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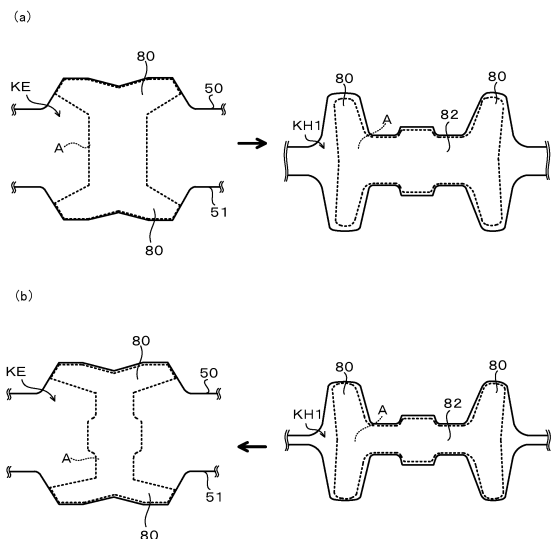
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(54) **H-SECTION STEEL MANUFACTURING METHOD**

(57) There are provided: an edging rolling step of rolling and shaping a material to be rolled into a predetermined shape; a raised part generating step of performing rolling of a web part by making the material to be rolled to be rotated, and forming a raised part at a middle of the web part of the material to be rolled; a supplementary edging rolling step of performing light reduction rolling by making the material to be rolled after being rolled in one pass or more in the raised part generating step to be rotated again and returning the material to be rolled to a final caliber in the edging rolling step; and a raised part eliminating step of reducing and eliminating the raised part formed in the raised part generating step, in upper and lower caliber rolls which perform the raised part generating step, recessed parts configured to form the raised part at the middle of the web part of the material to be rolled are provided at roll barrel length middle parts of the upper and lower caliber rolls, a roll shape of the upper and lower caliber rolls is designed to make tips of flange parts of the material to be rolled to be out of contact with the upper and lower caliber rolls, two steps of the raised part generating step and the supplementary edging rolling step are continuously performed one time or plural times, and the raised part eliminating step is performed after the raised part generating step and the supplementary edging rolling step are performed.

FIG.6



Description

[Technical Field]

5 (Cross-Reference to Related Applications)

[0001] This application is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2017-102423, filed in Japan on May 24, 2017, the entire contents of which are incorporated herein by reference.

10 **[0002]** The present invention relates to a production method for producing H-shaped steel using, for example, a slab having a rectangular cross section or the like as a raw material.

[Background Art]

15 **[0003]** In the case of producing H-shaped steel, a raw material such as a slab or a bloom extracted from a heating furnace is shaped into a raw blank (a material to be rolled in a so-called dog-bone shape) by a rough rolling mill (BD). A web and flanges of the raw blank are subjected to reduction in thickness by an intermediate universal rolling mill, and flanges of the material to be rolled are subjected to width reduction and forging and shaping of end surfaces by an edger rolling mill close to the intermediate universal rolling mill. Then, an H-shaped steel product is shaped by a finishing universal rolling mill.

20 **[0004]** In such a method for producing H-shaped steel, for shaping the raw blank in the so-called dog-bone shape from the slab raw material having a rectangular cross section, there is a known technique of creating splits on slab end surfaces in a first caliber at a rough rolling step, then widening the splits or making the splits deeper in second and subsequent calibers, and eliminating the splits on the slab end surfaces in calibers subsequent thereto.

25 **[0005]** Besides, in production of the H-shaped steel, it is known that after so-called edging rolling of edging the end surfaces of the raw material such as a slab (slab end surfaces), flat shaping and rolling is performed in which the material to be rolled is rotated by 90° or 270° and reduction of a web corresponding part is performed. In this flat shaping and rolling, a flange corresponding part is subjected to reduction and shaping together with the reduction of the web corresponding part.

30 **[0006]** Incidentally, in recent years, an H-shaped steel product with a larger size is required. Accordingly, it is studied to produce an H-shaped steel product from a slab raw material with a size larger than a conventional one. Here, in general flat shaping and rolling, when a large-size raw material is used as a material to be rolled, various problems such as elongation in a web height direction and deformation of the flange corresponding part may arise, and correction of the shape is sometimes required. Concretely, there is a concern about a phenomenon that with the reduction of the web corresponding part, the web corresponding part elongates in the longitudinal direction and the flange corresponding part

35 also elongates in the longitudinal direction by being drawn by the elongation of the web corresponding part, resulting in a decrease in thickness of the flange corresponding part.

[0007] Regarding the flat shaping and rolling as above, for example, Patent Document 1 discloses a technique in which groove parts are formed on a middle part of a flat shaping caliber, and an unreduced portion is provided at the middle of a web corresponding part when performing rolling, thereby reducing a length of a crop part. This Patent Document 1 describes that edging rolling is performed in a state where a protruding part (corresponding to a raised part of the present invention) is formed at the middle of the web corresponding part, and further reduction in the crop part and efficiency of the rolling are realized.

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[0008] Further, for example, Patent Document 2 discloses a width-widening rolling method for performing shaping processing in an advantageous manner on shaped blooms in a production process of shape steel. Concretely, this Patent Document 2 discloses a rolling method in which local rolling is performed on a web corresponding part, rolling for flattening a protruding part at the middle of the web corresponding part and widening a width is then performed, and after that, a material to be rolled is erected and subjected to edging rolling. It is described that according to this method, a lot of kinds of shaped blooms can be produced by adjusting a flange width, a web thickness, and a web height.

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50 [Prior Art Document]

[Patent Document]

[0009]

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Patent Document 1: Japanese Laid-open Patent Publication No. S59-35802

Patent Document 2: Japanese Laid-open Patent Publication No. S57-146405 [Disclosure of the Invention]

[Problems to Be Solved by the Invention]

[0010] As described above, recently, with an increase in size of structures and the like, production of a large-size H-shaped steel product is desired. In particular, a product having flanges, which greatly contribute to strength and rigidity of H-shaped steel, made wider as compared with conventional ones is desired. To produce the H-shaped steel product with widened flanges, it is necessary to shape a material to be rolled with a flange width larger as compared with a conventional one from the shaping at the rough rolling step.

[0011] In production of an H-shaped steel product, it is conventionally known to perform light reduction rolling by returning a material to be rolled to an edging caliber after flat shaping and rolling, in order to prevent an overfill at a position of a flange outer surface when performing the flat shaping and rolling. This light reduction rolling can be referred to as so-called supplementary ranked edging rolling. In the present description, this is referred to as "supplementary edging process" or simply referred to as "supplementary edging rolling". In this supplementary edging rolling, web thickness reduction and reduction in a flange width direction are performed by flat shaping and rolling, and then the material to be rolled is returned to the edging caliber, so that the material to be rolled whose flange width is shortened does not fill the edging caliber, and thus deterioration of a material passing property and deterioration of a shape of the material to be rolled are concerned. The deterioration of the material passing property and the deterioration of the shape of the material to be rolled when performing the supplementary edging rolling as described above may become more significant when the material to be rolled has a large size and when producing an H-shaped steel product with a large web height, in particular.

[0012] The technique disclosed in the aforementioned Patent Document 1 is a technique of reducing the length of the crop part, Patent Document 1 does not disclose at all the technical idea such that a material to be rolled with a large flange width is shaped, and does not mention at all the performance of the above-described "supplementary edging rolling", and the deterioration of the material passing property and the deterioration of the shape of the material to be rolled which become problems when performing the supplementary edging rolling. Further, in the technique disclosed in the aforementioned Patent Document 2 in which the protruding part is formed at the middle of the web corresponding part, the rolling for flattening the protruding part at the middle of the web corresponding part and widening the width is then performed, and after that, the material to be rolled is erected and subjected to the edging rolling, a step of flattening the protruding part every time the protruding part is formed at the middle of the web corresponding part, is employed, so that the increase in the number of times of movement of the material to be rolled between calibers is concerned. In particular, when the above "supplementary edging rolling" is performed plural times, the increase in the number of times of movement between calibers becomes significant and a rolling efficiency is lowered, which is a problem.

[0013] In consideration of the above circumstances, an object of the present invention is to provide a method for producing H-shaped steel capable of suppressing deterioration of a material passing property and deterioration of a shape of a material to be rolled in "supplementary edging rolling" in which light reduction rolling is performed by returning the material to be rolled to an edging caliber after forming a raised part on a web in flat shaping and rolling, to stabilize the supplementary edging rolling.

[Means for Solving the Problems]

[0014] To achieve the above object, according to the present invention, there is provided a method for producing H-shaped steel, the method including: a rough rolling step; an intermediate rolling step; and a finish rolling step, wherein: the rough rolling step includes: an edging rolling step of rolling and shaping a material to be rolled into a predetermined dog-bone shape; a raised part generating step of performing rolling of a web part by making the material to be rolled after completion of the edging rolling step to be rotated by 90° or 270°, and forming a raised part at a middle of the web part of the material to be rolled; a supplementary edging rolling step of performing light reduction rolling by making the material to be rolled after being rolled in one pass or more in the raised part generating step to be rotated by 90° or 270° again and returning the material to be rolled to a final caliber in the edging rolling step; and a raised part eliminating step of reducing and eliminating the raised part formed in the raised part generating step; in upper and lower caliber rolls which perform the raised part generating step, recessed parts configured to form the raised part at the middle of the web part of the material to be rolled are provided at roll barrel length middle parts of the upper and lower caliber rolls; a roll shape of the upper and lower caliber rolls is designed to make tips of flange parts of the material to be rolled to be out of contact with the upper and lower caliber rolls; two steps of the raised part generating step and the supplementary edging rolling step are continuously performed one time or plural times; and the raised part eliminating step is performed after the raised part generating step and the supplementary edging rolling step are performed.

[0015] In the supplementary edging rolling step, the light reduction rolling may be performed so as to make the tips of the flange parts of the material to be rolled fill the final caliber in the edging rolling step.

[0016] In the supplementary edging rolling step, the light reduction rolling may be performed so as to make a web height of the material to be rolled to be smaller than a web height of the material to be rolled supplied to a caliber which

performs the raised part generating step right before the supplementary edging rolling step.

[0017] The supplementary edging rolling step may be performed in one chance or two chances when one set of plural passes in which an edging height in a final pass is set to be constant is set to one chance.

[0018] A width of the raised part formed in the raised part generating step may be set to 25% or more and 50% or less of a web part inner size of the material to be rolled.

[Effect of the Invention]

[0019] According to the present invention, it becomes possible to suppress deterioration of a material passing property and deterioration of a shape of a material to be rolled in "supplementary edging rolling" in which light reduction rolling is performed by returning the material to be rolled to an edging caliber after forming a raised part on a web in flat shaping and rolling, to stabilize the supplementary edging rolling.

[Brief Description of the Drawings]

[0020]

[FIG. 1] FIG. 1 is a schematic explanatory view about a production line for H-shaped steel.

[FIG. 2] FIG. 2 is a schematic explanatory view of a first flat shaping caliber.

[FIG. 3] FIG. 3 is a schematic explanatory view of a second flat shaping caliber.

[FIG. 4] FIG. 4 is a schematic view of a final caliber in an edging rolling step of a rough rolling step in production of H-shaped steel.

[FIGS. 5] FIGS. 5(a) and 5(b) are schematic explanatory views regarding supplementary edging rolling between an edging final caliber and a general flat shaping caliber.

[FIGS. 6] FIGS. 6(a) and 6(b) are schematic explanatory views of supplementary edging rolling according to the present embodiment.

[FIG. 7] FIG. 7 is a graph indicating changes in flange width of a material to be rolled A for each pass when plural passes are completed during flat shaping and rolling.

[FIG. 8] FIG. 8 is a graph indicating changes in flange width in the case where an H-shaped raw blank is shaped by the rolling and shaping in 18 passes in total using the first flat shaping caliber, the second flat shaping caliber, and three widening calibers at subsequent stages.

[FIG. 9] FIG. 9 is a graph indicating a relationship between an escaping percentage and a flange width increase/decrease after the shaping of the H-shaped raw blank on the basis of data in FIG. 8.

[Embodiments for Carrying out the Invention]

[0021] Hereinafter, an embodiment of the present invention will be explained while referring to the drawings. Note that in the present description and the drawings, components having substantially the same functional configurations are denoted by the same numerals to omit duplicated explanation.

(Outline of production line)

[0022] FIG. 1 is an explanatory view about a production line T for H-shaped steel including a rolling facility 1 according to the present embodiment. As illustrated in FIG. 1, in the production line T, a heating furnace 2, a sizing mill 3, a rough rolling mill 4, an intermediate universal rolling mill 5, and a finishing universal rolling mill 8 are arranged in order from the upstream side. Further, an edger rolling mill 9 is provided close to the intermediate universal rolling mill 5. Note that, hereinafter, a steel material in the production line T is collectively described as a "material to be rolled A" for explanation and its shape is appropriately illustrated using broken lines, oblique lines and the like in some cases in the respective drawings.

[0023] As illustrated in FIG. 1, in the production line T, for example, a rectangular cross-section raw material (a later-described material to be rolled A) being a slab 11 extracted from the heating furnace 2 is subjected to rough rolling in the sizing mill 3 and the rough rolling mill 4. Then, the rectangular cross-section raw material is subjected to intermediate rolling in the intermediate universal rolling mill 5. During the intermediate rolling, reduction is performed on a flange tip part (a flange corresponding part 12) of the material to be rolled by the edger rolling mill 9 as necessary. In a normal case, an edging caliber and a so-called flat shaping caliber of thinning a web portion to form a shape of a flange portion are engraved on rolls of the sizing mill 3 and the rough rolling mill 4. An H-shaped raw blank 13 is shaped by reverse rolling in plural passes through these sizing mill 3 and rough rolling mill 4. The H-shaped raw blank 13 is subjected to application of reduction in plural passes using a rolling mill train composed of two rolling mills of the intermediate universal

rolling mill 5 and the edger rolling mill 9, whereby an intermediate material 14 is shaped. Subsequently, the intermediate material 14 is subjected to finish rolling into a product shape in the finishing universal rolling mill 8, whereby an H-shaped steel product 16 is produced.

[0024] Here, a slab thickness of the slab 11 extracted from the heating furnace 2 is, for example, within a range of 290 mm or more and 310 mm or less. This is the dimension of a slab raw material called a so-called 300 thick slab used when producing a large-size H-shaped steel product.

[0025] In the sizing mill 3 and the rough rolling mill 4 illustrated in FIG. 1, an edging rolling step is first performed as a pre-stage step. In the edging rolling step, rolling and shaping is performed in a state where the raw material having the rectangular cross section (slab 11) is erected, to thereby shape the raw material into a predetermined almost dog-bone shape.

[0026] Following the edging rolling step, a flat shaping and rolling step is performed as a post-stage step. In the flat shaping and rolling step, the material to be rolled A after being subjected to the edging rolling step is first rotated by 90° or 270°. By this rotation, the flange parts located at the upper and lower ends of the material to be rolled A (slab 11) in the edging rolling step are located on a rolling pitch line. Next, reduction of a web part being a connecting part connecting the flange parts at two positions is performed. By these edging rolling step and flat shaping and rolling step, the H-shaped raw blank 13 illustrated in FIG. 1 is shaped.

[0027] Generally, the above pre-stage step and post-stage step are collectively referred to as a rough rolling step. In the method for producing H-shaped steel according to the present embodiment, the edging rolling step being the pre-stage step in the rough rolling step is only required to be performed by a conventionally-known general method. Accordingly, detailed explanation regarding the edging rolling step will be omitted in the present description. Hereinafter, the flat shaping and rolling step being the post-stage step will be described in detail while referring to the drawings.

(Outline of caliber configuration)

[0028] FIG. 2 and FIG. 3 are schematic explanatory views of a first flat shaping caliber KH1 and a second flat shaping caliber KH2 used in the flat shaping and rolling step. The first flat shaping caliber KH1 is composed of an upper caliber roll 85 and a lower caliber roll 86 which are a pair of horizontal rolls. As illustrated in FIG. 2, in the first flat shaping caliber KH1, the material to be rolled A rolled and shaped in the edging rolling step is rotated by 90° or 270°, whereby the flange parts 80 located at the upper and lower ends of the material to be rolled A until the above pre-stage step are located on a rolling pitch line. Then, in the first flat shaping caliber KH1, reduction of a web part 82 being a connecting part connecting the flange parts 80 at two positions is performed.

[0029] Here, the upper and lower caliber rolls 85, 86 of the first flat shaping caliber KH1 have shapes formed with recessed parts 85a, 86a of a predetermined length L1 at their roll barrel length middle parts. With such a caliber configuration illustrated in FIG. 2, the reduction of the web part 82 is partially performed. As a result of this, in the web part 82 after the reduction, reduced portions 82a at both ends in the web height direction and a raised part 82b as an unreduced portion at the middle part thereof are formed. In this manner, the rolling and shaping of forming the raised part 82b in the web part 82 is performed in a material to be rolled in a so-called dog-bone shape. In the present description, the step of forming the raised part 82b in the web part 82 in the first flat shaping caliber KH1 is also described as a "raised part generating step".

[0030] Note that since the rolling and shaping of partially reducing the web part 82 to form the raised part 82b is implemented in the first flat shaping caliber KH1, this caliber is also referred to as a "web partial rolling caliber". The width length of the raised part 82b after the formation is the same length as the width length L1 of the recessed parts 85a, 86a. Herein, as illustrated in the enlarged view in FIG. 2, the width length L1 of the recessed parts 85a, 86a in the present description is defined as a width length at a depth of 1/2 of a depth hm of the recessed parts 85a, 86a. The later-described escaping amount L1 is also based on the same definition.

[0031] FIG. 3 is a schematic explanatory view of the second flat shaping caliber KH2. The second flat shaping caliber KH2 is composed of an upper caliber roll 95 and a lower caliber roll 96 which are a pair of horizontal rolls. In the second flat shaping caliber KH2, the rolling and shaping of eliminating the raised part 82b formed in the web part 82 and widening the inner size of the web part 82 is performed on the material to be rolled A rolled and shaped in the first flat shaping caliber KH1.

[0032] In the second flat shaping caliber KH2, the rolling of bringing the upper and lower caliber rolls 95, 96 into contact with the raised part 82b formed in the web part 82 to reduce (eliminate) the raised part 82b is performed. In accordance with the reduction of the raised part 82b, spread in the web height direction and the metal flow to the flange parts 80 are promoted. Because of the metal flow as above, it becomes possible to implement the rolling and shaping without causing decrease in area of the flange as much as possible. In the present description, the step of reducing (eliminating) the raised part 82b in the second flat shaping caliber KH2 is also described as a "raised part eliminating step". Further, the second flat shaping caliber KH2 eliminates the raised part 82b formed in the web part 82, so that it is also referred to as a "raised part eliminating caliber".

[0033] Regarding the rolling and shaping in the first flat shaping caliber KH1 and the second flat shaping caliber KH2, their detailed conditions and so on (dimensions, shapes and so on of the calibers) will be described later in more detail based on the finding and so on obtained by the present inventors in the explanation of the present embodiment.

[0034] The H-shaped raw blank 13 shaped by being passed through these first flat shaping caliber KH1 and second flat shaping caliber KH2 is subjected to application of reverse rolling in plural passes using the rolling mill train composed of two rolling mills of the intermediate universal rolling mill 5 and the edger rolling mill 9, whereby an intermediate material 14 is shaped. Subsequently, the intermediate material 14 is subjected to finish rolling into a product shape in the finishing universal rolling mill 8, whereby an H-shaped steel product 16 is produced (refer to FIG. 1).

[0035] In the rough rolling step in the production of H-shaped steel, when performing the edging rolling step and the flat shaping and rolling step, it is known that the reduction in thickness of the web part is performed, and following that, the "supplementary edging rolling" is performed by returning the material to be rolled A to the edging caliber again in order to prevent an overfill from a position of a lateral surface of the flange part of the material to be rolled in the flat shaping caliber, as described above. This "supplementary edging rolling" is a technique conventionally employed for the purpose of adjustment of a shape of an unsteady part of the material to be rolled, suppression of a shape defect such as an overfill, and the like.

(Conventional supplementary edging rolling)

[0036] First, conventional supplementary edging rolling will be briefly described with reference to FIG. 4 and FIGS. 5. FIG. 4 is a schematic view of a final caliber KE in an edging rolling step (also described as an edging final caliber KE, hereinafter) of a rough rolling step in production of H-shaped steel. As illustrated in FIG. 4, the edging final caliber KE is engraved on an upper caliber roll 50 and a lower caliber roll 51 which are a pair of horizontal rolls. A peripheral surface of the upper caliber roll 50 (namely, a caliber upper surface) is formed with a projection 55 protruding toward the inside of the caliber. Further, a peripheral surface of the lower caliber roll 51 (namely, a caliber bottom surface) is formed with a projection 56 protruding toward the inside of the caliber. These projections 55, 56 have tapered shapes, and dimensions such as a protrusion length of the projection 55 and the projection 56 are configured to be equal to each other.

[0037] As illustrated in FIG. 4, in the edging final caliber KE, reduction in a web width direction is performed in a state where the material to be rolled A is erected, to thereby widen a width of the flanges. Concretely, the upper and lower caliber rolls 50, 51 formed with the above projections 55, 56 are used to reduce outer surfaces of the flange parts 80 (the upper and lower end surfaces of the material to be rolled A).

[0038] In the conventional technique for producing H-shaped steel, the material to be rolled A after being passed through the edging final caliber KE illustrated in FIG. 4 is introduced into a general flat shaping caliber, and reduction in thickness of the web part is performed (FIGS. 5 are schematic explanatory views regarding supplementary edging rolling between the edging final caliber KE and a general flat shaping caliber GH, in which FIG. 5(a) illustrates a state before performing the supplementary edging rolling, and FIG. 5(b) illustrates a state of performing the supplementary edging rolling. As illustrated in FIG. 5(a), in the general flat shaping caliber GH, the reduction in thickness of the web part of the material to be rolled A is performed, and at the same time, reduction in the width direction of the flange parts 80 is also performed. For this reason, the width length of the flange parts 80 becomes considerably small, as illustrated in FIG. 5(b). As a result of this, the material to be rolled A including the flange parts 80 with small width length is returned to the edging final caliber KE for the supplementary edging rolling.

[0039] As illustrated in FIG. 5(b), if the material to be rolled A including the flange parts 80 with small width length is introduced again into the edging final caliber KE, there is created a state where the flange parts 80 do not fill the edging final caliber KE (refer to parts surrounded by broken lines in FIG. 5(b)). Since the flange parts 80 do not fill the caliber as described above, a phenomenon such as a defect of a right-left centering property during rolling, and a dimensional error and a shape defect such as buckling of the web, and an unbalanced thickness amount of right and left of the flange parts 80 is likely to occur, which has been a problem.

(Supplementary edging rolling according to present embodiment)

[0040] On the contrary, in the present embodiment, a flat shaping caliber used when performing the supplementary edging rolling employs the "web partial rolling caliber" being the first flat shaping caliber KH1 illustrated in FIG. 2. In addition to this, proper conditions under which a width reduction of the flange parts 80 in the rolling and shaping by the web partial rolling caliber is minimized, are further defined. This prevents unfilling in caliber when the material to be rolled A is introduced again into the edging final caliber KE. FIGS. 6 are schematic explanatory views of the supplementary edging rolling according to the present embodiment, in which FIG. 6(a) illustrates a state before performing the supplementary edging rolling, and FIG. 6(b) illustrates a state of performing the supplementary edging rolling.

[0041] As illustrated in FIGS. 6, in the first flat shaping caliber KH1 according to the present embodiment, the raised part 82b is generated when reducing the web thickness. Accordingly, pulldown of the flange parts 80 is difficult to occur,

and a decrease rate of the flange width is lowered. For this reason, as illustrated in FIG. 6(b), the width length of the flange parts 80 does not become small almost at all. Since the change in the flange width is small, restraining force of side wall parts of the caliber when the material to be rolled is returned to the edging final caliber KE and the supplementary edging rolling is performed, is also maintained. Consequently, good right-left centering property is provided, and further, the dimensional error and the shape defect such as buckling of the web, and an unbalanced thickness amount of right and left of the flange parts 80 are suppressed. Note that in the first pass in the first flat shaping caliber KH1, it is desirable to set a roll design such that the caliber has a shape so that the tips of the flange parts 80 are out of contact with the caliber when performing the rolling and shaping, and the flange tip parts are exactly in contact with the roll caliber in the flat shaping and rolling before the supplementary edging rolling (namely, the raised part generating step). By performing the supplementary edging rolling under such conditions, a caliber filling property when the material to be rolled A is returned to the edging final caliber KE is increased, which improves the rolling stability.

[0042] It is preferable that the edging rolling of about 40 mm or less, for example, is performed during the supplementary edging rolling, and in this case, a spread amount of the flange width is about 24 mm or less.

[0043] Incidentally, when performing the flat shaping and rolling, by setting the web height of the material to be rolled A to be as small as possible with respect to the caliber width length W of the "web partial rolling caliber" being the first flat shaping caliber KH1 (refer to FIG. 2), it is possible to increase a distance between lateral surfaces of the flange parts 80 and caliber roll outer walls. Consequently, it is possible to perform rolling having a margin for a pulldown flaw made by the caliber roll outer walls when the material to be rolled A spreads in the web height direction in accordance with the web reduction during the flat shaping and rolling. From such a point of view, an edging amount during the supplementary edging rolling is desirably set to be as large as possible.

[0044] On the other hand, in order to improve the rolling stability in the flat shaping and rolling, it is demanded to increase the caliber restraining force with respect to the material to be rolled A. Regarding the caliber restraining force, the larger the distance between the caliber roll outer walls of the flat shaping caliber and the material to be rolled A and the larger the amount of widening the web inner size, the lower the inductive property, which destabilizes the rolling. From a point of view of material passing property as above, the edging amount during the supplementary edging rolling is desirably set to be as small as possible.

[0045] Based on the above-described reasons, an optimum value of the edging amount during the supplementary edging rolling should be set by considering a balance between occurrence of flaws and the rolling stability. When the flat shaping and rolling is performed after completion of the supplementary edging rolling, it is desirable to design such that side walls (outer walls) of the flat shaping caliber and the web height of the material to be rolled A substantially coincide with each other.

[0046] Here, the rolling of the web part 82 is supposed to be plate rolling. Based on a dimensional relationship between a roll diameter of a normal shape steel rolling mill and a material to be rolled of large-size H-shaped steel, a plate width ratio is about 3 to 4, and a plate thickness ratio is about 4 to 5. Besides, since flange parts are provided at both ends in the plate thickness, a spread amount is further increased. As a result of this, a rate of spread in the web height direction of the material to be rolled A due to the web reduction is 4% or more of the web height. Namely, when considering the material to be rolled A with a web height dimension of 1000 mm, for example, as large-size H-shaped steel, a rate of spread of the web height is at least 40 mm. Accordingly, by applying, at the time of supplementary edging rolling, an edging amount of equal to or more than 40 mm being equal to or more than a spread amount of the web height during the flat rolling, as a condition under which the material to be rolled A is not in contact with the caliber roll outer walls of the flat shaping caliber, the material to be rolled is in a state of being in contact with caliber side walls at a roll outlet side in the flat shaping and rolling, and thus from a viewpoint of material passing property and the like, there is no chance that the material passing property is impaired. Specifically, the edging amount during the supplementary edging rolling is preferably set to 40 mm or less.

[0047] Further, regarding a flange width spread in accordance with the edging rolling, it is possible to apply a width spread rolling characteristic based on slab edging. Specifically, a flange width spread characteristic based on a conventional slab edging method performed by a caliber which is a so-called box caliber having a projection at a middle part thereof, is applied. In this case, at least approximately 60% or less of a reduction amount is known to be a flange width spread, and thus the flange width spread can be calculated as $40 \text{ mm} \times 0.6 \text{ (60\%)} = 24 \text{ mm}$.

[0048] FIG. 7 is a graph indicating changes in flange width of the material to be rolled A for each pass when plural passes are completed during the flat shaping and rolling. Note that the example in FIG. 7 indicates data in a case where a FEM calculation is performed by using a slab having a cross section of 2000 mm $\times$ 300 mm as a raw material. In FIG. 7, flat shaping and rolling in the conventional general flat shaping caliber GH (referred to as a "conventional method", hereinafter) and flat shaping and rolling in the first flat shaping caliber KH1 according to the present embodiment (referred to as a "method of the present invention", hereinafter) are compared.

[0049] As illustrated in FIG. 7, a flange width decrease rate due to the flat shaping and rolling according to the present embodiment was smaller than a flange width decrease rate based on the conventional method. For example, after the completion of 13 passes in the flat shaping and rolling, a difference in flange width between the flat shaping and rolling

according to the present embodiment and the conventional flat shaping and rolling was 100 mm or more. From the results in FIG. 7, it can be understood that in the flat shaping and rolling in the first flat shaping caliber KH1 according to the present embodiment, the flange width decrease rate is lowered, and unfilling in caliber during the supplementary edging rolling can be suppressed.

[0050] The present inventors confirmed, also by experiments, that the material passing property is different according to the filling property in the caliber during the supplementary edging rolling, and there is a problem in the material passing property when the caliber is not filled. Table 1 to be presented below indicates experimental examples showing a relationship between the caliber filling property and the material passing property in the supplementary edging rolling. Table 1 indicates a relationship between the caliber filling property and the material passing property in the conventional method and the method of the present invention under conditions of a case 1 to a case 4. Note that during the supplementary edging rolling, edging rolling with an edging amount of about 40 mm was performed in two passes in all of the cases 1 to 4. For this reason, a value of change in the web height during the supplementary edging rolling indicated in Table 1 is presented as -40 mm in all of the cases 1 to 4.

[Table 1]

	CUMULATIVE WEB REDUCTION AMOUNT (mm)	CHANGE IN WEB HEIGHT DURING SUPPLEMENTARY EDGING ROLLING (mm)	CONVENTIONAL METHOD		PRESENT INVENTION	
			FILLING IN CALIBER	MATERIAL PASSING PROPERTY	FILLING IN CALIBER	MATERIAL PASSING PROPERTY
CASE 1	30	-40	FILLED	GOOD	FILLED	GOOD
CASE 2	50	-40	NOT FILLED	BENDING OCCURS	FILLED	GOOD
CASE 3	80	-40	NOT FILLED	BENDING OCCURS	FILLED	GOOD
CASE 4	100	-40	NOT FILLED	BENDING OCCURS	NOT FILLED	BENDING OCCURS

[0051] As indicated in Table 1, when the caliber is filled during the supplementary edging rolling, the material passing property was good. On the contrary, when the caliber is not filled, bending occurred. Further, with reference to the cases 2 to 4, when the same cumulative web reduction amount was employed during the supplementary edging rolling in the conventional method and the method of the present invention, there was a case in which even at the cumulative web reduction amount at which the caliber is not filled in the conventional method, the caliber is filled and thus the material passing property is favorably maintained in the method of the present invention (refer to the cases 2, 3 in Table 1). Note that the edging rolling of about 40 mm was set to be performed during the supplementary edging rolling, so that a value of web height during the supplementary edging rolling indicated in Table 1 is -40 mm in all of the cases 1 to 4.

[0052] Next, the present inventors thought that the effect of suppressing the dimensional error and the shape defect differs depending on a schedule design (a reduction amount, a pass schedule, and so on) of the supplementary edging rolling according to the present embodiment. Accordingly, they verified, based on experiments, changes in flange width caused by the supplementary edging rolling in a case of producing H-shaped steel by using a slab having a cross section of 2000 mm × 300 mm as a raw material.

[0053] Table 2 to be presented below indicates changes in flange width for each pass when performing flat shaping and rolling by the first flat shaping caliber KH1 (namely, the web partial rolling caliber). Cases 1 to 3 in Table 2 differ in the number of times of performing the supplementary edging rolling for each pass of the flat shaping and rolling. When the supplementary edging rolling is performed (namely, the case 2 and the case 3), changes in flange width after performing the supplementary edging rolling are indicated. Further, the description of 15th pass to 23rd pass in Table indicates that edging rolling was performed at a previous stage as first to 14th passes before the flat shaping and rolling, and indicates that the 15th pass and thereafter correspond to the flat shaping and rolling.

[0054] During the supplementary edging rolling, the edging rolling of about 40 mm was performed. Concretely, in the case 2, the edging rolling of about 40 mm was performed one time in two passes. In the case 3, the edging rolling of about 20 mm was performed two times continuously in two passes. As indicated in Table 2, a spread amount of the flange width realized by the supplementary edging rolling was about 24 mm in each pass in the case 2, and it was about 44 mm in each pass in the case 3.

[Table 2]

	CASE 1 ABSENCE OF SUPPLEMENTARY EDGING ROLLING	CASE 2 SUPPLEMENTARY EDGING ROLLING OF ONE TIME	CASE 3 SUPPLEMENTARY EDGING ROLLING OF TWO TIMES
5	15TH PASS	1008	1032○
10	16TH PASS	1001	1025○
	17TH PASS	990	1014○
15	18TH PASS	984	1008 ×
	19TH PASS	979	1003 ×
20	20TH PASS	974	998 ×
	21ST PASS	971	995 ×
25	22ND PASS	967	991 ×
	23RD PASS	964	988 ×
UNIT: mm			

[0055] Note that the descriptions of "case 2: supplementary edging rolling of one time", "case 3: supplementary edging rolling of two times" in Table 2 indicate the number of times of the supplementary edging rolling performed in two passes which are set as one set, and the descriptions of the number of times of the supplementary edging rolling in two passes which are set as one set are also described as "one chance", "two chances". Practically, the number of times of passes of the supplementary edging rolling in one chance may be one or plural such as two or more, but, the pass schedule is designed by setting that the total edging amount satisfies a certain condition (namely, a condition that an edging height in a final pass is set to be constant).

[0056] Further, Table 2 presents, for reference, changes in flange width in each pass when performing the flat shaping and rolling without performing the supplementary edging rolling, as the case 1.

[0057] The case 2 in Table 2 indicates flange widths when the supplementary edging rolling under a condition where the spread of the flange width is not restricted is performed by only one chance in each pass indicated in the case 1.

[0058] As indicated in the case 2 in Table 2, when performing the supplementary edging rolling in one chance, the flange width after the supplementary edging rolling was greater than an edging caliber width (1010 mm) before the flat shaping and rolling in each of the 15th pass to the 17th pass. For this reason, the filling in caliber is realized in the edging final caliber KE during the supplementary edging rolling. The description of "○" in Table 2 indicates that the filling in caliber is realized and the rolling stability is good.

[0059] On the other hand, in the 18th pass and thereafter, the flange width after the supplementary edging rolling was less than the edging caliber width (1010 mm) before the flat shaping and rolling, so that the edging final caliber KE is not filled during the supplementary edging rolling, which may cause the dimensional error and the shape defect. The description of "×" in Table 2 indicates that the caliber is not filled, and thus there is a problem in the rolling stability.

[0060] Further, the present inventors also conducted verification regarding a case of performing the supplementary edging rolling in two chances (supplementary edging rolling of two times in Table), as indicated in the case 3 in Table 2. The case 3 indicates flange widths after increasing the number of times of supplementary edging rolling in the 18th pass in which the caliber was not filled in the case 2 and thereafter and performing the supplementary edging rolling under a condition where the spread of the flange width is not restricted in two chances.

[0061] When the supplementary edging rolling is performed in two chances, a larger spread of the flange width during the supplementary edging rolling can be expected when compared with the case of one chance, so that the filling in

caliber in the edging final caliber KE during the supplementary edging rolling can be realized even in a further subsequent-stage pass. Under the condition of the present verification, the filling in caliber is realized in the edging final caliber KE during the supplementary edging rolling until the 22nd pass, as indicated in Table 2.

[0062] It is generally desired that the supplementary edging rolling is stably performed in further subsequent-stage passes in the flat shaping and rolling. This is because as the supplementary edging rolling is performed more in the subsequent-stage passes of the flat shaping and rolling, the dimensional accuracy of the shape of the material to be rolled which is sent for the intermediate rolling and finish rolling being further subsequent-steps improves, resulting in that the rolling stability and the improvement in product dimension accuracy are realized.

[0063] Namely, it can be understood that by performing the supplementary edging rolling in two chances, the supplementary edging rolling at a further subsequent stage is realized without causing the dimensional error and the shape defect of the material to be rolled, which realizes efficient rolling.

[0064] Further, Table 3 to be presented below indicates, for reference, changes in flange width after the flat shaping and rolling in the conventional method (case 1) and changes in flange width when a flange width spread during the supplementary edging rolling after the supplementary edging rolling is performed after each pass is taken into consideration (case 2). As indicated in Table 3, in the conventional method, the flange width after the supplementary edging rolling is greater than the edging caliber width (1010 mm) before the flat shaping and rolling only in the 15th pass, in which the filling in caliber is realized in the edging final caliber KE during the supplementary edging rolling. On the other hand, in the 16th pass and thereafter, the flange width after the supplementary edging rolling is less than the flange width (1010 mm) before the flat shaping and rolling, so that the edging final caliber KE is not filled during the supplementary edging rolling, which may cause the dimensional error and the shape defect.

[Table 3]

	CASE 1 ABSENCE OF SUPPLEMENTARY EDGING ROLLING	CASE 2 SUPPLEMENTARY EDGING ROLLING OF ONE TIME
15TH PASS	992	1016○
16TH PASS	975	999 ×
17TH PASS	951	975 ×
18TH PASS	935	959 ×
19TH PASS	924	948 ×
UNIT: mm		

[0065] As can be understood by comparing Table 2 and Table 3, when the method of the present invention is applied, in a case of performing the supplementary edging rolling in only one chance, it was possible to perform the supplementary edging rolling realizing the filling in caliber until the 17th pass. In a case of performing the supplementary edging rolling in two chances, it was possible to perform the supplementary edging rolling realizing the filling in caliber until the 22nd pass. On the contrary, in the conventional method, it was possible to perform only the supplementary edging rolling realizing the filling in caliber until the 15th pass. Specifically, by applying the method of the present invention, the supplementary edging rolling in further subsequent-stage passes can be performed, and it becomes possible to carry out the rough rolling step with high precision while suppressing the dimensional error and the shape defect such as occurrence of flaws.

[0066] (Ratio of escaping amount (raised part forming width) in first flat shaping caliber KH1)

[0067] As described above, in the first flat shaping caliber KH1 (refer to FIG. 2 and the like) according to the present embodiment, the raised part 82b is formed at the middle of the web part 82 of the material to be rolled A. The formed raised part 82b is eliminated in the second flat shaping caliber KH2 at the subsequent stage. Then, the widening rolling of the web inner size is performed as needed after the elimination of the raised part, to thereby shape the H-shaped raw blank.

[0068] The present inventors found that the width length L1 of the raised part 82b formed in the first flat shaping caliber KH1 (namely, the escaping amount of the web inner size in the rolling and shaping in the first flat shaping caliber KH1, which is also simply referred to as "escaping amount", hereinafter) is changed to result in a difference in the flange width

of the finally obtained H-shaped raw blank. This is attributed to the fact that the flange thickness amount is more easily ensured with an increase in the width length L1 of the raised part 82b, and, on the other hand, the flange width decreases by the drawing action in the longitudinal direction of the material to be rolled A at the time of the subsequent elimination of the raised part.

[0069] Accordingly, the present inventors verified the relationship between the escaping amount of the web inner size in the rolling and shaping in the first flat shaping caliber KH1 and the flange width of the finally obtained H-shaped raw blank.

[0070] FIG. 8 is a graph indicating changes in the flange width for each pass in the case where the H-shaped raw blank is shaped by the rolling and shaping in 18 passes in total using the first flat shaping caliber KH1 and the second flat shaping caliber KH2 according to the present embodiment, and three more widening calibers at subsequent stages. Note that FIG. 8 is data using a raw material slab having a width of about 2000 mm.

[0071] Further, the horizontal axis in the graph of FIG. 8 indicates 1 to 18 passes, 1 to 13 passes of them correspond to the first flat shaping caliber KH1, 14, 15 passes correspond to the second flat shaping caliber KH2, and 16 to 18 passes correspond to the calibers of the widening rolling.

[0072] FIG. 8 further illustrates each data in the case of changing the above escaping amount L1. In FIG. 8, a value expressed in the following Expression (1) is defined as an escaping percentage, data regarding the cases of escaping percentages of 12%, 17%, 23%, 28%, 33%, 39%, 44%, 49% is illustrated, and the case of an escaping percentage of 0% is indicated as the conventional method.

$$\text{Escaping percentage [\%]} = (\text{escaping amount L1/web inner size L2}) \times 100 \dots$$

(1)

[0073] The thickness decrease amount at the flange part 80 (a decrease amount of the flange thickness amount) in the first flat shaping caliber KH1 is decreased by increasing the escaping percentage. For this reason, the flange width of the finally obtained H-shaped raw blank tends to increase together with the increase in escaping percentage as illustrated in FIG. 8. This tendency was recognized also by the experiments, as illustrated in FIG. 8. However, the flange width through the elimination of the raised part and the widening rolling in the second flat shaping caliber KH2 thereafter did not always increase even if the escaping percentage is increased to a predetermined value or more. This is estimated to be attributed to the increase in the flange thickness decrease amount at the time of the elimination of the raised part in the second flat shaping caliber KH2 in the case where an escaping part is made large.

[0074] Specifically, it is conceivable that in the case of adopting the method of forming the raised part 82b explained in the present embodiment as the production process of large-size H-shaped steel, there is a preferable range of the escaping percentage. Accordingly, the present inventors focused attention on the relationship between the escaping percentage and the increase/decrease of the flange width after the shaping of the H-shaped raw blank, and derived a preferable numerical value range of the escaping percentage.

[0075] FIG. 9 is a graph indicating the relationship between the escaping percentage and the flange width increase/decrease rate after the shaping of the H-shaped raw blank on the basis of the data in FIG. 8. Note that the flange width increase/decrease rate in FIG. 9 is a value indicating the flange width in the case where the escaping percentage is each value (12% to 55%) using the flange width in the case of the escaping percentage of 0% as a reference (1.000).

[0076] As illustrated in FIG. 9, in a region where the escaping percentage is small, the flange width of the H-shaped raw blank tends to increase with an increase in the escaping percentage. However, in a region where the escaping percentage is about 25% or more and about 50% or less, the flange width increase/decrease rate indicates an almost fixed value (refer to a broken line part in FIG. 9).

[0077] In consideration that the rolling and shaping of increasing also the flange width of the H-shaped raw blank is desired in the case of producing a large-size H-shaped steel product having a larger flange width as compared with the conventional one, it can be understood, from the results indicated in FIG. 9, that the numerical value range of the escaping percentage is desirably set to 25% to 50%. Further, from the viewpoints of preventing an increase in rolling load and of increasing the production efficiency in the rolling and shaping process, the escaping percentage is preferably set to a value as low as possible, and therefore it is desirable to set the escaping percentage to about 25%.

(Operations and effects)

[0078] According to the above-described method for producing the H-shaped steel according to the present embodiment, the flat shaping and rolling performed after the edging rolling, is carried out by using the first flat shaping caliber KH1 which forms the raised part 82b. Consequently, it becomes possible to suppress deterioration of the material passing property and deterioration of the shape of the material to be rolled in the "supplementary edging rolling" in which the light reduction rolling is performed by returning the material to be rolled A to the edging final caliber KE after the flat

shaping and rolling, to thereby stabilize the supplementary edging rolling. Further, it becomes possible to roll and shape the H-shaped raw blank 13 having a larger flange width as compared with the conventional one, resulting in that it becomes possible to produce an H-shaped steel product having a larger flange width as compared with the conventional one.

[0079] Further, for example, in the case of performing the rolling and shaping of the H-shaped raw blank according to the present embodiment using a raw material, which is called a 300 thick slab, having a thickness of about 300 mm and a width of about 2000 mm, by setting, when using the first flat shaping caliber KH1 being a so-called "web partial rolling caliber" during the flat shaping and rolling, the escaping percentage to fall within a range of 25% to 50% (more preferably about 25%) in the formation of the raised part 82b, it is possible to maximize the flange width of the H-shaped raw blank to be rolled and shaped.

[0080] One example of the embodiment of the present invention has been explained above, but, the present invention is not limited to the illustrated embodiment. It should be understood that various changes or modifications are readily apparent to those skilled in the art within the scope of the spirit as set forth in claims, and those should also be covered by the technical scope of the present invention.

[0081] For example, although the above embodiment explains that the rolling and shaping is performed on the rectangular cross-section raw material (slab) through the edging rolling as a previous stage of performing the flat shaping and rolling using the first flat shaping caliber KH1, and then the flat shaping and rolling is performed, but, the applicable range of the technique of the present invention is not limited to this. Specifically, the technique of the present invention is also applicable to a case where flat shaping and rolling is performed on a material to be rolled which is not subjected to an edging rolling step such as a beam blank.

[Industrial Applicability]

[0082] The present invention is applicable to a production method for producing H-shaped steel using, for example, a slab having a rectangular cross section or the like as a raw material.

[Explanation of Codes]

[0083]

1	rolling facility
2	heating furnace
3	sizing mill
4	rough rolling mill
5	intermediate universal rolling mill
8	finishing universal rolling mill
9	edger rolling mill
11	slab
13	H-shaped raw blank
14	intermediate material
16	H-shaped steel product
50	upper caliber roll (edging final caliber)
51	lower caliber roll (edging final caliber)
55, 56	projection (edging final caliber)
80	flange part
82	web part
82a	reduced portion
82b	raised part (unreduced portion)
85	upper caliber roll (first flat shaping caliber)
85a	recessed part
86	lower caliber roll (first flat shaping caliber)
86a	recessed part
95	upper caliber roll (second flat shaping caliber)
96	lower caliber roll (second flat shaping caliber)
KH1	first flat shaping caliber
KH2	second flat shaping caliber
KE	edging final caliber
GH	general flat shaping caliber

T production line
A material to be rolled

Claims

1. A method for producing H-shaped steel, the method comprising:

a rough rolling step;
an intermediate rolling step; and
a finish rolling step, wherein:

the rough rolling step includes:

an edging rolling step of rolling and shaping a material to be rolled into a predetermined dog-bone shape;
a raised part generating step of performing rolling of a web part by making the material to be rolled after completion of the edging rolling step to be rotated by 90° or 270°, and forming a raised part at a middle of the web part of the material to be rolled;

a supplementary edging rolling step of performing light reduction rolling by making the material to be rolled after being rolled in one pass or more in the raised part generating step to be rotated by 90° or 270° again and returning the material to be rolled to a final caliber in the edging rolling step; and

a raised part eliminating step of reducing and eliminating the raised part formed in the raised part generating step;

in upper and lower caliber rolls which perform the raised part generating step, recessed parts configured to form the raised part at the middle of the web part of the material to be rolled are provided at roll barrel length middle parts of the upper and lower caliber rolls;

a roll shape of the upper and lower caliber rolls is designed to make tips of flange parts of the material to be rolled to be out of contact with the upper and lower caliber rolls;

two steps of the raised part generating step and the supplementary edging rolling step are continuously performed one time or plural times; and

the raised part eliminating step is performed after the raised part generating step and the supplementary edging rolling step are performed.

2. The method for producing the H-shaped steel according to claim 1, wherein

in the supplementary edging rolling step, the light reduction rolling is performed so as to make the tips of the flange parts of the material to be rolled fill the final caliber in the edging rolling step.

3. The method for producing the H-shaped steel according to claim 2, wherein

in the supplementary edging rolling step, the light reduction rolling is performed so as to make a web height of the material to be rolled to be smaller than a web height of the material to be rolled supplied to a caliber which performs the raised part generating step right before the supplementary edging rolling step.

4. The method for producing the H-shaped steel according to any one of claims 1 to 3, wherein

the supplementary edging rolling step is performed in one chance or two chances when one set of plural passes in which an edging height in a final pass is set to be constant is set to one chance.

5. The method for producing the H-shaped steel according to any one of claims 1 to 4, wherein

a width of the raised part formed in the raised part generating step is set to 25% or more and 50% or less of a web part inner size of the material to be rolled.

FIG.1

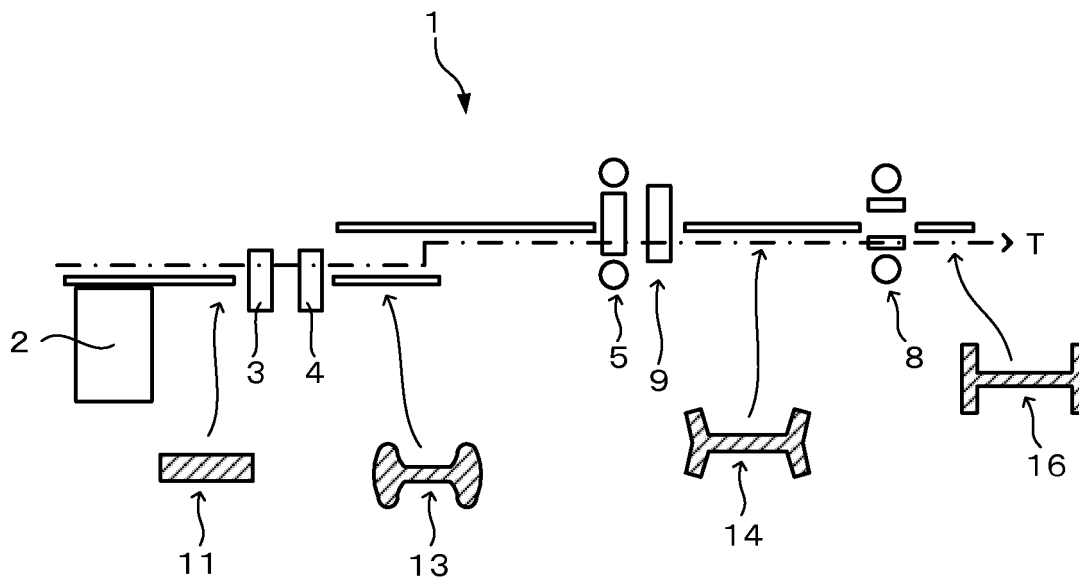


FIG.2

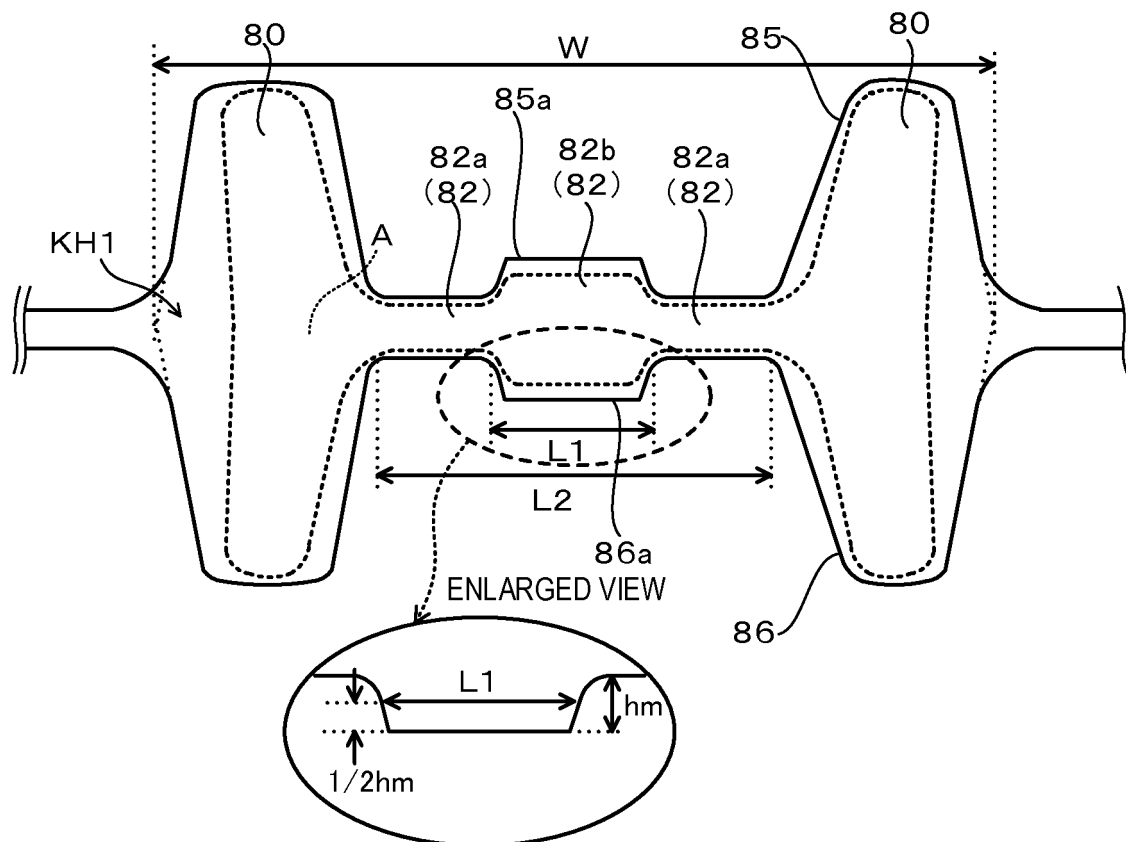


FIG.3

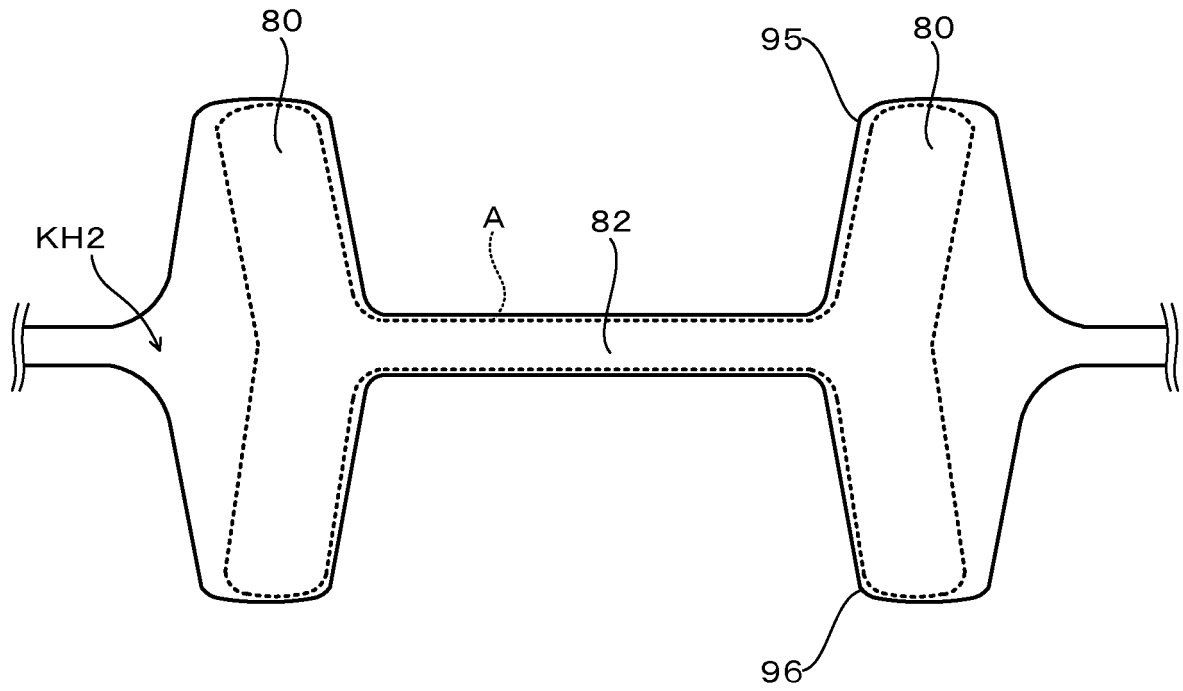


FIG.4

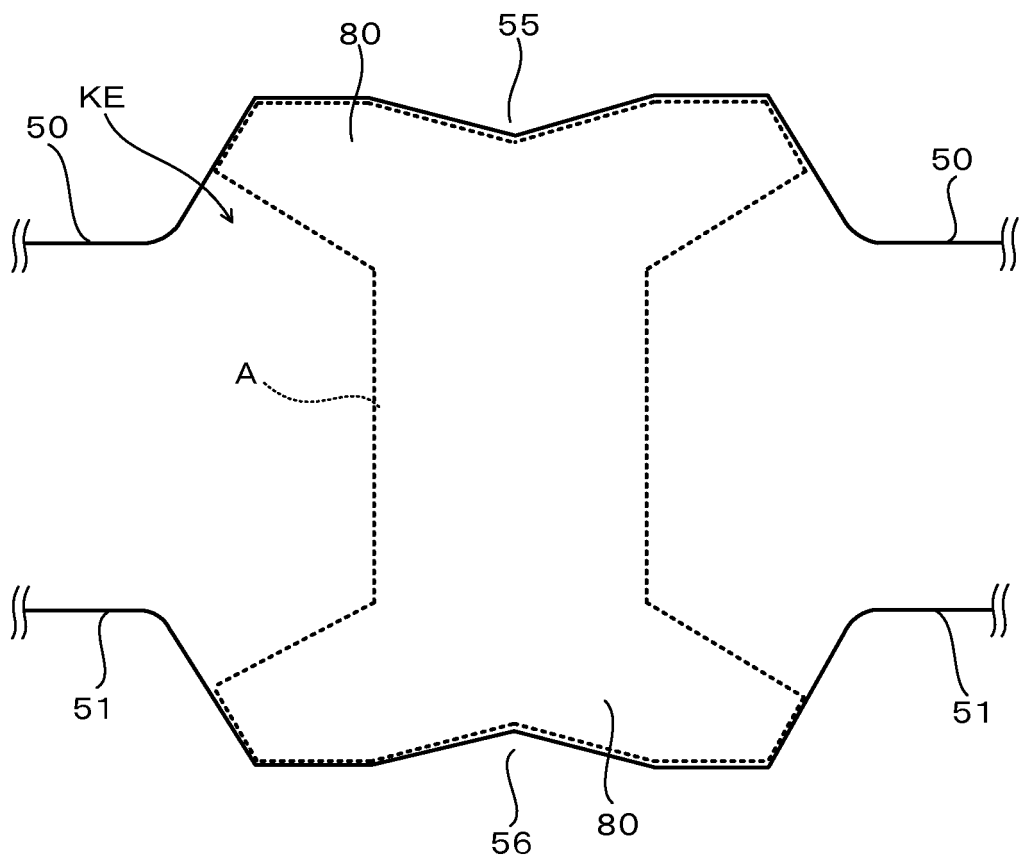
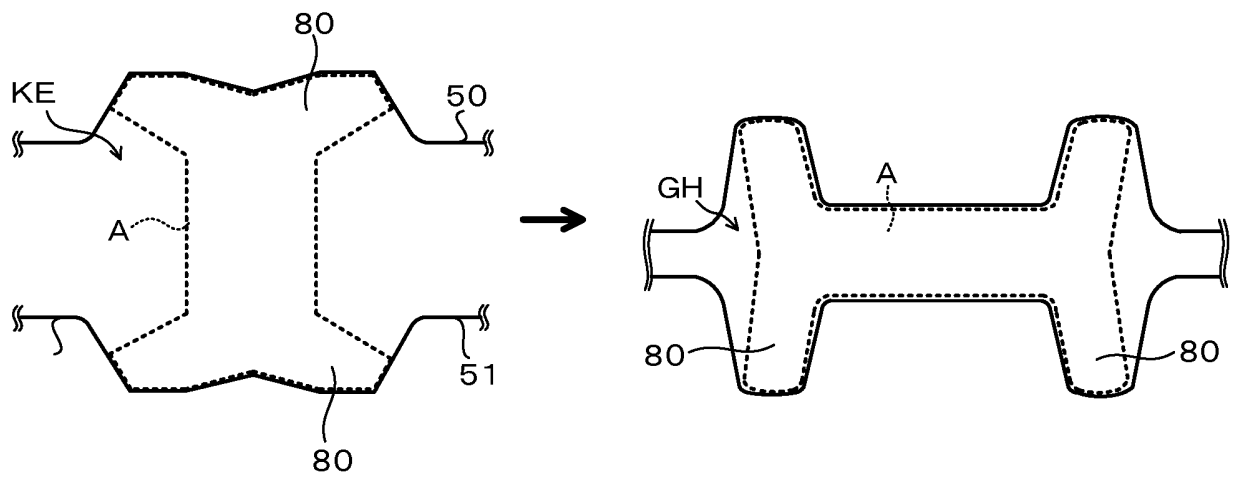


FIG.5

(a)



(b)

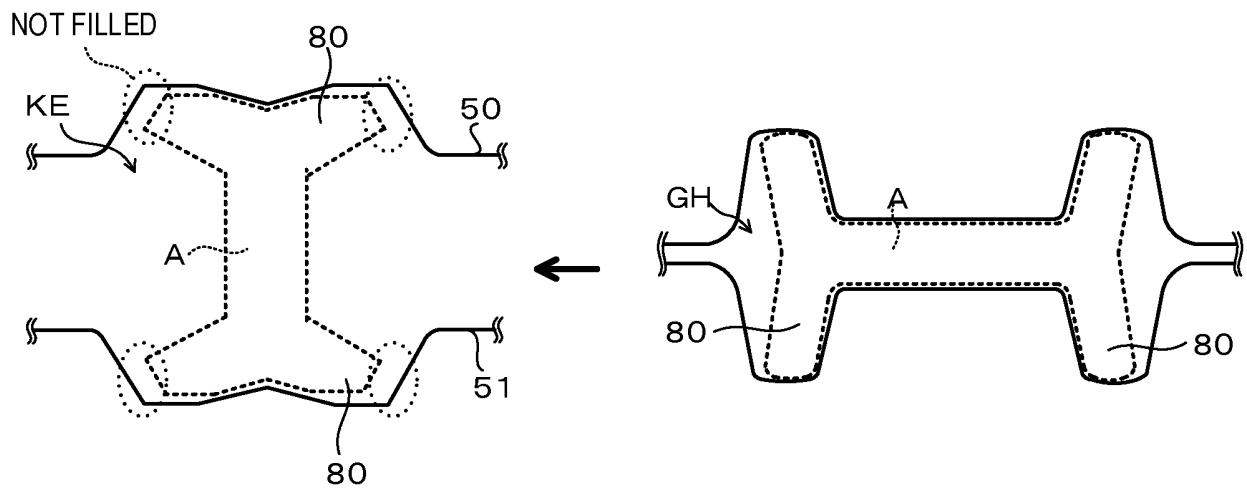
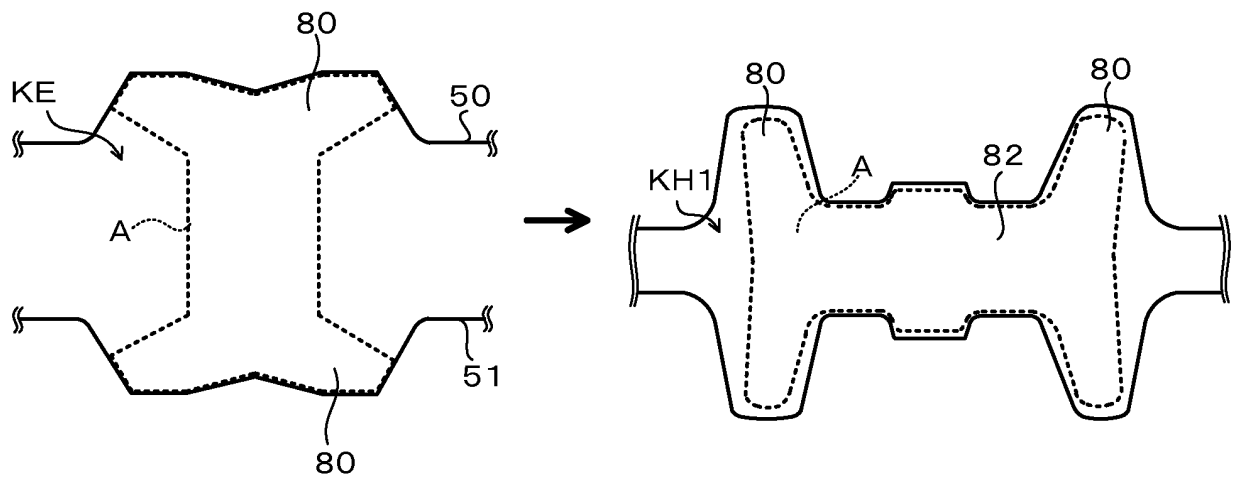


FIG.6

(a)



(b)

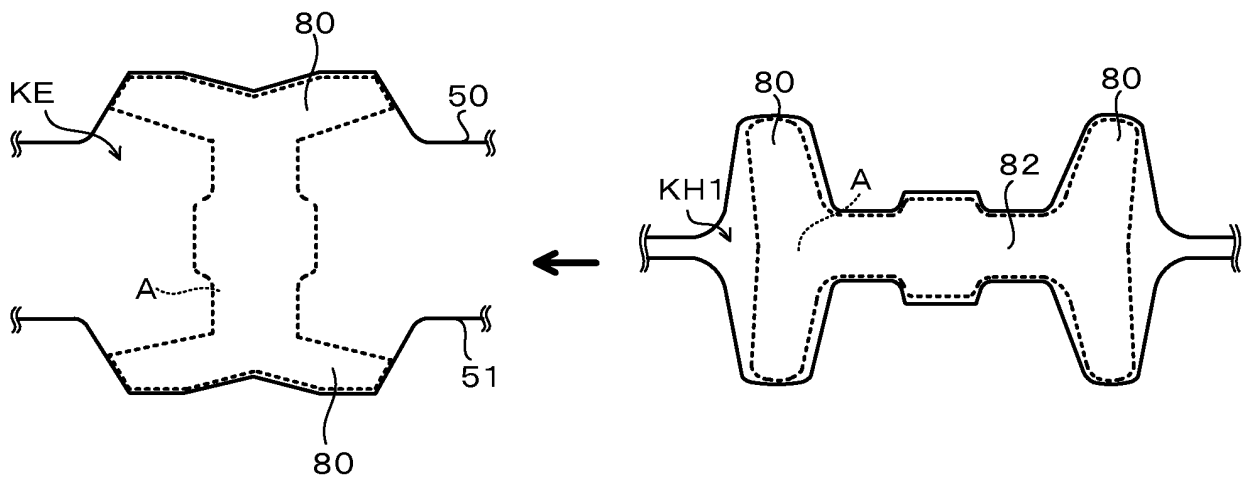


FIG.7

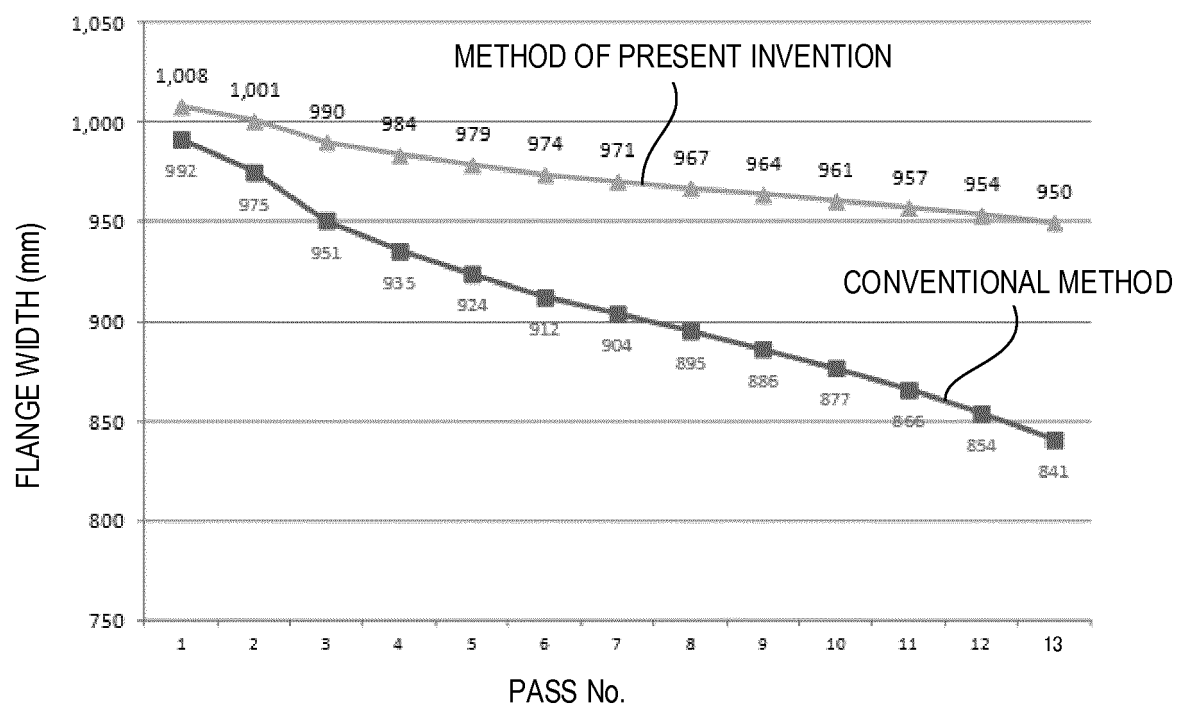


FIG.8

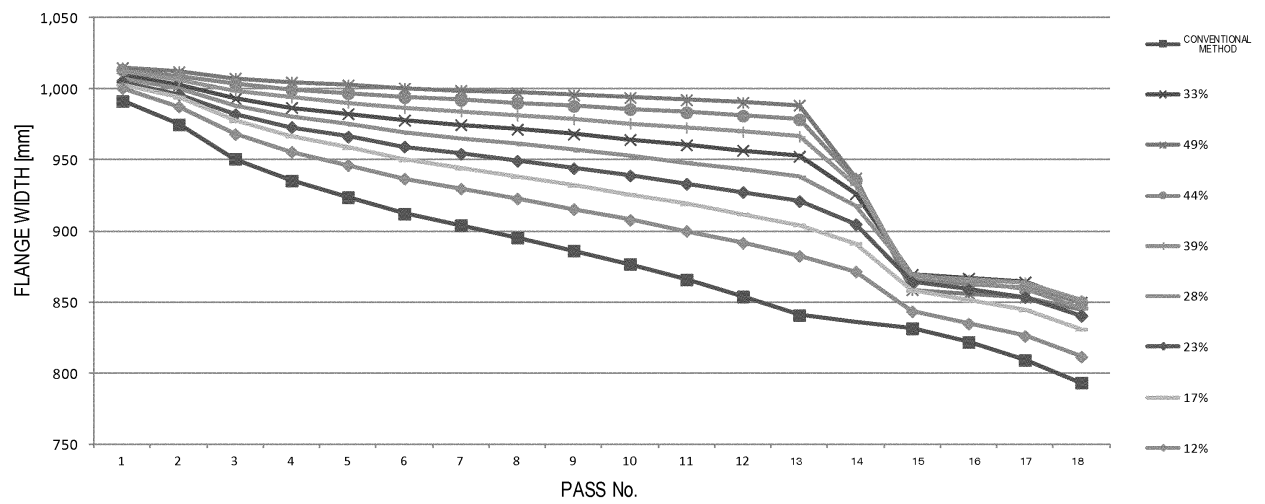
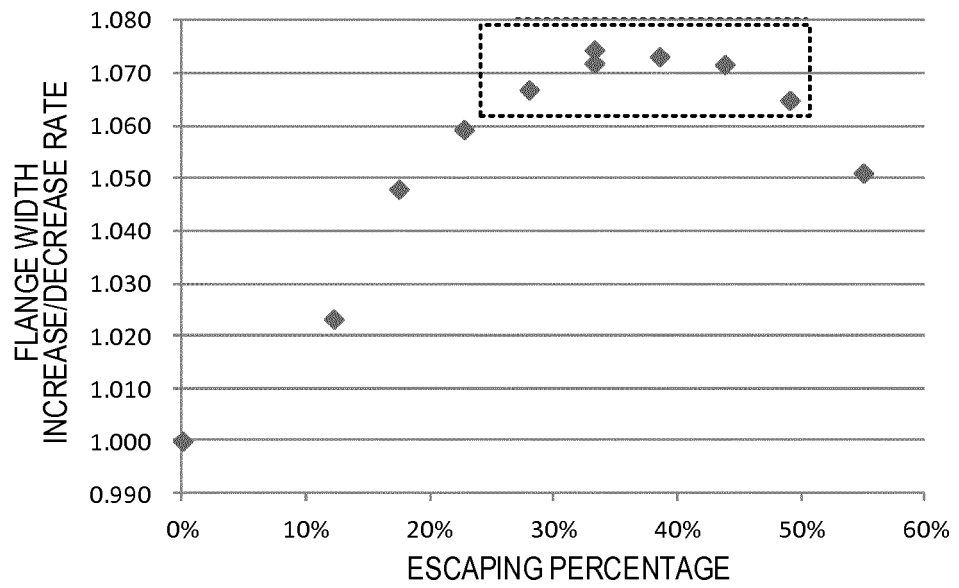


FIG.9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/019883

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. B21B1/08 (2006.01) i, B21B1/088 (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)

Int.Cl. B21B1/08, B21B1/088

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 57-146405 A (KAWASAKI STEEL CORP.) 09 September 1982 & US 4402206 A1	1-5
A	JP 57-171501 A (KAWASAKI STEEL CORP.) 22 October 1982 (Family: none)	1-5
P, A	WO 2018/029869 A1 (NIPPON STEEL & SUMITOMO METAL CORPORATION) 15 February 2018 (Family: none)	1-5

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Further documents are listed in the continuation of Box C.

☐

See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

30 July 2018 (30.07.2018)

Date of mailing of the international search report

07 August 2018 (07.08.2018)

Name and mailing address of the ISA/

Japan Patent Office

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Authorized officer

Telephone No.

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

REFERENCES CITED IN THE DESCRIPTION

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- JP S5935802 B [0009]
- JP S57146405 B [0009]