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

(11) EP 4 454 776 A1

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

(43) Date of publication:
30.10.2024 Bulletin 2024/44

(21) Application number: **22911675.1**

(22) Date of filing: **01.12.2022**

(51) International Patent Classification (IPC):
B21D 17/02 (2006.01) ***B21D 13/02*** (2006.01)
B21D 22/24 (2006.01) ***B21D 53/88*** (2006.01)

(52) Cooperative Patent Classification (CPC):
B21D 13/02; B21D 17/02; B21D 22/24; B21D 53/88

(86) International application number:
PCT/KR2022/019355

(87) International publication number:
WO 2023/121042 (29.06.2023 Gazette 2023/26)

(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: **20.12.2021 KR 20210182840**

(71) Applicant: **POSCO Co., Ltd**
Pohang-si, Gyeongsangbuk-do 37859 (KR)

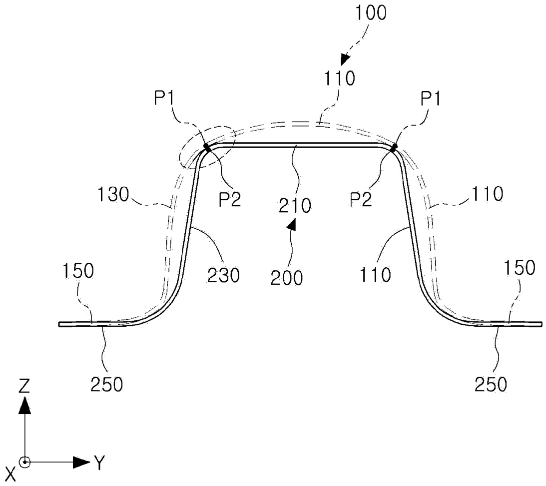
(72) Inventor: **OH, Kyung-Seok**
Incheon 21985 (KR)

(74) Representative: **Meissner Bolte Partnerschaft mbB**
Patentanwälte Rechtsanwälte
Postfach 86 06 24
81633 München (DE)

(54) METHOD FOR MANUFACTURING MOLDED PARTS

(57) The present invention provides a method for manufacturing molded parts, the method being characterized by comprising: a first molding step for molding a base material to form a first molded part including a first upper flange and a pair of first web members extending in intersecting directions from the left and right ends of the first upper flange; and a second molding step for compressing the first molded part to form a second molded part including a second upper flange and a pair of second web members extending in intersecting directions from the left and right ends of the second upper flange, wherein, in a width direction cross section, the first upper flange is longer than the second upper flange and the first web members are longer than the second web members.

FIG. 1b



EP 4 454 776 A1

Description

Technical Field

[0001] The present disclosure relates to a method for manufacturing molded members.

Background Art

[0002] It should be noted that the content described in this section merely provides background information on the present disclosure and does not constitute related art.

[0003] Automotive structural members have been developed for various purposes, such as high-strength shape members, high-stiffness members, compression collision members, and bending collision members. In particular, members to which multiple members are attached and which support complex collision loads should simultaneously possess different collision characteristics within a single member. In the case of a side member, for example, during a collision, a region adjacent to a load has to absorb collision energy, while collapsing, and a region away from the load has to support the collision energy.

[0004] In order to give different collision characteristics to a single member, it may be considered to design regions constituting a member to have different cross-sections to vary moments of region of the regions that resist an external load and to give a local operation to a surface of a region absorbing energy to induce sequential collapse during collision.

[0005] Hot press forming technology is a representative method for manufacturing members having different collision characteristics at the same time. Despite the disadvantages, such as heating equipment taking up a large space and high initial equipment investment costs, hot press forming technology, allowing for molding under high temperature conditions with relatively high ductility and low flow stress, has excellent formability and shape freezing, compared to cold forming, and thus, is applied to multiple new car platforms.

[0006] Recently, costs have been reduced by applying technology of molding two to four portions simultaneously in a single press operation, but the high price of raw materials still increases car body costs. For this reason, global automobile companies and parts companies have continuously attempted to replace some of the body members to which hot press forming technology has been applied with cold press forming technology to reduce costs.

[0007] In response to the demand, global steel companies have also developed steels having high strength (giga steels) with a tensile strength of 1000 MPa class and excellent ductility and new forming technologies suitable for the steel types. However, members with different collision characteristics have very complex shapes, such as having a deep depth, changing cross-section, and bending up, down, left, and right, and thus, forming giga steels, which have relatively poor ductility, by cold stamping involves problems, such as necking, cracks, wrinkles, shape holdability, and the like.

[0008] Among the above problems, shape holdability is a springback problem in which the shape changes due to elastic recovery when a member is released from a mold after molding. Types of springback include punch R opening, wall bending, and cross-sectional distortion. The size of springback increases as the strength increases, which is an important issue that should be solved in order to expand the application of members made by cold stamping of giga steels. Springback is known to be mainly caused by stress unevenness in a thickness direction and compressive residual stress, and it is necessary to review various solutions to resolve springback.

[0009] (Patent Document 1) KR 10-1995-0003541 B1

Summary of Invention

Technical Problem

[0010] An aspect of the present disclosure is to provide a method for manufacturing molded members having excellent shape holdability by eliminating springback to a level allowing for shape correction.

Solution to Problem

[0011] According to an aspect of the present disclosure, a method for manufacturing a molded member includes: a first molding operation of molding a base material to mold a first molded product including a first upper flange and a pair of first web members formed to extend in an intersecting direction from both ends of the first upper flange in a left-right direction; and a second molding operation of compressing the first molded product to mold a second molded product including a second upper flange and a pair of second web members formed to extend in an intersecting direction from both ends of the second upper flange in the left-right direction, wherein, in a transversal cross-section, a length of the first upper flange is greater than a length of the second upper flange, and a length of the first web member is greater than a length of the second web member.

[0012] In the transversal cross-section, the length of the first upper flange may be 105% to 120% of the length of the second upper flange, and in the transversal cross-section, the length of the first web member may be 105% to 120% of the length of the second web member.

[0013] In the second molding operation, molding may start in a state in which a first boundary point between the first upper flange and the first web member and a second boundary point between the second upper flange and the second web member overlap.

[0014] In the second molding operation, molding may proceed while both sides of an overlapping portion of the first boundary point and the second boundary point are pressed by a mold.

[0015] The first molded product may have a curved section around the first boundary point between the first upper flange and the first web member.

[0016] The first molded product may have a straight section around the first boundary point between the first upper flange and the first web member.

[0017] The second forming step may form a vertical bead portion, and the vertical bead portion may be formed by alternating a protruding surface and a depressed surface in the front-rear direction in the second web member, and the protruding surface and the depressed surface are connected by an inclined surface.

[0018] The vertical bead portion may be formed on the second web member and may be formed in an outer protruding portion protruding in a direction in which the second web member is away from the second upper flange.

[0019] Two to eight vertical bead portions may be arranged to be spaced apart from each other in the front-rear direction of the second web member.

[0020] In the vertical bead portion, a length of the depressed surface in the front-rear direction may range from 5 times or more and 30 times or less a thickness of a base material.

[0021] In the vertical bead portion, a distance between an extension line of the protruding surface and an extension line of the depressed surface may be twice or more and 10 times or less the thickness of the base material.

[0022] In the vertical bead portion, a length of the protruding surface in the front-rear direction may be 5 times or more and 30 times or less a thickness of the base material.

[0023] The vertical bead portion may have an arc-shaped shoulder portion formed at a boundary portion between the protruding surface and the depressed surface, and a radius of curvature of the shoulder portion is 4 times or more and 10 times or less a thickness of the base material.

[0024] The second molded product may be formed to extend in the front-rear direction, and positions of cross-sections of the second molded product in the up-down and left-right directions vary depending on a position of the second molded product in the front-rear direction.

[0025] In the second molded product, the second upper flange may have a first position variable section ranging from 80 to 200 mm in the up-down direction, and in the second molded product, the second upper flange has a second position variable section ranging from 40 to 120 mm in the left-right direction.

[0026] The base material may be a steel plate having a thickness in the range of 1.2 to 1.8 mm, and the base material is steel having a tensile strength of 980 MPa or more.

[0027] A cold forming method may be applied in the first molding operation and the second molding operation.

Advantageous Effects of Invention

[0028] According to an embodiment of the present disclosure, springback is eliminated to a level allowing for shape correction, resulting in excellent shape holdability.

Brief Description of Drawings

[0029]

FIG. 1a is a diagram illustrating a first molded product in a first molding operation represented by the solid line and a second molded product in a second molding operation represented by the dotted line.

FIG. 1a is a diagram illustrating a second molded product in a second molding operation represented by the solid line and a first molded product in a first molding operation represented by the dotted line.

FIG. 2a is a diagram illustrating a first molded product of a comparative example compared to the first molded product of the present disclosure.

FIG. 2b is a diagram illustrating a first molded product according to an embodiment of the present disclosure compared to the comparative example of FIG. 2a.

FIG. 2c is a diagram illustrating a first molded product according to another embodiment of the present disclosure compared to the comparative example of FIG. 2a.

FIG. 3a is a perspective view of a second molded product manufactured by a method for manufacturing a molded member according to an embodiment of the present disclosure.

FIG. 3b is a cross-sectional view taken along lines A-A' and B-B' of FIG. 3a.

FIG. 4a is an example of a cross-sectional view taken along line C-C' of FIG. 3a.

FIG. 4b is another example of a cross-sectional view taken along line C-C' of FIG. 3a.

FIG. 5a is a diagram illustrating a springback state when a first molding operation is not performed.

FIG. 5b is a diagram illustrating a springback state after the first molding operation is performed.

FIG. 6a is a diagram illustrating a springback state when a vertical bead portion is not formed in a second molding operation.

FIG. 6b is a diagram illustrating a springback state when the vertical bead portion is formed in the second molding operation.

FIG. 7a is a diagram illustrating a springback state when an interval between vertical bead portions formed in the second molding operation is excessive.

FIG. 7b is a diagram illustrating the springback state when the interval between vertical bead portions formed in the second molding operation is good.

FIG. 8 is a diagram illustrating comparison of various performance improvements of a comparative example to which a method for manufacturing molded members of the present disclosure is not applied and an example to which the method for manufacturing molded members of the present disclosure is applied.

FIGS. 9a and 9b are diagrams illustrating comparison of opening angles of punch R portions of the comparative example and the example of FIG. 8.

FIGS. 10a and 10b are diagrams illustrating comparison of radii of curvature of wall bending of the comparative example and the example of FIG. 8.

FIGS. 11a and 11b are diagrams illustrating comparison of angles of cross-sectional distortion of the comparative example and the example of FIG. 8.

FIG. 12a is a side view of a second molded product manufactured by a method for manufacturing molded members according to an embodiment of the present disclosure.

FIG. 12b is a plan view of a second molded product manufactured by a method for manufacturing molded members according to an embodiment of the present disclosure.

Best Mode for Invention

[0030] Hereinafter, preferred embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. In this case, in the drawings, the same components are denoted by the same reference symbols as possible. Further, the detailed description of well-known functions and constructions which may obscure the gist of the present disclosure will be omitted. For the same reason, some of the elements in the accompanying drawings are exaggerated, omitted, or schematically illustrated, and the size of each element does not entirely reflect the actual size.

[0031] Referring to the drawings, regarding a manufacturing method of the present disclosure, the first and second molded products are illustrated in a left-right direction, up-down direction, and front-rear direction, and the terms left-right direction, up-down direction, and front-rear direction are used in the detailed description of the invention. However, this is for convenience of description, and it should be noted that the technical features of the manufacturing method of the present disclosure are not limited thereto.

[0032] Hereinafter, in the attached drawings, the X-axis is the front-rear direction of the first and second molded products or the like, the Y-axis is the left-right direction of the first and second molded products or the like, and the Z-axis is the up-down direction of the first and second molded products or the like. A longitudinal cross-section is a cross-section along the X-Z axis, and a transversal cross-section is a cross-section on the Y-Z axis.

[0033] Hereinafter, components included in the method for manufacturing a molded member according to an embodiment of the present disclosure will be described in detail with reference to FIGS. 1a and 1b.

[0034] FIG. 1a is a diagram illustrating a first molded product 100 in a first molding operation represented by the solid line and a second molded product 200 in a second molding operation represented by the dotted line, and FIG. 1b is a diagram illustrating the second molded product 200 in the second molding operation represented by the solid line and the first molded product 100 in the first molding operation represented by the dotted line.

[0035] The method for manufacturing a molded member according to an embodiment of the present disclosure may include the first molding operation and the second molding operation.

[0036] In the first molding operation, a base material may be molded to mold a first molded product 100 including a first upper flange 110 and a pair of first web members 130 formed to extend in an intersecting direction from both ends of the first upper flange 110 in the left-right direction.

[0037] Of course, a first lower flange 150 may be formed to extend in an intersecting direction from the first web member 130 in the first molded product 100. For example, the first web member 130 may include a lower curved portion in the up-down direction, and the first lower flange 150 may include only a straight section.

[0038] In the second molding operation, the first molded product 100 may be compressed to mold the second molded product 200 including a second upper flange 210 and a pair of second web members 230 extending in an intersecting direction from both ends of the second upper flange 210 in the left-right direction

[0039] Of course, a second lower flange 250 may be formed to extend in an intersecting direction from the second web member 230 in the second molded product 200. For example, the second web member 230 may include a lower curved portion in the up-down direction, and the second lower flange 250 may include only a straight section.

[0040] In a transversal cross-section, a length of the first upper flange 110 may be greater than a length of the second upper flange 210, and a length of the first web member 130 may be greater than a length of the second web member 230.

[0041] The second molding operation may be an operation of compressing the first molded product 100 to match a final cross-section of the second molded product 200. When the second molding operation is completed, the first molded product 100 may be molded into the second molded product 200 having the final cross-section matching a final product. That is, the second molded product 200 may be a final product.

[0042] A cold press forming method may be applied to the method for manufacturing molded members of the molded member of the present disclosure.

[0043] In the transversal cross-section, the length of the first upper flange 110 may be 105% to 120% of the length of the second upper flange 210, and in the transversal cross-section, the length of the first web member 130 may be 1050 to 120% of the length of the second web member 230.

[0044] As the first molded product 100 is compressed to be molded into the second molded product 200, the first upper flange 110 may be compressed into the second upper flange 210 and the first web member 130 may be compressed into the second web member 230.

[0045] If the length of the first upper flange 110 is less than 1050 of the length of the second upper flange 210, it may be difficult to induce tensile residual stress, and if the length of the first upper flange 110 exceeds 120% of the length of the second upper flange 210, wrinkles may occur in the second upper flange 210 to increase the possibility of defects occurring in the second molded product 200.

[0046] If the length of the first web member 130 is less than 1050 of the length of the second web member 230, it may be difficult to induce tensile residual stress, and if the length of the first web member 130 exceeds 120% of the length of the second web member 230, wrinkles may occur in the second web member 230 to increase the possibility of defects occurring in the second molded product 200.

[0047] FIG. 2a is a diagram illustrating a first molded product 100 of a comparative example compared to the first molded product 100 of the present disclosure, FIG. 2b is a diagram illustrating a first molded product according to an embodiment of the present disclosure compared to the comparative example of FIG. 2a, and FIG. 2c is a drawing illustrating a first molded product 100 according to another embodiment of the present disclosure compared to the comparative example of FIG. 2a.

[0048] Referring to FIG. 2a, in the case of the first molded product 100 of the comparative example compared to the first molded product 100 of the present disclosure, a first boundary point between the first upper flange 110 and the first web member 130 and a second boundary point between the second upper flange 210 and the second web member 230 does not overlap.

[0049] A first compression section in which the first upper flange 110 is compression-molded into the second upper flange 210 and a second compression section in which the first web member 130 is compression-molded into the second web member 230 are not distinguished from each other, the first compression section and the second compression section may be pushed against each other, causing a problem in that wrinkles frequently occur in the second molded product 200.

[0050] Referring to FIGS. 2b and 2c, in the second molding operation, molding may start in a state in which a first boundary point between the first upper flange 110 and the first web member 130 and a second boundary point between the second upper flange 210 and the second web member 230 overlap.

[0051] The first boundary point of the first upper flange 110 and the first web member 130 may be formed in the first molded product 100, and the second boundary point of the second upper flange 210 and the second web member 230 may be formed in the second molded product 200.

[0052] As molding is performed in a state in which the first boundary point and the second boundary point overlap, compression molding may proceed in a state in which a first compression section in which the first upper flange 110 is compression-molded into the second upper flange 210 and a second compression section in which the first web member 130 is compression-molded into the second web member 230 are separated from each other.

[0053] In the second molding operation, forming may proceed while both sides of an overlapping portion of the first boundary point and the second boundary point are pressed by a mold.

[0054] In the second molding operation, since molding proceeds while both sides of the overlapping portion of the first boundary point and the second boundary point are pressed by the mold, the overlapping portion may be firmly fixed by the mold while the section in which the first upper flange 110 is compression-molded into the second upper flange 210 and the section in which the first web member 130 is compression-molded into the second web member 230 are separated from each other.

[0055] Accordingly, as compression molding proceeds with the first compression section and the second compression section firmly fixed, the occurrence of wrinkles frequently in the second molded product 200 due to a phenomenon in which the first compression section is pushed into the second compression section may be prevented.

[0056] Referring to FIG. 2b, the first molded product 100 may have a curved section around the first boundary point between the first upper flange 110 and the first web member 130.

[0057] Referring to FIG. 2c, the first molded product 100 may have a straight section around the first boundary point between the first upper flange 110 and the first web member 130.

[0058] FIG. 3a is a perspective view of the second molded product 200 manufactured by the method for manufacturing molded members according to an embodiment of the present disclosure, and FIG. 3b is a cross-sectional view taken along lines A-A' and B-B' of FIG. 3a.

[0059] FIG. 4a is an example of a cross-sectional view taken along line C-C' of FIG. 3a, and FIG. 4b is another example of a cross-sectional view taken along line C-C' of FIG. 3a.

[0060] The cross-sectional size of the second molded product 200 may vary in the front-rear direction. The second molded product 200 may be designed to have a different cross-section for each region constituting the molded member to vary a cross-sectional moment resistant to an external load and have a local step in a surface of a region absorbing energy to induct sequential collapse in the case of a collision.

[0061] The second forming step may form a vertical bead portion 270, and the vertical bead portion 270 may be formed by alternating a protruding surface 271 and a depressed surface 273 in the front-rear direction in the second web member, and the protruding surface 271 and the depressed surface 273 are connected by an inclined surface 275.

[0062] A plurality of vertical bead portions 270 may be formed to be spaced apart from each other in the front-rear direction of the second web member 230, and in the vertical bead portion 270, the depressed surface 273 may be formed to extend in the up-down direction and the protruding surface 271 may be formed to extend in the up-down direction.

[0063] Since the plurality of vertical bead portions 270 are formed to be spaced apart from each other in the front-rear direction of the second web member 230, the rigidity of the second web member 230 may increase to reduce cross-sectional distortion. Accordingly, springback may be resolved to a level allowing for a shape correction, which has the effect of producing a final product having excellent shape holdability.

[0064] Here, springback is a phenomenon in which a molded member changes in shape due to elastic recovery when released from the mold after molding, and a reduction in springback may lead to excellent shape holdability.

[0065] For example, it may be desirable to reduce the angle of cross-sectional distortion due to springback or the like to 3 degrees or less.

[0066] The vertical bead portion 270 may be formed on the second web member 230 and may be formed in an outer protruding portion 290 protruding in a direction in which the second web member 230 is away from the second upper flange 210. The outer protruding portion 290 is a portion of the second web member 230 protruding convexly outwardly in the left-right direction.

[0067] Since the vertical bead portion 270 is formed on the outer protruding portion 290 protruding convexly outwardly in the left-right direction in the second web member 230, the vertical bead portion 270 serves to change compressive residual stress into tensile residual stress in the outer protruding portion 290, achieving the effect of stably reducing springback in the outer protruding portion 290.

[0068] Two to eight vertical bead portions 270 may be arranged to be spaced apart from each other in the front-rear direction of the second web member 230. Tensile residual stress may be induced only when at least two vertical bead portions 270 are arranged in succession, and if the number of vertical bead portions 270 exceeds eight, the risk of shear cracking may increase.

[0069] In the vertical bead portion 270, a length L1 of the depressed surface in the front-rear direction may range from 5 times or more and 30 times or less a thickness of a base material.

[0070] If the length L1 of the depressed surface in the front-rear direction is less than 5 times the thickness of the base material, the risk of necking and cracking may increase, and if the length L1 of the depressed surface in the front-rear direction exceeds 30 times the thickness of the base material, it may be difficult to induce tensile residual stress.

[0071] In the vertical bead portion 270, a distance L2 between an extension line of the protruding surface 271 and an extension line of the depressed surface 273 may be twice or more and 10 times or less the thickness of the base material.

[0072] If the distance L2 between the extension line of the protruding surface 271 and the extension line of the depressed surface 273 is less than twice the thickness of the base material, the increase in cross-sectional rigidity may be insignificant, so rigidity reinforcement may not be efficient, and if the distance L2 between the extension line of the protruding surface 271 and the extension line of the depressed surface 273 exceeds 10 times the thickness of the base material, the risk of necking and cracking may increase.

[0073] In the vertical bead portion 270, a length L3 of the protruding surface in the front-rear direction may be 5 times or more and 30 times or less the thickness of the base material.

[0074] If the length L3 of the protruding surface in the front-rear direction is less than 5 times the thickness of the base material, the risk of necking and cracking may increase, and if the length L3 of the protruding surface in the front-rear direction exceeds 30 times the thickness of the base material, the yield of the material may decrease.

[0075] FIG. 4a is an example of a cross-sectional view taken along line C-C' of FIG. 3a, and FIG. 4b is another example of a cross-sectional view taken along line C-C' of FIG. 3a. In the case of FIGS. 4a and 4b, the lengths L3 in the front-rear direction of the protruding surfaces are the same, and the distances L2 between the extension line of the protruding surface 271 and the extension line of the depressed portion 273 are the same. In the case of FIG. 4b, the length L1 of the depressed portion is formed to be approximately twice as long, compared to FIG. 4a.

[0076] The vertical bead portion 270 may have an arc-shaped shoulder portion 277 formed at a boundary portion between the protruding surface 271 and the depressed surface 273, and the radius of curvature of the shoulder portion may be 4 times or more and 10 times or less the thickness of the base material.

[0077] If the radius of curvature of the shoulder portion 277 is less than 4 times the thickness of the base material, the risk of bending cracks may increase, and if the radius of curvature of the shoulder portion 277 exceeds 10 times the thickness of the base material, induction of tensile residual stress may become insignificant and the increase in cross-sectional rigidity may become insignificant.

[0078] Hereinafter, the degrees of occurrence of springback will be compared and described with reference to FIGS. 5a to 7b. In FIGS. 5a to 7b, a state in which springback does not occur is represented by the dotted line, and a state in which springback occurs is represented by the solid line.

[0079] FIG. 5a is a diagram illustrating a springback state of a comparative example E1 that did not undergo the first molding operation, and FIG. 5b is a diagram illustrating a springback state of an example E2 that went through the first molding operation.

[0080] Referring to FIGS. 5a and 5b, it can be seen that, in the case of comparative example E1 that did not undergo the first molding operation, springback occurred severely compared to the case of example E2 that went through the first molding operation, thereby resulting in the occurrence of significant dimension errors in the shape of the final product.

[0081] FIG. 6a is a diagram illustrating a springback state in the case of comparative example E1 in which the vertical bead portion 270 was not formed in the second molding operation, and FIG. 6b is a diagram illustrating a springback state in the case of example E2 in which the vertical bead portion 270 was formed in the second molding operation.

[0082] Referring to FIGS. 6a and 6b, it can be seen that, in the case of comparative example E1 in which the vertical bead portion 270 was not molded in the second molding operation, springback occurred severely compared to the case of example E2 in which the vertical bead portion 270 was molded in the second molding operation, thereby resulting in the occurrence of significant dimension errors in the shape of the final product.

[0083] FIG. 7a is a diagram illustrating a springback state in the case of comparative example E1 in which an interval between the vertical bead portions 270 formed in the second molding operation is excessive, and FIG. 7b is a diagram illustrating a springback state in the case of Example E2 in which the interval between the vertical bead portions 270 formed in the second molding operation is good.

[0084] Referring to FIGS. 7a and 7b, it can be seen that, in the case of Comparative Example E1 in which the interval between the vertical bead portions 270 formed in the second molding operation is excessive, springback occurred severely compared to the case of example E2 in which the interval between the vertical bead portions 270 formed in the second molding operation is good, thereby resulting in the occurrence of significant dimension errors in the shape of the final product.

[0085] Hereinafter, comparison of various performance improvements of comparative example E1 to which a method for manufacturing molded members of the present disclosure is not applied and Example E2 to which the method for manufacturing molded members of the present disclosure is applied will be described with reference to FIGS. 8 to 11b.

[0086] FIG. 8 is a diagram illustrating comparison of various performance improvements of comparative example E1 to which a method for manufacturing molded members of the present disclosure is not applied and Example E2 to which the method for manufacturing molded members of the present disclosure is applied.

[0087] FIGS. 9a and 9b are diagrams illustrating comparison of opening angles of punch R portions of comparative example E1 and example E2 of FIG. 8. In FIGS. 9a and 9b, a state in which the punch R portion is not opened is represented by the dotted line and a state in which the punch R portion is opened is represented by the solid line.

[0088] Referring to FIGS. 9a and 9b, in the case of Comparative Example E1, an opening angle S of the punch R portion is 12 degrees, and in the case of example E2, the opening angle S of the punch R portion is 2 degrees. It can be seen that, in Comparative Example E1, springback occurred severely and the opening angle S of the punch R portion increased, thereby resulting in the occurrence of significant dimension errors in the shape of the final product.

[0089] FIGS. 10a and 10b are diagrams illustrating comparison of radii of curvature T of wall bending of comparative example E1 and example E2 of FIG. 8. In FIGS. 10a and 10b, a state in which wall bending did not occur is represented by the dotted line, and a state in which wall bending occurred is represented by the solid line.

[0090] Referring to FIGS. 10a and 10b, in the case of comparative example E1, the radius of curvature T of the wall bending was 150 mm, and in the case of Example E2, the radius of curvature T of the wall bending was 300 mm. It can be seen that, in Comparative Example E1, springback occurred severely, and as the radius of curvature T of the wall bending occurred significantly, thereby resulting in the occurrence of significant dimension errors in the shape of the final product.

[0091] FIGS. 11a and 11b are diagrams illustrating comparison of angles U of cross-sectional distortion of comparative example E1 and example E2 of FIG. 8. In FIGS. 11a and 11b, a state in which cross-sectional distortion did not occur is represented by the dotted line and a state in which cross-sectional distortion occurred is represented by the solid line.

[0092] Referring to FIGS. 11a and 11b, the angle U of the cross-sectional distortion of Comparative Example E1 is 9 degrees, and the angle U of the cross-sectional distortion of Example E2 is 2 degrees. It can be seen that, in Comparative Example E1, springback occurred severely and the angle of the cross-sectional distortion increased, thereby resulting in the occurrence of significant dimension errors in the shape of the final product.

[0093] FIG. 12a is a side view of the second molded product 200 manufactured by the method for manufacturing molded members according to the embodiment of the present disclosure.

[0094] FIG. 12b is a plan view of the second molded product 200 manufactured by the method for manufacturing molded members according to the embodiment of the present disclosure.

[0095] The second molded product 200 is formed to extend in the front-rear direction, and the positions of the cross-sections of the second molded product 200 in the up-down and left-right directions may vary depending on the position of the second molded product 200 in the front-rear direction.

[0096] In the second molded product 200, the second upper flange 210 may have a first position variable section ranging from 80 to 200 mm in the up-down direction, and the second upper flange 210 may have a second position variable section ranging from 40 to 120 mm in the left-right direction.

[0097] For example, in the second molded product 200, based on the center portion of the second upper flange 210 in the left-right direction, a difference between the uppermost portion and the lowermost portion in the up-down direction may range from 80 to 200 mm, and based on the center portion of the second upper flange 210 in the left-right direction, a difference between the leftmost portion and the rightmost portion in the left-right direction may range from 40 to 120 mm.

[0098] The base material may be a steel plate having a thickness in the range of 1.2 to 1.8 mm, and the base material may be steel having a tensile strength of 980 MPa or more.

[0099] A cold forming method may be applied in the first molding operation and the second molding operation. The cold forming method to which the first molding operation and the second molding operation are applied may be a cold stamping forming method or a cold press forming method.

[0100] According to the method for manufacturing molded members of the present disclosure, a cold forming method may be applied in the first and second molding operations, thereby reducing equipment investment costs and achieving excellent shape holdability by resolving springback of a manufactured molded member to a level allowing for shape correction, unlike the hot forming method, which requires excessive equipment investment costs.

[0101] While the present invention has been described with respect to the specific embodiments, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention as defined in the following claims.

[Description of Reference Characters]

[0102]

100: first molded product 110: first upper flange
130: first web member 150: first lower flange
200: second molded product 210: Second upper flange
230: second web member 250: second lower flange
270: vertical bead portion 271: protruding surface
273: depressed portion 275: inclined surface
277: shoulder portion 290: outer protruding portion
E1: comparative example E2: example
L1: length of depressed portion in front-rear direction
L2: distance between extension line of protruding surface and extension line of depressed portion
L3: length of protruding surface in front-rear direction
P1: first boundary point P2: second boundary point
S: opening angle of punch R portion T: radius of curvature of wall bending
U: angle of cross-sectional distortion

Claims

1. A method for manufacturing a molded member, the method comprising:

a first molding operation of molding a base material to mold a first molded product including a first upper flange and a pair of first web members formed to extend in an intersecting direction from both ends of the first upper flange in a left-right direction; and
a second molding operation of compressing the first molded product to mold a second molded product including a second upper flange and a pair of second web members formed to extend in an intersecting direction from both ends of the second upper flange in the left-right direction,
wherein, in a transversal cross-section, a length of the first upper flange is greater than a length of the second upper flange, and a length of the first web member is greater than a length of the second web member.

2. The method of claim 1, wherein,

in the transversal cross-section, the length of the first upper flange is 105% to 120% of the length of the second upper flange, and
in the transversal cross-section, the length of the first web member is 105% to 120% of the length of the second web member.

3. The method of claim 1, wherein, in the second molding operation, molding starts in a state in which a first boundary point between the first upper flange and the first web member and a second boundary point between the second upper flange and the second web member overlap.

4. The method of claim 3, wherein, in the second molding operation, molding proceeds while both sides of an overlapping portion of the first boundary point and the second boundary point are pressed by a mold.

5. The method of claim 1, wherein the first molded product has a curved section around the first boundary point between the first upper flange and the first web member.

6. The method of claim 1, wherein the first molded product has a straight section around the first boundary point between the first upper flange and the first web member.

7. The method of claim 1, wherein, the second forming step forms a vertical bead portion, and the vertical bead portion is formed by alternating a protruding surface and a depressed surface in the front-rear direction in the second web member, and the protruding surface and the depressed surface are connected by an inclined surface.

8. The method of claim 7, wherein the vertical bead portion is formed on the second web member and is formed in an outer protruding portion protruding in a direction in which the second web member is away from the second upper flange.

9. The method of claim 7, wherein two to eight vertical bead portions are arranged to be spaced apart from each other in the front-rear direction of the second web member.

10. The method of claim 7, wherein, in the vertical bead portion, a length of the depressed surface in the front-rear direction ranges from 5 times or more and 30 times or less a thickness of a base material.

11. The method of claim 7, wherein, in the vertical bead portion, a distance between an extension line of the protruding surface and an extension line of the depressed surface is twice or more and 10 times or less the thickness of the base material.

12. The method of claim 7, wherein, in the vertical bead portion, a length of the protruding surface in the front-rear direction is 5 times or more and 30 times or less a thickness of the base material.

13. The method of claim 7, wherein the vertical bead portion has an arc-shaped shoulder portion formed at a boundary portion between the protruding surface and the depressed surface, and a radius of curvature of the shoulder portion is 4 times or more and 10 times or less a thickness of the base material.

14. The method of claim 1, wherein the second molded product is formed to extend in the front-rear direction, and positions of cross-sections of the second molded product in the up-down and left-right directions vary depending on a position of the second molded product in the front-rear direction.

15. The method of claim 1, wherein,

in the second molded product, the second upper flange has a first position variable section ranging from 80 to 200 mm in the up-down direction, and
in the second molded product, the second upper flange has a second position variable section ranging from 40 to 120 mm in the left-right direction.

16. The method of claim 1, wherein the base material is a steel plate having a thickness in the range of 1.2 to 1.8 mm, and the base material is steel having a tensile strength of 980 MPa or more.

17. The method of any one of claims 1 to 16, wherein a cold forming method is applied in the first molding operation and the second molding operation.

FIG. 1a

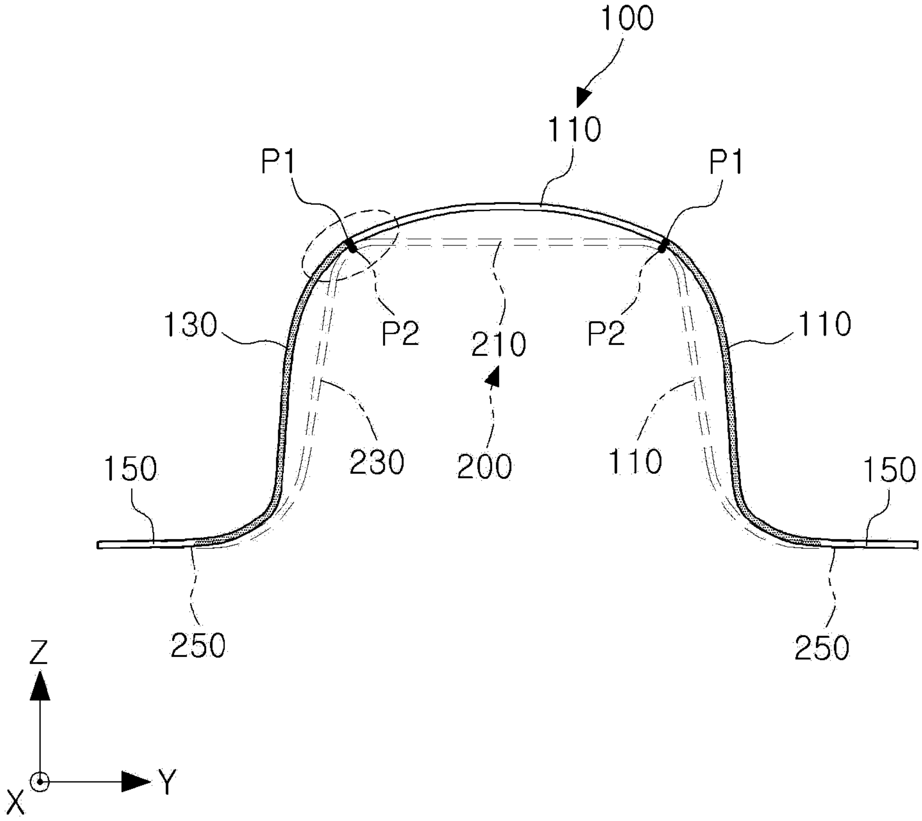


FIG. 1b

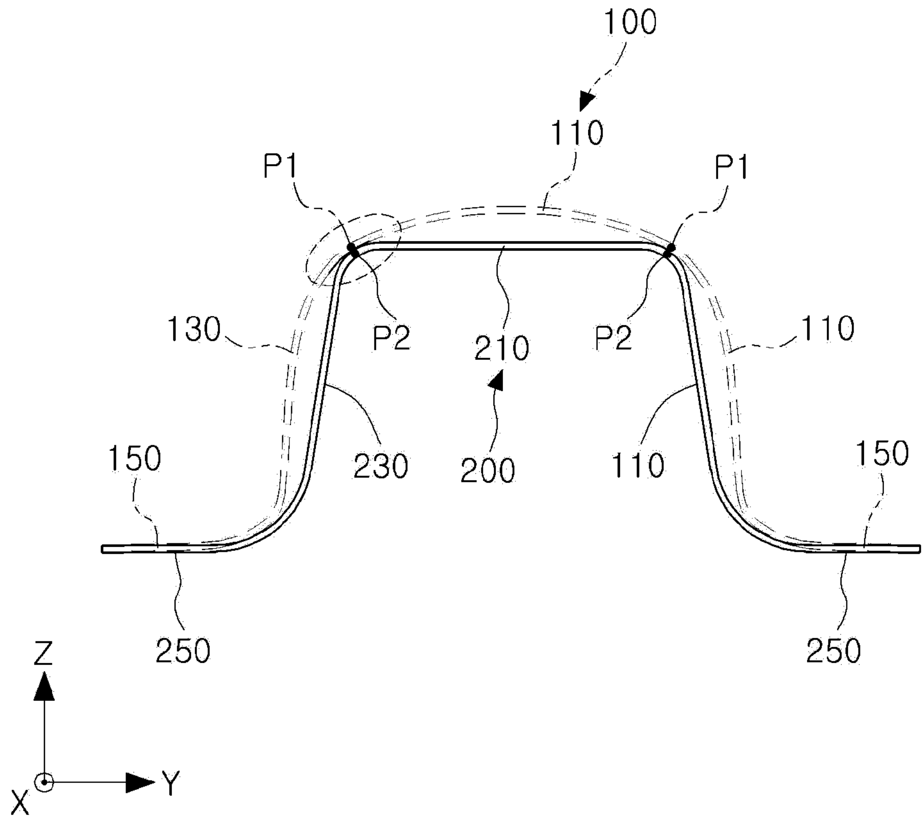


FIG. 2a

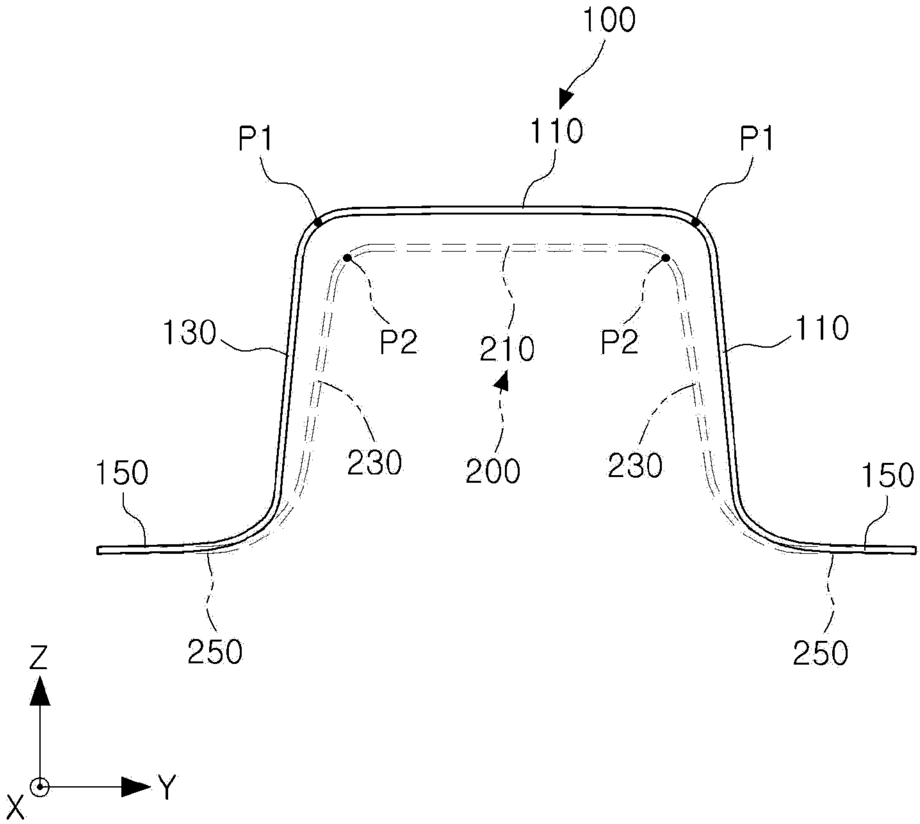


FIG. 2b

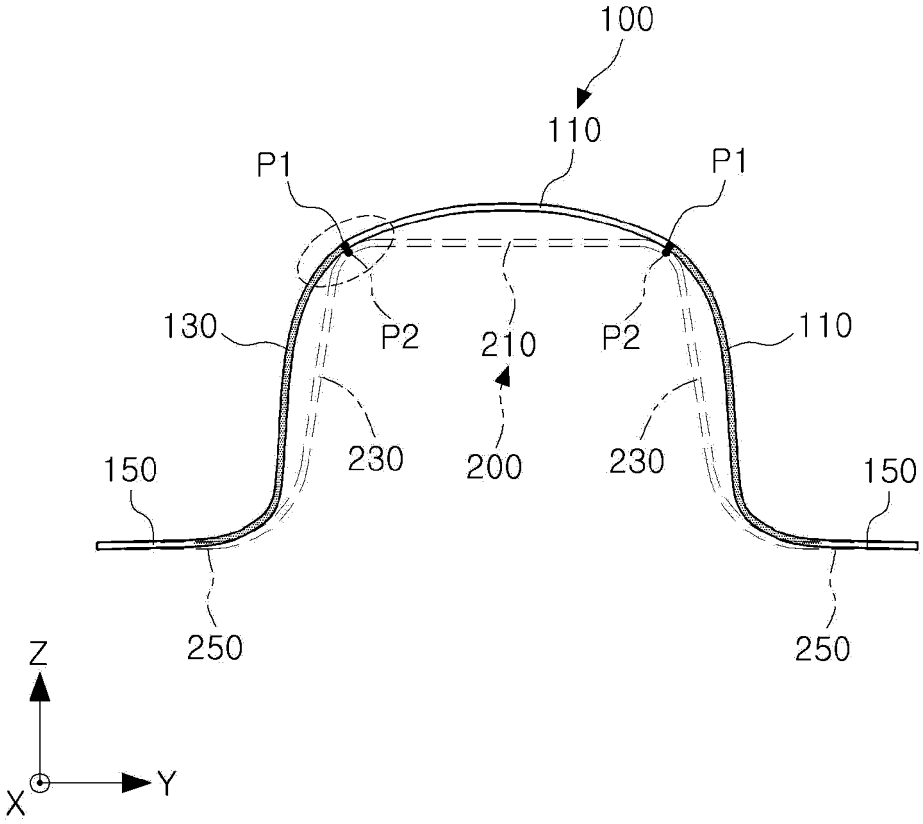


FIG. 2c

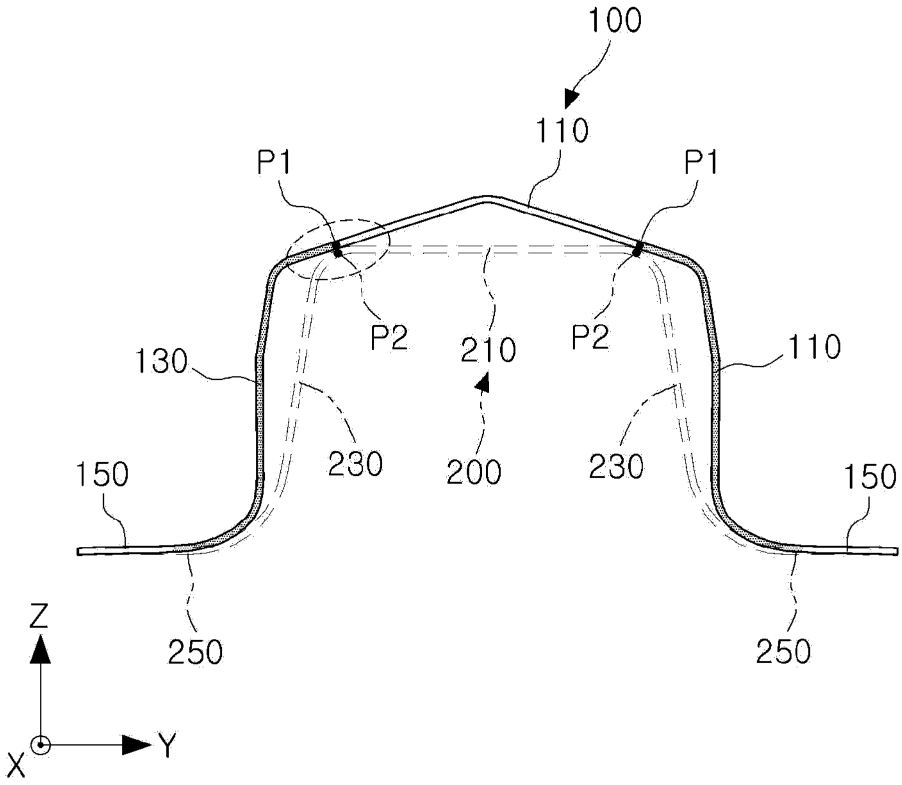


FIG. 3a

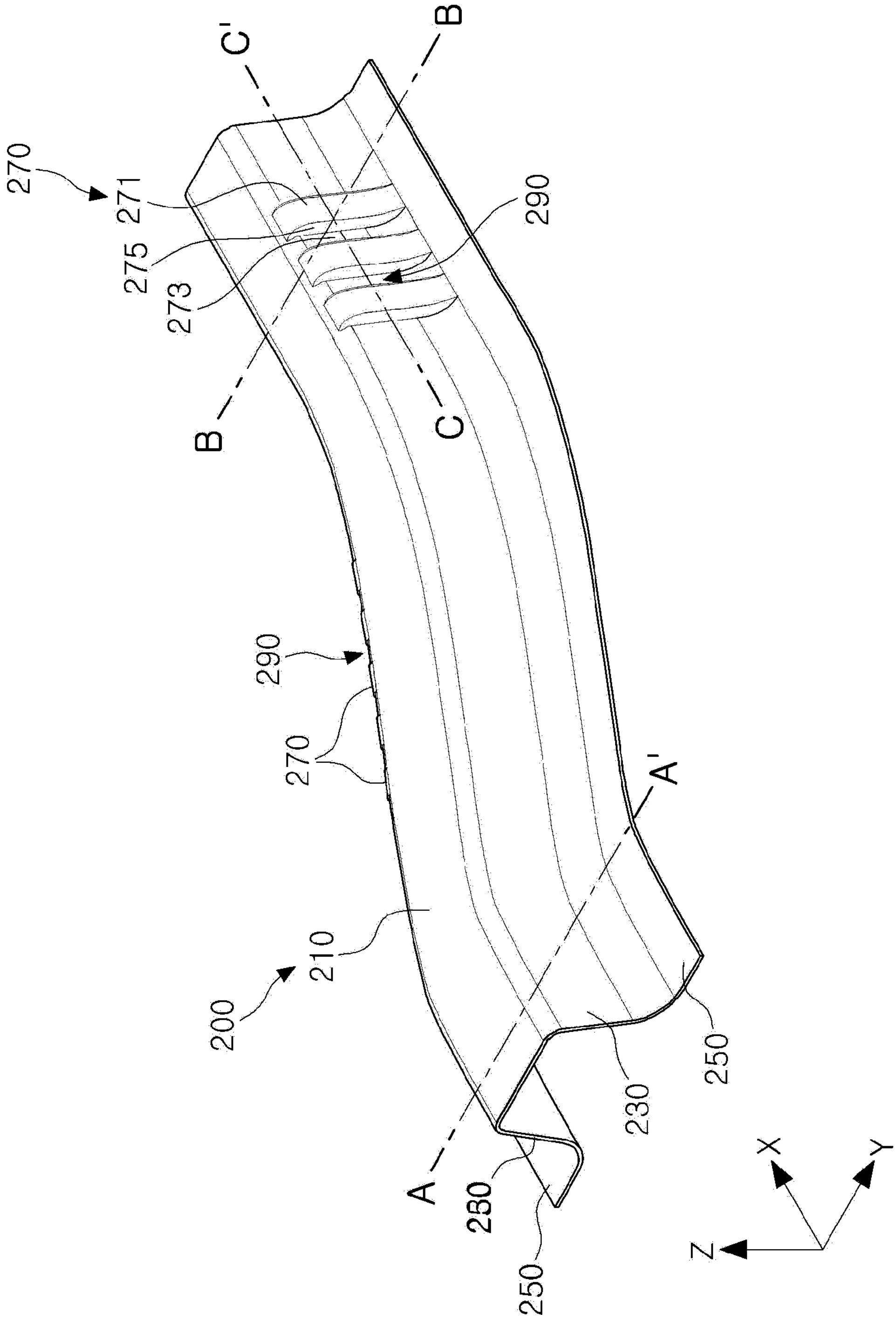
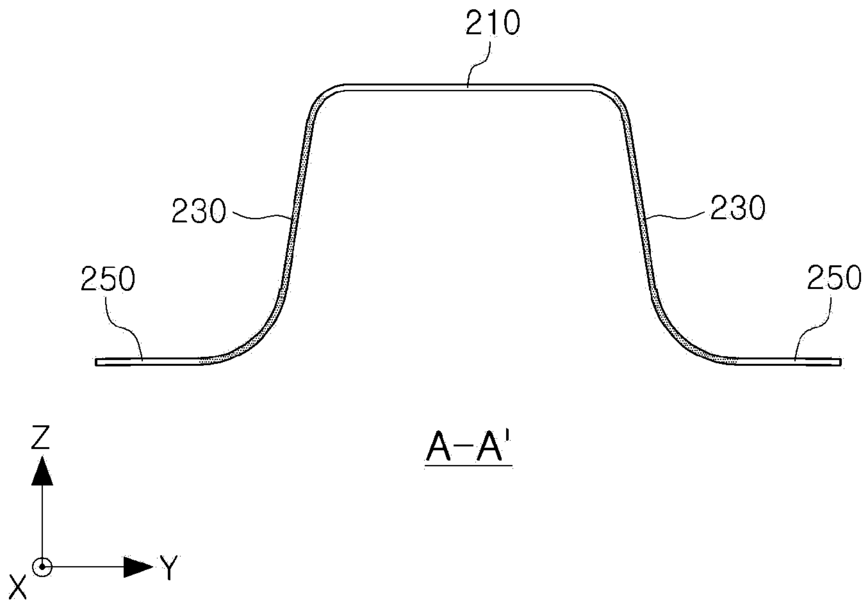


FIG. 3b



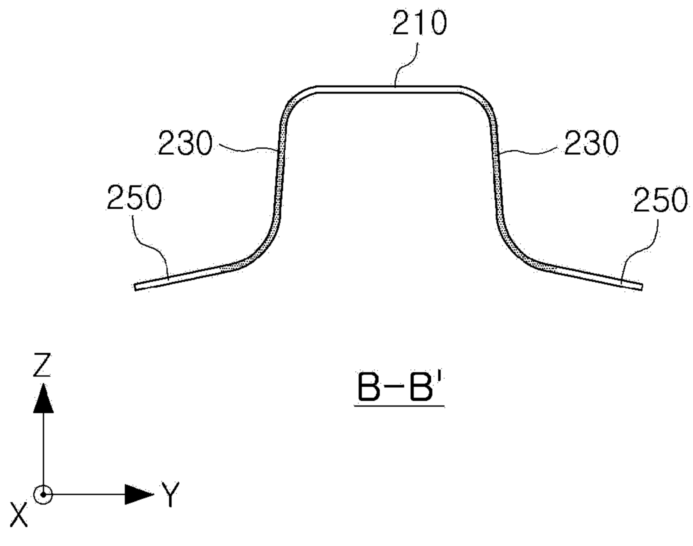


FIG. 4a

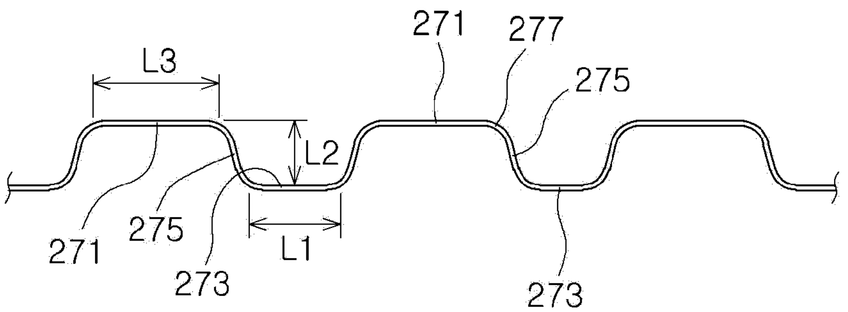


FIG. 4b

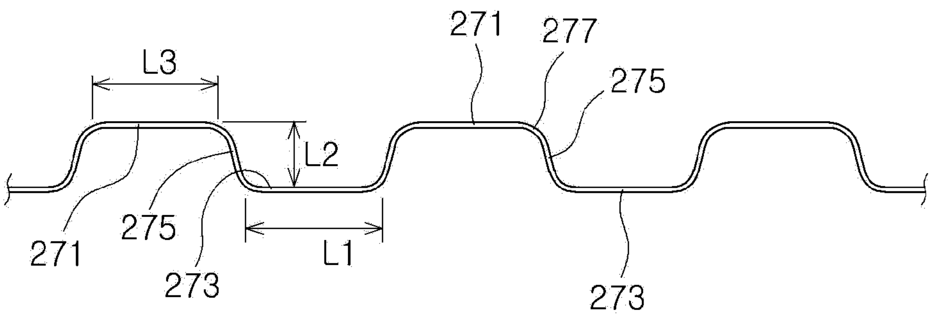


FIG. 5a

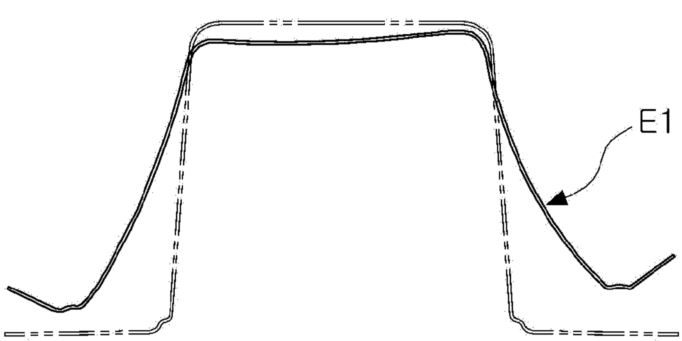


FIG. 5b

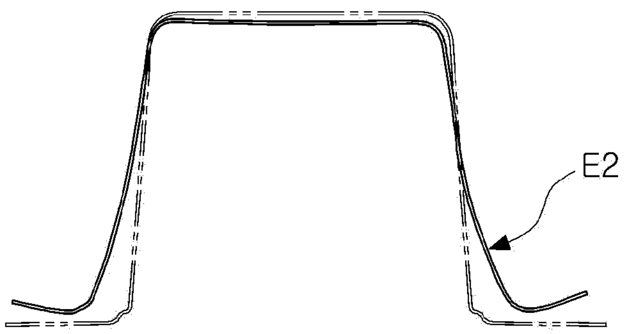


FIG. 6a

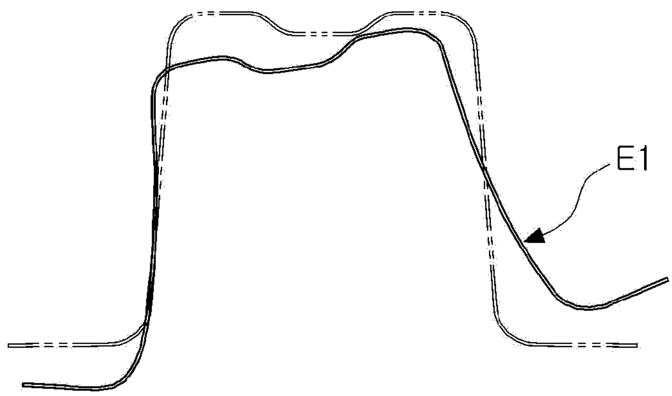


FIG. 6b

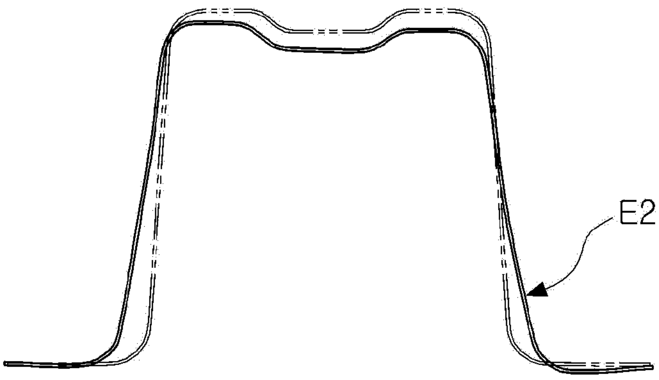


FIG. 7a

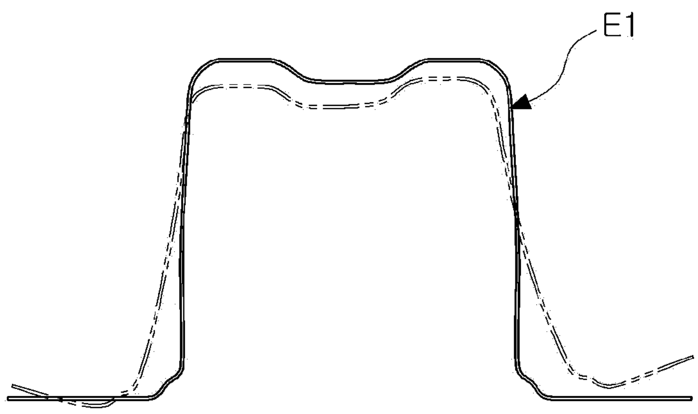


FIG. 7b

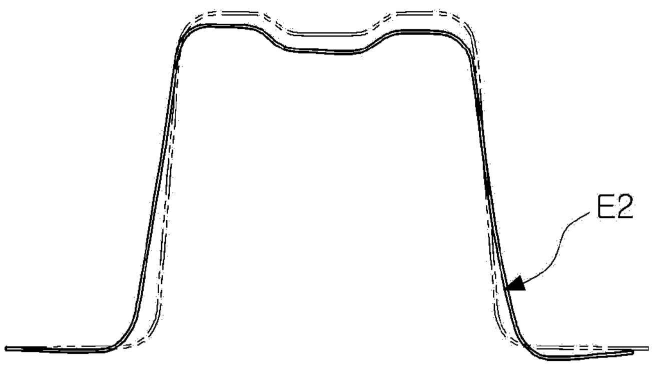


FIG. 8

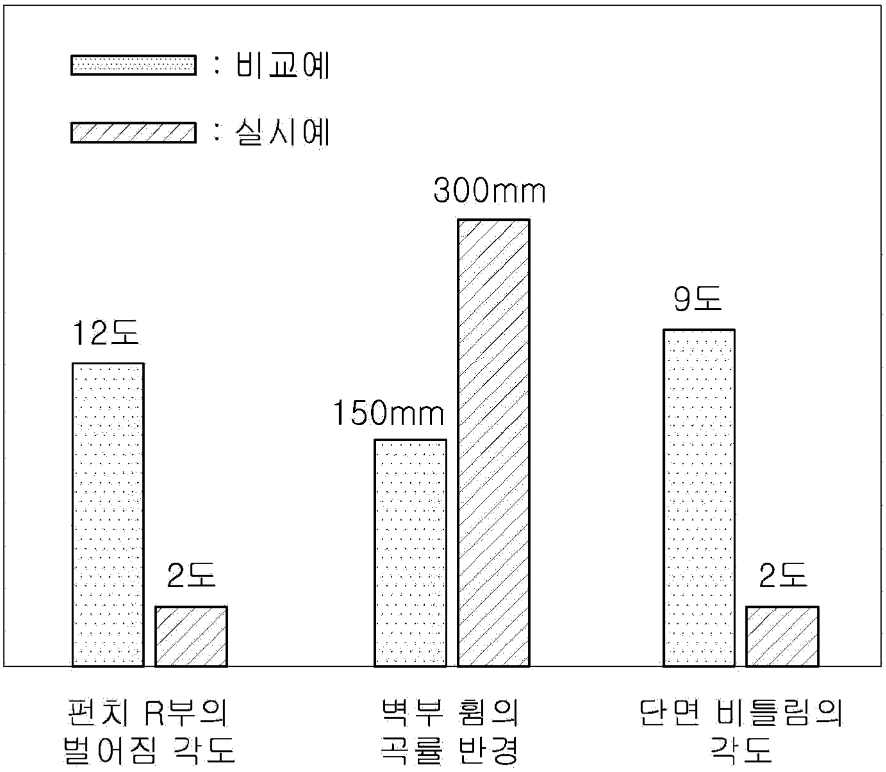

: 비교예
: 실시예
300mm
9도
12도
150mm
2도
2도
편치 R부의
벌어짐 각도
벽부 휨의
곡률 반경
단면 비틀림의
각도

FIG. 9a

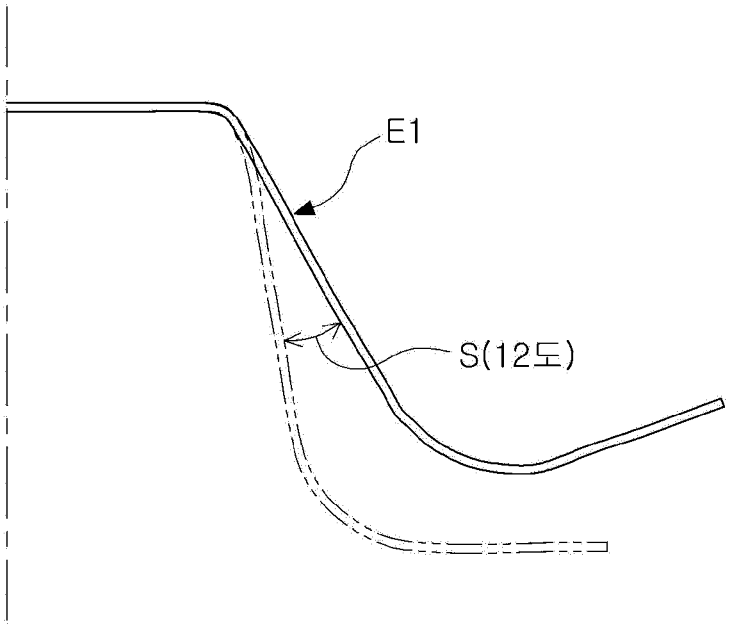

E1
S(12도)

FIG. 9b

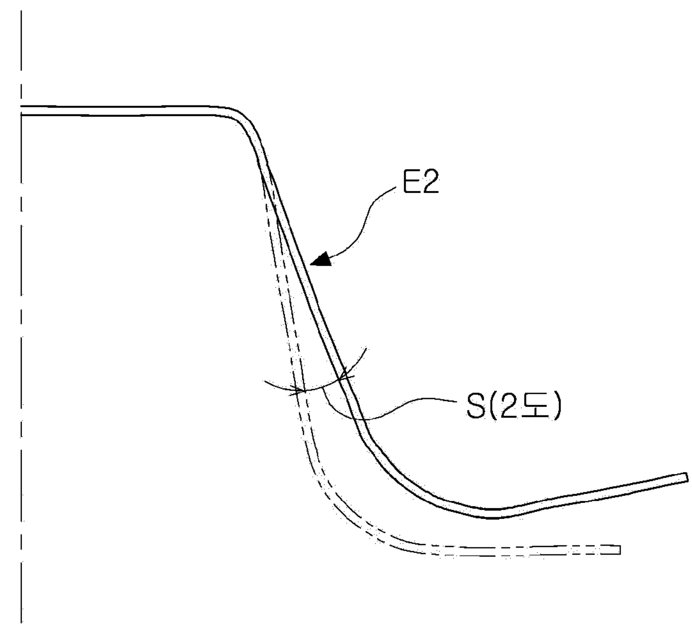


FIG. 10a

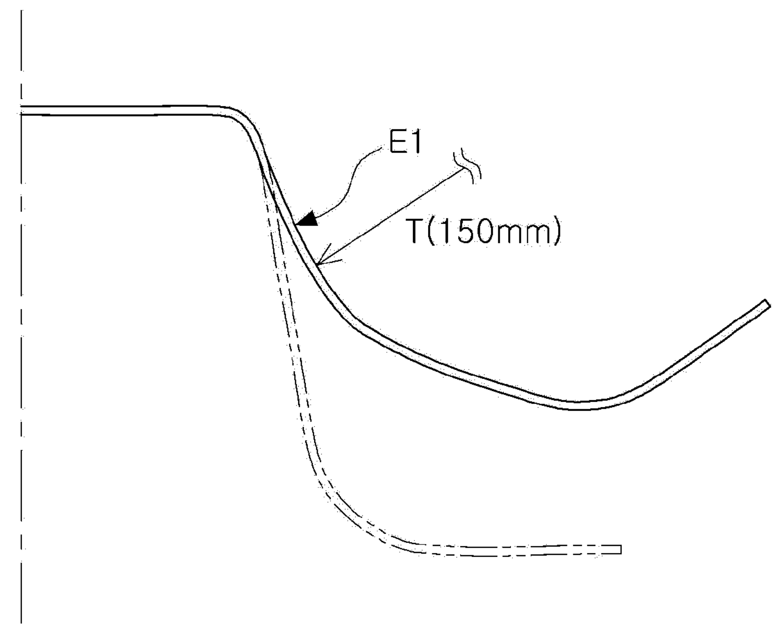


FIG. 10b

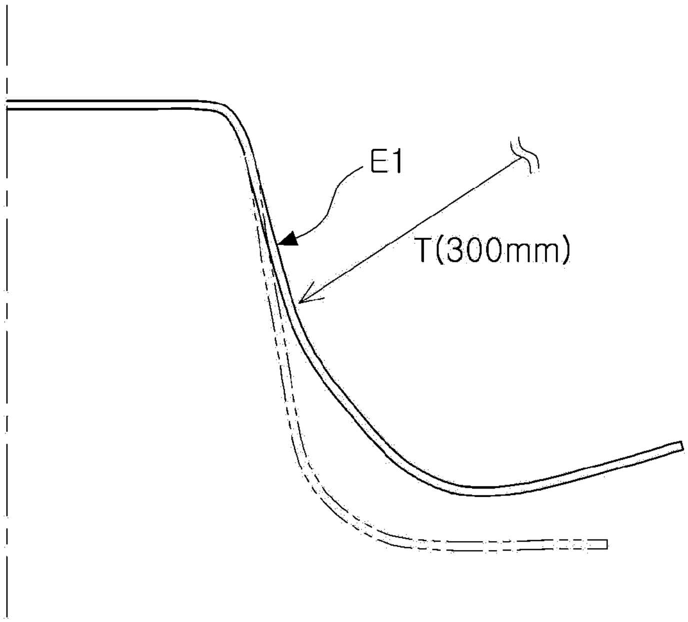


FIG. 11a

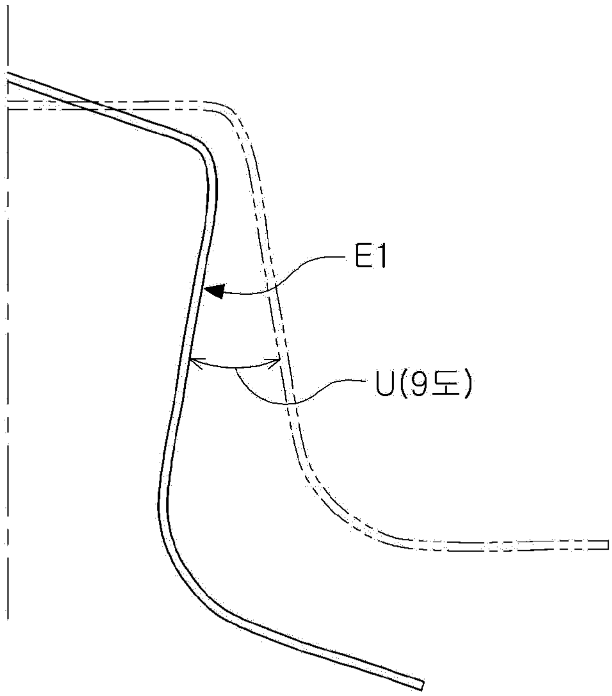


FIG. 11b

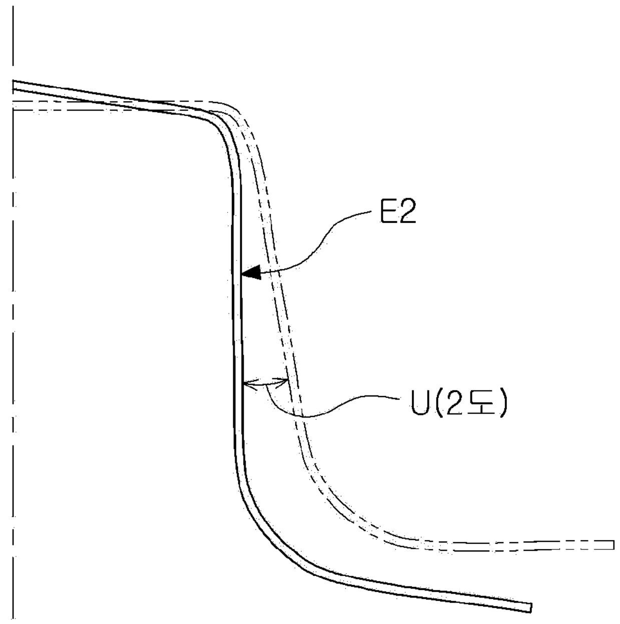


FIG. 12a

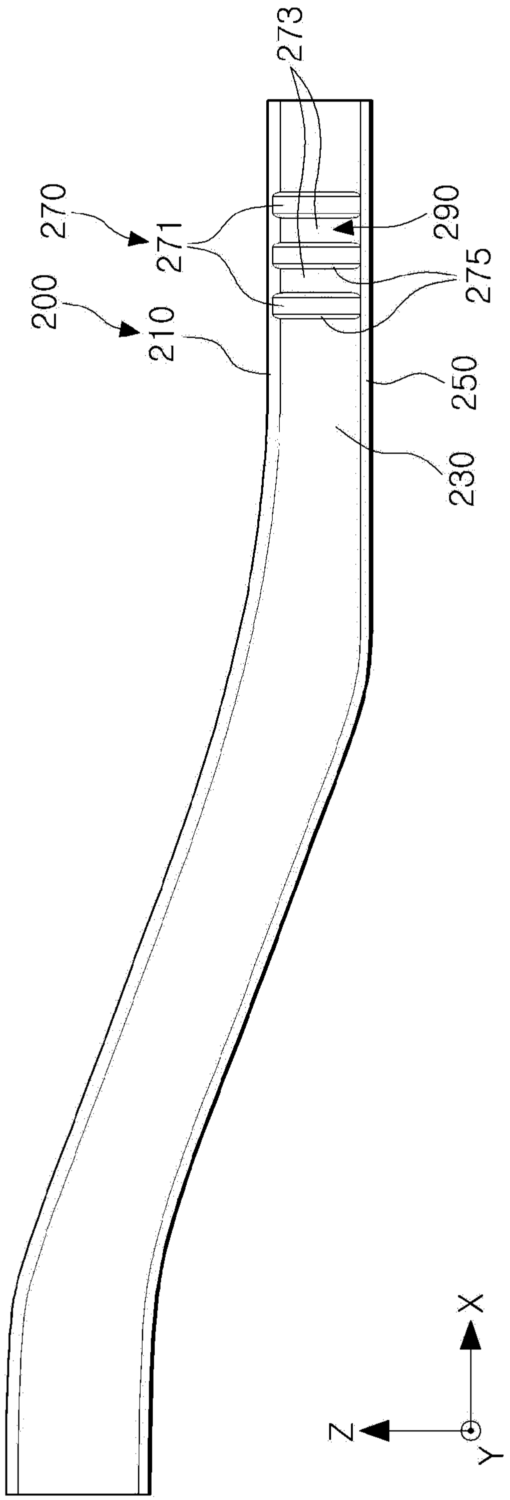
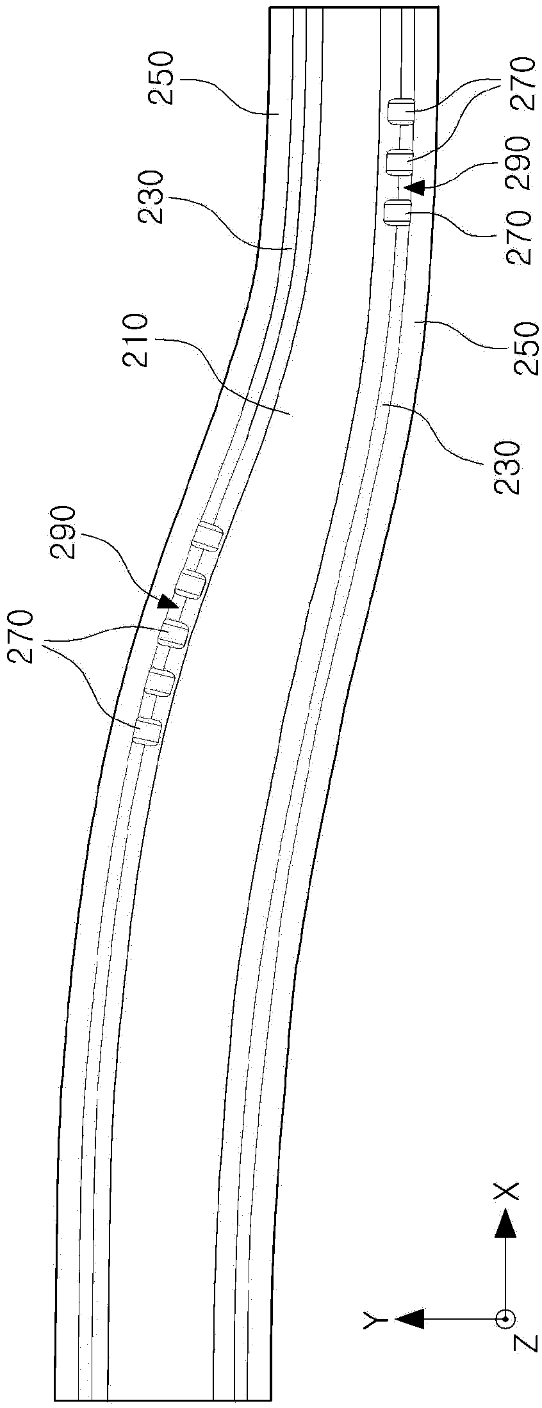


FIG. 12b



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2022/019355

A. CLASSIFICATION OF SUBJECT MATTER

B21D 17/02(2006.01)i; **B21D 13/02**(2006.01)i; **B21D 22/24**(2006.01)i; **B21D 53/88**(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)

B21D 17/02(2006.01); B21D 22/02(2006.01); B21D 22/20(2006.01); B21D 22/26(2006.01); B21D 22/30(2006.01); B21D 37/10(2006.01); B21D 5/01(2006.01); B21D 53/88(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: 스프링백(springback), 형상동결(shape fixability), 응력(stress), 압축응력(compressive stress), 인장응력(tensile stress), 성형(forming)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-1277939 B1 (HYUNDAI STEEL COMPANY) 27 June 2013 (2013-06-27) See paragraphs [0017] and [0033]-[0038], claims 1-2 and 5 and figures 1-3.	1-17
Y	KR 10-2019-0113779 A (THYSSENKRUPP STEEL EUROPE AG et al.) 08 October 2019 (2019-10-08) See paragraphs [0021] and [0051], claim 1 and figures 2 and 4b-5.	1-17
Y	JP 2005-103613 A (KOBE STEEL LTD. et al.) 21 April 2005 (2005-04-21) See paragraph [0023], claim 1 and figures 4 and 8.	7-13
Y	KR 10-2018-0069333 A (HYUNDAI MOTOR COMPANY) 25 June 2018 (2018-06-25) See paragraph [0033] and figures 3-5.	14-15
A	JP 2006-305627 A (KOBE STEEL LTD.) 09 November 2006 (2006-11-09) See claim 1 and figures 9-10.	1-17

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 March 2023	**09 March 2023**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208**	
Facsimile No. **+82-42-481-8578**	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2022/019355

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 9718113 B2 (NIPPON STEEL & SUMITOMO METAL CORPORATION et al.) 01 August 2017 (2017-08-01) See claim 1 and figures 4-5.	1-17

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2022/019355

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
KR 10-1277939 B1	27 June 2013	KR 10-2013-0013553 A	06 February 2013
KR 10-2019-0113779 A	08 October 2019	BR 112019012969 A2	31 December 2019
		CA 3050070 A1	28 June 2018
		CA 3050070 C	09 November 2021
		CN 110312580 A	08 October 2019
		DE 102016125671 A1	28 June 2018
		EP 3558558 A1	30 October 2019
		JP 2020-514059 A	21 May 2020
		MX 2019007605 A	29 July 2020
		US 11179762 B2	23 November 2021
		US 2020-0078849 A1	12 March 2020
		WO 2018-115282 A1	28 June 2018
JP 2005-103613 A	21 April 2005	None	
KR 10-2018-0069333 A	25 June 2018	None	
JP 2006-305627 A	09 November 2006	None	
US 9718113 B2	01 August 2017	CN 104136142 A	05 November 2014
		CN 104136142 B	14 September 2016
		EP 2796221 A1	29 October 2014
		EP 2796221 B1	21 December 2022
		JP 6069223 B2	01 February 2017
		JP WO2013-094705 A1	27 April 2015
		US 2014-0356643 A1	04 December 2014
		WO 2013-094705 A1	27 June 2013

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- KR 1019950003541 B1 **[0009]**