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(54) **Molding roll for metal thin plate as catalyst carrier**

Prägewalze für dünne Metallplatten als Katalysator-Träger

Rouleau à moulage pour pièces métalliques minces utilisées comme support de catalysateur

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Description

[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 corrugated metal thin plates formed of a stainless steel, etc. and flat metal thin plates alternately to create cells between laminated portions, as disclosed in Patent Application Publication (KOKAI) Hei 5-138040, Patent Application Publication (KOKAI) Hei 6-393, etc., A 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.

[0003] The former metallic catalyst converter in which the corrugated metal thin plates and the flat metal thin plates are laminated alternately is disadvantageous in cost since two types of metal thin plates are needed. This increases 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] US-A-4 297 866 discloses a molding roll for molding metal strip to produce slit segments of meshes. The molded metal strip comprises a series of first elongate regions that comprise first convex portions separated by first planar portions and second elongate regions that comprise second concave portions separated by second planar portions. The convex portions and concave portions being side-by-side such that the planar portions define planar strips extending perpendicular to the lengthways direction of the first and second elongate regions.

[0006] The molding roll of US-A-4 297 866 comprises a series of axially aligned plate-like blades having a circumferentially extending forming surface comprising alternating relatively flat equi-spaced portions for producing the first and second planar portions and convex portions for producing the first convex portions and second concave portions. The first convex portions and second concave portions have the same length and the series of blades are set at the same angle with respect to one another.

[0007] The invention provides a molding roll for mold-

ing a thin metal plate employed as a catalyst carrier, the thin metal plate including first elongate regions having first convex portions and first concave portions and second elongate regions having second concave portions and second convex portions, the first elongate regions and the second elongate regions being disposed alternately in a direction perpendicular to the length thereof, the first convex portions and first concave portions being arranged alternately along the length of the first elongate regions with cuts being provided between adjacent first convex portions and first concave portions and the second concave portions and the second convex portions being arranged alternately along the length of the second elongate regions with cuts being provided between adjacent second concave portions and second convex portions,

the molding roll comprising:

a plurality of plate-like blades having the same shape disposed in side-by-side relation with the center axes of the plates in line, the blades having forming regions which repeat at a constant first pitch angle to form a circumferentially extending forming surface, said first pitch angle being an integral multiple of a second pitch angle, each forming region comprising roll ridge portions for forming the first and second convex portions and roll root portions for forming the first and second concave portions, the number of successive roll ridge portions in the circumferential direction of the blades being no greater than two, the number of successive roll root portions in the circumferential direction of the blades being no greater than two, the forming regions further comprising substantially flat rack portions disposed between adjacent roll ridge and roll root portions such that each roll ridge and roll root portion has respective substantially flat rack portions on either side thereof, the formation distance between adjacent roll ridge and roll root portions in the circumferential direction of the blades defining said second pitch angle, and the blades being arranged in adjacent blade sets that each comprises one or more blades with each blade set being phase-shifted by an integral multiple of said second pitch angle relative to the or each adjacent blade set to define alternate first and second rows of aligned roll ridge portions and roll root portions extending parallel to the center axis of the molding roll, the first rows comprising alternating roll ridge portions and roll root portions for respectively forming the first convex portions and first concave portions, the second rows comprising alternating roll root portions and roll ridge portions for respectively forming the second concave portions and second convex portions and the blade sets being ar-

ranged such that the first rows of aligned roll ridge portions and roll root portions produce first elongate regions having first convex portions and first concave portions of different lengths and the second rows of aligned roll root portions and roll ridge portions produce second elongate regions, each having second concave portions and second convex portions of different lengths; and a respective spacer provided between adjacent blade sets, the spacers creating a clearance to permit the opposite projection of adjacent first convex portions and first concave portions and the opposite projection of adjacent second concave portions and second convex portions.

[0008] Preferably, the forming regions of each blade comprise the same pattern which is defined by the roll ridge portions and the roll root portions.

[0009] Preferably, the roll ridge portions and the roll root portions of each first row are positioned irregularly with respect to the roll ridge portions and roll root portions of other first rows and the roll ridge portions and roll root portions of each second row are positioned irregularly with respect to the roll ridge portions and roll root portions of the other second rows.

[0010] Preferably, the molding roll further comprises:

a holder having an axis portion which has a first flange at one end, the blades and spacers being mounted on the axis portion;
a second flange which is mounted at the other end of the axis portion, such that the blades and the spacers are disposed between the first flange and the second flange;
at least one locating pin passing through apertures therefor defined by the first flange, the second flange, the blades and the spacers; and
fastening members for fastening the blades and the spacer between the first flange and the second flange.

[0011] Preferably, the molding roll further comprises a stopper plate placed between one of the first flange and the second flange and the blade that is positioned adjacent the one of the first flange and the second flange, the stopper plate being arranged to engage with a partner roll of the molding roll to suppress axial displacement of the molding roll with respect to the partner roll.

[0012] In order that the present invention may be well understood, an embodiment thereof, which is given by way of example only, will now be described, with reference to the accompanying drawings, in which:

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.

[0013] 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. 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).

[0014] Diffusers 4 provided at each end 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.

[0015] 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.

[0016] 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.

[0017] 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.

[0018] A standard corrugation pattern of the metal thin plate 5 which is corrugated is shown in FIGS.5, 6.

[0019] 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.

[0020] The corrugated metal thin plate 5' of this type shown in FIG.7 has ridge portions 5'a and root portions 5'b acting as standard corrugations.

[0021] If the root portion on the left end in FIG.7 is assumed as the root portion 5'b, the ridge portions 5'a

and the root portions 5'b of this corrugated metal thin plate 5' are aligned alternately in sequence in the corrugation direction x (referred to as an "x direction" hereinafter). Flat rack portions 5'f are then provided successively at respective center positions of slant walls 5'c, which define the ridge portions 5'a and the root portions 5'b. The flat rack portions 5'f extend in the corrugation folded direction y (referred to as a "y direction" hereinafter). Using the ridge portions 5'a as their stop ends, a plurality of ridge portion depressions 5'd which project in the opposite direction are provided along the ridge portions 5'a of the corrugation at a constant distance along the y direction. Similarly, a plurality of root portion ridges 5'e which project in the opposite direction are provided along the root portions 5'b 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 5'a and the root portions 5'b are aligned via the rack portions 5'f alternately in sequence along the x direction, and a plurality of the ridge portion depression 5'd are provided to the ridge portions 5'a at a constant distance regularly along the y direction and also a plurality of root portion ridges 5'e are provided to the root portions 5'b at a constant distance regularly along the y direction.

[0022] 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.

[0023] 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 ridge portion depressions 5d, which project from the center position of the slant walls 5c constituting the ridge portions 5a and the root portions 5b in the opposite direction to the ridge portions 5a, 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 side ends. A plurality of root portion ridges 5e, which project in the opposite direction to the root portions 5b, are provided to the corrugated root portions 5b at a constant distance along the y direction.

[0024] Starting from the left end in FIG.5, there is a half portion of a ridge portion 5a, a root portion 5b, a ridge portion 5a, a root portion 5b, aligned alternately to form a corrugation pattern ending with a half portion of a ridge portion 5a at the right end in FIG.5. As shown in FIG.6, in the VIa column of the metal thin plate 5 located at the bottom end in FIG.5, starting from the left, there is a ridge portion depression 5d of half ridge portion 5a, a root portion 5b, ridge portion 5a, root portion ridge 5e, ridge portion depression 5d, root portion ridge 5e, ridge portion 5a, root portion 5b, ridge portion depression 5d, root portion ridge 5e and ridge portion depression 5d of the half ridge portion 5a". Similarly, sectional shapes of this metal thin plate 5 in VIb to VIe columns shown at

the left end in FIG.5 are given a "ridge-root" arrangement. In this way, as shown in FIG.5, this metal thin plate 5 constitutes corrugation patterns such that this "ridge-root" arrangement is arranged with a certain regularity on an entire surface but arranged nonuniformly in total.

[0025] The metal thin plate 5 is formed by using a molding roll 10 shown in FIGS. 1 to 4.

[0026] FIG.1 is a perspective view showing a molding roll 10 according to an embodiment of the 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 used to form the molding roll 10. FIG.4 is a fragmentary enlarged view showing the blade 11 in FIG.3.

[0027] As shown in FIG.1, the molding roll 10 is constructed by laminating a plurality of sheets of blades 11 which are formed under the same standard and have roll ridge portions 10a, 10e (see FIG.4) and roll root portions 10b, 10d (see FIG.4) formed on their peripheral surfaces. These roll ridge portions 10a, 10e correspond to the ridge portions 5a and the root portion ridges 5e of the corrugation of the metal thin plate 5. The roll root portions 10b, 10d correspond to the root portions 5b and the ridge portion depressions 5d of the metal thin plate 5.

[0028] 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 angles θ with respect to a blade center point O 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 not more than two.

[0029] Almost flat rack portions 10f of 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 portions 10a and the roll root portions 10b of the blade 11.

[0030] More specifically, on this blade 11, the roll ridge portion 10a and the roll ridge portion 10e which respectively 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 root portion ridge 5e respectively are formed as convex portions on the pitch circle PC, while the roll root portion 10b and the roll root portion 10d respectively 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 ridge portion 5d are formed as concave portions on the pitch circle PC.

[0031] 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.

[0032] Plural sheets of blades 11 are inserted onto 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 onto 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 locating 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 that pass through the flanges 14, 15 and the blades 11 and engage internal threads 18 being provided in the flange 14.

[0033] 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 the axis portion 13 of the holder 12 is inserted are formed symmetrically around the blade center point O.

[0034] In the present embodiment, six bolts 17 are used. The insertion directions of the bolts are positioned at symmetrical positions and the bolts are positioned at neighboring positions are set oppositely respectively. As a result, plural sheets of blades 11 can be fastened uniformly.

[0035] 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.

[0036] 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.

[0037] 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.

[0038] In the present embodiment, if these plural types of A to J blades 11 are laminated, the roll ridge

portions 10e constituting the root portion ridges 5e and the roll root portions 10d constituting the ridge portion depressions 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.

[0039] 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.

[0040] 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.

[0041] In addition, spacers 22 (as shown in Fig.2) which can set a clearance S (as shown in Fig.1) being needed to form the ridge portion depressions 5d and the root portion ridges 5e of the metal thin plate 5 are interposed between the blade groups A to J which have different phase angles respectively.

[0042] 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 the plate thickness of the metal thin plate that is to be molded.

[0043] 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.

[0044] In other words, spacers 22 for setting a clearance S necessary for forming the portions 5d, 5e are interposed between the blade groups, e.g., between the blade group B and the blade group A, whereas 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.

[0045] The metal thin plate 5 can be formed by engraving 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 has a great influence on the formation of the ridge portion depressions 5d and the root portion ridges 5e of the metal thin plate 5.

[0046] 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.

[0047] 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 depressions 5d formed along the corrugated ridge portions 5a and ridges 5e formed along the corrugated root portions 5b, can be formed easily.

[0048] 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 root portion ridges 5e and the ridge portion depression 5d can be formed properly with good precision.

[0049] 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 not more 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 corrugated 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 ridge portion depressions 5d and the root portion ridges 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 root portion ridges 5e of the corrugation and the contiguous number of the root portions 5b and the ridge portion depressions 5d of the corrugation, both being continuously adjacent in the x direction, can be set to not more than two respectively.

[0050] 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 not more than 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 ridge portion depressions 5d and root portion ridges 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 root portion ridges 5e of the corrugation, or the root portions 5b or the ridge portion depressions 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 root portion ridges 5e of the corrugation and the contiguous number of the root portions 5b and the ridge portion depressions 5d of the corrugation are not more than two respectively, it can be prevented that opening areas of the cells which are formed between the ridge portions 5a and the root portion ridges 5e of the corrugation of one metal thin plate 5 and the root portions 5b and the ridge portion depressions 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.

[0051] 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.

[0052] Furthermore, since the ridge portion depressions 5d and the root portion ridges 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 root portion depressions 5d and the root portion ridges 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.

[0053] 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.

[0054] 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.

[0055] 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.

[0056] In summary, and as best seen with reference to Figures 5 to 7, the embodiment provides a molding roll for molding a thin metal plate 5 to be employed as a catalyst carrier. The thin metal plate has first elongate regions having first convex portions (ridge portions 5a) and first concave portions (ridge portion depressions 5d) and second elongate regions having second concave portions (root portions 5b) and second convex portions (root portion ridges 5e). The first elongate regions 5a,5d and the second elongate regions 5b,5e are disposed alternately in a direction perpendicular to the length thereof. The first convex portions (ridge portions 5a) and first concave portions (ridge portion depressions 5d) are arranged alternately along the length of the first elongate regions with cuts being provided between adjacent first convex portions 5a and first concave portions 5d. The second concave portions (root portions 5b) and the second convex portions (root portion ridges 5e) are arranged alternately along the length of the second elongate regions with cuts being provided between adjacent second concave portions 5b and second convex portions 5e.

[0057] The molding roll comprises:

a plurality of plate-like blades 11 having the same shape disposed in side-by-side relation with the center axes of the plates in line. The blades have forming regions which repeat at a constant first pitch angle 10θ to form a circumferentially extending forming surface, said first pitch angle 10θ being an integral multiple of a second pitch angle θ . Each forming region comprises roll ridge portions 10a, 10e for forming the first and second convex portions 5a,5e and roll root portions 10b,10d for forming the first and second concave portions 5b,5e. The number of successive roll ridge portions 10a, 10e in the circumferential direction of the blades is no greater than two and the number of successive roll

root portions 10b, 10d in the circumferential direction of the blades being no greater than two. The forming regions further comprise substantially flat rack portions 10f disposed between adjacent roll ridge 10a, 0e and roll root 10b,10d portions such that each roll ridge and roll root portion has respective substantially flat rack portions on either side thereof, the formation distance between adjacent roll ridge 10a, 10e and roll root 10b, 10d portions in the circumferential direction of the blades 11 defining said second pitch angle θ .

[0058] The blades 11 are arranged in adjacent blade sets A-J that each comprises one or more blades. Each blade set A-J is phase-shifted by an integral multiple of said second pitch angle θ relative to the or each adjacent blade set to define alternate first and second rows of aligned roll ridge portions and roll root portions extending parallel to the center axis of the molding roll. The first rows comprise alternating roll ridge portions 10a and roll root portions 10d for respectively forming the first convex portions (ridge portions 5a) and first concave portions (ridge portion depressions 5d), the second rows comprises alternating roll root portions 10b and roll ridge portions 10e for respectively forming the second concave portions (root portions 5b) and second convex portions (root portion ridges 5e). The blade sets A-J are arranged such that the first rows of aligned roll ridge portions 10a and roll root portions 10e produce first elongate regions having first convex portions (ridge portions 5a) and first concave portions (ridge portions 5d) of different lengths and the second rows of aligned roll root portions 10b and roll ridge portions 10e produce second elongate regions, each having second concave portions (root portions 5b) and second convex portions (root portion ridges 5e) of different lengths. The molding roll further comprises respective spacers 22 between adjacent blade sets A-J. The spacers create a clearance to permit the opposite projection of adjacent first convex portions (ridge portions 5a) and first concave portions (ridge portion depressions 5d) and the opposite projection of adjacent second concave portions (root portions 5b) and second convex portions (root portion ridges 5e).

Claims

1. A molding roll for molding a thin metal plate (5) employed as a catalyst carrier, the thin metal plate including first elongate regions having first convex portions (5a) and first concave portions (5d) and second elongate regions having second concave portions (5b) and second convex portions (5e), the first elongate regions (5a,5d) and the second elongate regions (5b,5e) being disposed alternately in a direction perpendicular to the length thereof, the first convex portions (5a) and first concave portions (5d) being arranged alternately along the length of

the first elongate regions with cuts being provided between adjacent first convex portions (5a) and first concave portions (5d) and the second concave portions (5b) and the second convex portions (5e) being arranged alternately along the length of the second elongate regions with cuts being provided between adjacent second concave portions (5b) and second convex portions (5e),

the molding roll comprising:

a plurality of plate-like blades (11) having the same shape disposed in side-by-side relation with the center axes of the plates in line, the blades having forming regions (10a-10f) which repeat at a constant first pitch angle (10θ) to form a circumferentially extending forming surface, said first pitch angle (10θ) being an integral multiple of a second pitch angle (θ), each forming region comprising roll ridge portions (10a, 10e) for forming the first and second convex portions (5a, 5e) and roll root portions (10b, 10d) for forming the first and second concave portions (5b, 5e),

the number of successive roll ridge portions (10a, 10e) in the circumferential direction of the blades being no greater than two,

the number of successive roll root portions (10b, 10d) in the circumferential direction of the blades being no greater than two,

the forming regions further comprising substantially flat rack portions (10f) disposed between adjacent roll ridge and roll root portions such that each roll ridge and roll root portion has respective substantially flat rack portions on either side thereof, the formation distance between adjacent roll ridge (10a, 10e) and roll root (10b, 10d) portions in the circumferential direction of said blades (11) defining said second pitch angle (θ), and

the blades (11) being arranged in adjacent blade sets (A-J) that each comprises one or more blades with each blade set (A-J) being phase-shifted by an integral multiple of said second pitch angle (θ) relative to the or each adjacent blade set to define alternate first and second rows of aligned roll ridge portions and roll root portions extending parallel to the center axis of the molding roll, the first rows comprising alternating roll ridge portions (10a) and roll root portions (10d) for respectively forming the first convex portions (5a) and first concave portions (5d), the second rows comprising alternating roll root portions (10b) and roll ridge portions (10e) for respectively forming the second concave portions (5b) and second convex portions (5e) and the blade sets (A-J) being arranged such that the first rows of aligned roll ridge portions (10a) and roll root portions (10e)

produce first elongate regions having first convex portions (5a) and first concave portions (5d) of different lengths and the second rows of aligned roll root portions (10b) and roll ridge portions (10e) produce second elongate regions, each having second concave portions (5b) and second convex portions (5e) of different lengths; and

a respective spacer (22) provided between adjacent blade sets (A-J), the spacers creating a clearance to permit the opposite projection of adjacent first convex portions (5a) and first concave portions (5d) and the opposite projection of adjacent second concave portions (5b) and second convex portions (5e).

2. A molding roll according to claim 1, wherein the forming regions of each blade (11) comprise the same pattern which is defined by the roll ridge portions (10a, 10e) and the roll root portions (10b, 10d).
3. A molding roll according to claim 1, wherein the roll ridge portions (10a) and the roll root portions (10d) of each first row are positioned irregularly with respect to the roll ridge portions (10a) and roll root portions (10d) of other first rows and the roll ridge portions (10e) and roll root portions (10b) of each second row are positioned irregularly with respect to the roll ridge portions (10e) and roll root portions (10b) of the other second rows.
4. A molding roll according to claim 1, further comprising:

a holder having an axis portion (13) which has a first flange (14) at one end, the blades (11) and spacers (22) being mounted on the axis portion;

a second flange (15) which is mounted at the other end of the axis portion, such that the blades and the spacers are disposed between the first flange and the second flange;

at least one locating pin (16) passing through apertures therefor defined by the first flange, the second flange, the blades and the spacers; and

fastening members (17) for fastening the blades and the spacer between the first flange and the second flange.

5. A molding roll according to claim 1, further comprising:

a stopper plate (24) placed between one of the first flange (14) and the second flange (15) and the blade (11) that is positioned adjacent the one of the first flange and the second flange, the stopper plate being arranged to engage

with a partner roll of the molding roll to suppress axial displacement of the molding roll with respect to the partner roll.

Patentansprüche

1. Prägewalze zum Formen einer dünnen Metallplatte (5), die als Katalysatorträger verwendet wird, wobei die dünne Metallplatte erste längliche Zonen umfasst, die erste konvexe Abschnitte (5a) und erste konkave Ab - schnitte (5d) haben, und z weite längliche Zonen, die zweite konkave Abschnitte (5b) und zweite konvexe Ab - schnitte (5e) haben, wobei die ersten länglichen Ab - schnitte (5a, 5d) und die zweiten länglichen Ab - schnitte (5b, 5e) abwechselnd in eine Richtung senk - recht zu der Länge angeordnet sind, wobei die ersten konvexen Abschnitte (5a) und ersten konkaven Ab - schnitte (5d) abwechselnd entlang der ersten läng - lichen Zonen angeordnet sind, wobei Schnitte zwischen benachbarten ersten konvexen Abschnitten (5a) und ersten konkaven Abschnitten (5d) vorgesehen sind, und wobei zweite konkave Abschnitte (5b) und zweite kon - vexe Abschnitte (5e) abwechselnd entlang der Länge der zweiten länglichen Zonen angeordnet sind, wobei Schnitte zwischen benachbarten zweiten konkaven Ab - schnitten (5b) und zweiten konvexen Abschnitten (5e) vorgesehen sind, wobei die Prägewalze Folgendes umfasst:
 - eine Vielzahl plattenähnlicher Klingen (11) mit der gleichen Form, die in einer Beziehung Seite an Seite zu den Mittenachsen der Platten in Linie angeordnet sind,
 - wobei die Klingen Formzonen (10a -10f) haben, die sich in einem konstanten ersten Anstellwinkel (10 θ) wiederholen, um eine Formfläche zu bilden, die sich umkreisförmig erstreckt, wobei der erste Anstellwinkel (10 θ) ein integrales Vielfaches eines zweiten Anstellwinkels (θ) ist,
 - wobei jede Formzone Rollkantenabschnitte (10a, 10e) zum Bilden der ersten und zweiten konvexen Abschnitte (5a, 5e), und Rollgrundabschnitte (10b, 10d) zum Bilden der ersten und zweiten konkaven Abschnitte (5b, 5e) umfasst,
 - wobei die Anzahl aufeinander folgender Rollkantenabschnitte (10a, 10e) in die Umkreis - richtung der Klingen nicht größer ist als zwei,
 - wobei die Anzahl aufeinander folgender Rollgrundabschnitte (10b, 10d) in die Umkreis - richtung der Klingen nicht größer ist als zwei,
 - wobei die Formzonen ferner im Wesentlichen flache Etagenabschnitte (10f) umfassen, die zwischen benachbarten Rollkantenabschnitten und Rollgrundabschnitten angeordnet sind, so

- dass jeder Roll - kantenabschnitt und jeder Rollgrundabschnitt jeweils im Wesentlichen flache Etagenabschnitte auf jeder Seite hat und die Formentfernung zwischen benachbarten Rollkanten (10a, 10e) und Rollgrundabschnitten (10b, 10d) in die Umkreisrichtung der Klingen (11) den zweiten Anstellwinkel (θ) definiert, und
- die Klingen (11) in benachbarten Klingensätzen (A-J) angeordnet sind, die jeweils eine oder mehrere Klingen umfassen, wobei jeder Klingensatz (A-J) um ein integrales Vielfaches des zweiten Anstellwinkels (θ) relativ zu dem oder jedem be - nachbarten Klingensatz phasenverschoben ist, um abwechselnd erste und zweite Reihen gefluchteter Rollkantenabschnitte und Rollgrundabschnitte zu definieren, die sich parallel zu der Mittenachse der Prägewalze erstrecken, wobei die ersten Reihen abwechselnd Rollkantenabschnitte (10a) und Rollgrundabschnitte (10d) umfassen, um jeweils die ersten konvexen Abschnitte (5a) und ersten konkaven Abschnitte (5d) zu bilden, wobei die zweiten Reihen abwechselnd Rollgrundabschnitte (10b) und Rollkantenabschnitte (10e) umfassen, um jeweils die zweiten konkaven Abschnitte (5b) und zweiten konvexen Abschnitte (5e) zu bilden, und die Klingensätze (A -J) so angeordnet sind, dass die ersten Reihen gefluchteter Rollkantenab - schnitte (10a) und Rollgrundabschnitte (10e) erste längliche Zonen bilden, die erste konvexe Abschnitte (5a) haben, und erste konkave Ab - schnitte (5d) mit unterschiedlichen Längen und die zweiten Reihen gefluchteter Rollgrundab - schnitte (10b) und Rollkantenabschnitte (10e) zweite längliche Zonen ergeben, wobei jede zweite konkave Abschnitte (5b) und zweite konvexe Ab - schnitte (5e) mit unterschiedlichen Längen hat, und
 - jeweils ein Abstandshalter (22) zwischen benach - barten Klingensätzen (A - J) vorgesehen ist, wobei die Abstandshalter einen Durchlass schaffen, um das entgegen gesetzte Vorragen benachbarter erster konvexer Abschnitte (5a) und erster konkaver Abschnitte (5d) und das entgegen gesetzte Vorragen benachbarter zweiter konkaver Abschnitte (5b) und zweiter konvexer Abschnitte (5e) zu er - lauben.

2. Prägewalze nach Anspruch 1, wobei die Formzonen jeder Klinge (11) das gleiche Muster umfassen, das von den Rollkantenabschnitten (10a, 10e) und den Rollgrundabschnitten (10b, 10d) definiert ist.
3. Prägewalze nach Anspruch 1, wobei die Rollkantenabschnitte (10a) und die Rollgrundabschnitte (10d) jeder ersten Reihe unregelmäßig zu den Roll-

kantenabschnitten (10a) und den Rollgrundabschnitten (10d) anderer erster Reihen und die Rollkantenabschnitte (10e) und Rollgrundabschnitte (10b) jeder zweiten Reihe unregelmäßig zu den Rollkantenabschnitten (10e) und Rollgrundabschnitten (10b) anderer zweiter Reihen positioniert sind.

4. Prägewalze nach Anspruch 1, die ferner Folgendes umfasst:

- einen Halter mit einem Achsabschnitt (13), der einen ersten Flansch (14) an einem Ende hat, wobei die Klingen (11) und Abstandshalter (22) auf dem Achsabschnitt montiert sind,
- einen zweiten Flansch (15), der an dem anderen Ende des Achsabschnitts montiert ist, so dass die Klingen und die Abstandshalter zwischen dem ersten Flansch und dem zweiten Flansch angeordnet sind,
- mindestens ein Positionierstift (16), der durch Öffnungen durchgeht, die dazu von dem ersten Flansch, dem zweiten Flansch, den Klingen und den Abstandshaltern definiert werden, und
- Befestigungselemente (17) zum Befestigen der Klingen und Abstandshalter zwischen dem ersten Flansch und dem zweiten Flansch.

5. Prägewalze nach Anspruch 1, die ferner Folgendes umfasst:

- eine Verschlussplatte (24), die zwischen entweder dem ersten Flansch (14) oder dem zweiten Flansch (15) und der Klinge angeordnet ist, die benachbart zu entweder dem ersten Flansch oder dem zweiten Flansch positioniert ist, wobei die Verschlussplatte eingerichtet ist, um in eine Partnerwalze der Prägewalze einzugreifen, um axiales Verschieben der Prägewalze zu der Partnerwalze zu verhindern.

Revendications

1. Rouleau de moulage pour mouler une plaque métallique mince (5) employée comme support de catalyseur, la plaque métallique mince comprenant des premières régions allongées comportant des premières parties convexes (5a) et des premières parties concaves (5d) et des deuxièmes régions allongées comportant des deuxièmes parties concaves (5b) et des deuxièmes parties convexes (5e), les premières régions allongées (5a, 5d) et les deuxièmes régions allongées (5b, 5e) étant disposées de façon alternée dans une direction perpendiculaire à leur longueur, les premières parties convexes (5a) et les premières parties concaves (5d) étant agencées alternativement suivant la longueur

des premières régions allongées, des entailles étant formées entre les premières parties convexes (5a) et les premières parties concaves (5d) voisines et les deuxièmes parties concaves (5b) et deuxièmes parties convexes (5e) étant agencées alternativement suivant la longueur des deuxièmes régions allongées, des entailles étant formées entre les deuxièmes parties concaves (5b) et les deuxièmes parties convexes (5e) voisines,

le rouleau de moulage comprenant :

une pluralité de lames en forme de plaquettes (11) ayant la même forme et placées côte à côte, les axes des plaquettes alignés, les lames comportant des régions de formage (10a-10f) qui se répètent avec un premier angle de pas constant (θ) pour former une surface de formation qui s'étend dans le sens de la circonférence, ledit premier angle de pas (θ) étant un multiple entier d'un deuxième angle de pas (θ),

chaque région de formage comprenant des parties d'arête de rouleau (10a, 10e) pour former les premières et deuxièmes parties convexes (5a, 5e) et des parties de creux de rouleau (10b, 10d) pour former les premières et deuxièmes parties concaves (5b, 5e),

le nombre de parties d'arête de rouleau successives (10a, 10e) dans le sens de la circonférence des lames n'étant pas supérieur à deux, le nombre de parties de creux de rouleau successives (10b, 10d) dans le sens de la circonférence des lames n'étant pas supérieur à deux,

les régions de formage comprenant en outre des parties de palier substantiellement plates (10f) disposées entre les parties d'arête de rouleau et les parties de creux de rouleau voisines, de sorte que chaque partie d'arête de rouleau et chaque partie de creux de rouleau a des parties de palier substantiellement plates respectives sur chacun de ses côtés, la distance de formation entre parties d'arête de rouleau (10a, 10e) et parties de creux de rouleau (10b, 10d) voisines dans le sens de la circonférence desdites lames (11) définissant ledit deuxième angle de pas (θ), et

les lames (11) étant agencées en ensembles de lames voisins (A-J) qui comprennent chacun une ou plusieurs lame(s), chaque ensemble de lames (A-J) étant déphasé d'un multiple entier dudit deuxième angle de pas (θ) par rapport aux ou à chaque ensemble de lames voisin pour définir des premières et deuxièmes rangées alternées de parties d'arête de rouleau et de parties de creux de rouleau alignées s'étendant parallèlement à l'axe du rouleau de moulage, les premières rangées comprenant des

parties d'arête de rouleau (10a) et des parties de creux de rouleau (10d) alternées pour former respectivement les premières parties convexes (5a) et les premières parties concaves (5d), les deuxièmes rangées comprenant des parties de creux de rouleau (10b) et des parties d'arête de rouleau (10e) alternées pour former respectivement les deuxièmes parties concaves (5b) et les deuxièmes parties convexes (5e) et les ensembles de lames (A-J) étant agencés de telle manière que les premières rangées de parties d'arête de rouleau (10a) et de parties de creux de rouleau (10e) alignées produisent des premières régions allongées ayant des premières parties convexes (5a) et des premières parties concaves (5d) de différentes longueurs et les deuxièmes rangées de parties de creux de rouleau (10b) et de parties d'arête de rouleau (10e) alignées produisent des deuxièmes régions allongées, chacune ayant des deuxièmes parties concaves (5b) et des deuxièmes parties convexes (5e) de différentes longueurs ; et une entretoise respective (22) placée entre les ensembles de lames voisins (A-J), les entretoises créant un espace vide pour permettre la saillie opposée de premières parties convexes (5a) et premières parties concaves (5d) voisines et la saillie opposée de deuxièmes parties concaves (5b) et deuxièmes parties convexes (5e) voisines.

2. Rouleau de moulage selon la revendication 1, dans lequel les régions de formage de chaque lame (11) comprennent le même motif qui est défini par les parties d'arête de rouleau (10a, 10e) et les parties de creux de rouleau (10b, 10d).
3. Rouleau de moulage selon la revendication 1, dans lequel les parties d'arête de rouleau (10a) et les parties de creux de rouleau (10d) de chaque première rangée sont positionnées de façon irrégulière par rapport aux parties d'arête de rouleau (10a) et aux parties de creux de rouleau (10d) des autres premières rangées et les parties d'arête de rouleau (10e) et les parties de creux de rouleau (10b) de chaque deuxième rangée sont positionnées de façon irrégulière par rapport aux parties d'arête de rouleau (10e) et aux parties de creux de rouleau (10b) des autres deuxièmes rangées.
4. Rouleau de moulage selon la revendication 1, comprenant en outre :
 - un support ayant une partie axe (13) qui a une première bride (14) à une extrémité, les lames (11) et les entretoises (22) étant montées sur la partie axe ;

une deuxième bride (15) qui est montée à l'autre extrémité de la partie axe, de sorte que les lames et les entretoises sont disposées entre la première bride et la deuxième bride ; au moins une broche d'immobilisation (16) passant par des ouvertures définies à cet effet dans la première bride, la deuxième bride, les lames et les entretoises ; et des éléments de fixation (17) pour fixer les lames et l'entretoise entre la première bride et la deuxième bride.

5. Rouleau de moulage selon la revendication 1, comprenant en outre une plaque d'arrêt (24) placée entre l'une des première bride (14) et deuxième bride (15) et la lame (11) qui est positionnée juste à côté de ladite première bride ou deuxième bride, la plaque d'arrêt étant conçue pour se mettre en prise avec un rouleau associé du rouleau de moulage afin de supprimer le déplacement axial du rouleau de moulage par rapport au rouleau associé.

FIG.1

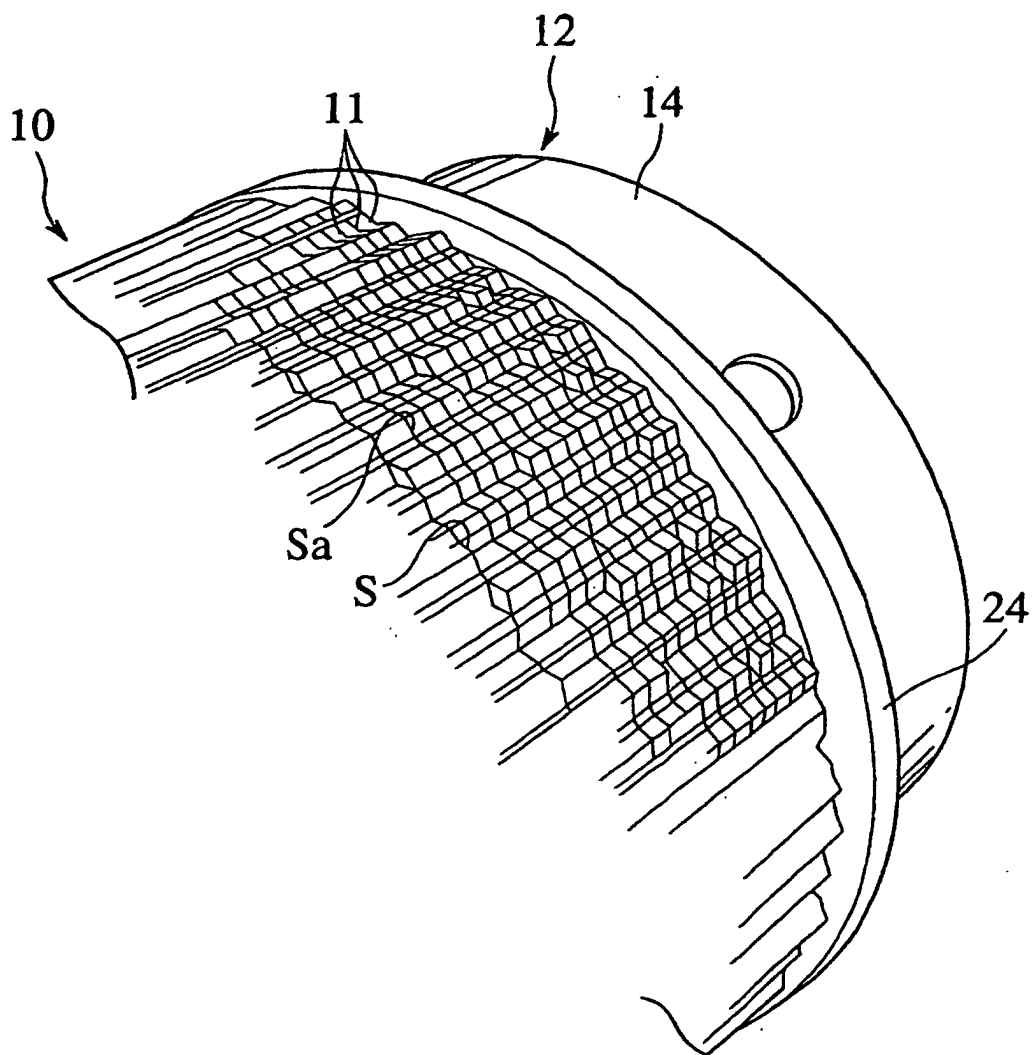


FIG. 2

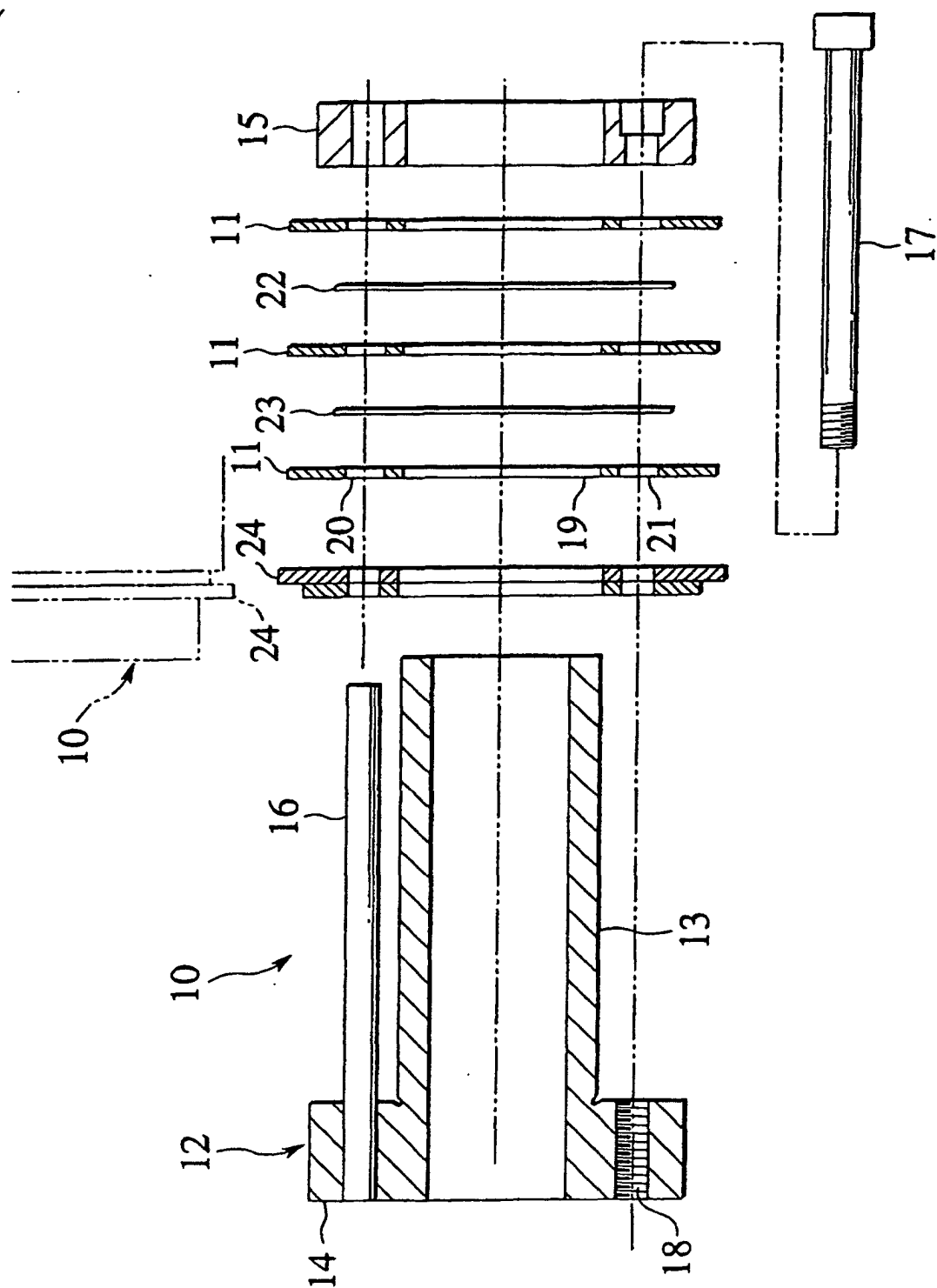


FIG.3

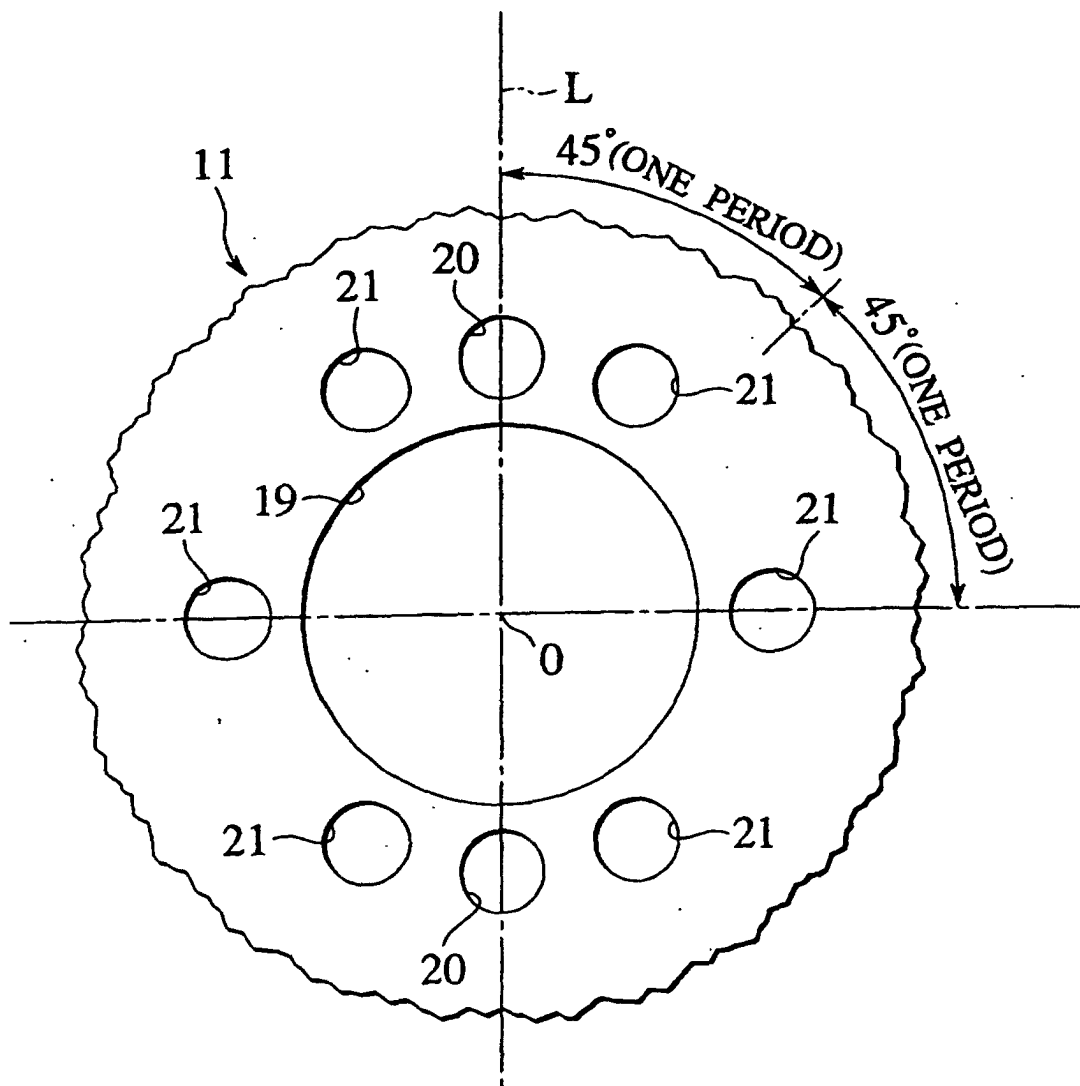


FIG. 4

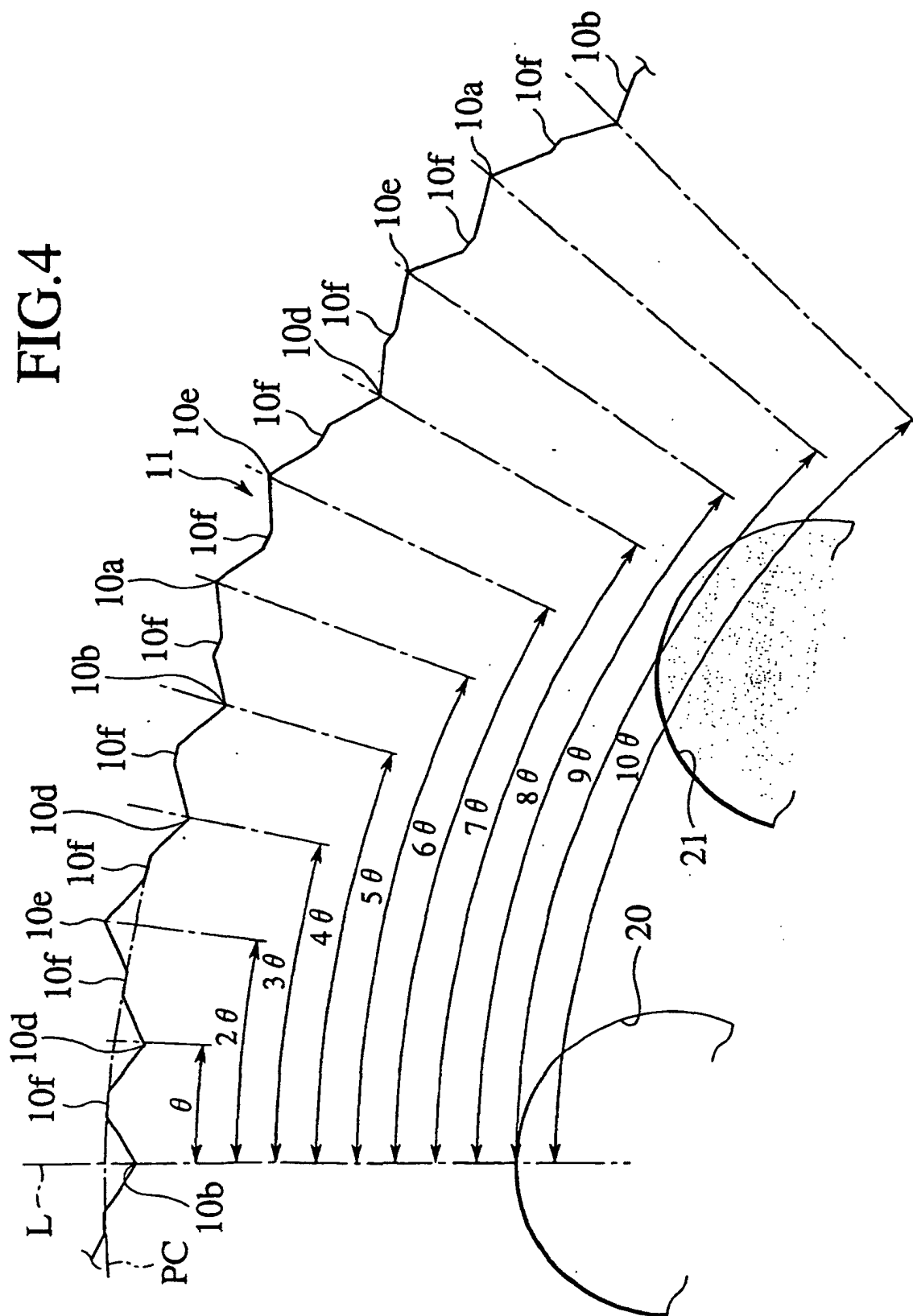


FIG.5

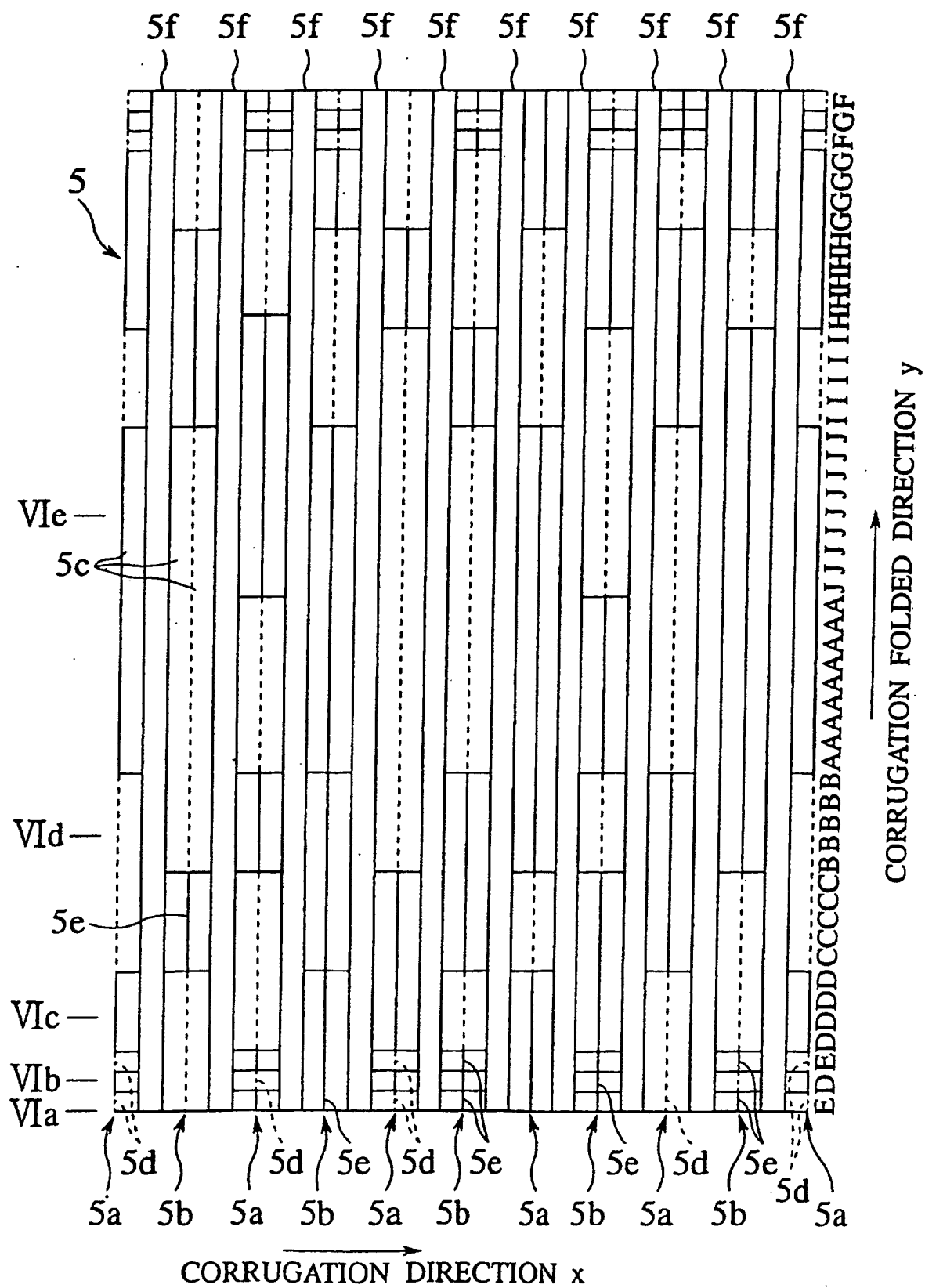


FIG.6

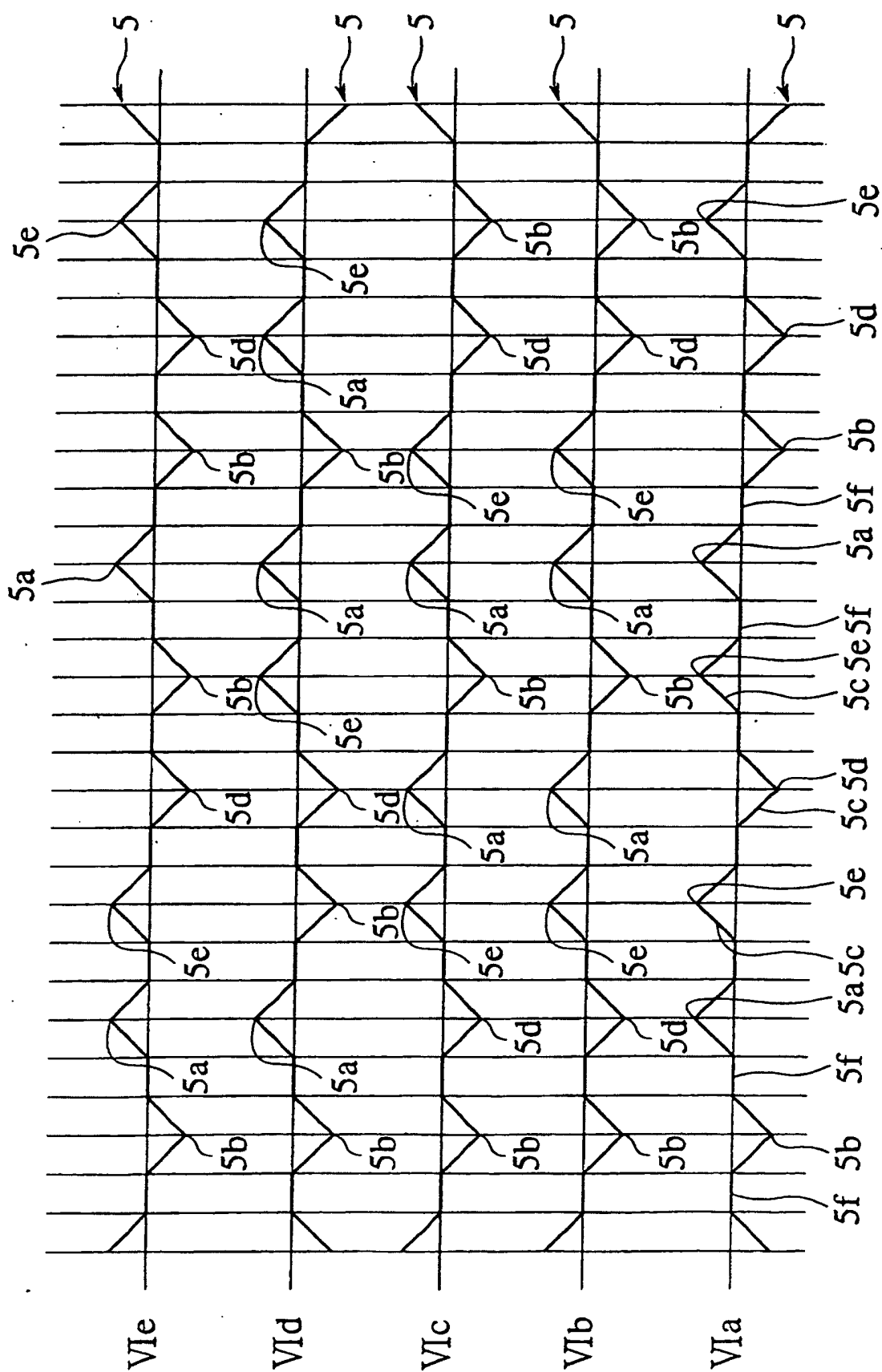
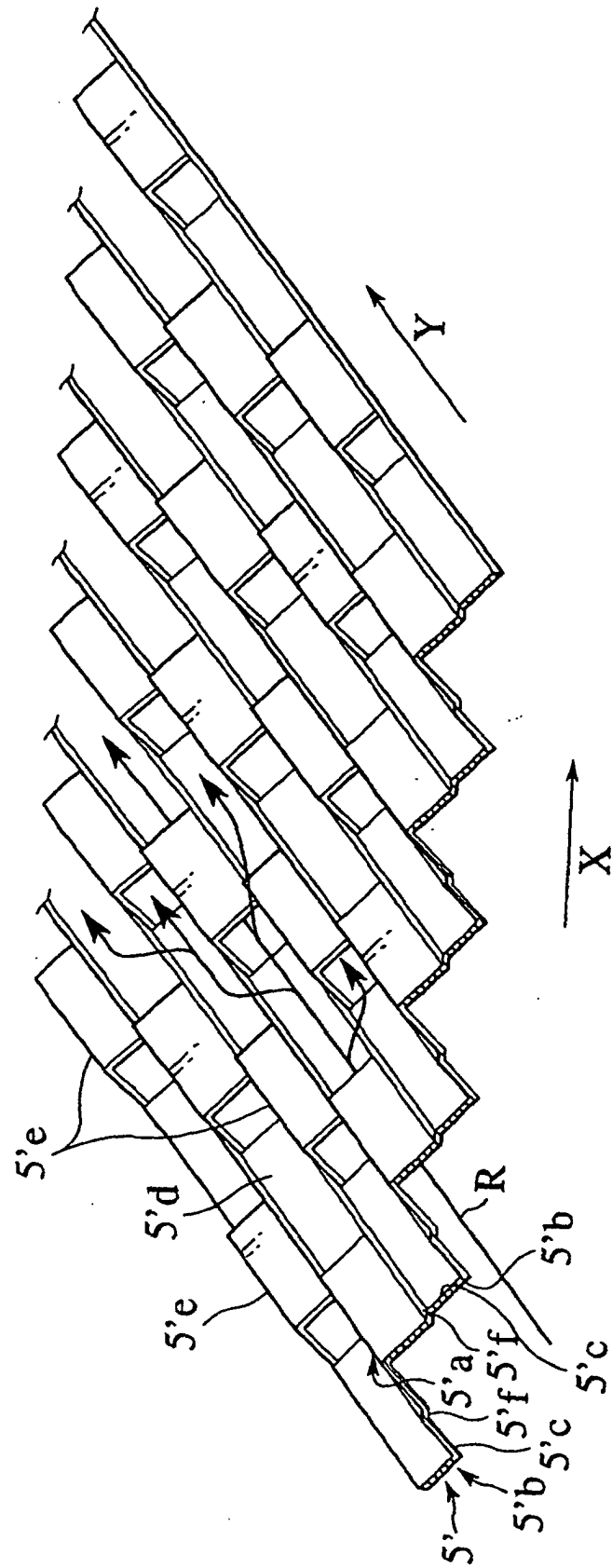


FIG.7



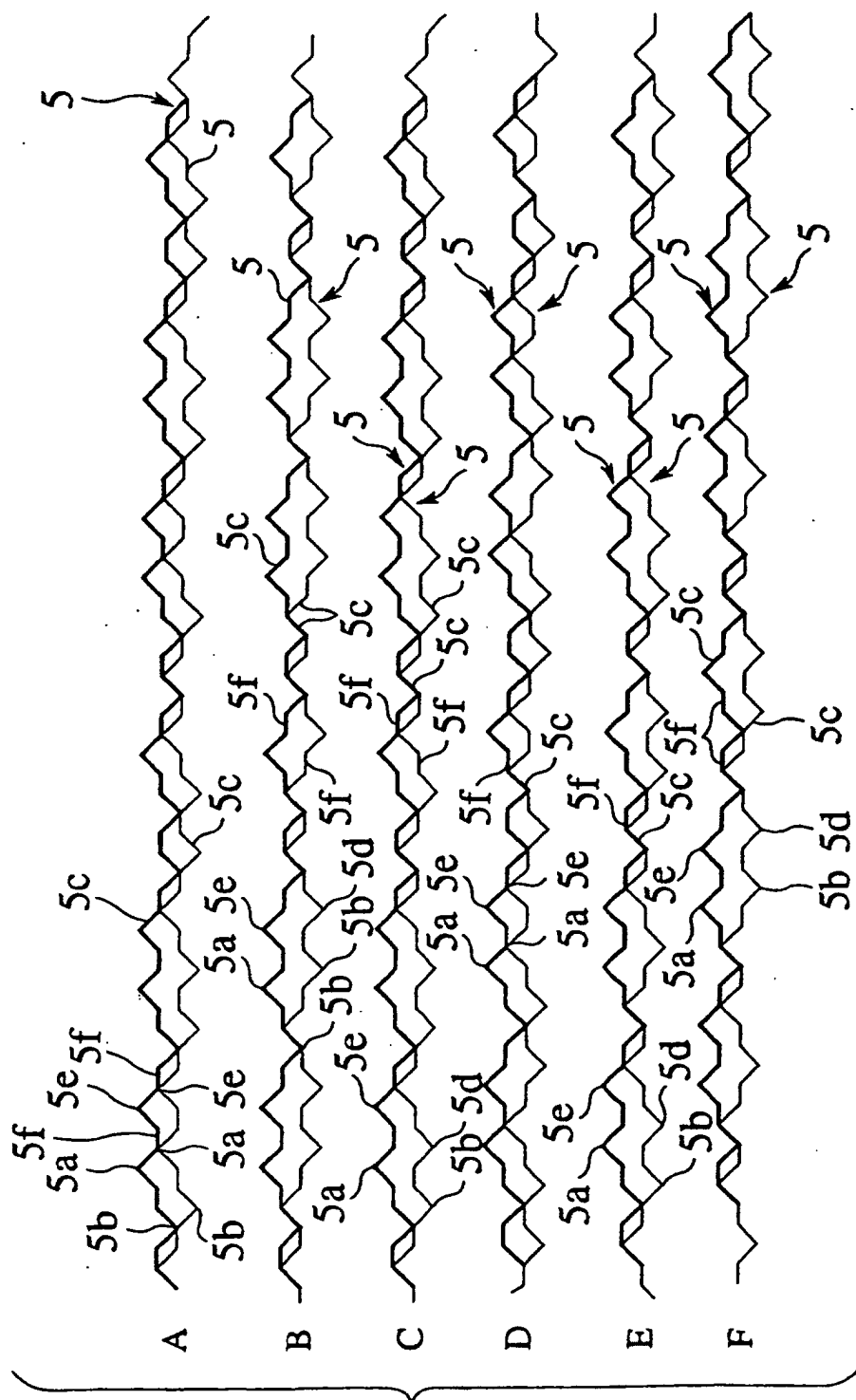


FIG.8

FIG.9

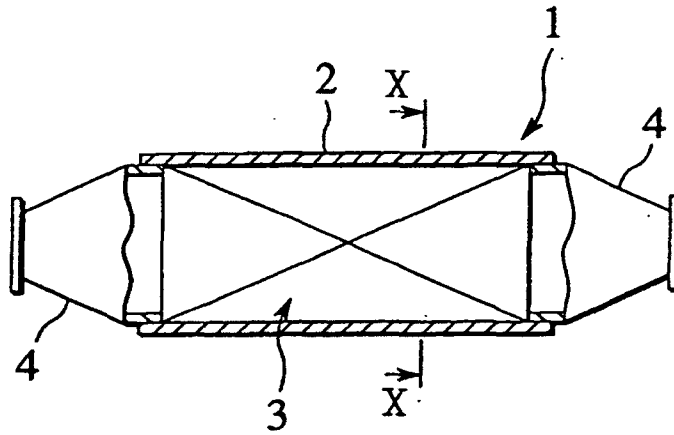


FIG.10

