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(30) Priority: 23.03.1998 JP 7459898 23.03.1998 JP 7459998	(74) Representative: Abbie, Andrew Kenneth et al R.G.C. Jenkins & Co. 26 Caxton Street London SW1H 0RJ (GB)
(71) Applicant: Calsonic Corporation Nakano-ku, Tokyo 164 (JP)	

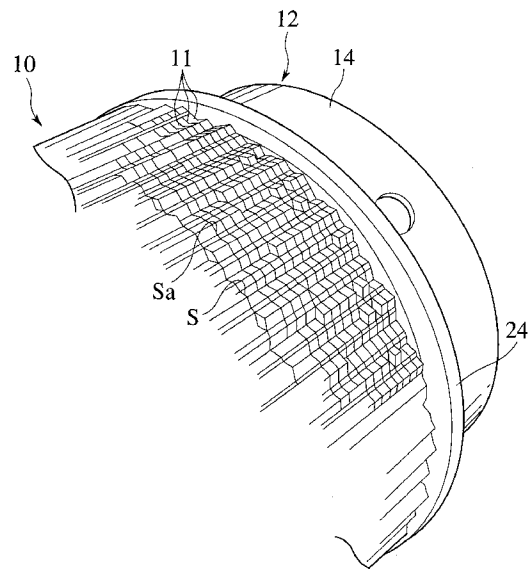
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Molding roll for metal thin plate as catalyst carrier and molding roll apparatus

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A molding roll (10) comprises a plurality of plate-like blades (11) having a same shape and including neighboring first blades and second blades respectively, the blades being laminated and center axes of the blades being positioned on the same line, the blades having convex portion forming regions which are formed continuously every constant pitch angle at their outer peripheries, each of the convex portion forming regions constituting one of a roll ridge portion and a roll root portion, the roll ridge portion being protruded outward to form one of the first convex portion and the fourth convex portion, the roll root portion becoming depressed inward to form one of the second convex portion and the third convex portion, the second blades being positioned to be shifted by an integral multiple of the pitch angle relative to the first blades, neighboring convex portion forming regions being aligned along the center axes when the blades are laminated, laminated blades having first columns, which consist of roll ridge portions constituting the first convex portions and roll root portions constituting the third convex portions and are aligned along the center axes, and second columns, which consist of roll root portions constituting the second convex portions and ridge root portions constituting the fourth convex portions and are aligned along the center axes, the first columns and the second columns being arranged alternatively along a peripheral direction of the blades; and a spacer provided between the first and second blades, the spacer creating a clearance to rise up the third convex portions and the fourth convex portions.

FIG.1



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a molding roll for molding a metal thin plate as a catalyst carrier employed in a metallic catalyst converter.

[0002] As the metallic catalyst converter in the prior art, for example, there have been known the converter in which honeycomb carriers are constructed by laminating the corrugated metal thin plates formed of a stainless steel, etc. and the flat metal thin plates alternatively to thus create cells between laminated portions, as disclosed in Patent Application Publication (KOKAI) Hei 5-138040, Patent Application Publication (KOKAI) Hei 6-393, etc., the converter in which honeycomb carriers are constructed by rising up a plurality of holding plate portions which have their upper flat surfaces from corrugated concave portions of the corrugated metal thin plate in the opposite direction and then laminating the metal thin plates, as disclosed in Utility Model Application (KOKOKU) Sho 57-8915, and other converters.

SUMMARY OF THE INVENTION

[0003] In the former metallic catalyst converter in which the corrugated metal thin plates and the flat metal thin plates are laminated alternatively, it is impossible to deny that such converter is disadvantageous in cost since two types of metal thin plates are needed to increase the forming step of the honeycomb carrier as well as the forming step and the managing step of the metal thin plates.

[0004] In the latter metallic catalyst converter, even in the case that adjacent laminated metal thin plates are held by holding plates whose upper surfaces being provided at corrugated concave portions are formed flat, there is a possibility that the metal thin plates are fitted mutually and thus cells are not properly formed at the laminated portions when such adjacent laminated metal thin plates are displaced or shifted in the corrugation direction or the corrugation folded direction.

[0005] Therefore, it is an object of the present invention to provide a molding roll which is capable of constructing a core by laminating corrugated metal thin plates to form cells at their laminated portions, and avoiding the fitting of the metal thin plates to ensure the cells even when adjacent laminated metal thin plates are shifted in the corrugation direction or in the corrugation folded direction, and thus forming easily metal thin plates employed as the catalyst carriers.

[0006] In order to achieve the above object, according to a first aspect of the present invention, there is provided a molding roll for molding a metal thin plate employed as a catalyst carrier, the metal thin plate including first regions having first convex portions and third convex portions and second regions having second convex portions and fourth convex portions, the first regions and

the second regions being provided alternatively along a second direction intersected orthogonally with a first direction, the first convex portions and the third convex portions being arranged alternatively and linearly along the first direction in same regions, cuttings being formed between the first convex portions and the third convex portions, the second convex portions and the fourth convex portions being arranged alternatively and linearly along the first direction in same regions, cuttings being formed between the second convex portions and the fourth convex portions, the first convex portions and the fourth convex portions being folded to protrude to one surface side of the metal thin plate, and the second convex portions and the third convex portions being folded to protrude to other surface side of the metal thin plate, the molding roll comprising: a plurality of plate-like blades having a same shape and including neighboring first blades and second blades respectively, the blades being laminated and center axes of the blades being positioned on a same line, the blades having convex portion forming regions which are formed continuously every constant pitch angle at their outer peripheries, each of the convex portion forming regions constituting one of a roll ridge portion and a roll root portion, the roll ridge portion being protruded outward to form one of the first convex portion and the fourth convex portion, the roll root portion becoming depressed inward to form one of the second convex portion and the third convex portion, the second blades being positioned to be shifted by an integral multiple of the pitch angle relative to the first blades, neighboring convex portion forming regions being aligned along the center axes when the blades are laminated, laminated blades having first columns, which consist of roll ridge portions constituting the first convex portions and roll root portions constituting the third convex portions and are aligned along the center axes, and second columns, which consist of roll root portions constituting the second convex portions and roll ridge portions constituting the fourth convex portions and are aligned along the center axes, the first columns and the second columns being arranged alternatively along a peripheral direction of the blades; and a spacer provided between the first and second blades, the spacer creating a clearance to rise up the third convex portions and the fourth convex portions.

[0007] One pattern which is composed of the roll ridge portion and the roll root portion may be arranged repeatedly on outer peripheral edges of the blades along the peripheral direction.

[0008] According to the above configuration, the roll ridge portions constitute the first convex portions and also the roll root portions constitute the third convex portions in the first columns, and the roll root portions constitute the second convex portions and the roll ridge portions constitute the fourth convex portions in the second columns. Convex/concave profiles of the metal thin plate are decided according to outer peripheral edge shapes of the blades and a degree of displacement be-

tween the first blades and the second blades. Hence, alignment patterns of the first convex portions and the third convex portions in the first regions and alignment patterns of the second convex portions and the fourth convex portions in the second regions (the convex/concave profiles of the metal thin plate) can be changed by changing the degree of displacement between the first blades and the second blades. Therefore, the metal thin plate having various convex/concave profiles can be molded by the same molding roll. As a result, the molding roll for molding the metal thin plate of the convex/concave profiles, which are hard to fit and stick to each other in a laminated state, can be easily obtained. In addition, since the clearance is created between the first blades and the second blades by the spacer, the third convex portions and the fourth convex portions can be formed to be risen up rather than the first convex portions and the second convex portions.

[0009] The blades may include plural sets of first blades and second blades.

[0010] According to the above configuration, since the plural sets of first blades and second blades are contained, types of changeable patterns of the convex/concave profiles of the metal thin plate can be further increased.

[0011] The roll ridge portion and the roll root portion may be positioned irregularly in respective first columns, and the roll ridge portion and the roll root portion may be positioned irregularly in respective second columns.

[0012] According to the above configuration, the metal thin plate molded by the molding roll contains the first regions in which the first convex portions and the third convex portions are positioned irregularly and the second regions in which the second convex portions and the fourth convex portions are positioned irregularly. Therefore, the metal thin plate having the convex/concave profiles, which are hard to fit and stick to each other in the laminated state, can be easily obtained.

[0013] The contiguous number of the roll ridge portions provided along the peripheral direction of the blades may be set to less than two, and the contiguous number of the roll root portions provided along the peripheral direction of the blades may be set to less than two.

[0014] According to the above configuration, in the molded metal thin plate, both the contiguous number of the first convex portions and the fourth convex portions and the contiguous number of the second convex portions and the third convex portions are set to less than two in neighboring first and second regions respectively. Therefore, infinite expansion of the cell opening area in the laminated state can be suppressed, and also extreme irregularity of the cells in size can be prevented.

[0015] The blades may further comprise the substantially flat rack portions placed between the convex portion forming regions.

[0016] According to the above configuration, the molded metal thin plate has the substantially flat rack

portions between neighboring first and second regions. Therefore, when the metal thin plates are laminated, mutual fitting and sticking of the metal thin plates can be avoided without fail. In addition, rupture of the rising-up stop ends of the third convex portions and the fourth convex portions due to difference in the coefficient of thermal expansion can be avoided.

[0017] The molding roll may further comprise a holder having an axis portion which has a first flange at its one end, the blades together with the spacer being inserted into the axis portion and laminated; a second flange which is inserted into other end of the axis portion, the blades and the spacer, when laminated, being arranged between the first flange and the second flange; a locate pin into which the first flange, the second flange, the blades, and the spacer are inserted and press-fitted; and fastening members for fastening the blades and the spacer between the first flange and the second flange.

[0018] According to the above configuration, plural sheets of blades and the spacers interposed between these blades are positioned in good order by the press-fitting positions of the locate pin between the first flange and the second flange and laminated, and then fastened/ fixed more tightly by the fastening members. For this reason, no mutual displacement of the blades is caused along the peripheral direction, and forming precision of the convex/concave profiles of the metal thin plate can be improved further more.

[0019] The molding roll may further comprise a stopper plate placed between one of the first flange and the second flange and the blade positioned adjacent to one of the first flange and the second flange, the stopper plate engaging with a partner roll of the molding roll to suppress displacement of the molding roll with respect to the partner roll along the center axis.

[0020] According to the above configuration, since the stopper plate can engage with the partner roll of the molding roll to thus suppress displacement of the molding roll with respect to the partner roll along the center axis, the forming precision of the convex/concave profiles of the metal thin plate can be improved much more.

[0021] According to a second aspect of the present invention, there is provided a molding roll machine for a metal thin plate employed as a catalyst carrier, comprising a frame having a base plate; a first roll stand for molding a first corrugated metal plate, the first roll stand including a pair of rolls having roll ridge portions and roll root portions on its peripheral surface; a second roll stand for molding a second corrugated metal plate, the second roll stand including a pair of rolls having roll ridge portions and roll root portions on its peripheral surface, the first roll stand and the second roll stand being attachably/detachably fixed selectively to different positions of the base plate; a first roll driving mechanism provided on the base plate, for rotating a roll of the first roll stand; a second roll driving mechanism provided on the base plate, for rotating a roll of the second roll stand; a pair of first couplings for connecting the first roll driving

mechanism and the roll attachably/detachably; a pair of second couplings for connecting the second roll driving mechanism and the roll attachably/detachably; and a slide mechanism placed between the first roll stand and the base plate, the slide mechanism being able to be moved upward relative to the base plate to adjust a position of the first roll stand.

[0022] According to the above configuration, the first and second roll stands, which are used to form different types of corrugated metal thin plates on the transfer line of the strip material, are provided on the base plate of the base frame to be selectively removed from the base plate. Therefore, in molding the corrugated metal thin plate, one roll stand can be removed from the base plate, while leaving the other roll stand which corresponds to the to-be-formed corrugation metal thin plate, and thus different types of corrugated metal thin plates can be easily formed by using a single molding roll machine. As a result, the cost of equipment can be reduced, the space for the production line can be reduced, and the desired catalyst carrier corrugated metal thin plate can be produced advantageously in cost.

[0023] Meanwhile, since the slide mechanism which lifts up the first roll stand from the fixing surface of the base plate is provided on the base plate, the fitting position of the heavy roll stand can be adjusted easily by lifting up this roll stand from the fixing surface of the base plate. In addition, the drive shaft of the roll drive mechanism and the roll shaft can be easily attached and detached by the couplings. Accordingly, a removing operation as well as a fitting operation of the roll stand can be performed quickly and easily.

[0024] One of the first couplings may be provided slidably along the rotation axial direction of the corresponding roll.

[0025] According to the above configuration, in attaching and detaching the roll stand, especially in installing the roll stand, one of the couplings is slid previously to a position which is put back from the end of the corresponding drive shaft in the axial direction. Therefore, when the roll stand is moved vertically by the slide mechanism, no interference between the couplings is caused and the installing operability of the roll stand can be improved much more.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

FIG. 1 is a perspective view showing a molding roll according to an embodiment of the present invention;

FIG. 2 is a front exploded view showing the molding roll in FIG. 1;

FIG. 3 is a side view showing a blade employed in the molding roll in FIG. 1;

FIG. 4 is a fragmentary enlarged view showing the blade in FIG. 3;

FIG. 5 is a plan view showing a metal thin plate molded by the molding roll in FIG. 1;

FIG. 6 is a sectional view showing sectional shapes of the metal thin plate at respective positions VIa, VIb, VIc, VId, VIe in FIG. 5;

FIG. 7 is a perspective view showing a basic pattern profile of the metal thin plate in FIG. 5;

FIG. 8 is a sectional view showing laminated portions of the metal thin plates if a honeycomb carrier is formed by using the metal thin plates shown in FIG. 5;

FIG. 9 is a sectional view showing a metallic catalyst carrier;

FIG. 10 is a sectional view, taken along a line X-X in FIG. 9, showing the metallic catalyst carrier;

FIG. 11 is a plan view showing a molding roll machine;

FIG. 12 is a side view showing the molding roll machine in FIG. 11;

FIG. 13 is a perspective view showing a slide mechanism in the molding roll machine in FIG. 11; and

FIG. 14 is a perspective view showing a coupling structure in the molding roll machine in FIG. 11.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] An embodiment of the present invention will be explained along with the accompanying drawings hereinafter.

[0028] FIGS. 9, 10 show a metallic catalyst carrier 1 including a metallic catalyst carrier 3 which employs metal thin plate 5 molded by a molding roll of the present invention. The metallic catalyst carrier 3 is arranged in a metal outer cylinder 2 which is formed to have an elliptic sectional shape (including an ellipse).

[0029] Diffusers 4 provided to both ends of the outer cylinder 2 are separately formed. The diffusers 4 are fitted into both ends of the outer cylinder 2 and then fixed thereto.

[0030] The metallic catalyst carrier 3 is formed by coating a binder, which is formed of alumina called a "wash coat", on a honeycomb carrier 3a as a base body, and then applying catalysts such as Pt, etc. on a surface of the binder.

[0031] The honeycomb carrier 3a is constructed by folding the metal thin plate 5, which is formed of stainless steel, etc. and is corrugated, successively like the S-shape along the corrugation direction and then laminating them like a honeycomb to thus form cells at respective laminated portions.

[0032] In this case, in addition to the above, the honeycomb carrier 3a may be constructed by laminating plural sheets of the metal thin plates 5 being cut up into desired lengths, otherwise the honeycomb carrier 3a may be constructed by winding the metal thin plate 5 to be laminated.

[0033] A standard corrugation pattern of the metal thin

plate 5 which is corrugated is shown in FIGS.5, 6.

[0034] The metal thin plate 5 will be explained with reference to a basic profile of a corrugated metal thin plate 5' of this type shown in FIG.7.

[0035] The corrugated metal thin plate 5' of this type shown in FIG.7 has ridge portions 5a' and root portions 5b' acting as standard corrugations.

[0036] If the root portion on the left end in FIG.7 is assumed as the root portion 5b', the ridge portions 5a' and the root portions 5b' of this corrugated metal thin plate 5' are aligned alternatively in sequence along the corrugation direction x (referred to as an "x direction" hereinafter). Flat rack portions 5f' are then provided successively at respective center positions of slant walls 5c', which constitute the ridge portions 5a' and the root portions 5b', along the corrugation folded direction y (referred to as a "y direction" hereinafter). Using the ridge portions 5a' as their stop ends, a plurality of rising-up root portions 5d' which are risen up in the opposite direction are provided to the ridge portions 5a' of the corrugation at a constant distance along they direction. Similarly, a plurality of rising-up ridge portions 5e' which are risen up in the opposite direction are provided to the root portions 5b' of the corrugation at a constant distance along the y direction. In this manner, in the corrugated metal thin plate 5' in FIG.7, the ridge portions 5a' and the root portions 5b' are aligned via the rack portions 5f' alternatively in sequence along the x direction, and a plurality of the rising-up root portions 5d' are provided to the ridge portions 5a' at a constant distance regularly along the y direction and also a plurality of the rising-up ridge portions 5e' are provided to the root portions 5b' at a constant distance regularly along the y direction, whereby the uniform corrugated metal thin plate 5' can be formed in total.

[0037] The corrugated metal thin plate 5' shown in FIG.7 constitutes a uniform corrugation pattern in total as described above, whereas the metal thin plate 5 has a certain regularity but constitutes a nonuniform corrugation pattern in total.

[0038] More particularly, the metal thin plate 5 shown in FIGS.5, 6 has the ridge portions 5a and the root portions 5b of the corrugation as basic profiles, like the metal thin plate 5' shown in FIG.7. A plurality of rising-up root portions 5d, which are risen up from the center position of the slant walls 5c constituting the ridge portions 5a and the root portions 5b in the opposite direction, are provided to the corrugated ridge portions 5a at a constant distance along the y direction, using the rack portions 5f being provided at the above center positions as the stop ends. While, a plurality of rising-up ridge portions 5e, which are risen up similarly in the opposite direction, are provided to the corrugated root portions 5b at a constant distance along the y direction.

[0039] Assume that the ridge portions 5a of this metal thin plate 5 is formed at the left end in FIG.5, a half portion of the ridge portion 5a the root portion 5b, the ridge portion 5a, the root portions 5b, .. are aligned alternatively

from the left end in FIG.5 in this corrugation pattern, and thus a half portion of the ridge portion 5a which corresponds to the above half portion of the ridge portion 5a is formed in the right end in FIG.5. As shown in Fig. 6, in the a column of the metal thin plate 5 located at the bottom end in FIG.5, "rising-up root portion 5d of the half portion of the ridge portion 5a - root portion 5b - ridge portion 5a - rising-up ridge portion 5e - rising-up root portion 5d - rising-up ridge portion 5e - ridge portion 5a - root portion 5b - rising -up root portion 5d - rising-up ridge portion 5e - rising-up root portion 5d of the half portion of the ridge portion 5a" are formed via the rack portions 5f in this order along the x direction. That is, if this end edge is viewed from the front side, "half root-root-ridge- ridge-root-ridge-ridge-root-root-ridge-half root" are formed along the x direction. Similarly, sectional shapes of this metal thin plate 5 in b to e columns shown at the left end in FIG.5 are given as "ridge- root" arrangement. In this way, as shown in FIG.5, this metal thin plate 5 constitutes corrugation patterns such that this "ridge-root" is arranged with a certain regularity on an entire surface but arranged nonuniformly in total.

[0040] The metal thin plate 5 is formed by using a molding roll 10 shown in FIGS.1 to 4.

[0041] FIG.1 is a perspective view showing the molding roll 10 according to an embodiment of the present invention. FIG.2 is an exploded view showing the molding roll 10. FIG.3 is a side view showing a blade 11 of a plurality of blades to form the molding roll 10. FIG.4 is a fragmentary enlarged view showing the blade 11 in FIG. 3.

[0042] As shown in FIG.1, the molding roll 10 is constructed by laminating plural sheets of blades 11 which are formed under the same standard and in which roll ridge portions 10a, 10e (see FIG.4) and roll root portions 10b, 10d (see FIG.4) are formed on their peripheral surfaces. These roll ridge portions 10a, 10e correspond to the ridge portions 5a and the rising-up ridge portions 5e of the corrugation of the metal thin plate 5. These roll root portions 10b, 10d correspond to the root portions 5b and the rising-up root portions 5d of the corrugation of the metal thin plate 5.

[0043] As shown in FIGS.3, 4, the roll ridge portions 10a, 10e and the roll root portions 10b, 10d of the blade 11 are formed to have a predetermined assignment angle θ around a blade center point O respectively. in this embodiment, respective contiguous numbers of the roll ridge portions 10a, 10e and the roll root portions 10b, 10d, which are adjacent along the peripheral direction of the blade 11, are set to less than two.

[0044] Almost flat rack portions 10f which partition the roll ridge portion 10a and the roll root portion 10b, or the roll ridge portion 10a and the roll ridge portion 10e, or the roll root portion 10b and the roll root portion 10d, both being adjacent along the peripheral direction, are formed on a pitch circle PC which partitions the roll ridge portion 10a and the roll root portion 10b of the blade 11.

[0045] More specifically, on this blade 11, the roll ridge

portion 10a and the roll ridge portion 10e which correspond to a convex portion being assumed as the ridge portion 5a of the metal thin plate 5 and a convex portion being assumed as the rising-up ridge portion 5a of the root portion 5b respectively are formed as convex portions on the pitch circle PC, while the roll root portion 10b and the roll root portion 10d which correspond to a concave portion being assumed as the root portion 5b of the metal thin plate 5 and a concave portion being assumed as the rising-up root portion 5d of the ridge portion 5a respectively are formed as concave portions on the pitch circle PC.

[0046] As shown in FIG.3 and FIG.4 as an enlarged view, for example, a continuous pattern of the roll ridge portions 10a, 10e and the roll root portions 10b, 10d on the peripheral surface of the blade 11 is formed successively every 45° as one period around the blade center point O. That is, in the case of the present embodiment, a pitch angle $\theta=4.5^\circ$, and eight 45° period patterns are formed successively to constitute an outer periphery of the blade 11.

[0047] Plural sheets of blades 11 are inserted into a cylindrical axis portion 13 of a holder 12, on one end of which a flange 14 is formed as shown in FIG.2, and laminated, as will be described later. A flange 15 is then inserted into the other end of the cylindrical axis portion 13 to put the blades 11 between the flanges 14, 15. The blades 11 are then positioned by press-fitting a plurality of locate pins 16 through the flanges 14, 15 and the plural sheets of blades 11. The blades 11 are then compressed and fixed by fastening members which consist of bolts 17 being provided through the flanges 14, 15 and the blades 11 and internal threads 18 being provided in the flanges 14, 15.

[0048] Therefore, as shown in FIG.3, a plurality of pin insertion holes 20 and a plurality of bolt insertion holes 21 as well as a center hole 19 into which an axis portion 13 of the holder 12 is inserted are formed symmetrically around the blade center point O.

[0049] In the present embodiment, six bolts are used, and insertion directions of the bolts being positioned at symmetrical positions and the bolts being positioned at neighboring positions are set oppositely respectively. As a result, plural sheets of blades 11 can be fastened uniformly.

[0050] Some of the blades 11 are shifted by an integral multiple of a formation distance (pitch angle) θ between the roll ridge portions 10a, 10e and the roll root portions 10b, 10d on the peripheral surface, and then laminated.

[0051] For example, if E-type blades 11 constituting the VIa column and D-type blades 11 constituting the VIb column are compared in FIG.5, the "ridge-root" arrangement on the VIb column is formed to be shifted clockwise relative to the "ridge-root" arrangement on the VIa column by one pitch, as shown in FIG.6, since the D-type blades 11 are shifted clockwise relative to the E-type blades 11 by one pitch from the reference line L.

[0052] In other words, as described above, the blades 11 have the pin insertion holes 20 and the bolt insertion holes 21 respectively and are positioned and fixed by fitting the locate pins 16 and the bolts 17 into the pin insertion holes 20 and the bolt insertion holes 21 respectively. Therefore, if a reference position is set on a reference line L connecting the pin insertion holes 20, 20, for example, the molding roll 10 according to the present embodiment can be formed by laminating plural types, e.g., ten types corresponding to A to J (see FIG.5), of blades 11 in combination. Such plural types of blades 11 are prepared by shifting the period (45° assignment) of the continuously formed patterns of the roll ridge portions 10a, 10e and the roll root portions 10b, 10d on the peripheral surface from the reference line L by θ degree in phase angle.

[0053] In the present embodiment, if these plural types A to J of blades 11 are laminated, the roll ridge portions 10e constituting the rising-up ridge portions 5e and the roll root portions 10d constituting the rising-up root portions 5d are formed respectively to have different forming distances and forming lengths in the axis direction of the molding roll 10 under the condition that respective blades 11 are laminated.

[0054] The laminated states A to J of the blades 11 are shown together with the corrugation pattern of the metal thin plate 5 in FIG.5.

[0055] Here, character numbers A to J represent the number of laminated sheets of a group of blades which are formed by laminating plural sheets of blades 11 having the same profile. For instance, a blade group B is formed by laminating five sheets of blades having the same profile.

[0056] In addition, spacers 22 (as shown in Fig.2) which can set a clearance S (as shown in Fig.1) being needed to rise up the rising-up root portions 5d and the rising-up ridge portions 5e of the metal thin plate 5 are interposed between the blade groups A to J which have different phase angles respectively.

[0057] A distance of this clearance S is decided such that an optimal shearing force is applied between the blades 11. In the present embodiment, such distance is set below a plate thickness of the metal thin plate to be worked.

[0058] Further, in the present embodiment, for example, spacers 23 (as shown in Fig.2) for setting a clearance Sa (as shown in Fig.1) to insert guide pieces (not shown) are interposed between respective laminated blades 11, 11 in blade groups B, H at plural locations of the blade groups. Such guide pieces can separate the formed metal thin plate 5 from surfaces of the molding roll 10.

[0059] In other words, spacers 22 for setting a clearance S necessary for rising-up are interposed between the blade groups, e.g., between the blade group B and the blade group A, whereas the spacers 23 for setting the clearance Sa to separate the formed metal thin plate 5 are interposed at desired locations between the blade

groups, e.g., between the blades 11, 11 of the blade group B.

[0060] The metal thin plate 5 can be formed by engaging a pair of molding rolls 10, 10, in which positions of the roll ridge portions 10a, 10e and the roll root portions 10b, 10d are set oppositely, with each other. In this case, mutual slight displacement of these molding rolls 10, 10 in the axis direction have a great influence on the formation of the rising-up root portion 5d and the rising-up ridge portion 5e of the metal thin plate 5.

[0061] Therefore, in this embodiment, as shown in Fig.2, a stopper plate 24 which can engage with the pair of molding rolls 10, 10 mutually to prevent axial displacement of the molding rolls 10, 10 is interposed between any one of the flanges 14, 15 of the molding roll 10, e.g., the flange 14 and the blade 11 being positioned adjacent to the flange 14.

[0062] When the corrugated metal thin plate 5 is formed by using the molding roll 10 which has the structure in the above embodiment, the molding roll 10 can be constructed by laminating plural sheets of same blades 11, in which the roll ridge portions 10a, 10e and the roll root portions 10b, 10d are formed by the predetermined assignment angle θ to mate with the corrugation pattern of the corrugated metal thin plate 5 to be formed as shown in Fig.4, into the A to J blade groups while shifting the assignment angle θ as the pitch. Therefore, the desired corrugated metal thin plate 5, which has a plurality of rising-up root portions 5d being formed on the corrugated ridge portion 5a by rising up oppositely and a plurality of rising-up ridge portions 5e being formed on the corrugated root portion 5b by rising up oppositely along the y direction respectively, can be formed easily.

[0063] In addition, the predetermined clearance S is set by interposing the spacers 22 between the A to J blades groups having different phase angles, and also a pair of molding rolls 10, 10 have respective stopper plates 24 which engage with each other to prevent mutual axial displacement of the molding rolls 10, 10. Therefore, mutual slight displacement of the molding rolls 10, 10 along the axial direction can be eliminated completely, and thus the rising-up ridge portions 5e and the rising-up root portions 5d can be formed properly with good precision.

[0064] In respective blades 11, the rack portions 10f which partition the roll ridge portions 10a, 10e and the roll root portions 10b, 10d being adjacent in the peripheral direction respectively are formed on the pitch circle PC on the peripheral surface, and also respective contiguous numbers of the roll ridge portions 10a, 10e and the roll root portions 10b, 10d are set to less than two, and in addition combination of the A to J blade groups are arranged in lamination such that the roll ridge portions 10a, 10e and the roll root portions 10b, 10d have different forming distances and different forming lengths along the axial direction of the molding roll 10 respectively. Therefore, as shown in FIGS.5, 6, the ideal cor-

rugated metal thin plate 5 can be achieved wherein the flat rack portions 5f can be formed at the center positions of the slant walls 5c, which constitute the ridge portions 5a and the root portions 5b of the corrugation, along the y direction in the corrugated metal thin plate 5 formed by the molding roll 10, and also the rising-up root portions 5d and the rising-up ridge portions 5e can be formed on both sides of these rack portions 5f in the y direction to have different forming distances and different forming lengths respectively, and also the contiguous number of the ridge portions 5a and the rising-up ridge portions 5e of the corrugation and the contiguous number of the root portions 5b and the rising-up root portions 5d of the corrugation, both being continuously adjacent in the x direction, can be set to less than two respectively.

[0065] In the event that the honeycomb carrier 3a is constructed by using the metal thin plate 5 in which the contiguous numbers of all the ridge portions and the root portions are set below two in this manner, it is of course that mutual fitting/sticking of the metal thin plates 5, 5 can be avoided because of the presence of a plurality of rising-up root portions 5d and rising-up ridge portions 5e both having different forming distances and different forming lengths even when the metal thin plates 5, 5 are displaced mutually along the y direction when superposed, and that mutual fitting/sticking of the metal thin plates 5, 5 can be avoided to thus keep the cells therebetween because the ridge portions 5a or the rising-up ridge portions 5e of the corrugation, or the root portions 5b or the rising-up root portions 5d of the corrugation come into collision with the rack portions 5f even when the metal thin plates 5, 5 are displaced mutually along the x direction. In addition, since the contiguous number of the ridge portions 5a and the rising-up ridge portions 5e of the corrugation and the contiguous number of the root portions 5b and the rising-up root portions 5d of the corrugation are set to less than two respectively, it can be prevented that opening areas of the cells which are formed between the ridge portions 5a and the rising-up ridge portions 5e of the corrugation of one metal thin plate 5 and the root portions 5b and the rising-up root portions 5d of the corrugation of the other metal thin plate 5 are increased infinitely, as shown by A to F of FIG.8, to thus cause extreme differences of respective cells even though the metal thin plates 5, 5 are displaced mutually along the x direction and thus the slant walls 5c, 5c are partially stuck. As a result, formation of the cells can be ensured and also the purification performance for the exhaust gas can be much more improved.

[0066] In this case, the foregoing ridge-root patterns of the metal thin plate 5 act to distribute the exhaust gas into many flow paths as the exhaust gas flows through the cells (see an arrow R labeled to the metal thin plate 5' in FIG.7), whereby the purification performance for the exhaust gas can be still much more improved.

[0067] Furthermore, since the rising-up root portions 5d and the rising-up ridge portions 5e, which are formed

adjacent in the corrugation direction of the metal thin plate 5, are risen up on both sides of the rack portions 5f which are formed at the center positions of the slant walls 5c constituting the ridge portions 5a and the root portions 5b of the corrugation of the metal thin plate 5, distances corresponding to the widths of the rack portions 5f can be kept in the corrugation direction between respective rising-up stop ends of the rising-up root portions 5d and the rising-up ridge portions 5e which are positioned in the neighborhood along the corrugation direction, and therefore rupture of the rising-up stop ends due to difference in a coefficient of thermal expansion can be avoided. As a result, breaking endurance rigidity of the metal thin plate 5 per se can be enhanced and in turn durability of the honeycomb carrier 3a, i.e., durability of the metallic catalyst carrier 3 can be improved.

[0068] Meanwhile, plural sheets of blades 11 and the spacers 22, 23 interposed between these blades 11, which constitute the molding roll 10, are positioned in good order by the press-fitting positions of the locate pins 16 between the flange 14 provided to one end of the holder 12 and the flange 15 provided to the other end of the holder 12, then laminated, and then fastened/ fixed tightly by the fastening members which consist of a plurality of bolts 17, 17 and internal threads 18, 18 being cut in the flanges 14, 15. For this reason, no mutual displacement of the blades 11, 11 is caused along the peripheral direction, and axial displacement of a pair of molding rolls 10, 10 can be suppressed by the stopper plates 24, and also forming precision of the corrugated metal thin plate 5 can be improved further more.

[0069] In addition, various corrugation patterns of the metal thin plate 5 can be easily created by changing phase angles of plural sheets of blades 11 to be laminated, i.e., shifting modes of the pitch θ appropriately.

[0070] The above fastening members may be composed of the bolts and nuts. However, it is preferable that the embedded nut in the flange should be employed as the nuts in view of fitting to the manufacturing machine.

[0071] Next, a molding roll machine of the present embodiment will be explained hereunder.

[0072] In FIG. 11 and FIG. 12, a base plate 102 provided on an upper surface of a base frame 101 is formed to have a predetermined area which is enough to provide two different roll stands 104, 110 on a transfer line of a strip material (not shown) which is formed of a stainless steel, etc. and drawn out from a reel 103.

[0073] The roll stand 104 is a relatively small stand which is employed to form the simply corrugated catalyst carrier metal thin plate in which the ridge portions and the root portions of the corrugation are continued alternatively, for example. The roll stand 104 comprises a square stand base 105, bearing stands 106, 106 which are provided upright on the right and left side portions of the stand base 105, and a pair of upper and lower rolls 107, 107 which are supported rotatably to the bearing stands 106, 106 via roll shafts 108 respectively.

[0074] A pair of upper and lower rolls 107, 107 have reversed positional relationship between the roll ridge portions and the roll root portions on their peripheral surfaces. A roll shaft 108 of the lower roll 107 is connected to a drive shaft 125 of a roll drive mechanism 123 described later.

[0075] The roll stand 110 is employed to form the catalyst carrier metal thin plate with a special corrugation, like the metal thin plate 5. Since the roll stand 110 has a cutter function for rising up the rising-up root portions 5d and the rising-up ridge portions 5e, such roll stand 110 is constructed firmly and relatively large rather than the roll stand 104 which folds the thin metal into the simple corrugation. Basically, like the roll stand 104, the roll stand 110 also comprises a square stand base 111, bearing stands 112, 112 which are provided upright on the right and left side portions of the stand base 111, and a pair of upper and lower rolls 10, 10 which are supported rotatably to the bearing stands 112, 112 via roll shafts 114 respectively.

[0076] A pair of upper and lower rolls 10, 10 have reversed positional relationship between the roll ridge portions 10a, 10e and the roll root portions 10b, 10d on their peripheral surfaces. A roll shaft 114 of the lower roll 10 is connected to a drive shaft 126 of a roll drive mechanism 124 described later.

[0077] Slide mechanisms 115 are provided to fixing portions which fix the roll stand 110 to the base plate 102. The slide mechanism 115 can adjust a fitting position of the roll stand 110 by lifting up the roll stand 110 from a fixing surface 102A of the base plate 102.

[0078] As the slide mechanism 115, for example, as shown in FIG. 13, a mechanism can be employed wherein a ball holder 117 is moved up and down between guide bars 116, which are formed of a pair of bar members constituting the fixing surface 102A, by using a fluid pressure such as a compressed air, then the stand base 111 of the roll stand 110 is lifted up from the fixing surface 102A by balls 118 held in the ball holder 117, and then the stand base 111 can be slid and moved freely by the balls 118.

[0079] In the present embodiment, as described above, the relatively large roll stand 110 is fixed on the fixing surface 102A of the guide bars 116 and has a roll height different from the relatively small roll stand 104. Therefore, a spacer 119 acting as a fixing surface 102B is secured to the fixing portions of the roll stand 104 by the fastening members such as the bolts and the nuts, etc., and then the roll stand 104 is fixed on the spacer 119 to make the roll heights of the roll stand 104 and the roll stand 110 equal.

[0080] Back/forth and right/left positions of the roll stand 110 are adjusted by using stoppers 120 which are directly secured to the base plate 102, and then the stand base 111 is fixed tightly by clamps 121. While, back/forth and right/left positions of the roll stand 104 are adjusted by using the stoppers 120 which are secured to the spacer 119, and then the stand base 105 is

fixed tightly by the clamps 121. Since the roll stand 110 is large in size and one side edge portion of the stand base 111 coincides substantially with one edge portion of the base plate 102, stoppers 122 which prevent side-ward movement and displacement of the roll stand 110 after the roll stand 110 has been fixed to the fixing surface 102A are detachably attached to one edge portion of the base plate 102, in addition to the stoppers 120 which position the roll stand 110.

[0081] Reference numerals 123, 124 denote roll driving mechanisms which are provided on the side of the base plate 102, on which the stoppers 122 are provided, and the opposite side of the base plate 102 in correspondence to the roll stand 104 and the roll stand 110 respectively. The drive shafts 125, 126 are supported by bearings 127, 128 to be positioned concentrically with the roll shafts 108, 114 of the lower rolls 107, 113 in the roll stands 104, 110. The drive shafts 125, 126 are rotated synchronously by winding a belt 132 on a motor 131, which acts as a driving source and is placed below the base frame 101, and the pulleys 129, 130, which are provided to the drive shafts 125, 126 respectively, to connect them.

[0082] The drive shafts 125, 126 and the roll shafts 108, 114 are connected attachably and detachably via couplings 133, 134 respectively. In this case, on the roll stand 110 side, the fitting position of the roll stand 110 can be adjusted by moving up and down on the fixing surface 102A in fitting the roll stand 110. Hence, as shown in FIG.4, the coupling 133a on the drive shaft 126 side can be slidably attached along the axial direction of the drive shaft 126 and then separated from the coupling 133b on the roll shaft 114 side by operating a lever 135, so that interference between the couplings 133a, 133b can be prevented in fitting the roll stand 110.

[0083] In addition, guide rails 136 which are employed to transfer a strip material (not shown) at a proper height without lateral displacement are provided attachably and detachably on the base plate 102.

[0084] According to the above molding roll machine, in case the simple corrugated metal thin plate (not shown) in which the ridge portions and the root portions of the corrugation are successively formed alternatively is to be formed, the roll stand 104 is left as it is on the base plate 102 of the base frame 101, but the roll stand 110 is removed from the base plate 102 by uncoupling the coupling 133 between the roll shaft 114 and the drive shaft 126 of the roll drive mechanism 124 and then unclamping the clamps 121 of the stand base 111. After this, the simple corrugation metal thin plate can be formed by the roll stand 104.

[0085] In case the special corrugation metal thin plate 5 is to be formed in place of formation of such simple corrugation metal thin plate, the roll stand 104 is removed from the base plate 102 by uncoupling the coupling 14 between the roll shaft 108 of the roll stand 104 and the drive shaft 125 of the roll drive mechanism 123 and then unclamping the clamp 121 of the stand base

105, while the roll stand 110 is placed on the base plate 102 and the stand base 111 is fixed by the clamp 121 and then the roll shaft 114 and the drive shaft 126 of the roll drive mechanism 124 are connected via the coupling 134. After this, the special corrugation metal thin plate 5 can be formed by the roll stand 110.

[0086] In this way, according to the present embodiment, the relatively small roll stand 104, which is used to form the simple corrugated metal thin plate on the transfer line of the strip material, and the relatively large roll stand 110, which has the cutter function employed to form the special corrugated metal thin plate 5, are provided to the base plate 102 of the base frame 101 to be selectively removed from the base plate 102. Therefore, while leaving one roll stand 104 or 110 which corresponds to the to-be-formed corrugation metal thin plate, the other roll stand 110 or 104 can be removed from the base plate 102. As a result, since two types of corrugated metal thin plates can be easily formed by using a single molding roll machine, the cost of equipment can be reduced, the space for the production line can be reduced, and the desired catalyst carrier corrugated metal thin plate can be produced advantageously in cost.

[0087] Meanwhile, since the slide mechanism 115 which lifts up the roll stand 110 from the fixing surface 102A is provided to the fixing portion of the base plate 102 to which the large roll stand 110 is fixed, the fitting position of the heavy roll stand 110 can be adjusted easily by lifting up the roll stand 110 from the fixing surface 102A. Accordingly, removing operation of the large and heavy roll stand 110 as well as fitting operation thereof can be performed quickly and easily. In addition, the coupling 133 of the drive shaft 126 in the roll drive mechanism corresponding to the roll stand 110 can be slid by operating the lever 135 in the axial direction of the drive shaft 126. Therefore, if the coupling 133a is slid previously to a position, which is put back from the end of the drive shaft 126 in the axial direction, in attaching and detaching the roll stand 110, especially in installing the roll stand 110, no interference between the couplings 133a, 133b is caused when the roll stand 110 is moved vertically by the slide mechanism 115. As a result, the installing operability of the roll stand 110 can be improved much more.

[0088] In this embodiment, although the slide mechanism 115 is provided to the fixing portion of the roll stand 110, it may also be provided to the fixing portion of the roll stand 104. In addition, the coupling 133b provided to the drive shaft 125 of the roll drive mechanism 123 corresponding to the roll stand 104 may also be installed to be slid in the axial direction of the drive shaft 125.

[0089] Moreover, two or more of different roll stands can be provided to the base plate 102 of the base frame 101 to be removed selectively.

Claims

1. A molding roll for molding a metal thin plate employed as a catalyst carrier, the metal thin plate including first regions having first convex portions and third convex portions and second regions having second convex portions and fourth convex portions, the first regions and the second regions being provided alternatively along a second direction intersected orthogonally with a first direction, the first convex portions and the third convex portions being arranged alternatively and linearly along the first direction in same regions, cuttings being formed between the first convex portions and the third convex portions, the second convex portions and the fourth convex portions being arranged alternatively and linearly along the first direction in same regions, cuttings being formed between the second convex portions and the fourth convex portions, the first convex portions and the fourth convex portions being folded to protrude to one surface side of the metal thin plate, and the second convex portions and the third convex portions being folded to protrude to other surface side of the metal thin plate,

the molding roll comprising:

a plurality of plate-like blades having a same shape and including neighboring first blades and second blades respectively, the blades being laminated and center axes of the blades being positioned on a same line, the blades having convex portion forming regions which are formed continuously every constant pitch angle at their outer peripheries, each of the convex portion forming regions constituting one of a roll ridge portion and a roll root portion, the roll ridge portion being protruded outward to form one of the first convex portion and the fourth convex portion, the roll root portion becoming depressed inward to form one of the second convex portion and the third convex portion, the second blades being positioned to be shifted by an integral multiple of the pitch angle relative to the first blades, neighboring convex portion forming regions being aligned along the center axes when the blades are laminated, laminated blades having first columns, which consist of roll ridge portions constituting the first convex portions and roll root portions constituting the third convex portions and are aligned along the center axes, and second columns, which consist of roll root portions constituting the second convex portions and roll ridge portions constituting the fourth convex portions and are aligned along the center axes, the first columns and the second columns being arranged alternatively along a peripheral direction of the blades; and

a spacer provided between the first and second blades, the spacer creating a clearance to rise up the third convex portions and the fourth convex portions.

2. A molding roll according to claim 1, wherein one pattern which is composed of the roll ridge portion and the roll root portion is arranged repeatedly on outer peripheral edges of the blades along the peripheral direction.
3. A molding roll according to claim 1, wherein the blades include plural sets of first blades and second blades.
4. A molding roll according to claim 1, wherein the roll ridge portion and the roll root portion are positioned irregularly in respective first columns, and the roll ridge portion and the roll root portion are positioned irregularly in respective second columns.
5. A molding roll according to claim 1, wherein a contiguous number of the roll ridge portions provided along the peripheral direction of the blades is set to less than two, and a contiguous number of the roll root portions provided along the peripheral direction of the blades is set to less than two.
6. A molding roll according to claim 1, further comprising: substantially flat rack portions placed between the convex portion forming regions.
7. A molding roll according to claim 1, further comprising: a holder having an axis portion which has a first flange at its one end, the blades together with the spacer being inserted into the axis portion and laminated; a second flange which is inserted into other end of the axis portion, the blades and the spacer, when laminated, being arranged between the first flange and the second flange; a locate pin into which the first flange, the second flange, the blades, and the spacer are inserted and press-fitted; and fastening members for fastening the blades and the spacer between the first flange and the second flange.
8. A molding roll according to claim 6, further comprising: a stopper plate placed between one of the first flange and the second flange and the blade positioned adjacent to one of the first flange and the sec-

ond flange, the stopper plate engaging with a partner roll of the molding roll to suppress displacement of the molding roll with respect to the partner roll along the center axis.

9. A molding roll machine for a metal thin plate employed as a catalyst carrier, comprising:

a frame having a base plate;
 a first roll stand for molding a first corrugated metal plate, the first roll stand including a pair of rolls having roll ridge portions and roll root portions on its peripheral surface;
 a second roll stand for molding a second corrugated metal plate, the second roll stand including a pair of rolls having roll ridge portions and roll root portions on its peripheral surface, the first roll stand and the second roll stand being attachably/detachably fixed selectively to different positions of the base plate;
 a first roll driving mechanism provided on the base plate, for rotating a roll of the first roll stand;
 a second roll driving mechanism provided on the base plate, for rotating a roll of the second roll stand;
 a pair of first couplings for connecting the first roll driving mechanism and the roll attachably/detachably;
 a pair of second couplings for connecting the second roll driving mechanism and the roll attachably/detachably; and
 a slide mechanism placed between the first roll stand and the base plate, the slide mechanism being able to be moved upward relative to the base plate to adjust a position of the first roll stand.

10. A molding roll machine according to claim 9, wherein one of first couplings is provided to be moved slidably along a rotation axis direction of a corresponding roll.

11. A molding roll machine according to claim 9, wherein the metal thin plate including first regions having first convex portions and third convex portions and second regions having second convex portions and fourth convex portions, the first regions and the second regions being provided alternatively along a second direction intersected orthogonally with a first direction, the first convex portions and the third convex portions being arranged alternatively and linearly along the first direction in same regions, cuttings being formed between the first convex portions and the third convex portions, the second convex portions and the fourth convex portions being arranged alternatively and linearly along the first direction in same regions, cuttings being formed be-

tween the second convex portions and the fourth convex portions, the first convex portions and the fourth convex portions being folded to protrude to one surface side of the metal thin plate, and the second convex portions and the third convex portions being folded to protrude to other surface side of the metal thin plate,

each roll of the first roll stand, comprising:
 a plurality of plate-like blades having a same shape and including neighboring first blades and second blades respectively, the blades being laminated and center axes of the blades being positioned on a same line, the blades having convex portion forming regions which are formed continuously every constant pitch angle at their outer peripheries, each of the convex portion forming regions constituting one of a roll ridge portion and a roll root portion, the roll ridge portion being protruded outward to form one of the first convex portion and the fourth convex portion, the roll root portion becoming depressed inward to form one of the second convex portion and the third convex portion, the second blades being positioned to be shifted by an integral multiple of the pitch angle relative to the first blades, neighboring convex portion forming regions being aligned along the center axes when the blades are laminated, laminated blades having first columns, which consist of roll ridge portions constituting the first convex portions and roll root portions constituting the third convex portions and are aligned along the center axes, and second columns, which consist of roll root portions constituting the second convex portions and ridge root portions constituting the fourth convex portions and are aligned along the center axes, the first columns and the second columns being arranged alternatively along a peripheral direction of the blades; and
 a spacer provided between the first and second blades, the spacer creating a clearance to rise up the third convex portions and the fourth convex portions.

12. A molding roll machine according to claim 11, wherein one pattern which is composed of the roll ridge portion and the roll root portion is arranged repeatedly on outer peripheral edges of the blades along the peripheral direction.

13. A molding roll machine according to claim 11, wherein the roll ridge portion and the roll root portion are irregularly in respective first columns, and the roll ridge portion and the roll root portion are irregularly in respective second columns.

14. A molding roll machine according to claim 11,
wherein a contiguous number of the roll ridge por-
tions provided along the peripheral direction of the
blades is set to less than two, and
a contiguous number of the roll root portions 5
provided along the peripheral direction of the blades
is set to less than two.
15. A molding roll machine according to claim 11, fur-
ther comprising: 10
substantially flat rack portions placed be-
tween the convex portion forming regions.
16. A forming roll for use with a cooperating roll for form-
ing corrugated portions in a metal sheet, said roll 15
comprising a plurality of discs secured together
against relative rotation, the periphery of at least
some of the discs comprising convex and concave
circumferentially extending portions . 20

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FIG.1

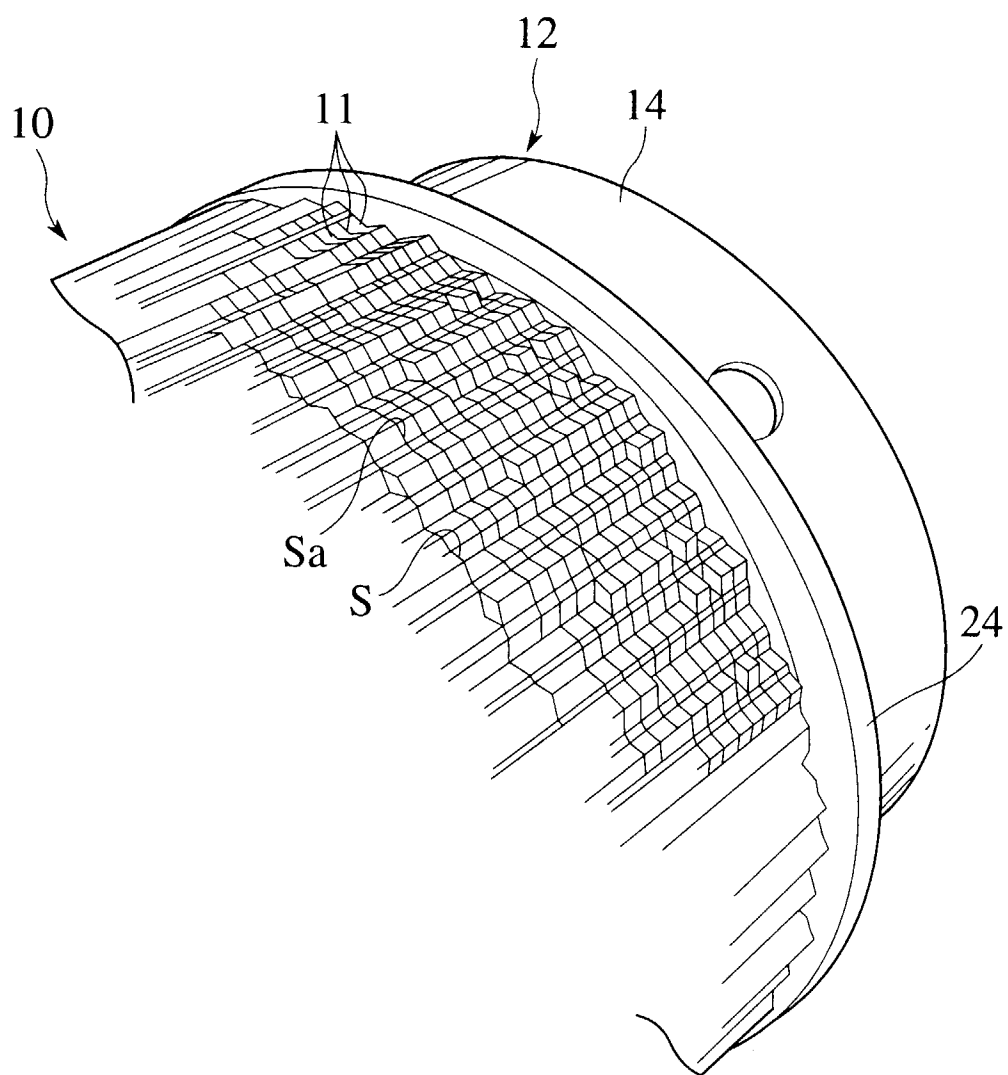


FIG.2

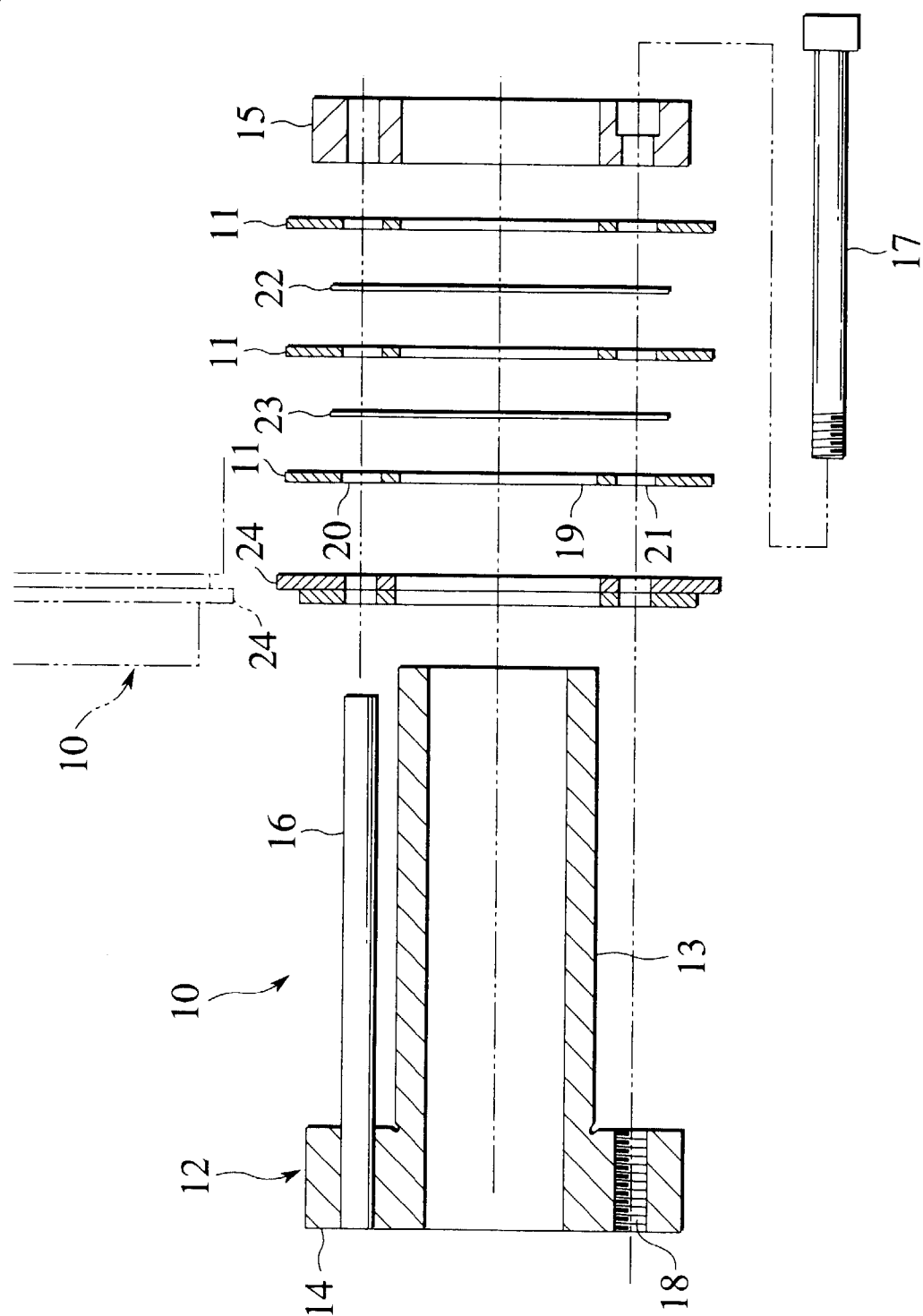
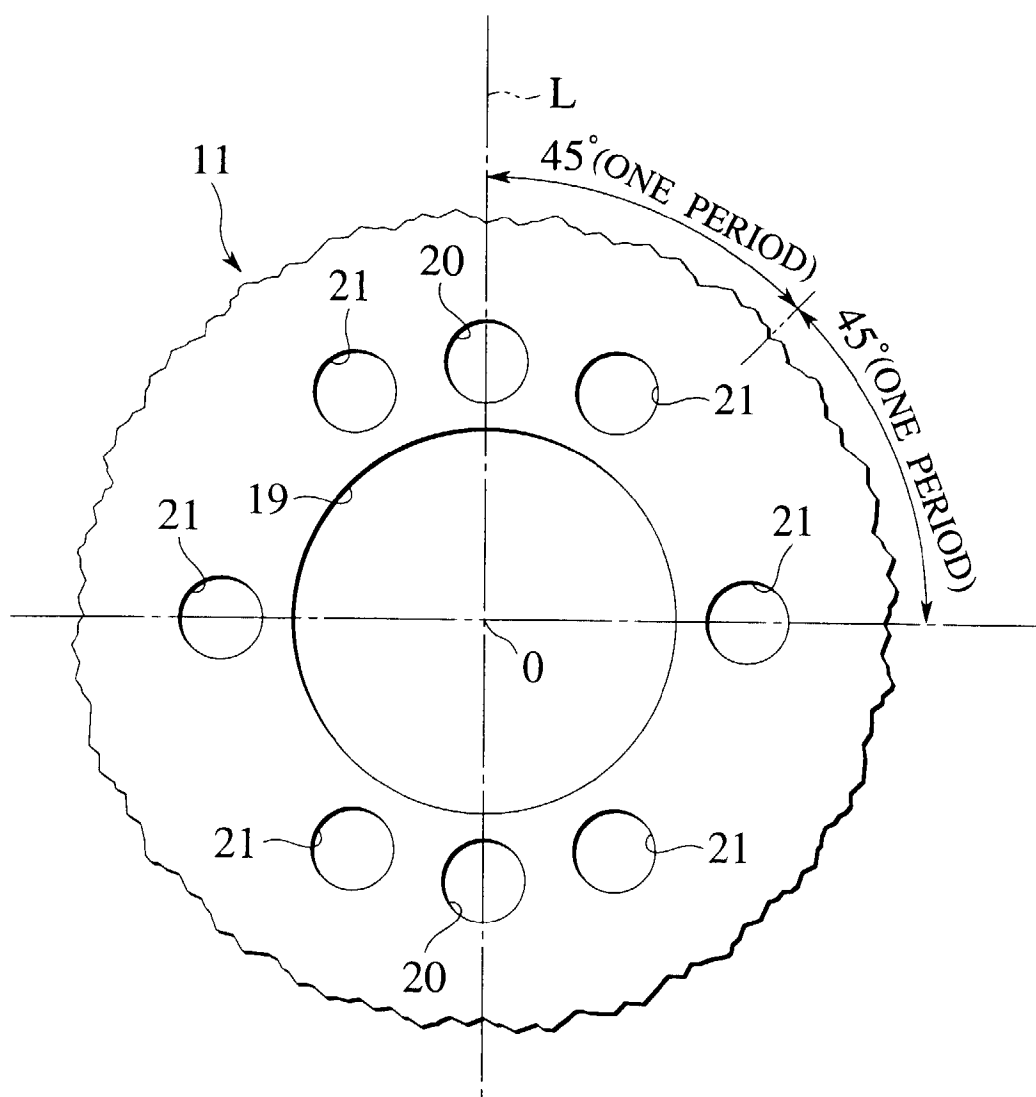


FIG.3



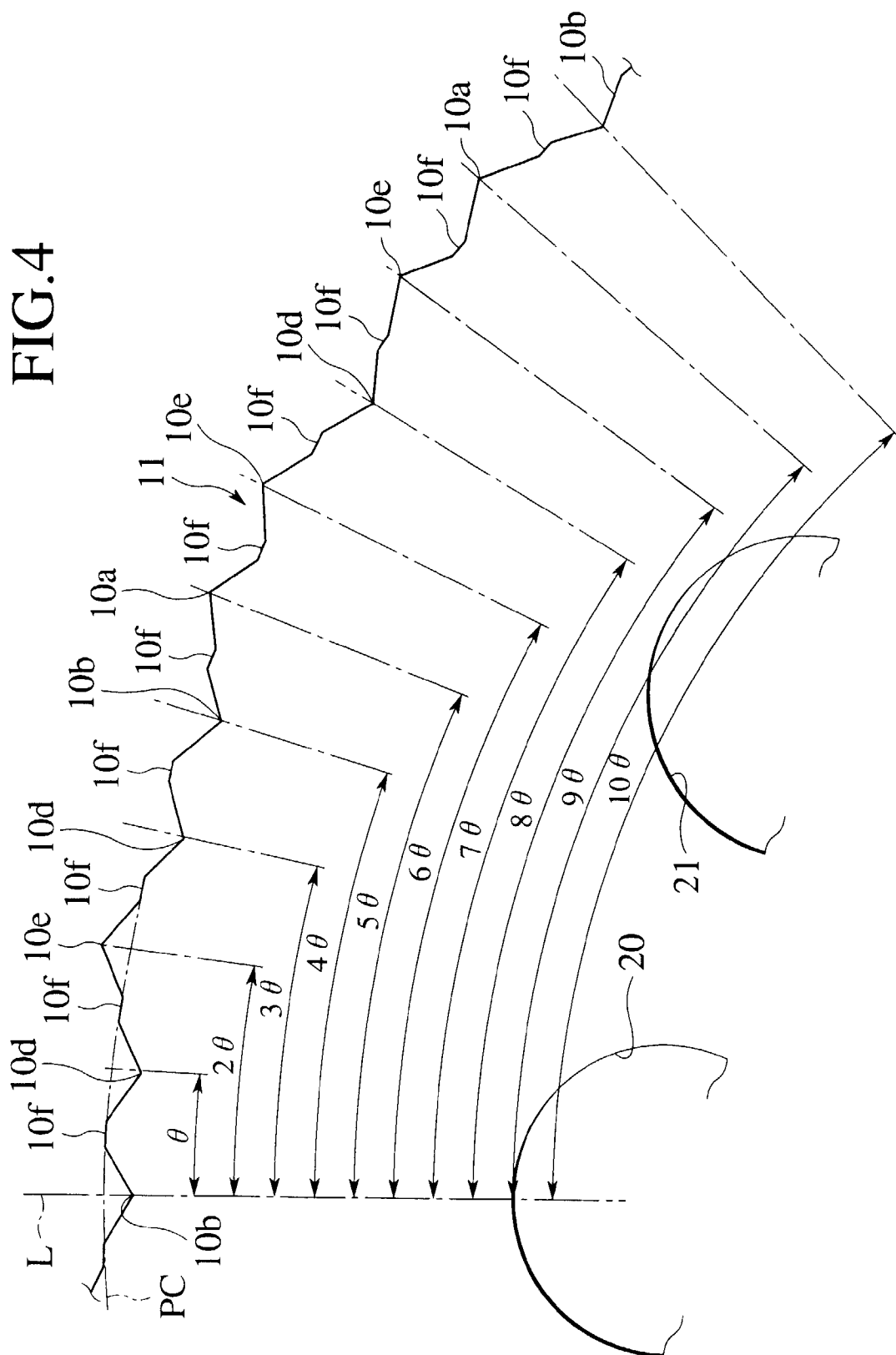


FIG.5

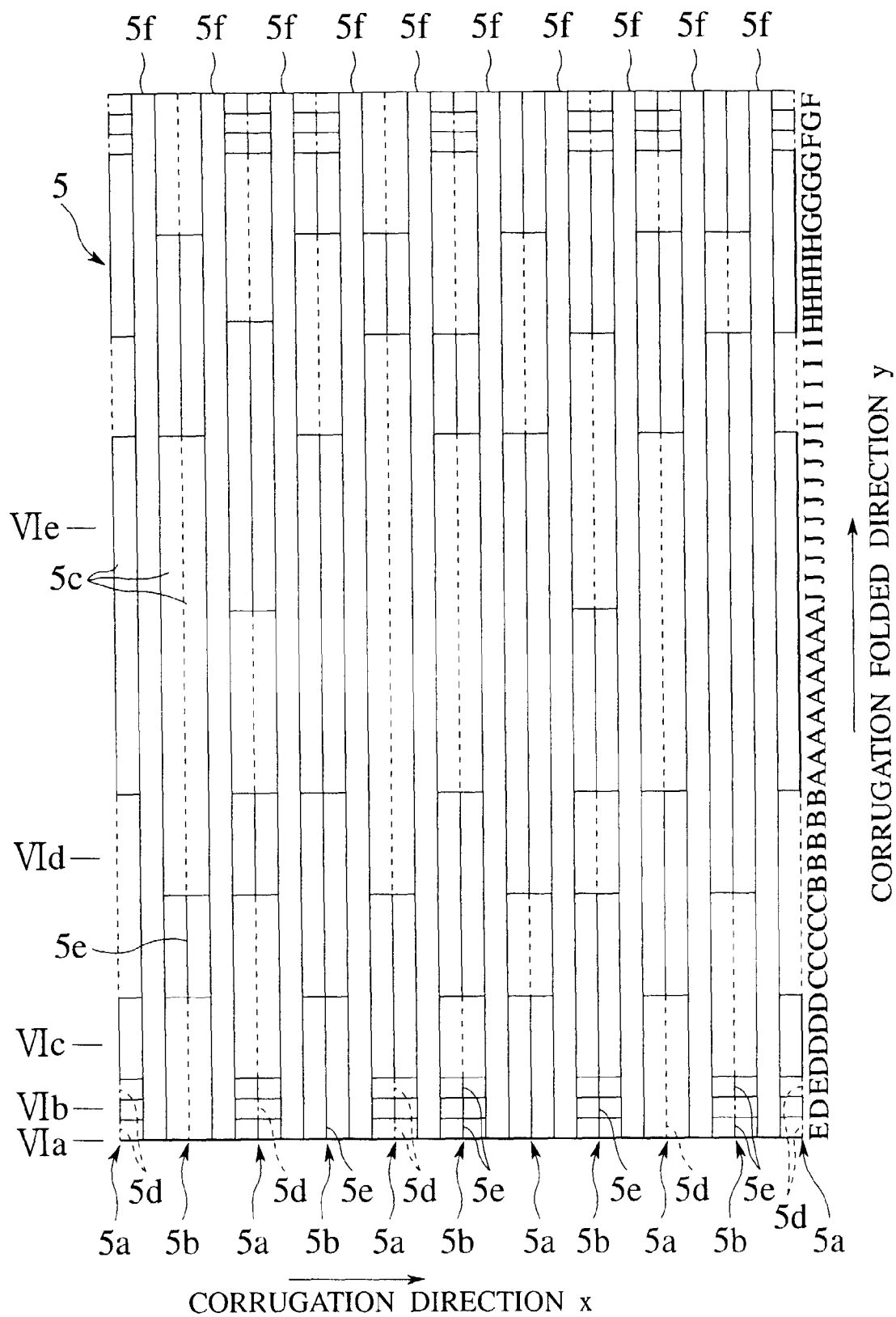


FIG.6

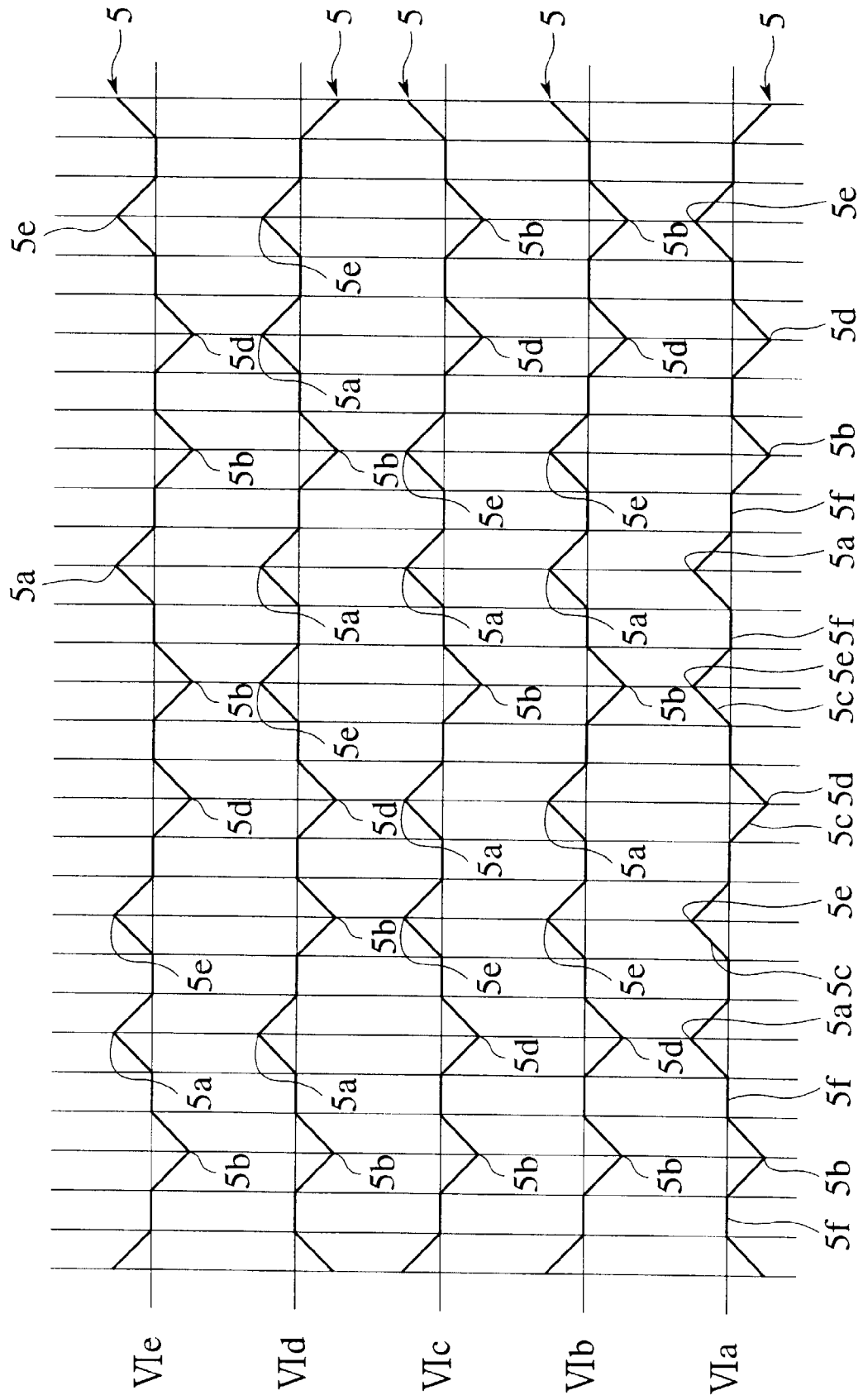
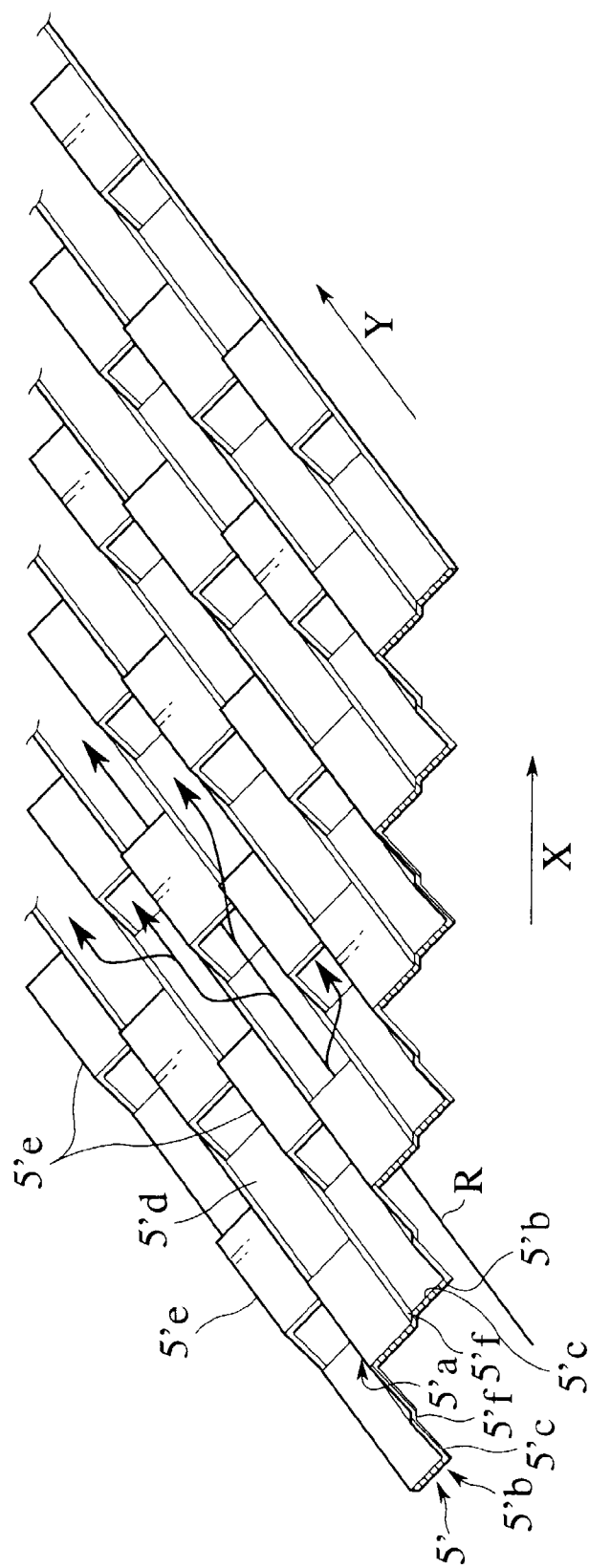


FIG.7



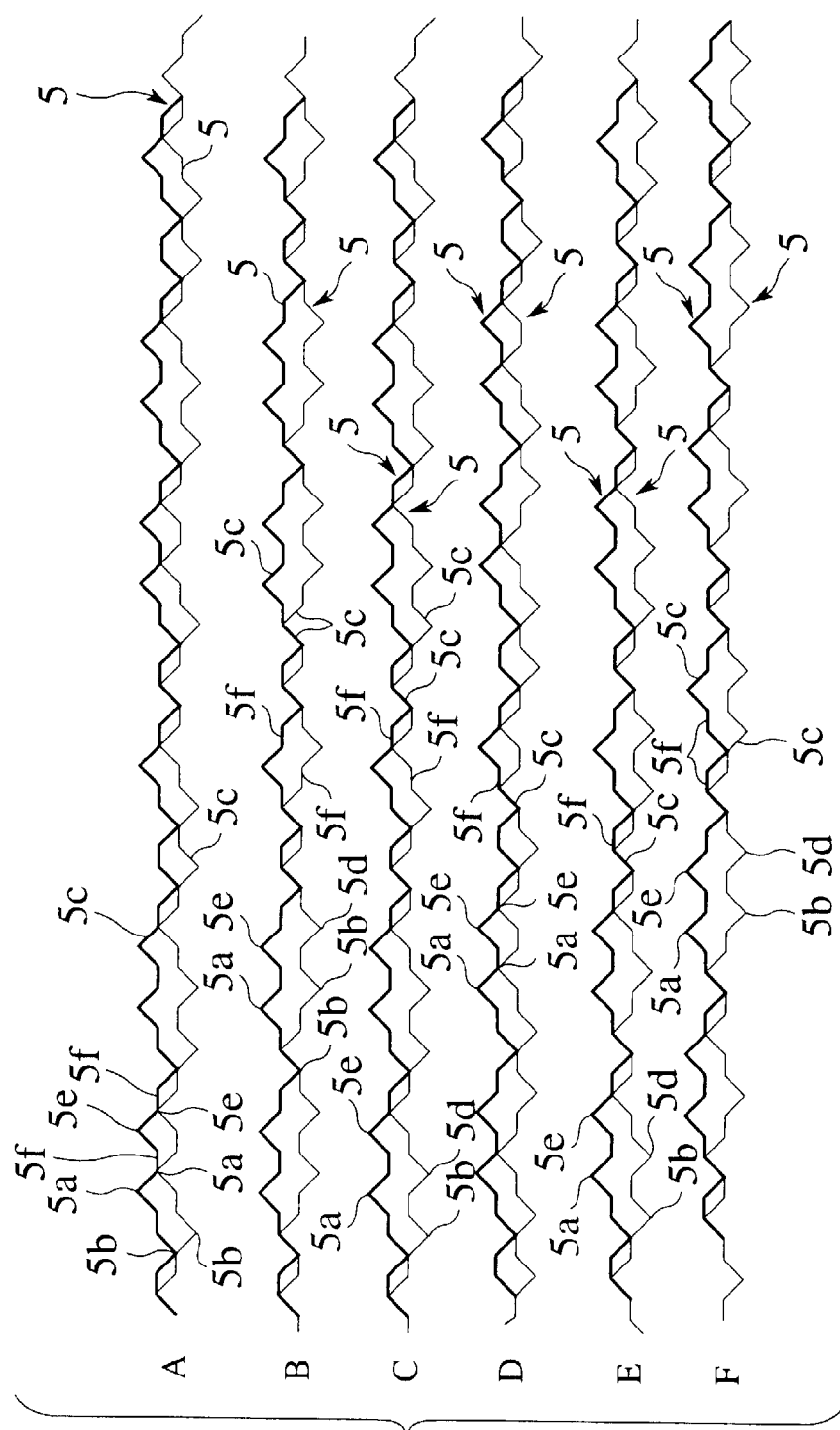


FIG.8

FIG.9

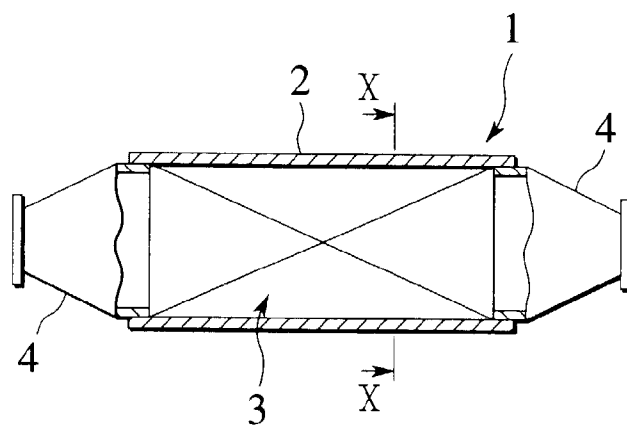


FIG.10

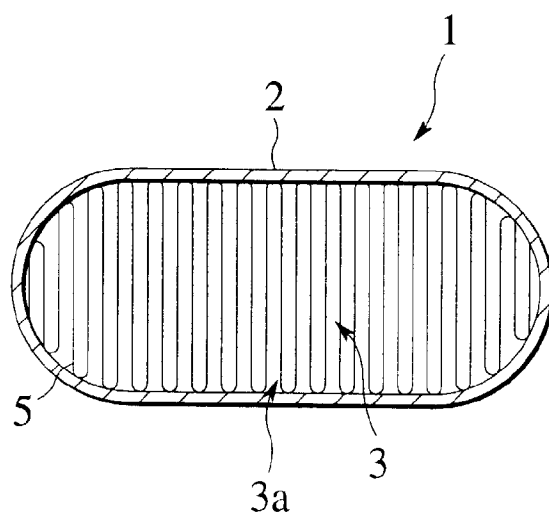


FIG.11

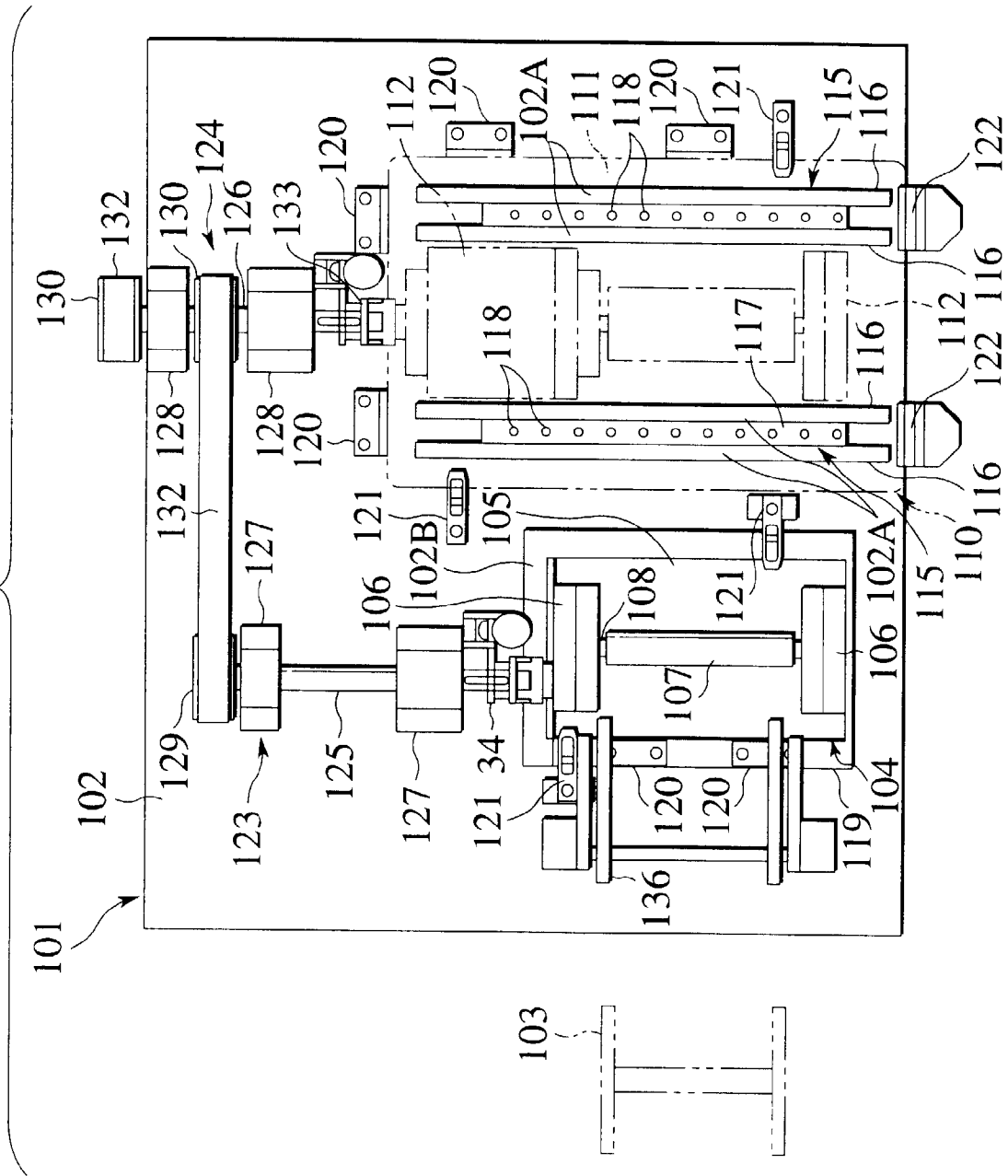


FIG.12

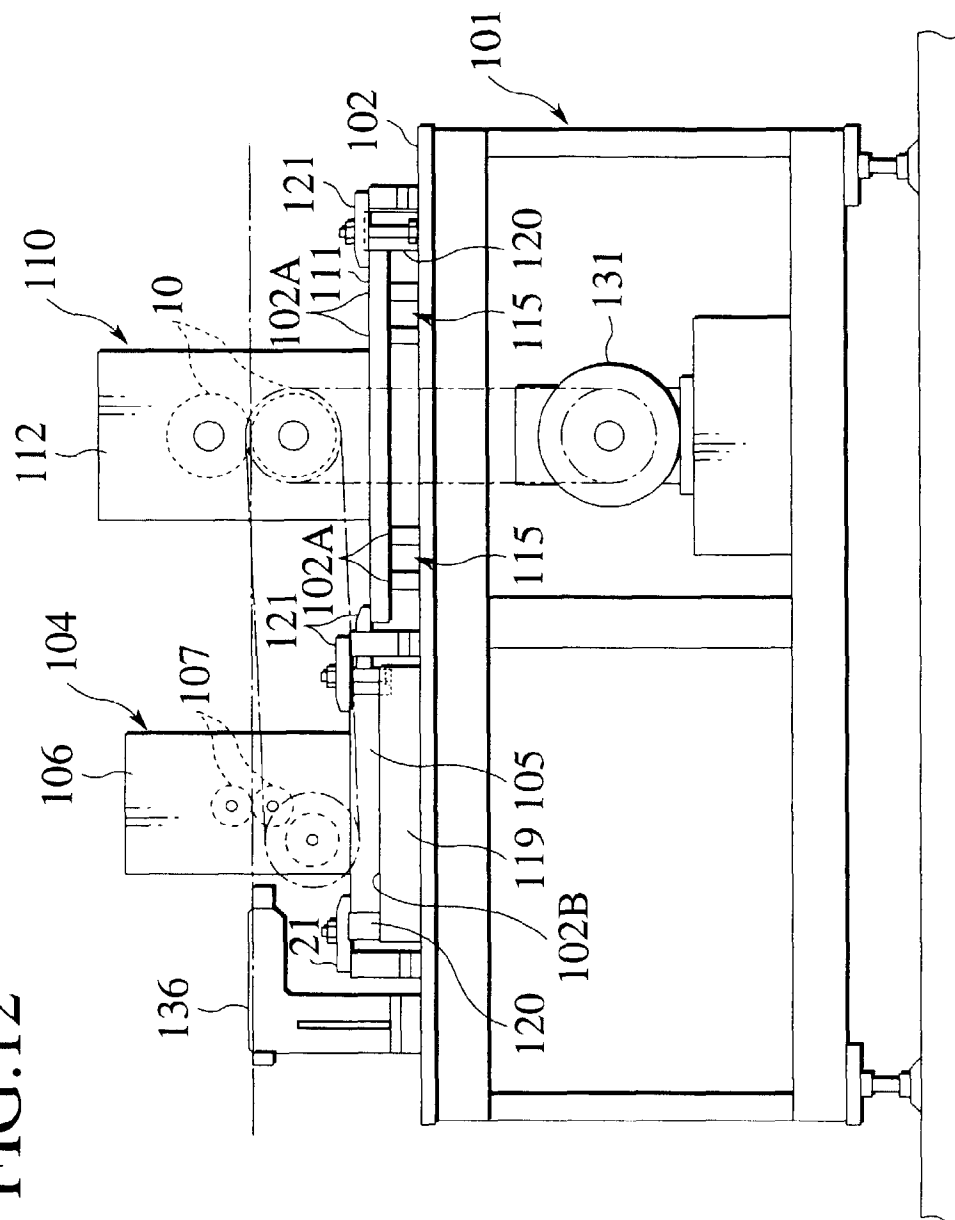


FIG.13

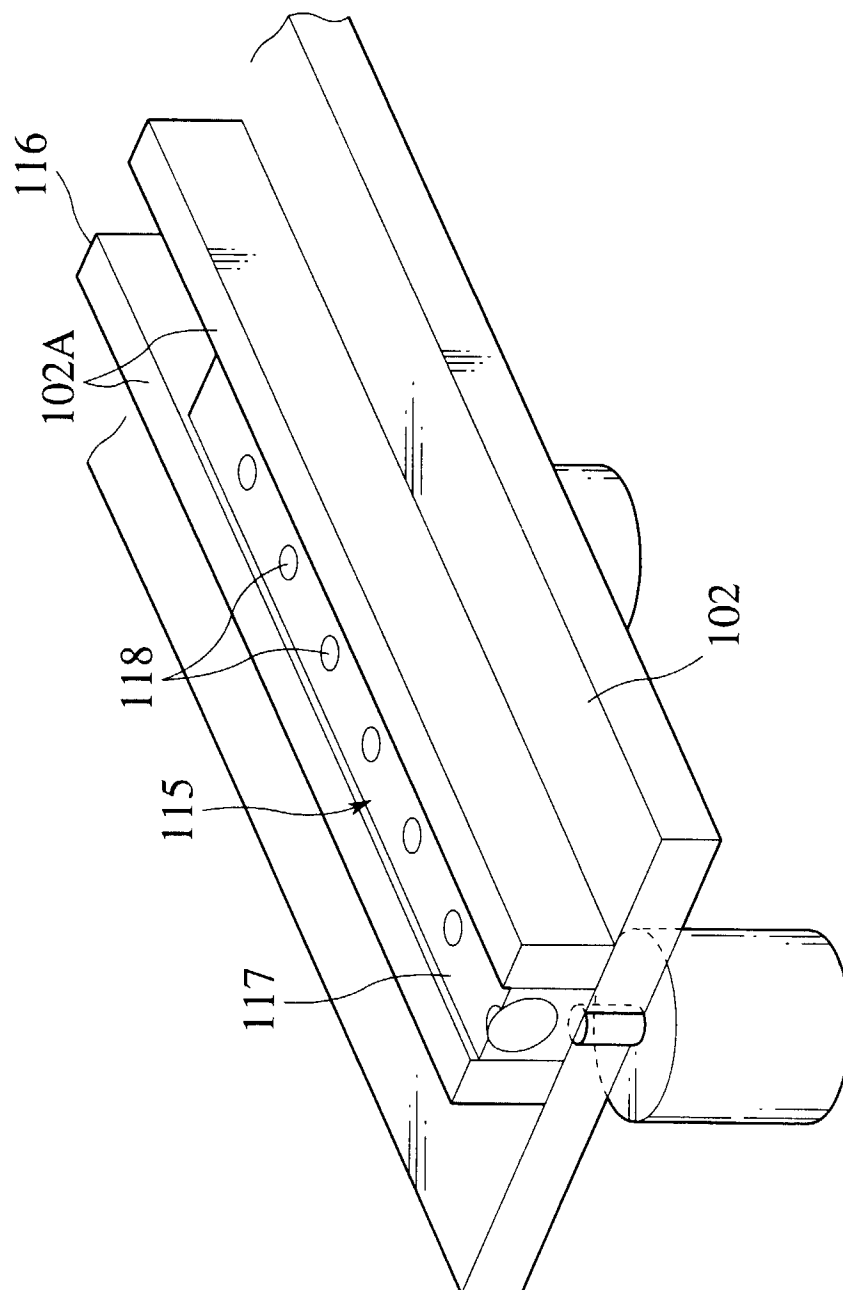


FIG.14

