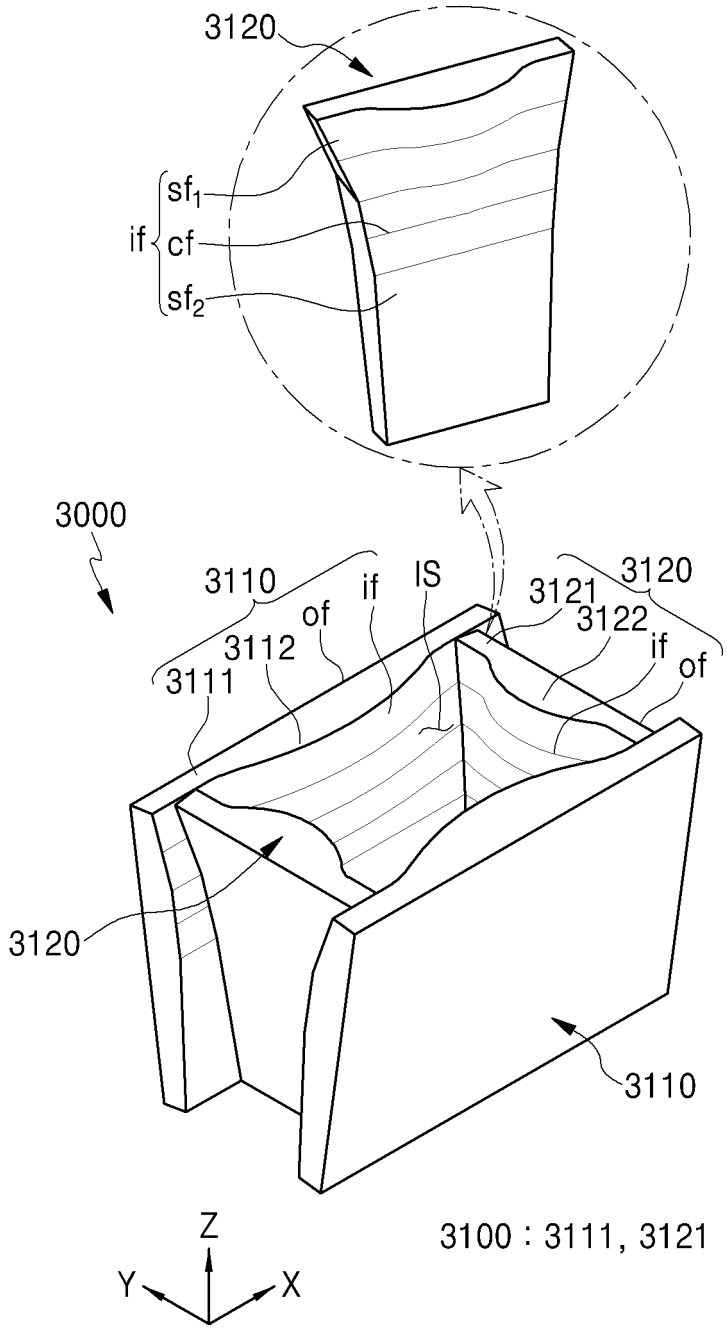

3120
sf1
if
cf
sf2
3000
3110
if
IS
3121
3120
of
3122
3112
if
3111
of
3120
3110
Z
Y
X
3100 : 3111, 3121

FIG. 17

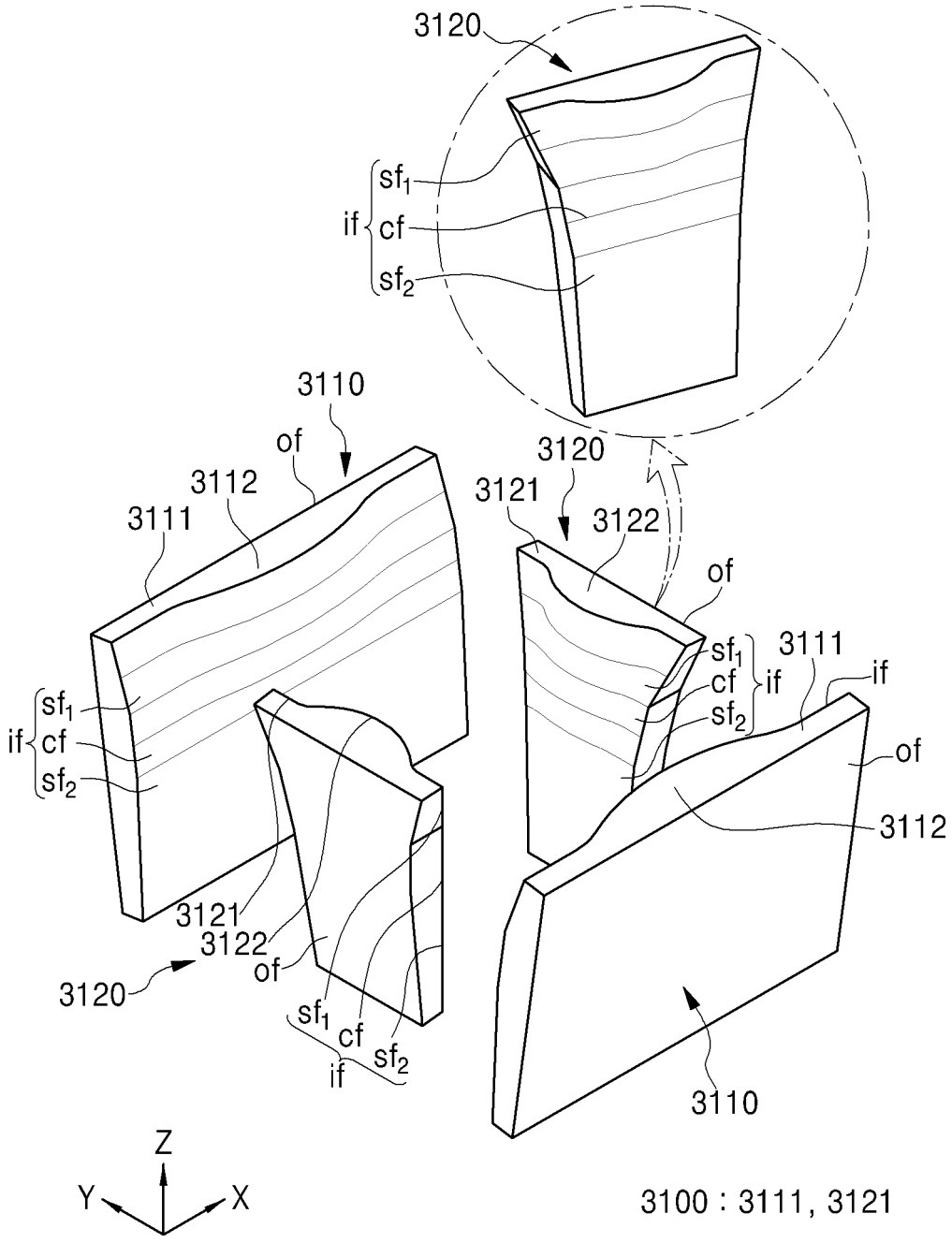

3120
sf1
if
cf
sf2
3110
of
3112
3111
3120
3121
3122
of
3111
if
sf1
cf
if
sf2
if
sf1
cf
sf2
of
3112
3121
3122
of
3120
sf1
cf
sf2
if
3110
Z
Y
X
3100 : 3111, 3121

FIG. 18

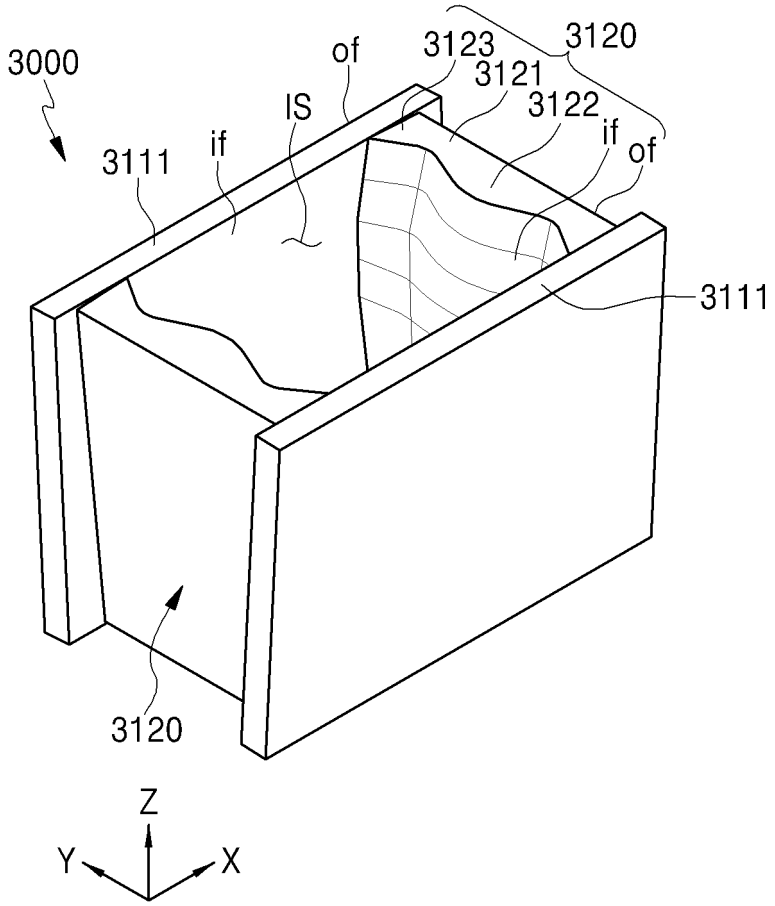
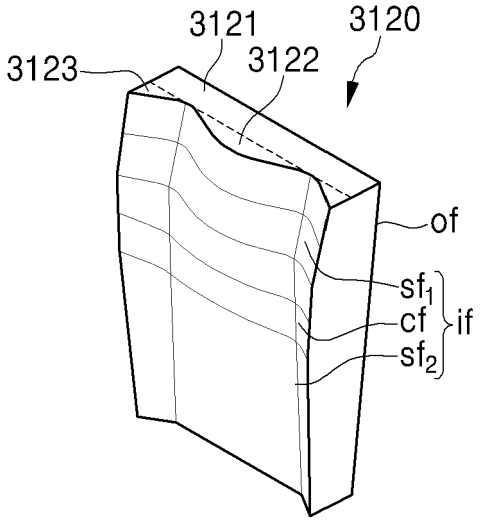

3000
of
3123
3120
3121
IS
3122
if
of
3111
if
3111
3120
Z
Y
X

FIG. 19


3121
3120
3123
3122
of
sf1
cf
if
sf2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2021/019194

A. CLASSIFICATION OF SUBJECT MATTER

B22D 11/04(2006.01)i; **B22D 11/041**(2006.01)i

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)

B22D 11/04(2006.01); B22D 11/059(2006.01); B22D 11/16(2006.01)

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

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

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

eKOMPASS (KIPO internal) & keywords: 주형(mold), 응고(shrink), 경사(angle), 모따기(chamfer)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2010-201450 A (MISHIMA KOSAN CO., LTD. et al.) 16 September 2010 (2010-09-16) See paragraphs [0012]-[0013], [0017] and [0020] and figures 1 and 2B.	1-6,10
Y		11-15
A		7-9,16-17
Y	KR 10-2019-0130430 A (POSCO) 22 November 2019 (2019-11-22) See paragraphs [0041], [0053], [0058], [0099]-[0100] and [0137] and figures 3-5, 9 and 22.	11-15
A	JP 01-162542 A (NKK CORP.) 27 June 1989 (1989-06-27) See claim 1 and figure 1.	1-17
A	JP 2012-157872 A (JFE STEEL CORP.) 23 August 2012 (2012-08-23) See paragraphs [0012]-[0018] and figure 3.	1-17

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search	Date of mailing of the international search report
23 March 2022	**23 March 2022**
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2021/019194

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2004-0059082 A (POSCO) 05 July 2004 (2004-07-05) See claim 1 and figure 7.	1-17

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2021/019194

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2010-201450 A	16 September 2010	JP 5180876 B2	10 April 2013
KR 10-2019-0130430 A	22 November 2019	CN 112118924 A	22 December 2020
		EP 3795273 A1	24 March 2021
		JP 2021-521016 A	26 August 2021
		KR 10-2074364 B1	06 February 2020
		WO 2019-221469 A1	21 November 2019
JP 01-162542 A	27 June 1989	None	
JP 2012-157872 A	23 August 2012	JP 5673149 B2	18 February 2015
KR 10-2004-0059082 A	05 July 2004	KR 10-0940679 B1	08 February 2010

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Patent documents cited in the description

- KR 1020000008003 **[0006]**