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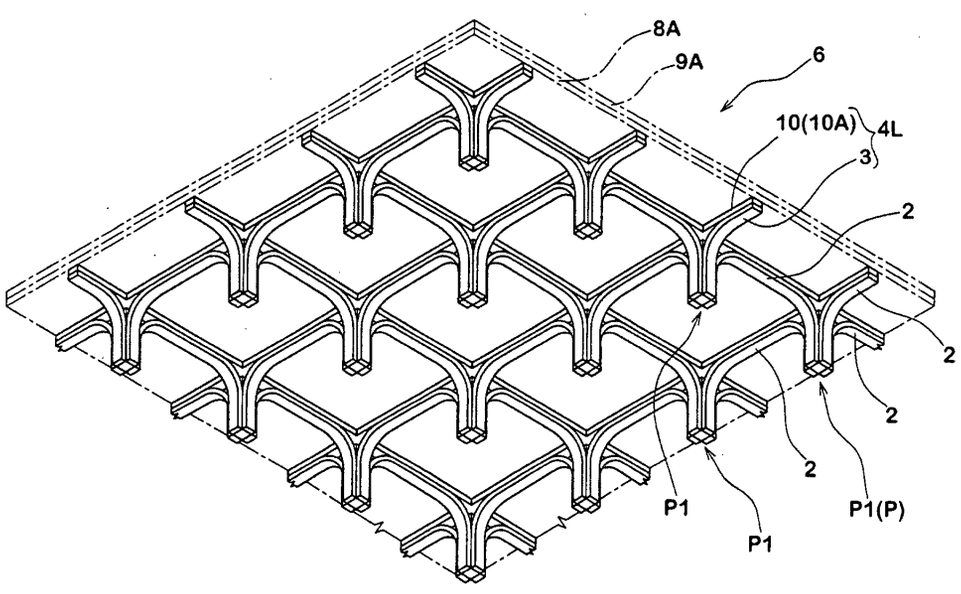
(54) BUILDING STRUCTURE

(57) An architectural structure 1A includes architectural frameworks 4 obtained by mutually joining bent architectural members 2 in which horizontal frame portions 11 and longitudinal frame portions 13 continue into each other upon being bent in a substantially right-angular manner with arc-like portions 12 interposed therebetween. The architectural framework 4 includes a planar base portion 3 in which horizontal frame portions 11 continue into each other and in which joint portions P project out by sequentially joining the longitudinal frame portions 13 by using joint portions P with multiple surface connecting portions P1 for joining at least the longitudinal frame portions 13 while facing each other at multiple surfaces of not less than three surfaces.

FIG.2



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Description

Technical Field

[0001] The present invention relates to an architectural structure through which, for instance, roofs, ceilings, floors and walls of large size can be formed while exhibiting quake-resistant and oscillation-absorbing properties and that is suitably employed as a large space structure such as a gymnasium, a school building or an exhibition hall.

Background Art

[0002] In large space structures such as gymnasiums, school buildings or exhibition halls, planar structures such as roofs, ceilings, floors or walls are formed to be large size for securing a large internal space while it is necessary to support these planar structures by means of columns or similar that are collected at peripheries of the building. It was thus conventionally performed to form the planar structures themselves or frames such as beams and binding beams for supporting the same of rigid steel material to comprise rigid structures with improved flexural rigidity.

[0003] However, since the rigid structures are inferior in weight absorbability, there are possibilities that they are apt to deform upon application of excess load and that they receive unconsidered damages, and their arrangement as rigid structures lead to increased weight which makes the load applied to the columns or similar even larger.

Disclosure of the Invention

[0004] The present invention has been worked out in view of the above problems, and the first invention of the present application aims to provide an architectural structure that is capable of forming planar structures that are suitable for use as roofs, ceilings and floors to be of large size while holding down increase in weight, and that is capable of absorbing, upon application of elastic functions to the planar structures, excess load through such elastic deformation for improving quake-resistant and oscillation-absorbing properties.

[0005] The second invention aims to provide an architectural structure that is capable of forming planar structures that are suitable for use as outer walls to be of large size while holding down increase in weight, and that is capable of absorbing, upon application of elastic functions to the planar structures, excess load through such elastic deformation for improving quake-resistant and oscillation-absorbing properties.

[0006] For achieving the above purposes, the architectural structure of the first invention is characterized in that it comprises architectural frameworks in which bent architectural members, each of which includes, in a successive manner, a horizontal frame portion and a longitudinal portion that succeeds from an end portion of the horizontal frame portion through an arc-like portion and that bends in a substantially right-angular manner with respect to the horizontal frame portion, are arranged in that joint portions including a multiple surface connecting portions for joining at least the longitudinal frame portions while facing each other at multiple surfaces of not less than three surfaces are used for sequentially joining the longitudinal frame portions so as to comprise a planar base portion in which the horizontal frame portions continue into each other and in which the joint portions are projecting out.

[0007] The architectural structure of the second invention is characterized in that it comprises an architectural framework in which bent architectural members, each of which includes, in a successive manner, a horizontal frame portion and a longitudinal portion that succeeds from an end portion of the horizontal frame portion through an arc-like portion and that is bent with respect to the horizontal frame portion, are arranged in that joint portions for double surface connection for joining the frame portions at two surfaces back to back for sequentially joining the frame portions so as to comprise a planar base portion in which the frame portions continue into each other and in which the joint portions are not projecting out.

Brief Explanation of the Drawings

[0008]

Fig. 1 is a perspective view for conceptually illustrating one embodiment of the architectural structure according to the first invention.

Fig. 2 is a partial perspective view for illustrating a case in which the architectural frameworks are employed as a floor portion.

Fig. 3 is a side view thereof.

Figs. 4(A) to 4(C) are horizontal sectional views in horizontal directions for illustrating examples of joint portions for longitudinal framework portions that are joined by using filler materials.

Figs. 5(A) and 5(B) are a side view and a horizontal sectional view in a horizontal direction for illustrating examples of joint portions for longitudinal framework portions that are joined without using filler materials.

Figs. 6(A) and 6(B) are side views for illustrating another embodiment of the bent architectural members and an architectural framework employing the same.

Figs. 7(A) to 7(D) are diagrams for explaining definitions of "substantially right-angular".

Fig. 8 is a partial perspective view illustrating an example in which the architectural framework is employed at a roof portion.

Fig. 9 is a side view thereof.

Fig. 10 is a side view illustrating another embodi-

ment of the architectural frameworks employed at a roof portion.

Fig. 11 is a perspective view illustrating still another embodiment of the architectural frameworks employed at a roof portion.

Fig. 12 is a perspective view for conceptually illustrating an embodiment of the architectural structure according to the second invention.

Fig. 13 is a front view illustrating an example in which the architectural frameworks are employed as an outer wall portion.

Figs. 14 (a) to 14 (c) are perspective views illustrating one example of bent architectural members.

Figs. 15 (a) to 15 (g) are perspective views illustrating another example of bent architectural members.

Fig. 16 is a perspective view illustrating a condition in which the bent architectural members are dovetail joined.

Fig. 17 is an exploded perspective view thereof.

Fig. 18 (a) is a sectional view illustrating a condition prior to insertion of a placing tool at the dovetail joint.

Fig. 18 (b) is a sectional view illustrating a condition after insertion.

Fig. 19 is a perspective view illustrating another placing tool.

Fig. 20 is a sectional view illustrating still another placing tool.

Fig. 21 is a sectional view illustrating a fixing tool.

Fig. 22(a) is a plan view illustrating another example of the architectural framework and (b) a plan view illustrating still another example of the architectural framework.

Fig. 23 is a front view of Figs. 22(a) and 22(b).

Fig. 24 is a perspective view conceptually illustrating an architectural structure that is composed of the architectural frameworks of Figs. 22(a) and 22 (b).

Fig. 25 is a side view illustrating an architectural framework that gradually inclines in approaching the top.

Fig. 26 is a side view illustrating another architectural framework that gradually inclines in approaching the top.

Fig. 27 is a plan view of ring-like bodies in which a part of the architectural framework of Fig. 28 is illustrated in exploded form.

Fig. 28 is a diagram illustrating another example of the architectural framework.

Figs. 29 to 31 are diagrams for illustrating still another example of the architectural framework.

Best Mode for Carrying Out the Invention

[0009] Embodiments for carrying out the present invention will now be explained on the basis with illustrated examples. In this respect, Figs. 1 to 11 related to a first invention of the present application wherein Fig. 1 is a perspective view for conceptually illustrating a case in which an architectural structure 1A of the first invention is formed as a gymnasium representing one large space structure, Fig. 2 a perspective view illustrating a floor portion of a first floor portion of the architectural structure 1A, and Fig. 8 a perspective view illustrating a roof portion. Further, Figs. 12 to 31 are drawings for explaining an architectural structure according to a second invention of the present application. Figs. 12 and 13 are a diagram and a front view for explaining an outer wall portion thereof.

[0010] In Fig. 1, the architectural structure 1A of the first invention is, in the present example, a two-storied gymnasium having an arc-like roof portion, 7, and includes upper and lower architectural frameworks 4U, 4L with planar base portions 3 that are composed by sequentially joining bent architectural members 2.

[0011] The lower architectural frameworks 4L are employed for forming a first planar structure S1, which comprises a floor portion 6 of the second floor portion, and the upper architectural frameworks 4U are employed for forming a second planar structure S2, which comprises a roof portion 7.

[0012] The floor portion 6 includes the lower architectural frameworks 4L that are supported by frames (not shown) including, for instance, columnar bodies that are erected along an outer wall W and horizontal beam members that connect between the columnar bodies, and floor materials 9A (as illustrated in Figs. 2 and 3) are attached onto the lower architectural frameworks 4L with floor wood sheathings 8A being interposed therebetween.

[0013] As illustrated in Figs. 2 and 3, the lower architectural frameworks 4L are further formed of the base portions 3 composed of bent architectural members 2 and shape retaining retention frame materials 10 for retaining the shape of the base portions 3 upon being fixed onto the upper surfaces of the base portion 3.

[0014] As illustrated in Fig. 3 in enlarged form, the bent architectural member 2 comprises, in a successive manner, a horizontal frame portion 11 and a longitudinal frame portion 13 that continues from an end portion of the horizontal frame portion 11 through an arc-like portion 12 and that is bent in a substantially right-angular manner with respect to the horizontal frame portion 11. The present example illustrates a case in which longitudinal frame portions 13 are provided at both ends of the horizontal frame portion 11 to form a substantially U-shaped manner.

[0015] In the present example, each bent architectural member 2 is composed of a flat wood-based material having a rectangular section, wherein the arc-like portion 12 is formed such that a wide width surface thereof faces in- and outward in the radial direction and such that its wooden fiber is deflected in a length direction. In this respect, while laminated wood and composite wood may be favorably used as the wood-based material besides solid wood material as in the present example, it is also possible to form them of other materials such as

synthetic resin materials or metallic materials upon demand.

[0016] The above-mentioned term "substantially right-angular" denotes a case in which, when respective longitudinal frame portions 13 are respectively connected in a back-to-back aligned manner as illustrated in Figs. 7(A) to (D), the longitudinal frame portions 13 are orthogonal to a horizontal frame portion connecting line L that is formed by the respective horizontal frame portions 11 that are ranged serially. At this time, the connecting line of the horizontal frame portions L maybe a straight line (Fig. 7 (A)), an arc-like curve (Fig. 7 (8)), or a wave-like zigzag line (Figs. 7(C), (D)), and in case of a zigzag line, orthogonalization is made with respect to a center N of the zigzag.

[0017] As for the bent architectural members 2, while it is preferable to form the horizontal frame portions 11 thereof in a straight-linear manner as in the present example when forming the floor portion 6, it is alternatively possible, upon demand, to form the same in an arc-like shape with a large radius of curvature R as illustrated in Fig. 7 (C) . In this respect, an "arc-like shape with a large radius of curvature R" means an arc which radius of curvature R is not less than 2. 5 times than the radius of curvature r of the arc-like portion 12.

[0018] By mutually joining such bent architectural members 2, the base portions 3 are formed in a planar shape. More particularly, the base portions 3 are formed by sequentially joining the longitudinal frame portions 13 by using connecting portions P each including a multiple surfaces connecting portion P1 with at least longitudinal frame portions 13 being joined while facing each other at multiple surfaces of not less than three surfaces. In this manner, the base portion 3 will be arranged in that the horizontal frame portions 11 continue into each other and the joint portions P project downward.

[0019] The present example illustrates a case in which the horizontal frame portions 11 continue into each other in a grid-like manner. In such a case, each multiple surface connecting portion P1 comprises, as illustrated in Fig. 4 (A) , a cross-shaped four surface connecting portion P1a that comprises a major portion of the base portion 3 upon joining the longitudinal frame portions 13 upon facing each other at four surfaces and, as illustrated in Fig. 4 (B) , a T-shaped three surface connecting portion P1b that comprises a side edge portion of the base portion 3 upon joining them while facing each other at three surfaces. The joint portion P may also include, other than the multiple surface connecting portion P1, as illustrated in Fig. 4 (C) , an L-shaped two surface connecting portion P2 that comprises a corner portion of the base portion 3 upon joining the longitudinal frame portions 13 facing each other at two surfaces.

[0020] At this time, the joint portion P of the present invention is arranged in that filler materials 15 are interposed between the longitudinal frame portions 13 facing each other to thus achieve a firm joint while stabilizing intervals between the respective longitudinal frame portions 13. However, it is also possible to directly join the clearances between the respective longitudinal frame portions 13 without interposing filler materials 15 as illustrated in Figs. 5(A) and (B). In this respect, while the present example illustrates a case in which the fastening tools 16 such as bolts or nuts are employed as the connecting means, it is also possible to suitably employ, for instance, various kinds of dovetail joints in which dovetail tenons and dovetail grooves (also including dovetail tenon holes) are fitted with each other.

[0021] Here, the bent architectural member 2 can exhibit superior elastic functions through its arc-like portion 12, and as illustrated in Fig. 3, external force F (such as load or oscillation) acting thereon are converted in an in-plane direction while absorbing the same so that it is sequentially transmitted to adjoining bent architectural members 2 for dispersion. Accordingly, in the presence of a local destructive movement (such as oscillation) in the base portions 3 that are formed by the bent architectural members 2, this movement will be sequentially attenuated through the elastic function of the bent architectural members 2 that are connected through the joint portions P to be dispersed in all directions. In the presence of a movement in the entire base portion 3, all bent architectural members 2 will simultaneously exhibit elastic functions so that the movement is individually attenuated through the resistivity thereof.

[0022] Accordingly, also where the base portion 3 is of large size and its supporting span is long, destruction owing to load, impact or oscillation and others can be effectively restricted, and it is possible to remarkably improve the endurance strength. Moreover, since wood-based materials may be employed, it is possible to contribute to improvements in the endurance strength of the entire architectural structure in that increases in weight can be held down and in that reductions in the burden applied to columns and others can be achieved.

[0023] In the present example, the base portions 3 comprising the floor portion 6 comprise, at the same time, the ceiling portion of the ground floor portion. At this time, since the bent architectural members 2 are connected in a grid-like manner in the base portion 3, the ceiling portion can be finished so as to have a coffered-ceiling-like pattern and thus leads to improvements in the appearance as well.

[0024] The retention frame material 10 for retaining the shape of the base portions 3 is, as illustrated in Fig. 2, a subframe in which bar member 10A are connected in a grid-like manner along the bent architectural members 2, and by fixing the horizontal frame portions 11 on an opposite side than the joint portions P (in this example, the upper surface), the shapes of the base portions 3 are retained. In this respect, while the present example is arranged in that the floor wood sheathings 8A and the floor materials 9A are sequentially attached onto the retention frame materials 10, it is alternatively possible to directly connect the base portions 3 and the floor wood sheathings 8A without interposing the retention frame

materials 10.

[0025] In this respect, another embodiment of the bent architectural member 2 is illustrated in Figs. 6(A) and (B). This bent architectural member 2 is arranged in a ring-like manner in which both ends of upper and lower horizontal frame portions 11U, 11L continue into each other at the longitudinal frame portions 13 through the arc-like portions 12. In this respect, Fig. 6(A) illustrates a case in which respective longitudinal frame portions 13 are sequentially connected with filler materials 15 interposed between while Fig. 6(B) illustrates a case in which respective longitudinal frame portions 13 are directly connected. In case of such a ring-like arrangement, it will also be possible to mount ceiling plates 17 to the lower horizontal frame portions 11L so as to hide the base portions 3.

[0026] The roof portion 7 will now be explained. The roof portion 7 is formed, as illustrated in Figs. 8 and 9, in that roof covering materials 9B are attached onto an upper surface of the upper architectural frameworks 4U that are supported by the frame with roof wood sheathings 8B being interposed therebetween. Similarly to the lower architectural frameworks 4L, the upper architectural frameworks 4U include base portions 3 that are retained by the retention frame materials 10.

[0027] As for the points that differ from those of the lower architectural frameworks 4L, the base portions 3 of the upper architectural frameworks 4U of the present example are arranged in that first bent architectural members 2A in which the horizontal frame portions 11 are aligned in a straight line are employed similarly to Fig. 3 in a ridge direction J1 that is parallel to the ridge A (illustrated in Fig. 1) while second bent architectural members 2B in which the horizontal frame portions 11 are deflected in an arc-like shape along the arch-like curve of the roof portion 7 as illustrated in Fig. 9 are employed in the gable direction J2 that is orthogonal to the ridge A. It also makes sense that it is possible to employ a structure for the first bent architectural members 2A in which the horizontal frame portions 11 are deflected such that a center N of the zigzag of the horizontal frame portion connecting line L becomes a straight line as illustrated in Fig. 7 (C). It is alternatively possible to employ an arrangement for the second bent architectural members 2B in which the horizontal frame portions 11 are deflected such that a center N of the zigzag of the horizontal frame portion connecting line L faces along the arch-like curve of the roof portion 7 as illustrated in Fig. 7(D).

[0028] By sequentially connecting respective longitudinal frame portions 13 of the first and second bent architectural members 2A, 2B by using joint portions P, an arch-like base portion 3 is formed. In this respect, by employing base portions 3 that are of substantially the same structure as the lower architectural frameworks 4L, the roof portion 7 may also be formed in a horizontal planar shape or an inclined planar shape. In this manner, it will be possible to comprise various roofs such as flat roofs, gabled roofs and rectangular hipped roofs.

[0029] Fig. 10 illustrates a case, similarly to Fig. 6, in which the second bent architectural members 2B are formed in a ring-like manner. When the base portion 3 is formed of the second bent architectural members 2B alone, it is, for instance, possible to form the roof portion 7 in a circular dome-like shape as illustrated in Fig. 11.

[0030] The architectural structure 1B according to the second invention will now be explained by using Figs. 12 to 31.

[0031] In Fig. 12, the architectural structure 1B of the second invention is a rectangular structure in which four surfaces thereof are surrounded by wall body portions 20 for forming outer walls, wherein at least one of planar structures SW composing the wall body portions 20, in the present example, four planar structures SW, are formed by using planar side architectural frameworks 26W in which bent architectural members 22A, 22B (generally referred to as "bent architectural members 22") are mutually joined as illustrated in Fig. 13.

[0032] The side architectural frameworks 26W are supported by a frame including, for instance, columnar bodies 40 that are erected along an outer wall and horizontal beam materials 39 that connected between the columnar bodies 40. The planar structures SW (wall body portions 20) are formed by attaching outer wall materials (not shown) or similar either with a wood sheathing being interposed therebetween or directly onto the side architectural frameworks 26W.

[0033] Here, each of the bent architectural members 22A, 22B comprises, as illustrated in Figs. 14(a) and (b), a linear horizontal frame portion 31a and a linear longitudinal frame portion 31b that continues from an end portion of the horizontal frame portion 31a with an arc-portion 32 having a relatively large radius r being interposed therebetween and that bents from the horizontal frame portion 31a. The present example illustrates a case in which the horizontal and longitudinal frame portions 31a, 31b (generally referred to as "frame portions 31") are respectively bent at right angles, that is, the arc-like portion 32 comprises a 1/4 arc with a central angle θ being 90° and an outward facing surface 31S is parallel to a central line C that passes through a bending center of the arc. Among these, the bent architectural member 22A is of isosceles shape in which the frame portions 31a, 31b are relatively short and of identical size while the bent architectural member 22B is of L-shaped form in which one frame portion 31b is of longer size than that of the other frame portion 31a.

[0034] In this respect, the bent architectural member 22 is formed by bending a flat wood-based material having a rectangular section such that its wooden fiber is deflected in a length direction, similar to the bent architectural member 2 employed in the first invention.

[0035] In the present example, such bent architectural members 22 are employed for forming ring-like bodies 25 (illustrated in Fig. 13), and the outward facing faces 31S of the ring-like bodies 25 are mutually joined as fac-

ing surfaces S that are faced back-to-back. With this arrangement, the side architectural frameworks 26W including planar base portions 27 with frame portions 31 continuing into each other are composed. At this time, unlike the first invention, the joint portions P, which is a double surface connecting portion P2, at which the facing surfaces S, S are joined will be aligned on the same plane as the base portion 27 without projecting.

[0036] As particularly illustrated at the rectangular ring-like body 25 on the upper left end of Fig. 13, the L-shaped bent architectural members 22B are disposed at diagonal corners c1, c3, and the isosceles-shaped bent architecture members 22A are disposed at the other diagonal corners c2, c4. With this arrangement, a rectangular ring-like body 25A1 with four sides thereof being surrounded by longitudinal and horizontal ring pieces with seams a1, a2, a3 and a4 is formed.

[0037] In the present example, the ring-like body 25A1 further comprises a firm rectangular ring-like body 25A1 upon mutually joining the same to a beam material 39 upward thereof, to a columnar body 40 on the left-hand side thereof, to a ring-like body 25A2 on the right-hand side thereof, and to a ring-like body 25B1 downward thereof. In this respect, there are also cases in which no members such as the columnar bodies and beam materials are employed, and also cases in which they are only joined to peripheral ring-like bodies 25 such as the ring-like body 25B2 adjoining the lower ring-like body 25B1.

[0038] For solidifying the joint between ring-like bodies 25, one seam a4 of one ring-like body 25A1 is shifted in its position either upward or downward with respect to a seam a2 of another ring-like body 25A2 as illustrated in Fig. 13 in summarized form at opposing longitudinal ring pieces of adjoining ring-like bodies 25, 25. Seam a3 and seam a1 are similarly shifted in position also at opposing horizontal ring pieces of upper and lower ring-like bodies 25, 25. With this arrangement, decoupling owing to overlapping seams a, a or degradations in strength owing to approaching thereof are prevented. It is therefore favorable to remote the seams a, a by approximately 1/5 to 1/2 of the length of the longitudinal and horizontal ring pieces.

[0039] In this manner, it is possible to exhibit elastic functions through the arc-like portions 32 in the second invention, similar to the first invention, to sequentially transmit external force acting in an in-plane direction and to disperse the same to adjoining bent architectural members 22 while absorbing the same, and to improve the quake-resistant and vibration-absorbing properties.

[0040] For joining respective ring pieces of respective ring-like bodies 25 with adjoining members (including ring pieces, beam materials 39 and columnar bodies 40) to form the side architectural frameworks 26W, the present example employs dovetail joint as illustrated in Figs. 16 to 18.

[0041] In the dovetail joint, from among the respective outward facing surfaces 31S of the straight-linear frame portions 31a, 31b, surface portions that are in contact with adjoining members are defined to be facing surfaces S. Dovetail grooves 42 extending in longitudinal directions are formed on both of the mutually contacting facing surfaces to face each other (in this respect, the dovetail grooves 42 are omitted in Figs. 14 and 15). The dovetail grooves 42 include expanded width portions 41, which groove widths increase in approaching the groove bottom (illustrated in Fig. 18).

[0042] Into such dovetail grooves 42, usually, dovetail tenons 44 that are smaller than a minimum width of the dovetail grooves 42 and that are divided in a width direction are inserted. The dovetail tenons 44 have a width that bridges over opposing facing surfaces S, S (and that preferably contacts the groove bottoms) and their sectional shape assumes a butterfly shape in which dovetail portions that meet the expanded width portions 41 are provided on both sides.

[0043] The dovetail tenons 44 are inserted into dovetail grooves 42 of at least either bent architectural member 22 and after matching the other bent architectural member 22, as illustrated in Fig.18, a placing tool 45 that is inserted from a non-facing plane is used for dividing the dovetail tenon material 44 to expand the same in a width direction. With this arrangement, the dovetail portions are made to closely fit the expanded width portion 41 for joining both of these members. In this respect, the dovetail grooves 42 can be easily formed by using a so-called dovetail groove milling cutter or similar.

[0044] Further, in such a dovetail joint of the present example, a region y1 from the top to the upper seam a4, a region y2 from the seam a4 to the lower seam a2, and a region y3 below the seam a2 are respectively formed individually as illustrated in Fig. 16. Moreover, by setting the respective length of the dovetail groove 42 and the dovetail tenon 44 to be identical, relatively positional shift between the bent architectural members 22A, 22B in axial directions can be prevented and decoupling through seams can be eliminated to achieve a firm joint. Even though dovetail joint is employed, two bent architectural members 22 can be easily joined without relative movements between these members in axial directions or without inserting a dovetail tenon 24 in axial directions.

[0045] In the embodiment of Figs. 12 and 13, by sequentially aligning a side architectural framework 26W, which is formed by aligning a plurality of ring-like bodies 25 between column bodies 40 or similar, with respect to another side architectural framework 26W at right angles, the architectural structure 1B having a rectangular outer wall is formed as illustrated in Fig. 12. In this respect, in case of the architectural structure 1B, it is possible to further provide a roof portion according to the first invention or a roof portion of a conventional structure onto the upper beam materials 39.

[0046] In this respect, such dovetail joint is not limited to joints between bent architectural members or to joints between such bent architectural members and linear ar-

chitectural members such as columns or beams, but may be suitably used for joining between facing surfaces of all kinds of architectural members such as between linear architectural members.

[0047] As the placing tool 45 for the dovetail joint, it is also possible to employ a flat-plate like one that extends in the tenon length direction (illustrated in Fig. 19) besides one of the above-described pin-like body. Further, it is also possible to employ one of screw-like type in which a pin portion 46b for pushing and expanding the tenon is provided at a head portion 46a of an outer peripheral screw as illustrated in Fig. 20, wherein this type is capable of expanding the width of the dovetail tenon 44 through threading and of decomposing through back threading.

[0048] As illustrated in Fig. 21, various joining means employing fixing tools 48 such as bolts and nuts, screws or nails or adhesive and similar can be employed simultaneously with the dovetail joint or instead of the dovetail joint. In this respect, it is preferable to employ such fixing tools 48 for the region y2 (illustrated in Fig. 16) for reliably preventing positional shifts in the longitudinal direction.

[0049] In this respect, it is possible to employ, instead of the bent architectural members 22A, 22B, a U-shaped bent architectural member 22C in which linear horizontal frame portions 31a, 31a of short length are provided on both sides of the linear longitudinal frame portion 31b via arc-like portions 32, 32 as illustrated in Fig. 14 (c) , and by combining two of these, it is possible to form the rectangular ring-like body 25.

[0050] Another embodiment of the side architectural framework 26W (wall body portion 20) is illustrated in Figs. 22 to 24.

[0051] In Fig. 22(a) and Fig. 23, by joining the rectangular ring-like bodies 25, a side architectural framework 26W having an arc-like surface as illustrated in Fig. 22 (a) is formed, and by connecting such architectural frameworks 26W, the architectural structure 1Ba having a circular cage-like outer wall as illustrated in Fig. 24 is formed. By employing the same in a partial manner, it is possible to form a corner portion of a parallelepiped architectural structure 1B of Fig. 12 to be of arc-like shape.

[0052] For forming such architectural frameworks 26W with arc-like surfaces, bent architectural members 22D with only frame portions 31a located at upper sides and lower sides being deflected in an arc-like manner of a radius of R as illustrated, for instance, in Fig. 15(a) to comprise the ring-like bodies 25.

[0053] Fig. 22(b) further illustrates an architectural framework 26W that is deflexed in a polygonal manner along the arc-like surface. As illustrated in Fig. 15 (b), this architectural framework 26W can be formed by employing bent architectural members 22E of which only horizontal frame portions 31a located at upper sides and lower sides are twisted at angle α within a horizontal plane with respect to the longitudinal frame portion 31b that becomes orthogonal thereto. The architectural framework 26W of Fig. 22 (b) can also be formed through another method in which bent architectural members 22A, 22B or 22C are employed while an interposing member 47 having a tapered slope as illustrated in Fig. 15(c) is interposed between the longitudinal frameworks 31b. In this respect, the interposing members 47 can be short-sized to be provided only at joint regions.

[0054] Fig. 25 illustrates an embodiment in which the architectural framework 26W gradually inclines either inward or outward in approaching the top. In such a case, bent architectural members 22G, in which outward facing surface 31S is inclined at an angle β with respect to a central line C extending through a flexural center of the arc-like portion 32, are employed at the horizontal frame portions 31a that are located, for instance, at the upper sides and lower sides as illustrated in Fig. 15 (d) . In this respect, by interposing the interposing members 47 between the horizontal frame portions 31a as illustrated in Fig. 26 in addition to employing the bent architectural members 22A, 22B or 22C, it is similarly possible to comprise a hog-backed architectural structure or the arch-like roof portion 7 in which the architectural frameworks 26W are inwardly inclined in approaching the top.

[0055] Fig. 27 illustrates a part of the architectural framework 26W of a regular dodecahedron body as illustrated in Fig. 28 expanded in a planar form. In this respect, the arc-like portion 25 is omitted herein for sake of convenience. In such a a case, a bent architectural member 22H having a conical outer surface in which long and short frame portions 31a, 31b are provided through the arc-like portions 32 with an interior angle θ of 108° as illustrated in Fig. 15 (e) , and respective outward facing surfaces 31S of the frame portions 31a, 31b are inclined at angle β with respect to a central line C extending through a flexural center of the arc-like portions 32 is employed. By combining these members, the ring-like body 25 having a regular pentagonal shape as illustrated in Fig. 27 is formed, and the ring-like bodies 25 are mutually joined with each other. With this arrangement, it is possible to comprise an architectural structure 1Bb comprised of a single architectural framework 26 of regular dodecahedron shape in which the outer walls and the roof are integral with each other.

[0056] In this respect, it is possible to comprise the same while interposing the interposing members 47, and by further using bent architectural members 22I having a trapezoid section with one wide width surface being inclined in a section as illustrated in Fig. 15(f), it is possible to comprise a ring-like body 25 in which all outward facing surfaces 31S are inclined with respect to the central line C.

[0057] By further employing bent architectural members 22 of various shapes such as a bent architectural member 22J having not less than three arc-like portions 32 or which angle θ, α, or β is changed as illustrated in Fig. 15 (g), it is possible to comprise architectural struc-

tures 1Bc to 1Be that are formed of architectural frameworks 26W of various spatial shapes such as one octahedral shape with an obliquely cut head (upper half) as illustrated in Fig. 29, a delta icosahedral body as illustrated in Fig. 30, a cuboctahedral shape (half) as illustrated in Fig. 31, or spherical shell-like such as a circular, an elliptic or a fan-like shape.

[0058] In the polygonal shapes of Figs. 27 to 31, it is possible to separate respective surfaces into a plurality of surface portions and to form the surface portions of triangular or rectangular ring-like bodies employing architectural members 22. In such a case, the respective surfaces will be formed of architectural frameworks 26W in which ring-like bodies, which correspond to the separated surface portions, are joined.

[0059] While particularly preferred embodiments of the present invention have been explained in details so far, the architectural structure according to the present invention is not limited to large space structures alone, but the present invention may be embodied upon various modifications such as forming the structure as normal houses and similar.

[0060] As described above, the present invention enables it to form surface structures such as roofs, ceilings, floors and walls of large size while holding down increases in weight. Moreover, the surface structure is capable of dispersing and absorbing stress through its elastic function when load is acting thereon, and also when the surface structure is of large size and the supporting span is long, it is possible to hold down deformation or impact with respect to load in the out-of-plane direction or in-plane direction to prevent breaking and damages and to improve the endurance strength.

[0061] When the architectural frameworks are to be exposed as ceilings or similar, it is possible to achieve geometric beauty of figuration and patterns like a coffered ceiling, and when the architectural frameworks are used as outer walls, it is possible to form the architectural structure of free dimensional shape so as to largely contribute to improvements in the performance of external appearance.

Industrial Applicability

[0062] As explained so far, the present invention is capable of forming surface structures that are favorably used as roofs, ceilings, floors or walls of large size while holding down increases in weight, and it will also be possible to apply elastic functions to the surface structures for absorbing excess load through elastic deformation thereof, and the quake-resistant and oscillation-absorbing properties of architectural structures can accordingly be improved.

Claims

1. An architectural structure, **characterized in that** it comprises architectural frameworks in which bent architectural members, each of which includes, in a successive manner, a horizontal frame portion and a longitudinal portion that succeeds from an end portion of the horizontal frame portion through an arc-like portion and that bends in a substantially right-angular manner with respect to the horizontal frame portion, are arranged **in that** joint portions including a multiple surface connecting portions for joining at least the longitudinal frame portions while facing each other at multiple surfaces of not less than three surfaces are used for sequentially joining the longitudinal frame portions so as to comprise a planar base portion in which the horizontal frame portions continue into each other and in which the joint portions are projecting out.

2. The architectural structure as claimed in Claim 1, wherein the bent architectural member assumes a substantially U-like shape with the longitudinal frame portions being provided at both ends of the horizontal frame portion.

3. The architectural structure as claimed in Claim 1 or 2, wherein the horizontal frame portion is either straight-linear or has a curved shape with a large radius of curvature.

4. The architectural structure as claimed in any one of Claims 1 to 3, wherein the architectural framework is provided, at the base portion, with a retention frame material for shape retention for retaining the shape of the base portion that is fixed at the horizontal frame portion at a surface of the horizontal frame portion opposite to the joint portion.

5. The architectural structure as claimed in Claim 4, wherein the architectural framework is arranged in that wood sheathings for floors or roofs are attached to the base portion with the retention frame material interposed therebetween.

6. The architectural structure as claimed in any one of Claims 1 to 5, wherein the multiple surface joint portion is interposed with filler materials between a plurality of opposing longitudinal frame portions.

7. An architectural structure, **characterized in that** it comprises an architectural framework in which bent architectural members, each of which includes, in a successive manner, a horizontal frame portion and a longitudinal portion that succeeds from an end portion of the horizontal frame portion through an arc-like portion and that is bent with respect to the horizontal frame portion, are arranged **in that** joint portions for double surface connection for joining the frame portions at two surfaces back to back for sequentially joining the frame portions so as to com-

prise a planar base portion in which the frame portions continue into each other and in which the joint portions are not projecting out.

8. The architectural structure as claimed in Claim 7, wherein the bent architectural members form ring-like bodies of polygonal shape including triangles, and outward facing surfaces of the ring-like bodies are mutually joined as facing surfaces to comprise the architectural framework.

9. The architectural structure as claimed in Claim 8, wherein the ring-like body is arranged in that at least one outward facing surface thereof is inclined with respect to a central line of the ring-like body.

10. The architectural structure as claimed in Claim 8, wherein the ring-like bodies are joined such that their outward facing surfaces are parallel to a central line of the ring-like bodies while interposing interposing members, which include two tapered sloped surfaces, between the facing surfaces.

11. The architectural structure as claimed in any one of Claims 7 to 10, wherein the bent architectural members are joined through dovetail joint in which dovetail tenons are fitted into dovetail grooves that are provided on the facing surfaces.

12. The architectural structure as claimed in Claim 11, wherein the dovetail joint is performed through joining the dovetail tenon in a closely fitted manner into the dovetail groove upon expanding a width of the dovetail tenon, which is dividable in a width direction of the dovetail groove and which has a width that is smaller than a minimum width of the dovetail groove, through a placing tool.

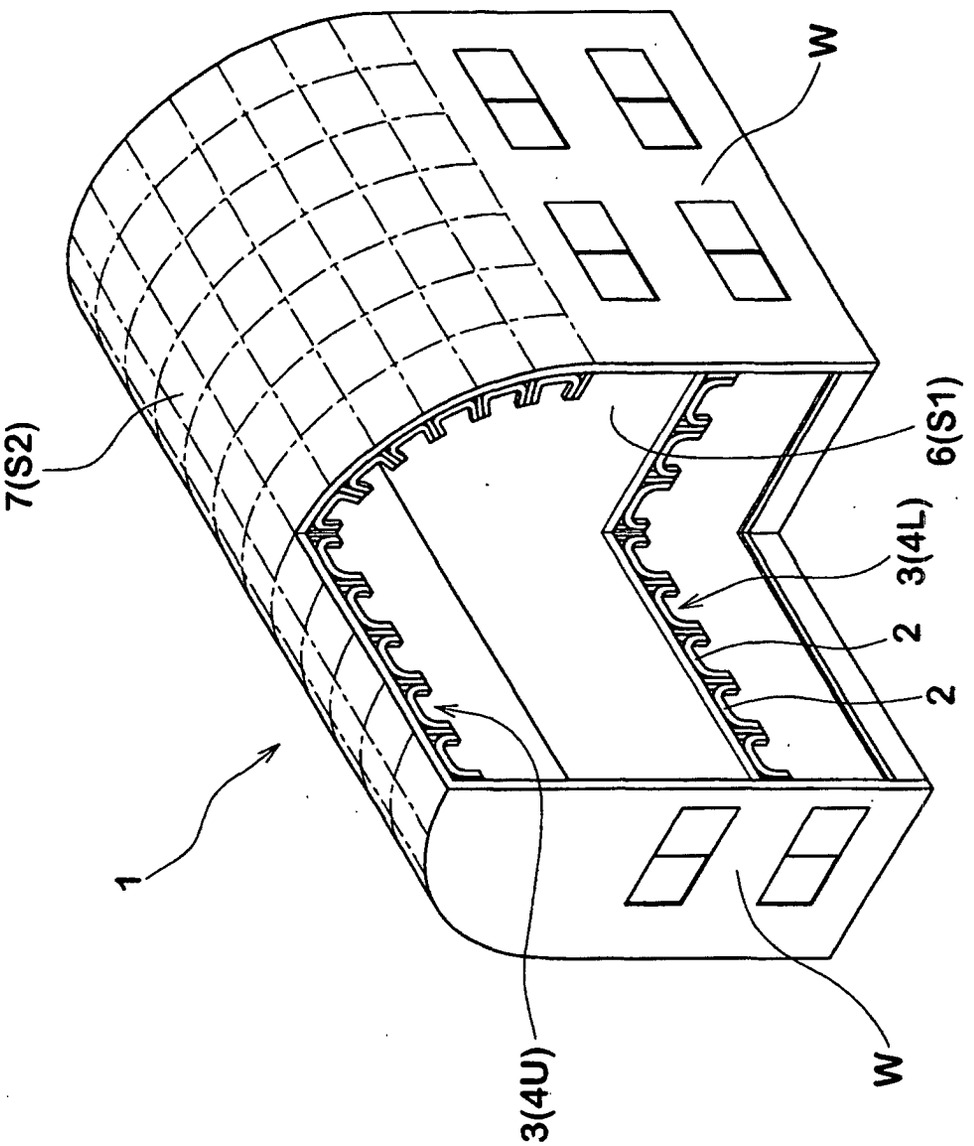


FIG.1

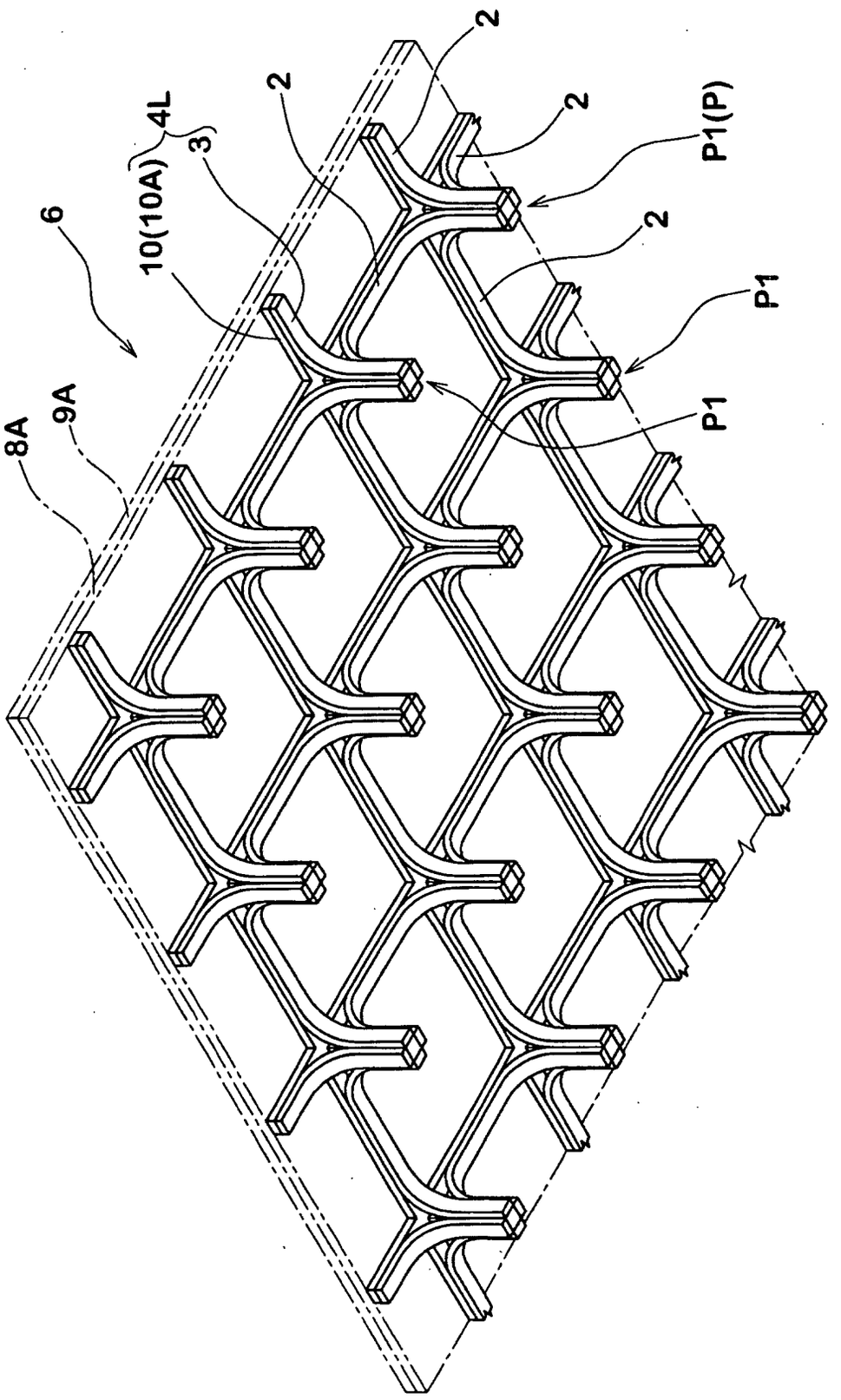


FIG.2

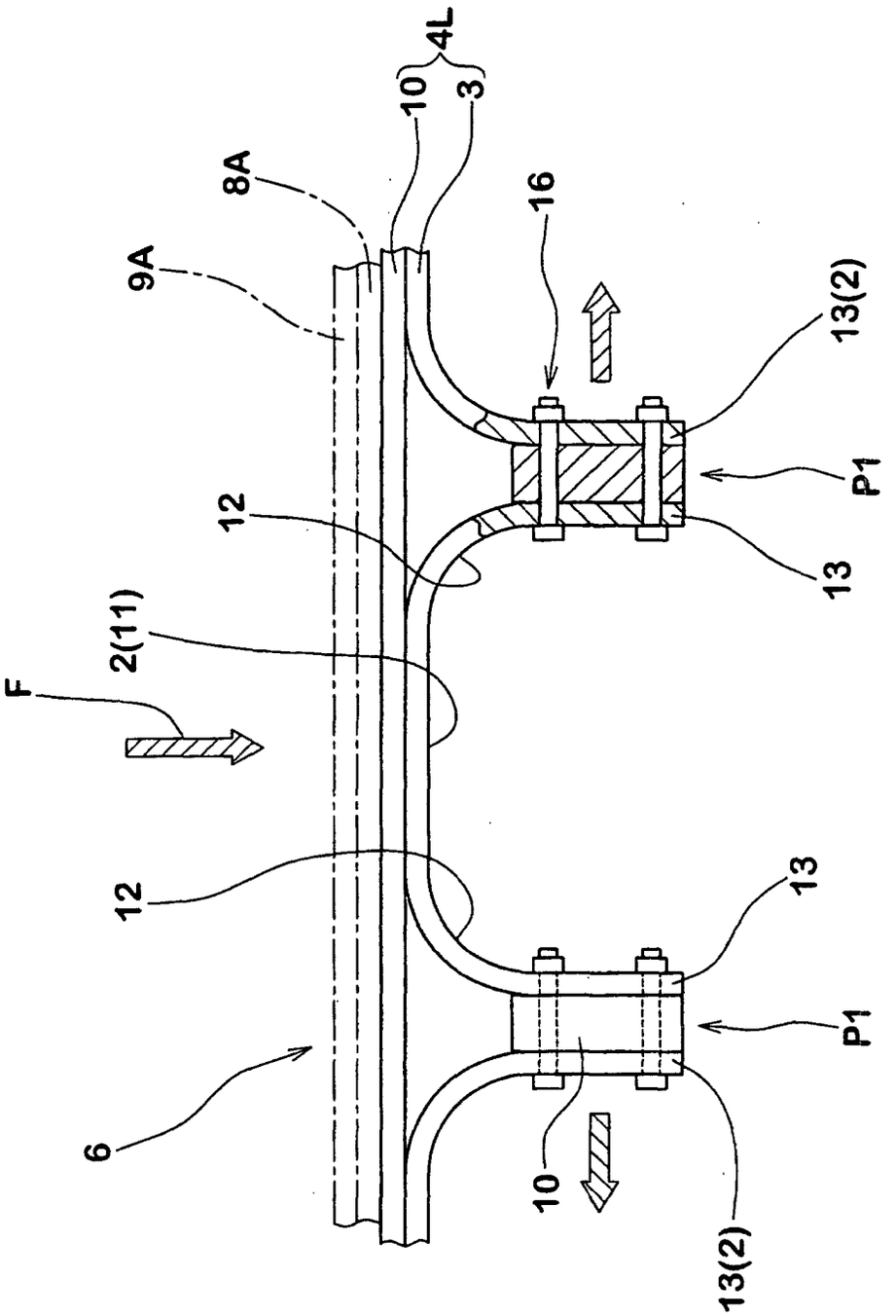


FIG.3

FIG.4(A)

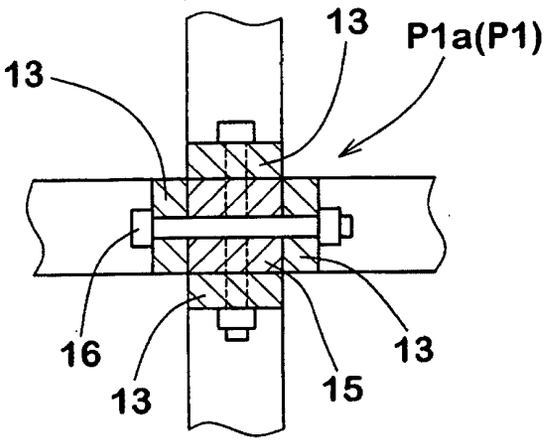


FIG.4(B)

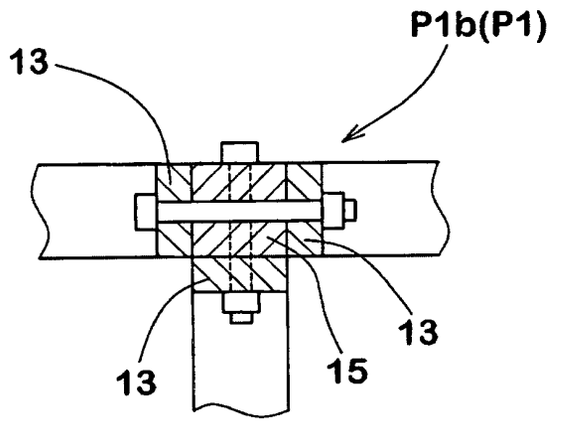


FIG.4(C)

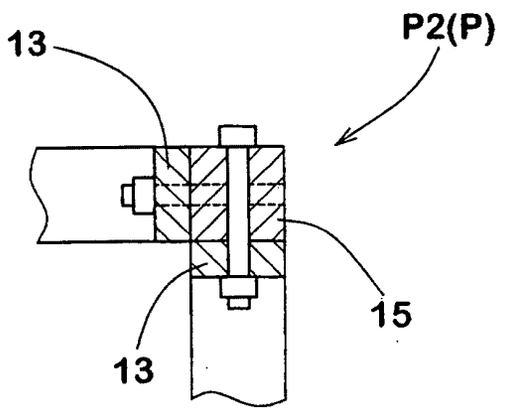


FIG.5(A)

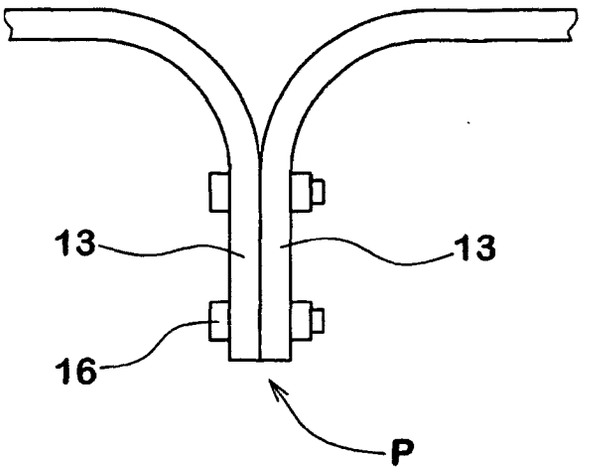


FIG.5(B)

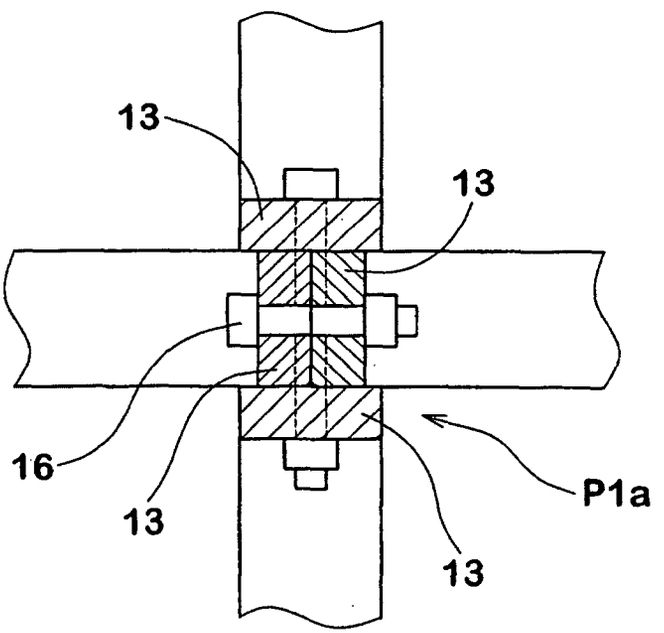


FIG.6(A)

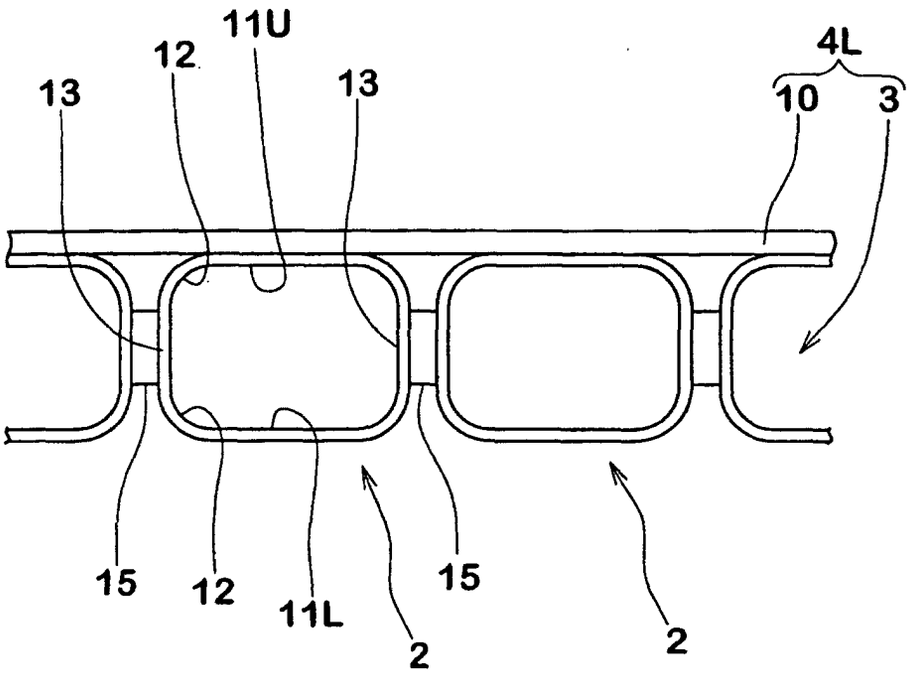


FIG.6(B)

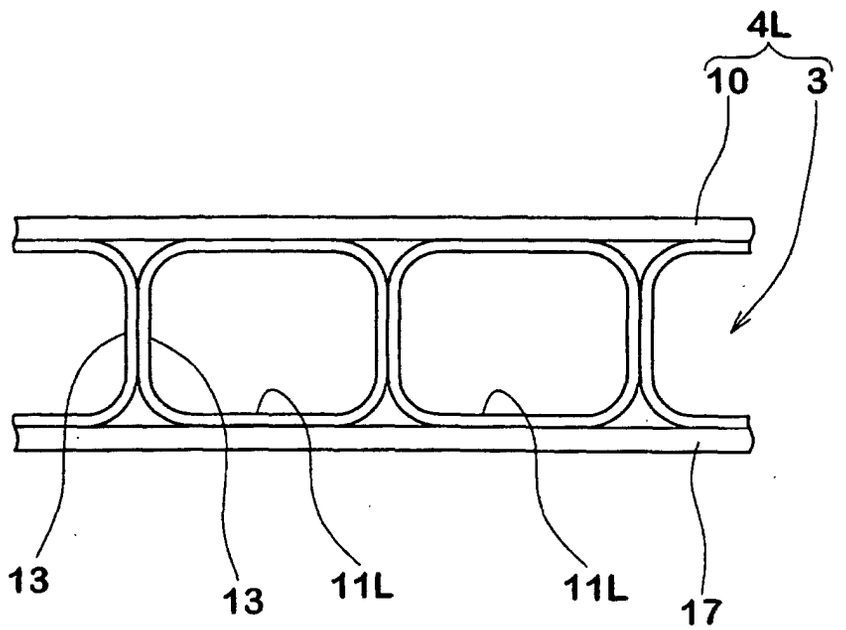


FIG.7(A)

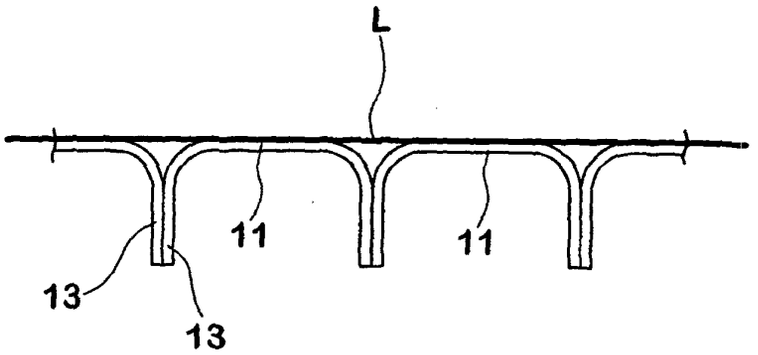


FIG.7(B)

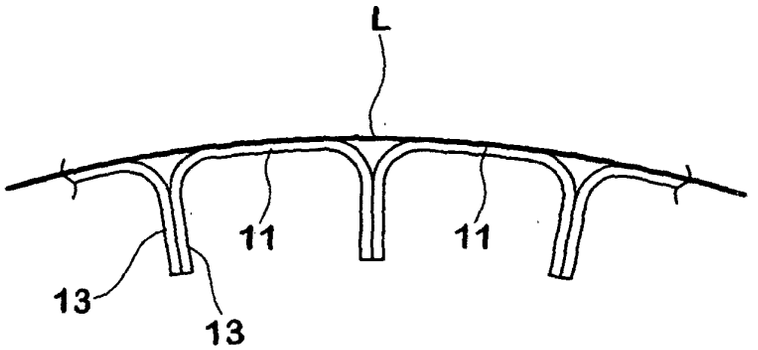


FIG.7(C)

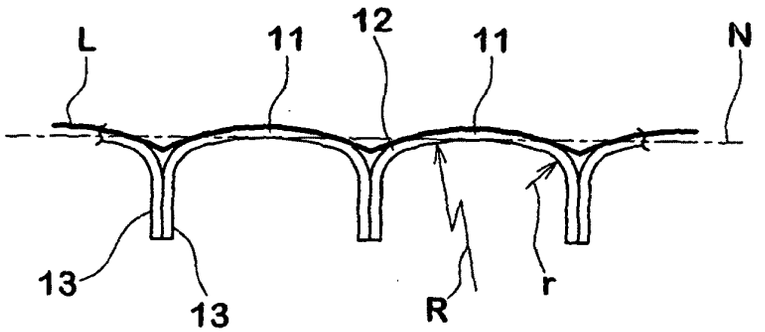


FIG.7(D)

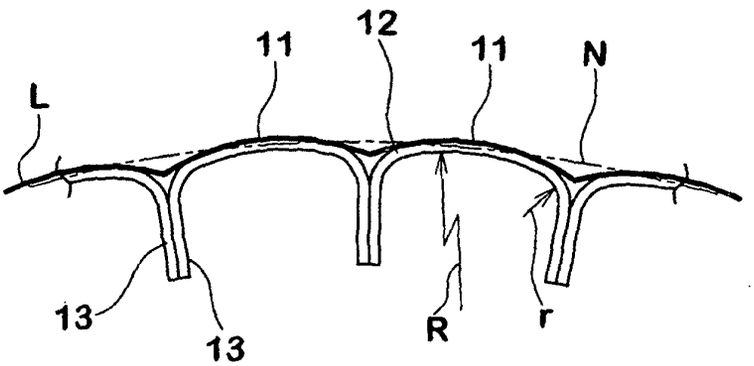
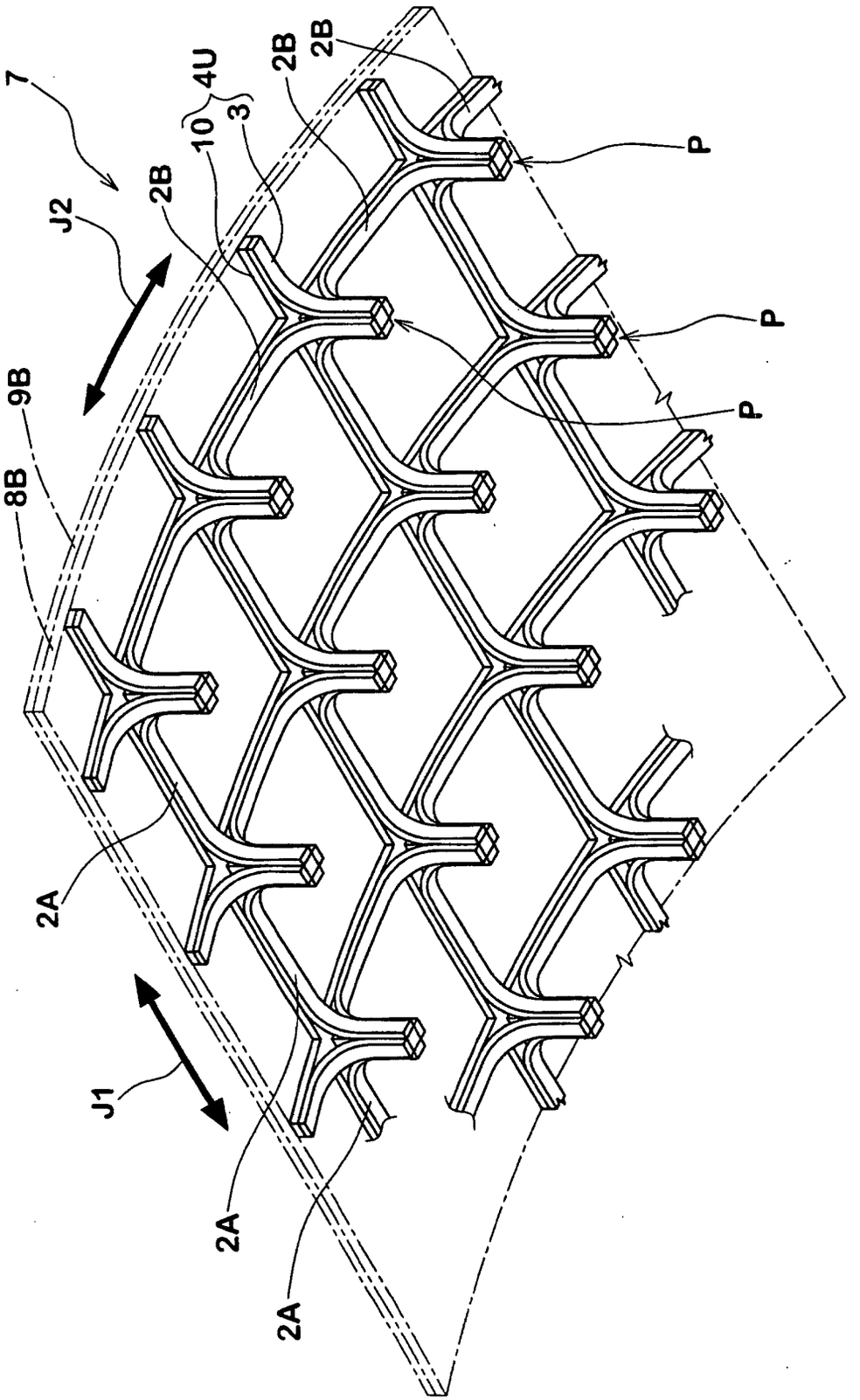


FIG.8



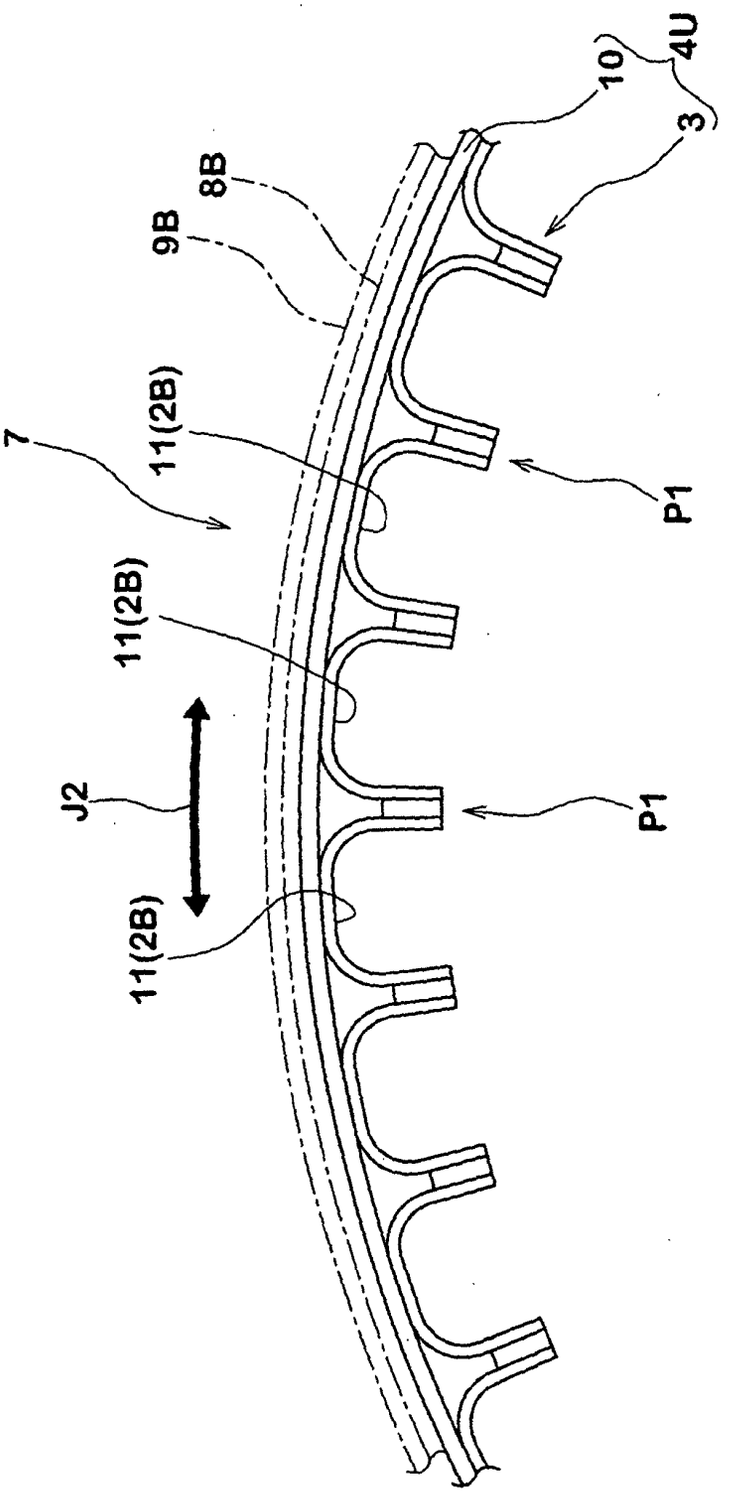


FIG.9

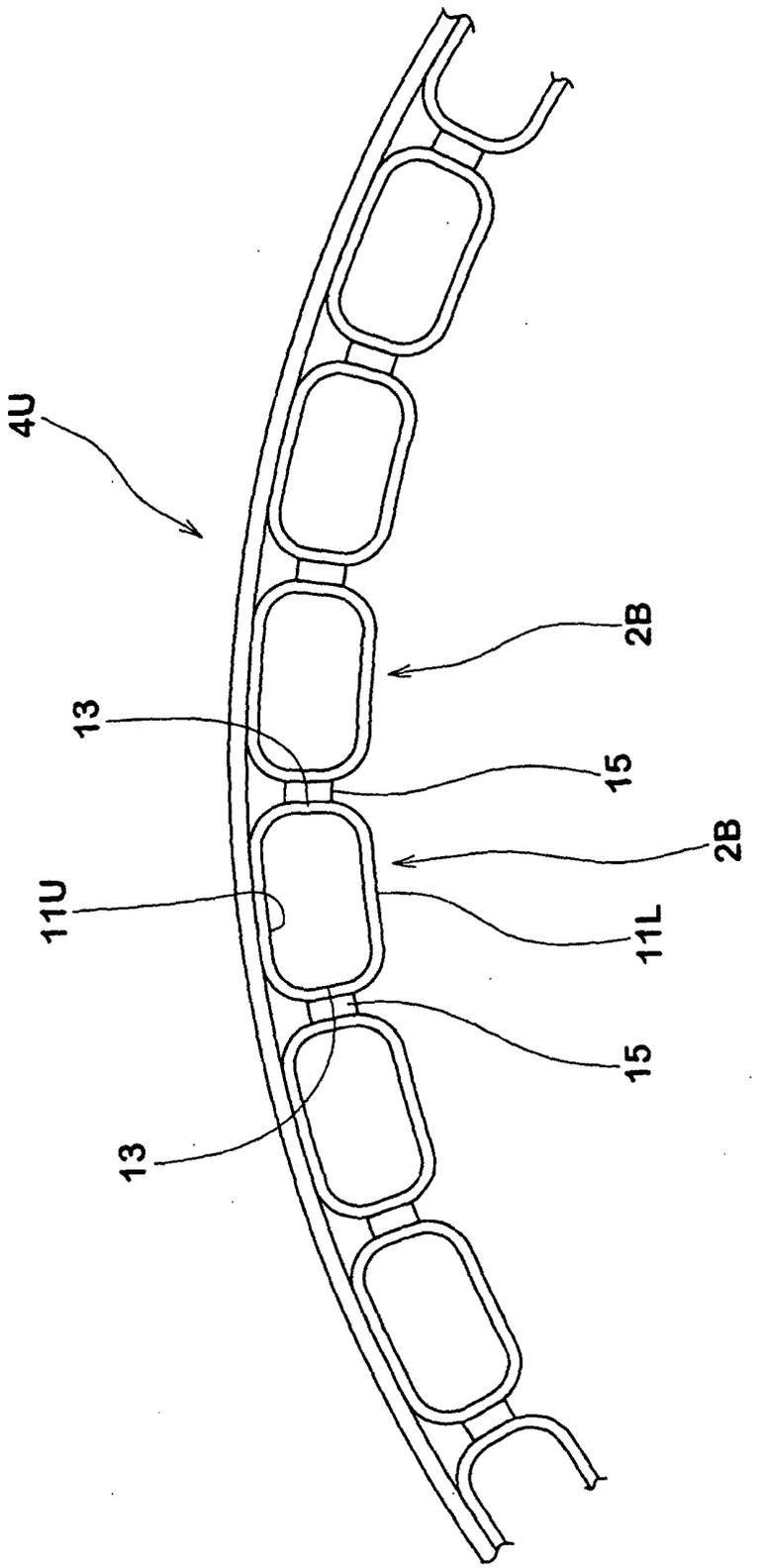


FIG.10

FIG.11

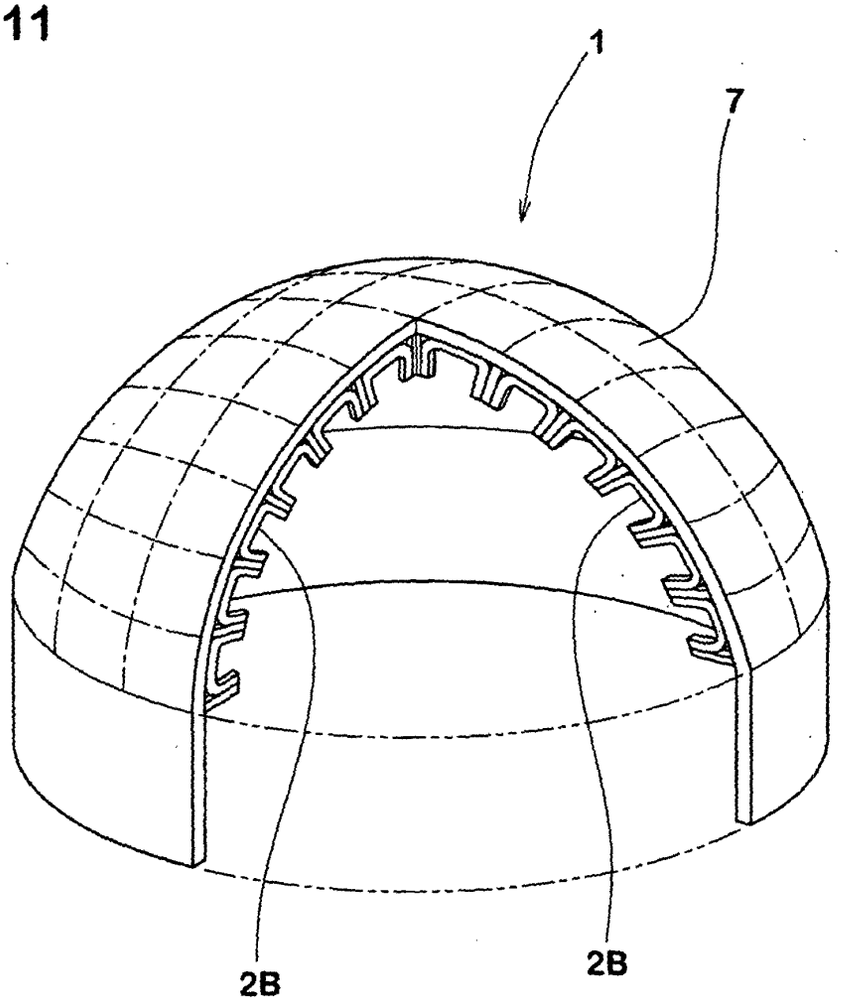


FIG.12

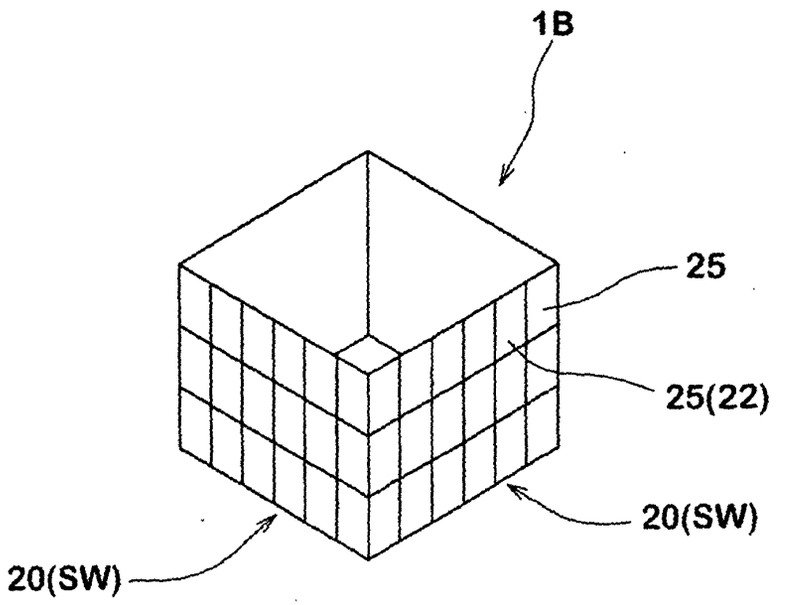


FIG.13

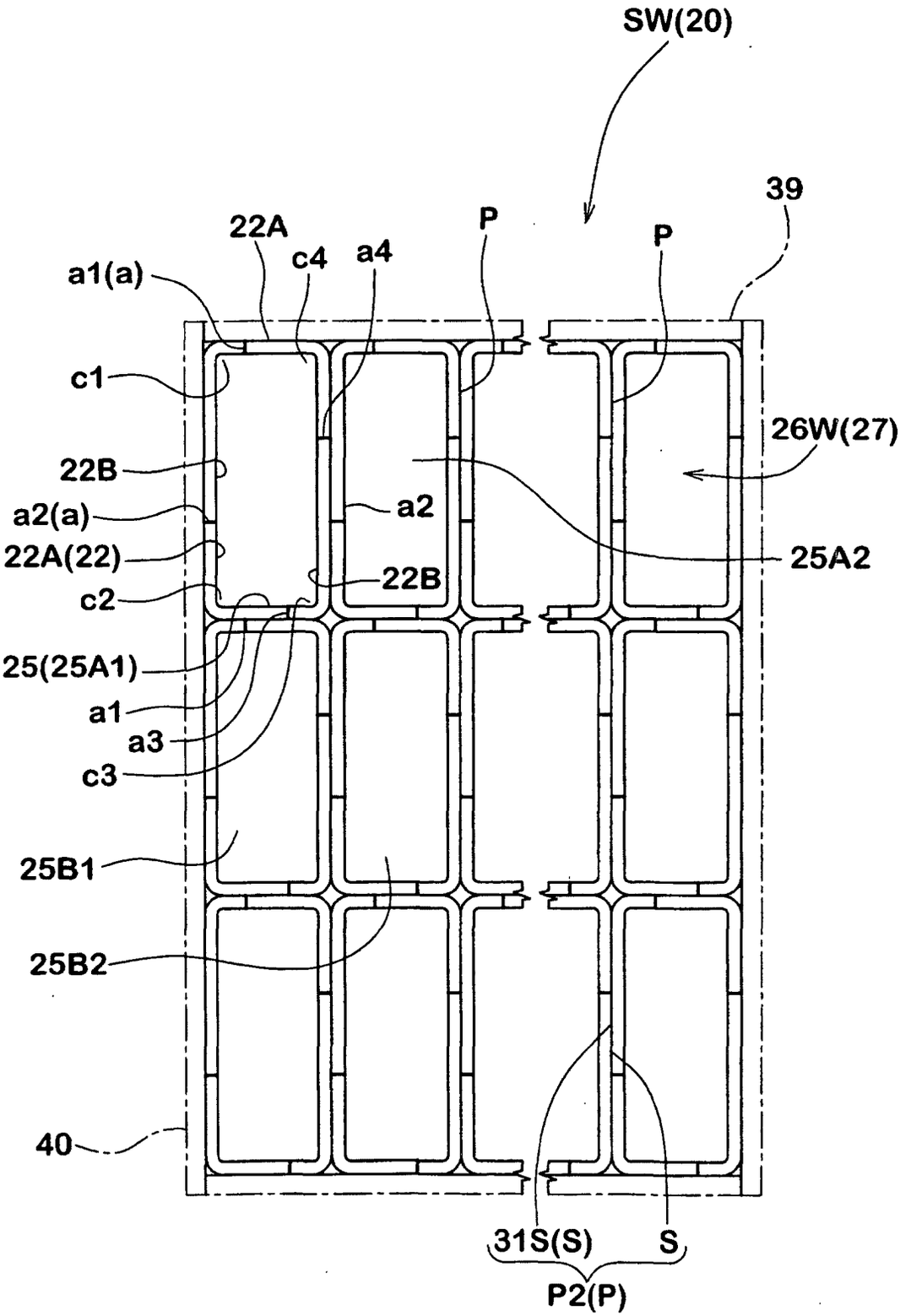

SW(20)
39
22A
c4
a4
P
P
a1(a)
c1
26W(27)
22B
a2(a)
a2
22A(22)
25A2
22B
c2
25(25A1)
a1
a3
c3
25B1
25B2
40
31S(S)
S
P2(P)

FIG.14(A)

FIG.14(B)

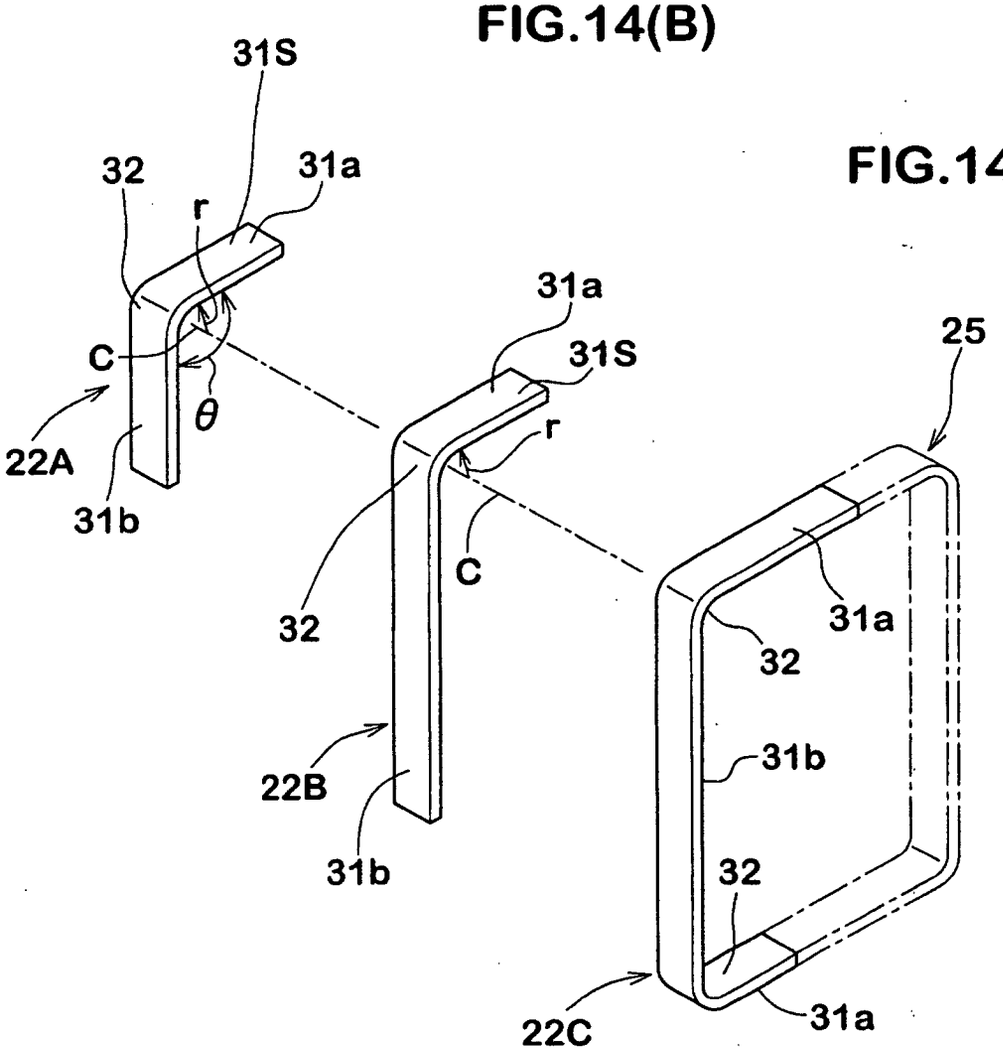


FIG.14(C)

FIG.15(A)

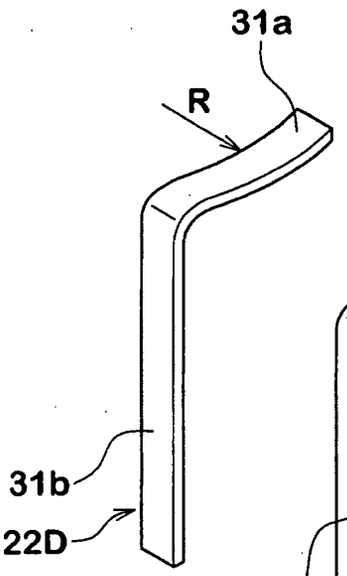


FIG.15(B)

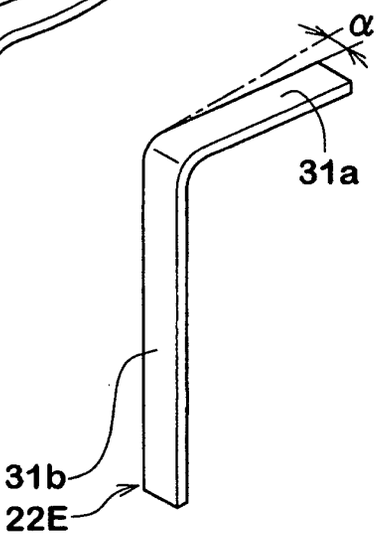


FIG.15(C)

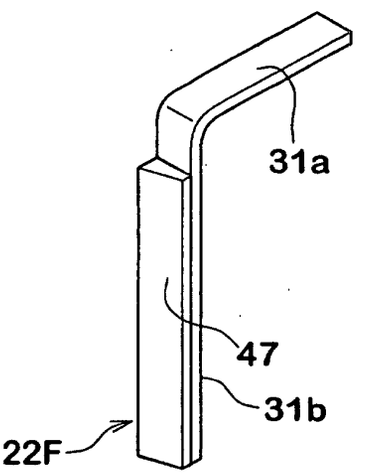


FIG.15(D)

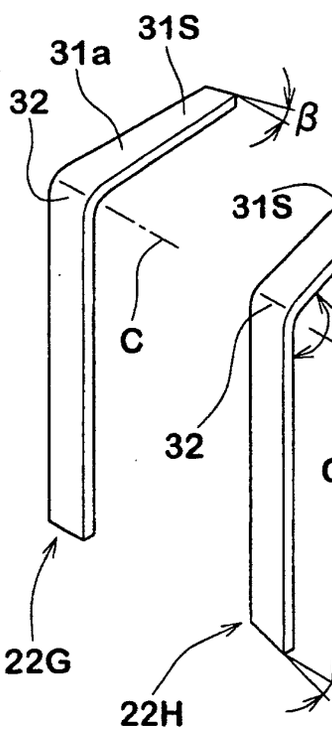


FIG.15(E)

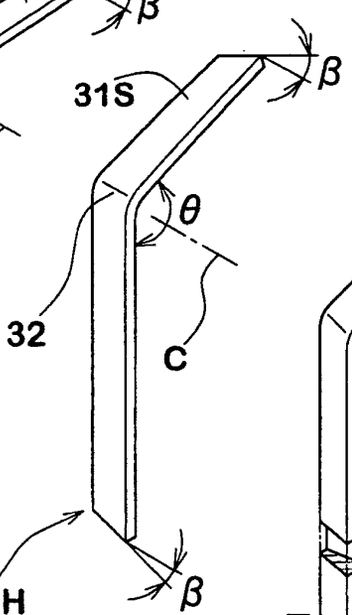


FIG.15(F)

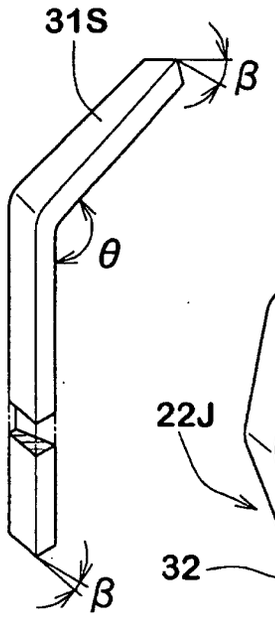


FIG.15(G)

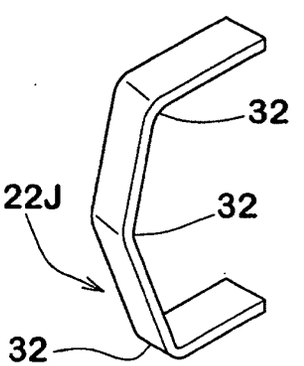


FIG.16

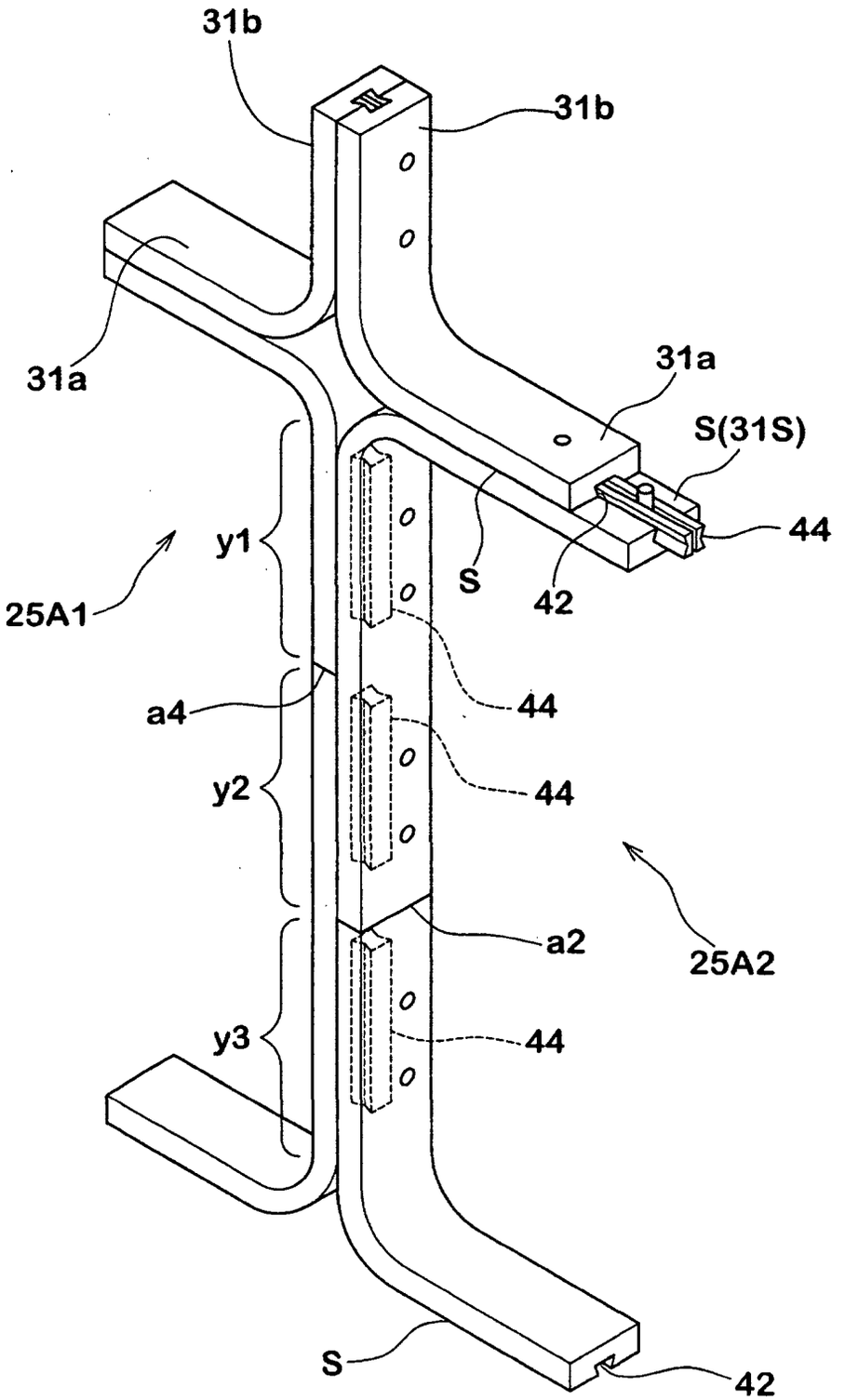


FIG.17

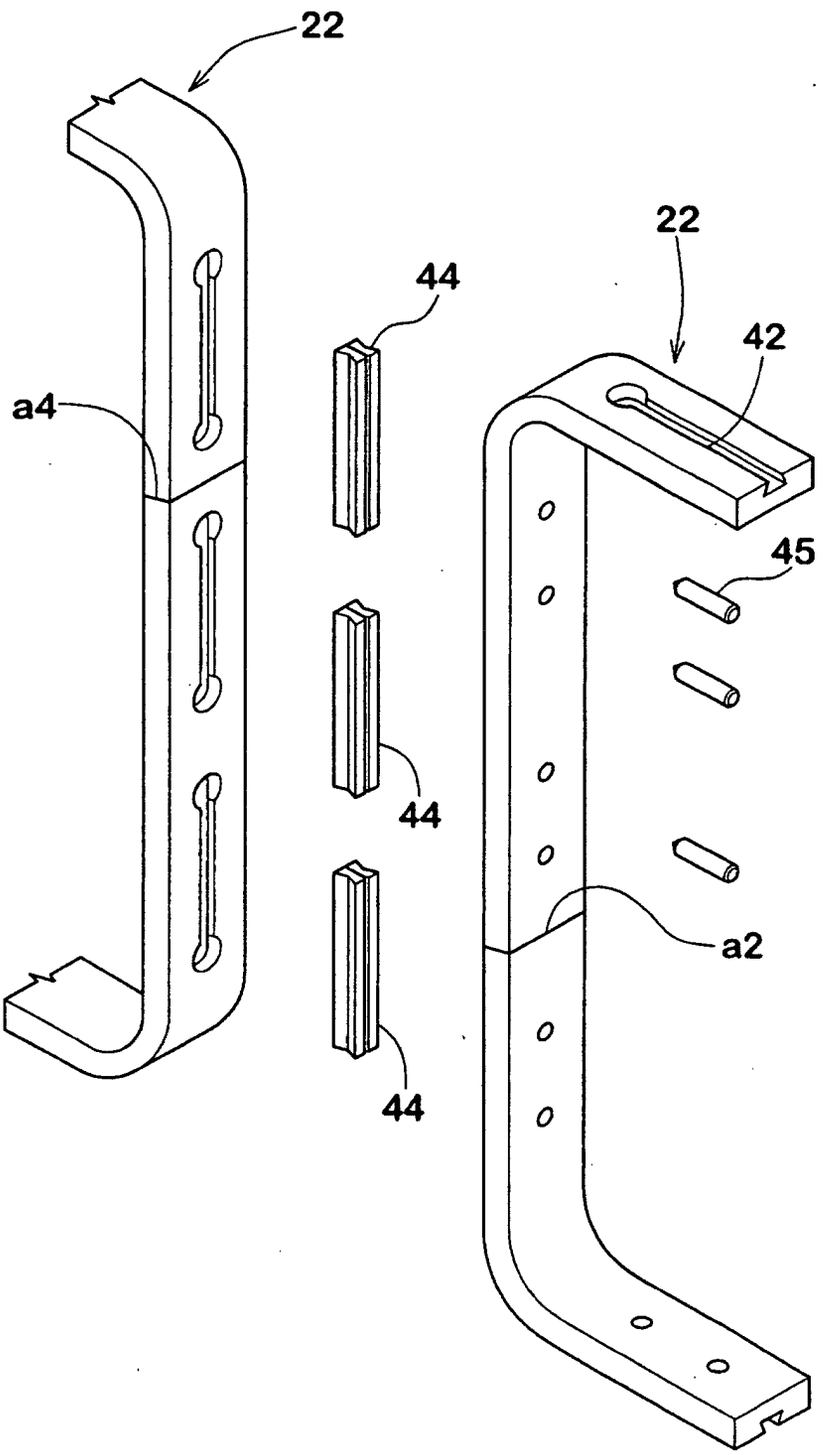


FIG.18(A)

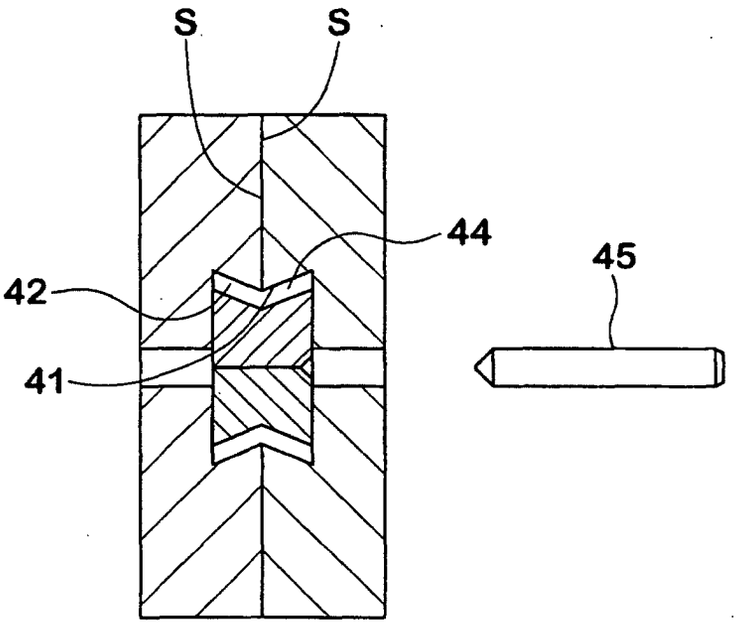


FIG.18(B)

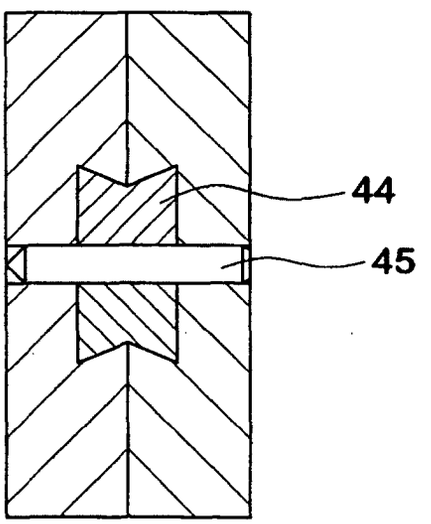


FIG.19

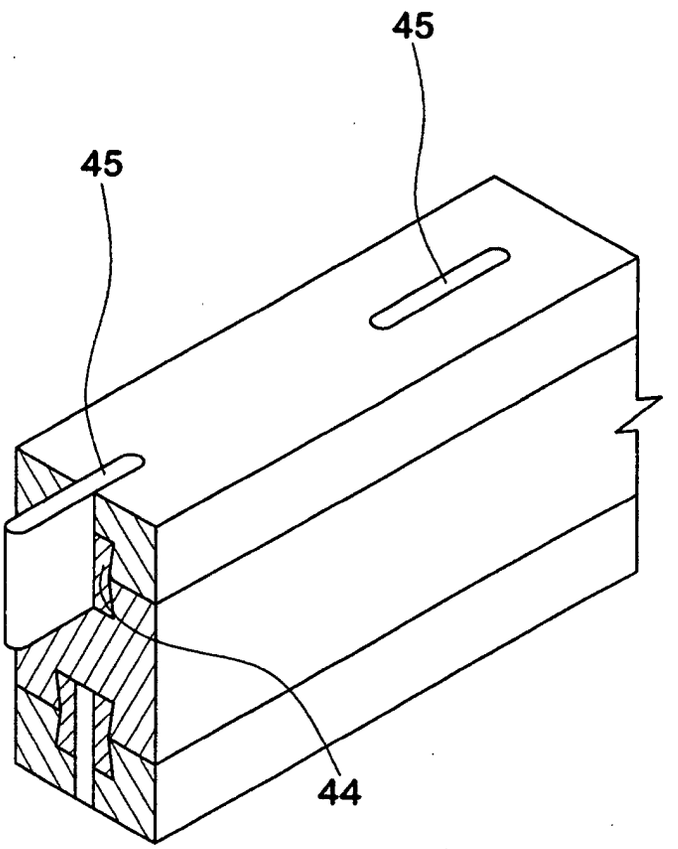


FIG.20

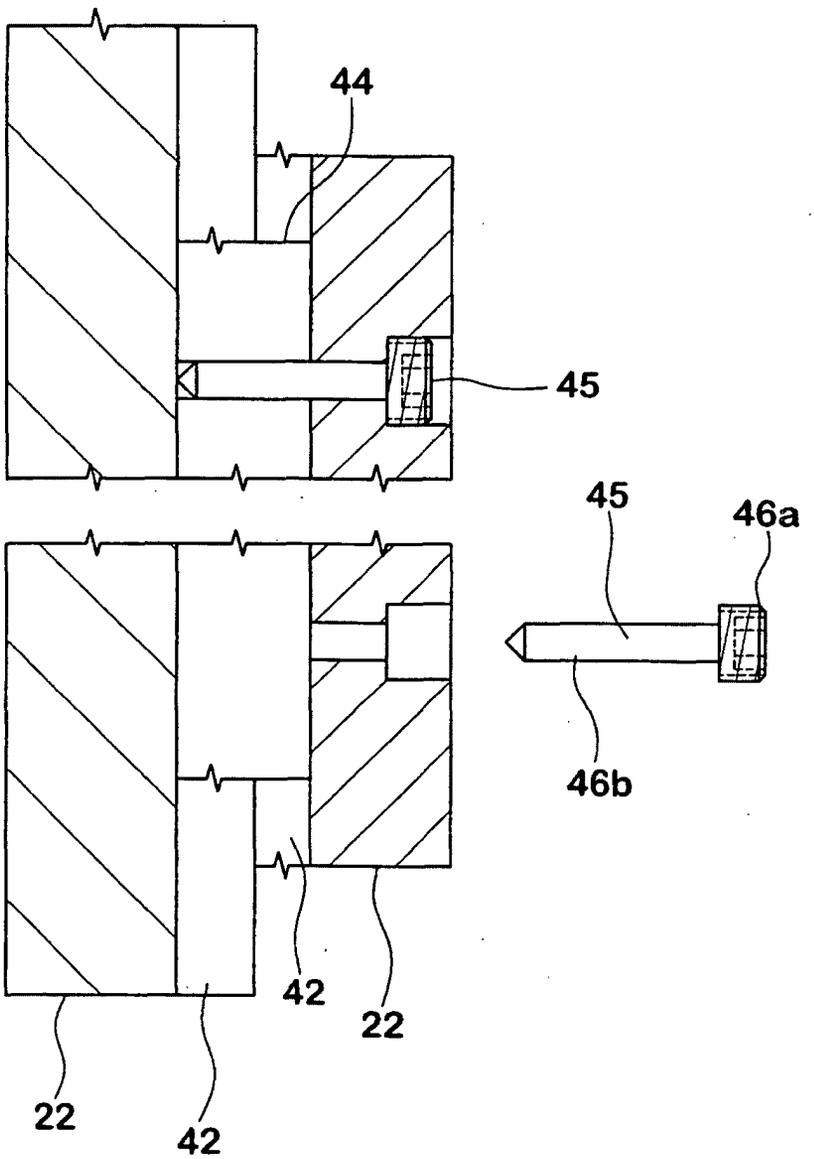


FIG.21

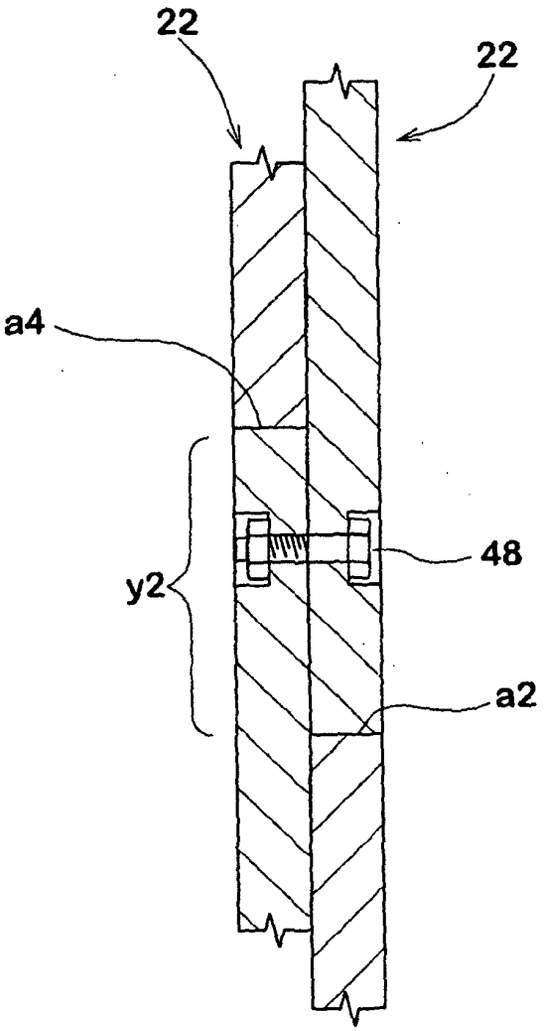


FIG.22(A)

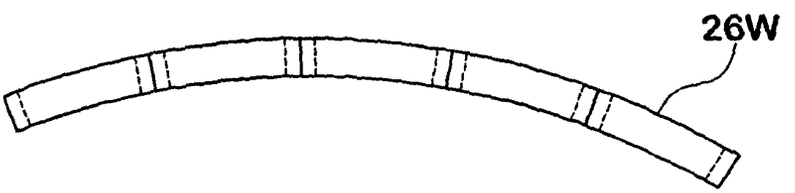


FIG.22(B)

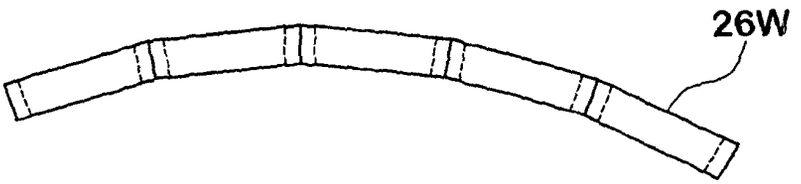


FIG.23

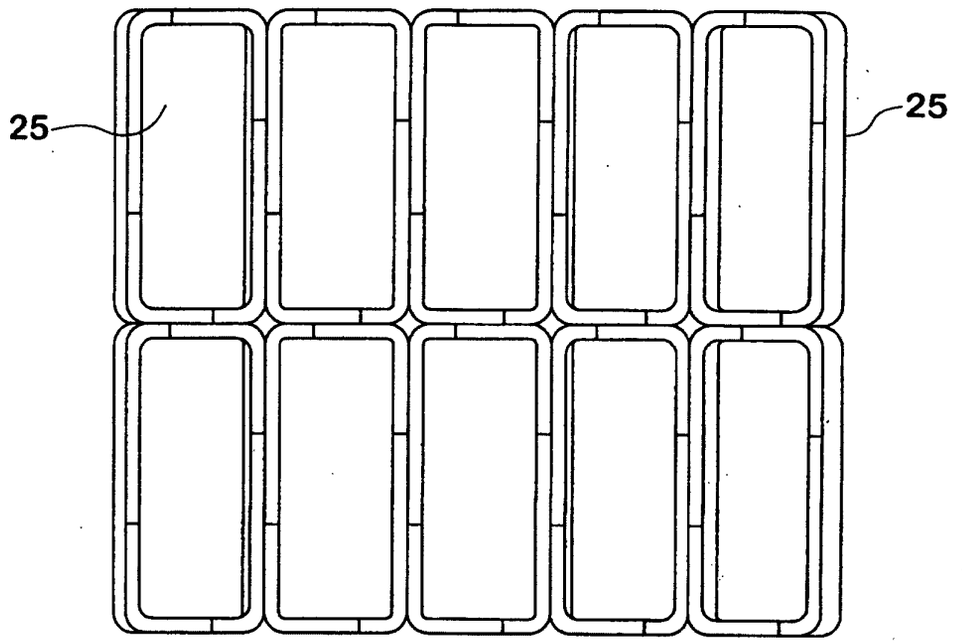


FIG.24

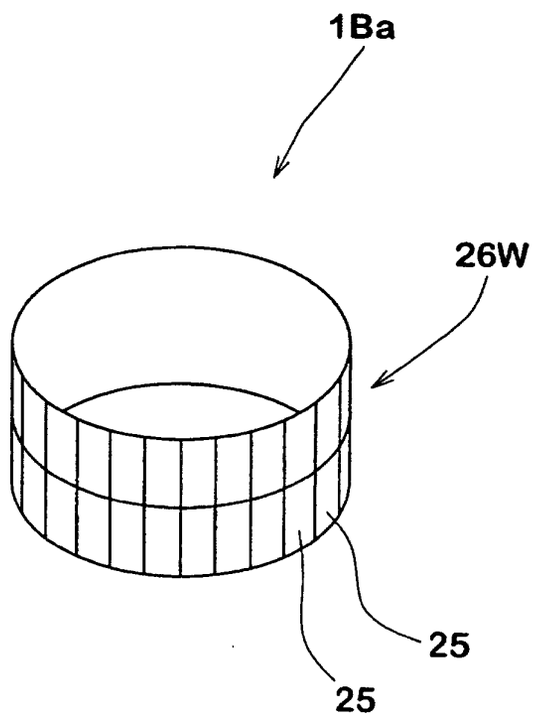


FIG.25

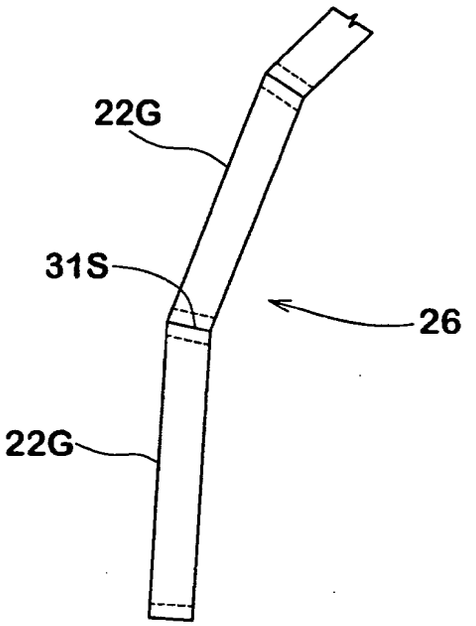


FIG.26

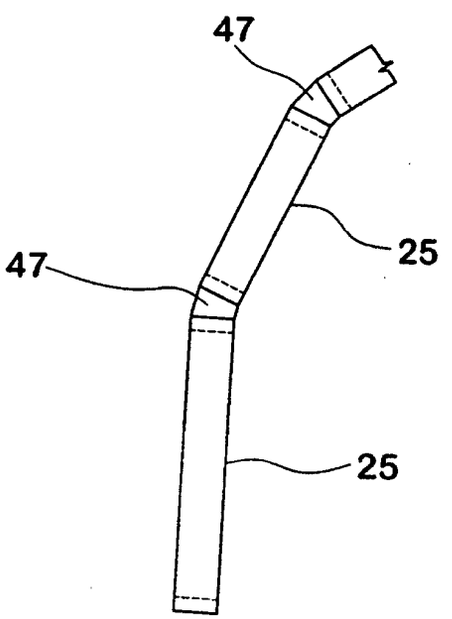


FIG.27

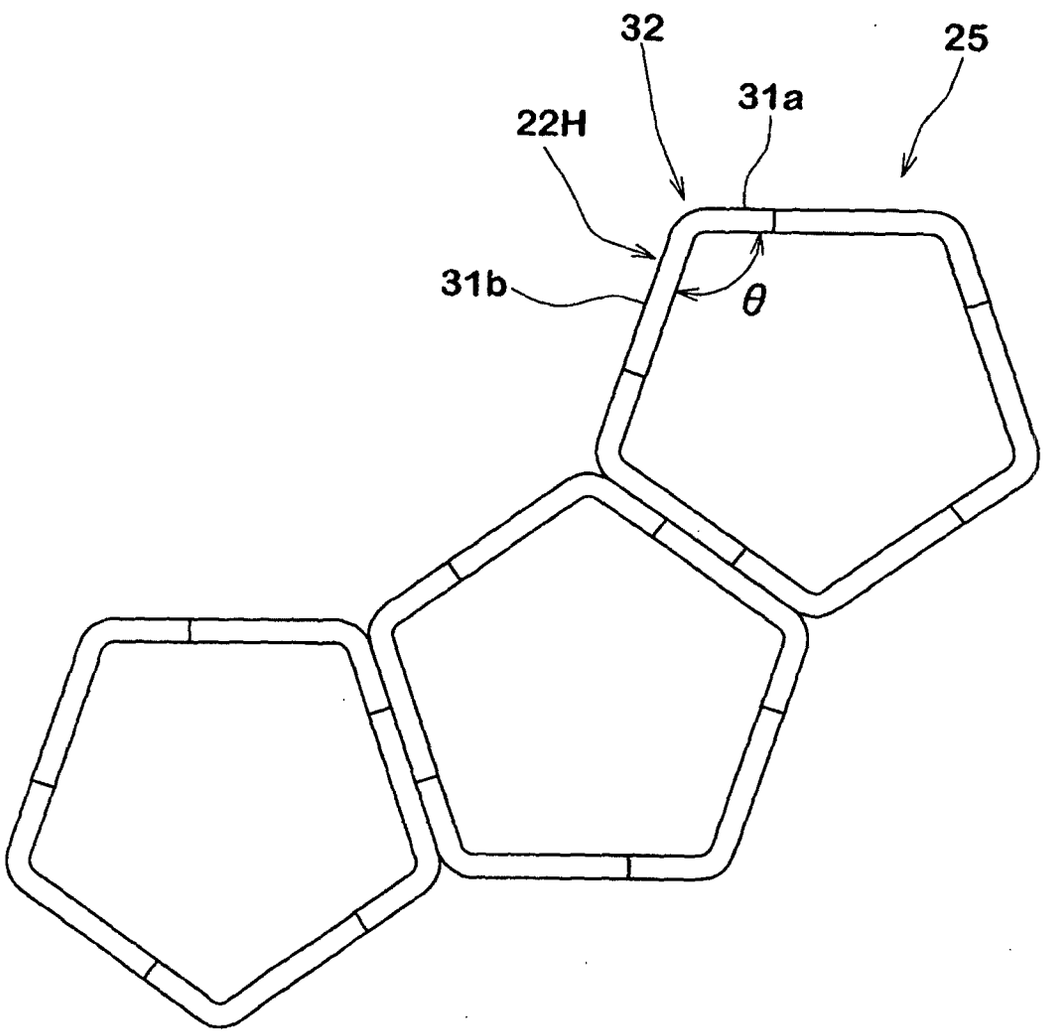


FIG.28

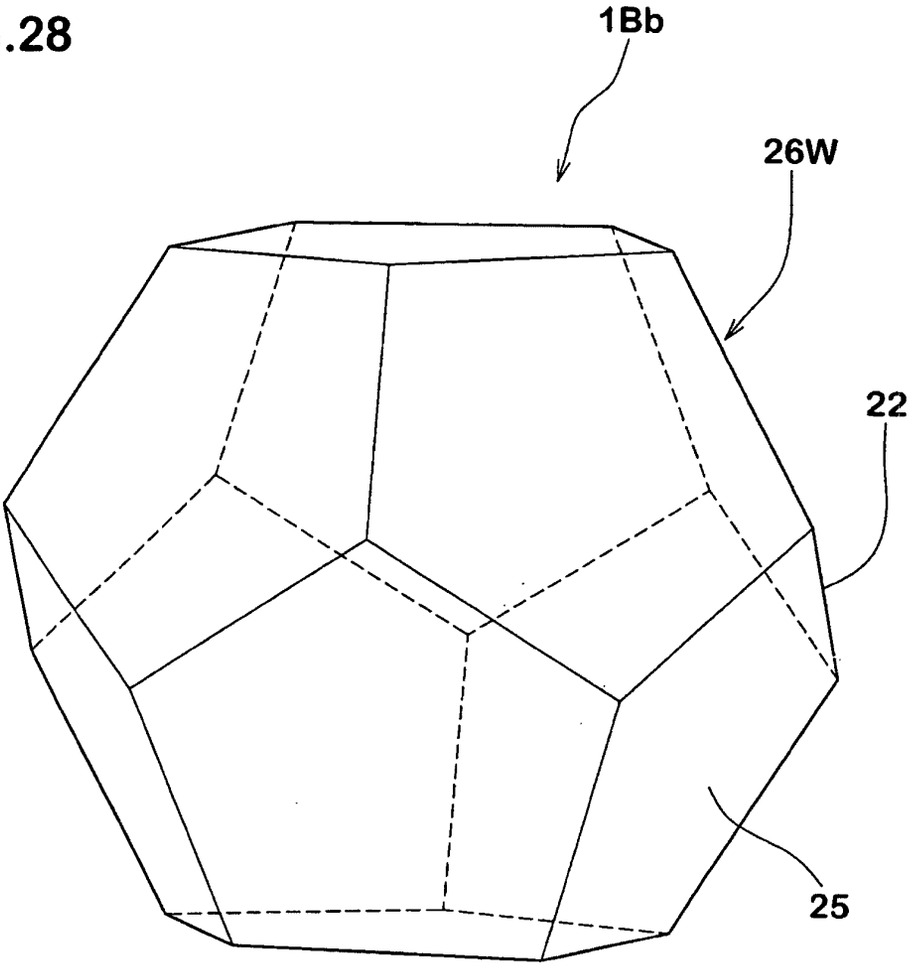


FIG.29

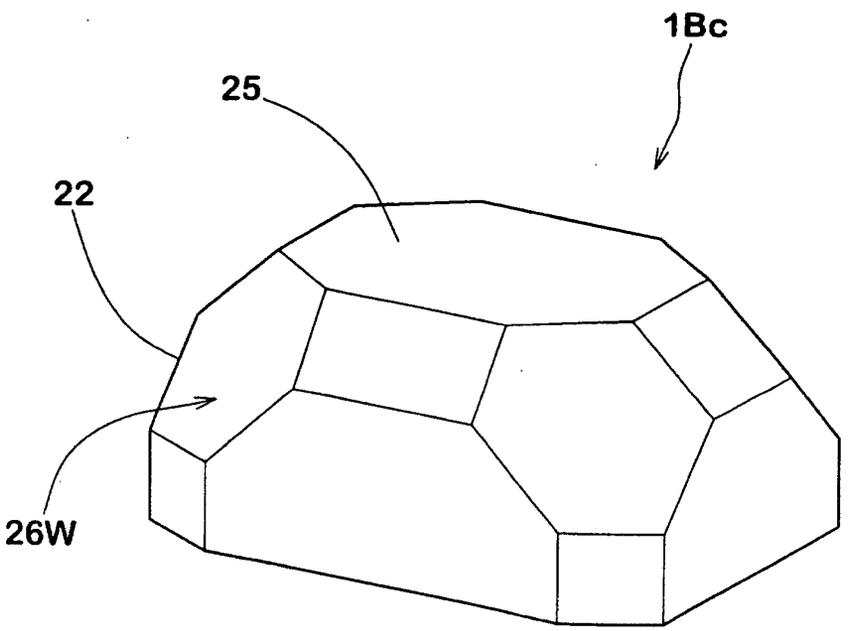


FIG.30

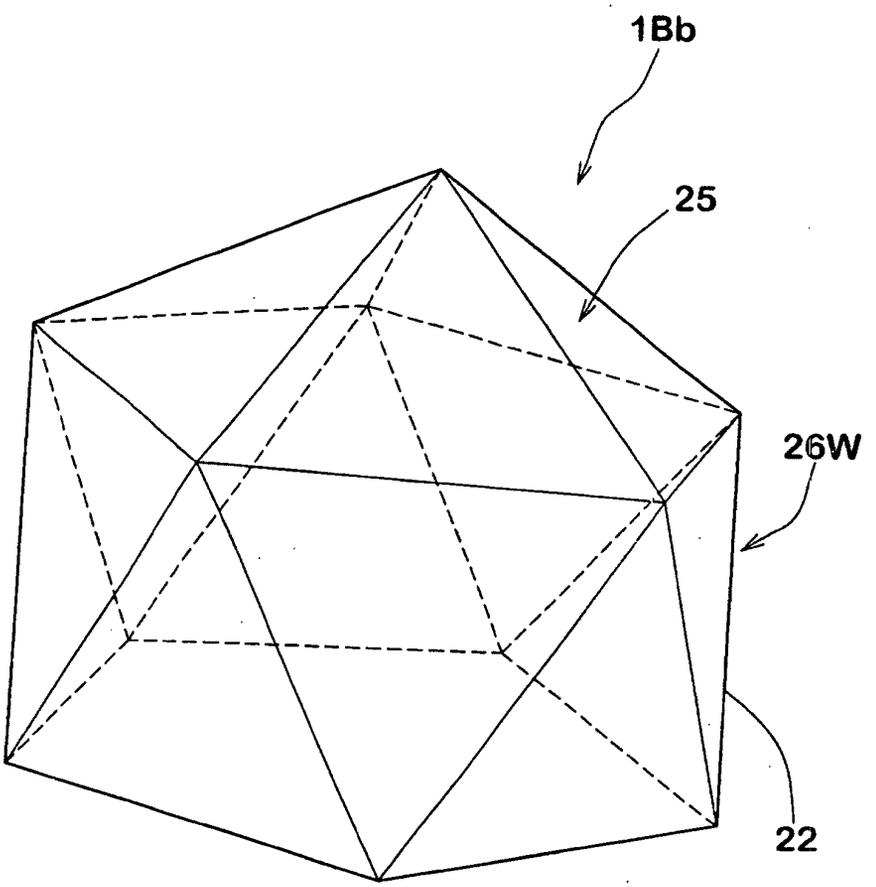
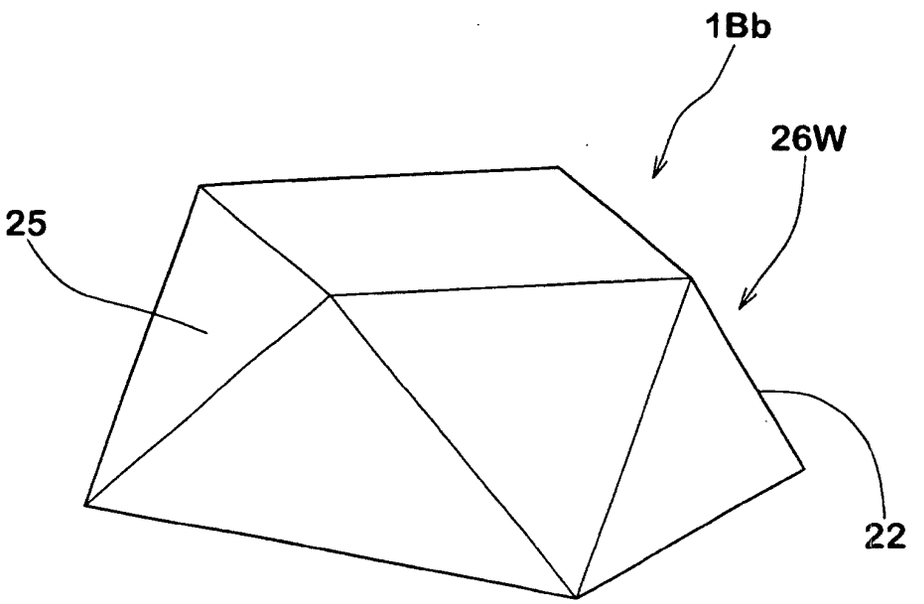


FIG.31



TERNATIONAL SEARCH F

International application No.
PCT/JP03/01203

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] E04B1/19

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] E04B1/18-19, 1/32, 1/342-1/343, 1/38, 7/10, 9/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Toroku Jitsuyo Shinan Koho	1994-2003

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 9-280488 A (Tadayoshi WAYAMA), 31 October, 1997 (31.10.97), Full text; all drawings (Family: none)	7-12 1-6
Y	WO 00/58575 A1 (PROVITOLA, Anthony, I.), 05 October, 2000 (05.10.00), Full text; all drawings & JP 2002-541360 A & US 6250355 B1 & EP 1173644 A	7-12
Y	JP 36-21898 B1 (Takeo NAKA et al.), 22 August, 1961 (22.08.61), Full text; Fig. 3 (Family: none)	10

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

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09 April, 2003 (09.04.03)	22 April, 2003 (22.04.03)
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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 106033/1979 (Laid-open No. 23714/1981) (Eidai Co., Ltd.), 03 March, 1981 (03.03.81), Full text; all drawings (Family: none)	11-12
Y	US 4461116 A1 (Erik Bach), 24 July, 1984 (24.07.84), Full text; all drawings & JP 58-65188 A	12

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