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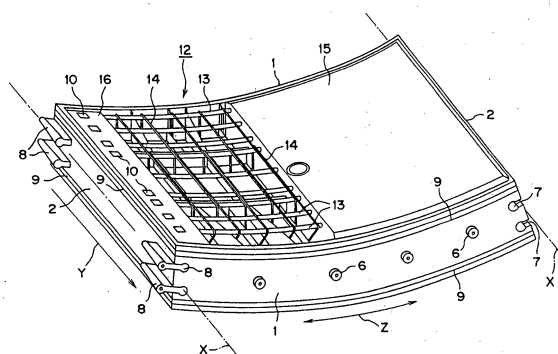
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(54) COMPOSITE SEGMENT

(57) There is disclosed a composite segment, which allows an integral structure between a concrete portion and a steel material portion and a reasonable joining between the segments and is particularly suitable for a lining material of a tunnel for water channel, wherein a plurality of main reinforcements (13) and shearing reinforcements (14) are disposed in a steel shell (12) formed of main beam plates (1), joint plates (2) and back plates (3), and concrete (15) is filled therein. Joints formed of dovetail grooves (7) and cotters (8) are provided, in two stages, in and on the joint plates (2). Projections (10) for fixing are projectedly provided on the joint plates (2), and fixing plates (16) having holes 16a for fixing are projectedly provided at the end parts of the main reinforcements (13). The projections (10) for fixing are engaged with the holes (16a) to fix the end parts (13a) of the main reinforcements (13) to the joint plates (2).

FIG. 1



EP 1 326 004 A1

Description

TECHNICAL FIELD

[0001] This invention relates to a composite segment of an integral structure which is composed of a metal segment (hereinafter referred to as a steel shell) such as a steel segment, a cast iron segment and a cast steel segment also inclusive of a spheroidal graphite cast iron segment (ductile segment) and concrete filled therein, and more particularly, to a composite segment developed as a lining material of a tunnel for water channel that is used as a main sewage line, an underground flow or the like always subjected to a high internal hydraulic pressure action.

TECHNICAL BACKGROUND

[0002] Recently, a composite segment of an integral structure between a steel material portion and a concrete portion as described above has been widely used as a lining material of a tunnel for water channel used as a main sewage line, an underground flow or the like by reason that the composite segment enables the smooth execution of works for an inner surface of the tunnel and besides, may eliminate the need for secondary lining.

[0003] In this kind of composite segment, as shown in Fig. 7(a) for instance, main beam plates 30 are disposed at the opposite sides in an axial direction Y of the tunnel, joint plates 31 are disposed at the opposite ends in a circumference direction Z of the tunnel, and skin plates 32 are also disposed at a bedrock side of the tunnel, thereby providing twenty box-shaped steel shells 33 having an arc-shaped curve with a predetermined curvature along the circumference direction Z of the tunnel.

[0004] In addition, a necessary amount of main reinforcements 34 and shearing reinforcements 35 are disposed as reinforcing bars respectively in the steel shells 33 thus provided, and concrete 36 is filled therein. On the one hand, the main beam plates 30 and the joint plates 31 have, on outer side parts thereof, joints which are engaged with each other in the axial direction Y and the circumference direction Z of the tunnel when the main beam plates 30 are attached to the joint plates 31 contiguously. Joints formed of dovetail grooves 37 provided at outer side parts of the joint plates 31 and cotters 38 engaged with the dovetail grooves 37 as shown in Fig. 7(b), for instance, are well known as the joints provided at the outer side parts of the joint plates 31 among the joints engaged with each other in the circumference direction Z of the tunnel. The dovetail grooves 37 and the cotters 38 are engaged by a sliding action in the axial direction Y of the tunnel.

[0005] The conventional composite segment, however, has no particular established method as a method of fixing the main reinforcements 34 and a method of managing the shearing reinforcements 35, and also copes

with a case where the steel shell 33 has a smooth surface by a means of providing projections on an inner side of the steel shell 33 and so on to unite the steel shell 33 with the concrete 36 by reason that the steel shell 33 having the smooth surface prevents the concrete 36 from having satisfactory adherence to make it difficult to provide the integral structure between the steel shell 33 and the concrete 36.

[0006] The above means, however, is only effective at a contact between the steel shell 33 and the concrete 36, so that some reinforcement to a tensile stress has been required for an opposite portion having exposed concrete.

[0007] Specifically, segments in the tunnel for water channel are always subjected to a high internal hydraulic pressure action, so that there is a fear that the inner surface of the concrete 36 is cracked or the concrete 36 is stripped. For this reason, the concrete 36 has been evaluated, in most cases, merely as a material for receiving a reaction force of a propulsion jack of a shield while smoothening an inner face of a shield lining body, and the main reinforcements 34 and the shearing reinforcements 35 have been also evaluated no more than a crack-proofing material for the concrete 36. Thus, both of the concrete 36 and the main reinforcements 34 and the shearing reinforcements 35 have been not recognized as structural members of the lining material in most cases, and use of the above materials has been supposed to be extremely uneconomical.

[0008] In addition, use of the above materials has been limited to a case under conditions, except those that the concrete on the inner side of the tunnel is in extremely severe conditions due to the action of high internal hydraulic pressure.

[0009] In addition, in the tunnel for water channel always subjected to the high internal hydraulic pressure action, single-stage joints as shown in Fig. 7(b) as a means of joining between the mutually adjacent segments particularly in the circumference direction Z of the tunnel are not supposed to attain a reasonable joining as a stress transmitting means between the segments, and are also quite unsatisfactory in the water cutoff aspect.

[0010] The present invention is made for solving the above problems, and an object of the present invention is to provide a composite segment, which allows an integral structure between a concrete portion and a steel material portion and a reasonable joining between the segments, and is particularly suitable for the lining material of the tunnel for water channel.

DISCLOSURE OF THE INVENTION

[0011] In a composite segment wherein a plurality of main reinforcements and shearing reinforcements are respectively disposed in a steel shell formed of main beam plates, joint plates and back plates, while concrete is filled therein, and joints are provided in and on the

joint plates, the composite segment according to claim 1 is characterized in that connection parts for fixing the main reinforcements are provided on the joint plates to fix the end parts of the main reinforcements to the connection parts, and the joints are provided in two stages.

[0012] The steel shell used herein is, in principle, made of cast iron or cast steel also inclusive of spheroidal graphite cast iron, and the main beam plates, the joint plates and the back plates are provided in an integral structure by casting. Alternatively, in the case of the steel shell made of steel, use of another assemble method of separately forming each of the main beam plates, the joint plates and the back plates to join them together later is also conceivable.

[0013] In addition, both of the main reinforcements and the shearing reinforcements are disposed in the steel shell. Alternatively, the shearing reinforcements may be omitted to allow only the main reinforcements to be disposed therein in some cases. Further, round steels, deformed bars and the like are disposed as the main reinforcements and the shearing reinforcements.

[0014] In a composite segment wherein a plurality of main reinforcements and shearing reinforcements are respectively disposed in a steel shell formed of main beam plates, joint plates and back plates, while concrete is filled therein, and joints are provided in and on the joint plates, the composite segment according to claim 2 is characterized in that ribs having holes for fixing are projectedly provided at an inner side part of the steel shell, and hooks for fixing are projectedly provided at end parts of the shearing reinforcements, while the hooks and the holes are engaged to fix the end parts of the shearing reinforcements to the inner side part of the steel shell, and the joints are provided in two stages.

[0015] It is to be noted that the ribs having the holes for fixing are, in principle, projectedly provided on the back plates, or alternatively, may be projectedly provided at inner side parts of the main beam plates.

[0016] In the composite segment according to claim 1 or 2, the composite segment according to claim 3 is characterized in that joints formed of dovetail grooves and cotters engaged therewith are provided as a joining. It is to be noted that the joining to be used in this case may be ones based on bolting, a system of external/internal fits or the like and is not limited to any specific type of joining.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a perspective view illustrating an embodiment of a composite segment.

Fig. 2 illustrates a steel shell, Fig. 2(a) being a plan view thereof, and Figs. 2(b), 2(c) and 2(d) being cross-sectional views taken along lines a-a, b-b and c-c in Fig. 2(a) respectively.

Fig. 3(a) illustrates a state in which main reinforcements

and shearing reinforcements are disposed in the steel shell, Fig. 3(a) being a plan view thereof and Figs. 3(b), 3(c), and 3(d) being cross-sectional views taken along lines a-a, b-b and c-c in Fig. 3(a) respectively.

Figs. 4(a) and 4(b) are both perspective views illustrating main reinforcements and fixing plates after being assembled in a panel-like configuration, Fig. 4(c) is an exploded perspective view illustrating fixing parts of the main reinforcements and Fig. 4(d) is a longitudinal sectional view of Fig. 4(c).

Figs. 5(a) and 5(b) are both perspective views of the shearing reinforcement, and Fig. 5(c) is a partial perspective view illustrating fixing parts of the shearing reinforcement.

Fig. 6 is a partial perspective view of a shield tunnel. Fig. 7(a) is a perspective view, partly broken-away illustrating an exemplary conventional composite segment, and Fig. 7(b) is a longitudinal sectional view illustrating an exemplary joint part.

1 --- Main beam plate, 2 --- Joint plate, 3 --- Back plate, 4 --- Longitudinal rib, 5 --- Lateral rib, 6 --- Joint, 7 --- Dovetail groove, 8 --- Cotter, 9 --- Seal member, 10 --- Projection for fixing (connection part for fixing main reinforcement), 11 --- Rib, 11a --- Hole for fixing, 12 --- Steel shell, 13 --- Main reinforcement, 13a --- End part of main reinforcement, 14 --- Shearing reinforcement, 14a --- Vertical part of shearing reinforcement, 14b --- Hook, 15 --- Concrete, 16 --- Fixing plate, 16a --- Hole for fixing, 17 --- Wedge, X --- Neutral axis, Y --- Axial direction of tunnel, Z --- Circumference direction of tunnel

BEST MODE FOR EMBODYING THE INVENTION

[0018] Figs. 1 to 6 show an embodiment of a composite segment according to the present invention. In Figures, main beam plates 1 are disposed at the opposite sides in an axial direction Y of a tunnel, joint plates 2 are disposed at the opposite ends in a circumference direction Z of the tunnel, and back plates 3 are disposed at a bedrock side of the tunnel, respectively.

[0019] In addition, a plurality of longitudinal ribs 4 are disposed at predetermined intervals between the main beam plates 1, 1 at the opposite sides, and a plurality of lateral ribs 5 are disposed at predetermined intervals between the joint plates 2, 2 at the opposite ends.

[0020] Joints 6, which may join the mutually adjacent segments in the axial direction Y of the tunnel with each other simultaneously with the assemblage of the segments by using the principle of "hole-in-anchor", for instance, to insert one joint into the other joint in the axial direction Y of the tunnel so as to provide the tensile and shearing strengths equivalent to or more than those provided by a joining with bolts, are provided, as a joining between the mutually adjacent segments in the axial direction Y of the tunnel, at outer side parts of the main beam plates 1.

[0021] In addition, joints, which may join the mutually adjacent segments in the circumference direction Z of the tunnel with each other simultaneously with the assemblage of the segments by using wedge-system joints formed of dovetail grooves 7 and cotters 8 engaged with the dovetail grooves 7 to insert the joints in the axial direction Y of the tunnel, are provided, as a joining between the mutually adjacent segments in the circumference direction Z of the tunnel, at outer side parts of the joint plates 2.

[0022] Further, seal members 9 are mounted doubly, as a primary water-cutoff material between the mutually adjacent segments, to the outer side parts of the main beam plates 1 and the joint plates 2 so as to be placed at the opposite sides of the joints and also extend continuously in the axial direction Y of the main beam plates 1 and the joint plates 2 (i.e., continuously in the circumference direction Z of a steel shell 12 described later).

[0023] It is to be noted that corrosion-proof measures such as coating and baking are applied to all joining members such as the joints 6 and the cotters 8 to provide for a case where the seal members 9 fail to provide a water-cutoff performance.

[0024] In addition, a plurality of projections 10 for fixing are projectedly provided, as connection parts for fixing main reinforcements 13 described later, on upper end parts of the joint plates 2 at predetermined intervals in the axial direction Y of the tunnel. The most general shape of the projections 10 is considered to be rectangular as shown in the drawing. Alternatively, the projections 10 are not limited to any particular shape, and the shape of projections 10 may be a circular one. The projections 10 also may be provided in a plurality of rows and besides in a staggered arrangement without being limited to a single row arrangement.

[0025] In addition, a plurality of ribs 11 are projectedly provided, as fixing parts for shearing reinforcements 14 described later, on opposite side parts of the back plates 3 in the axial direction Y of the tunnel at predetermined intervals in the circumference direction Z of the tunnel, and holes 11a for fixing are provided in the ribs 11. It is to be noted that holes 5a similar to the holes 11a for fixing are also provided in the opposite ends of the lateral ribs 5.

[0026] The dovetail groove 7 and the cotter 8 are both shaped to have a gradually smaller diameter in the insertion direction so as to be engaged with each other in accordance with a so-called wedge system, and are also provided in two stages in a radial direction of the tunnel so as to be placed at an outer side (the bedrock side) and an inner side (the tunnel side) with a so-called neutral axis X as a boundary therebetween. Further, the joints formed of the dovetail grooves 7 and the cotters 8 are provided in and on the joint plates 2 at the opposite ends in the circumference direction Z of the tunnel so as to have a predetermined length in the axial direction Y of the tunnel.

[0027] Since the joints formed of the dovetail grooves

7 and the cotters 8 as described above are provided in two stages with the neutral axis X as the boundary therebetween, it is possible to cope with an outer tensile stress state in which the surrounding earth pressure causes a tensile stress to act on the outer side of the neutral axis X, an inner tensile stress state in which the internal hydraulic pressure causes a tensile stress to act on the inner side of the neutral axis X or a whole cross-sectional tensile stress state. Thus, the above joints may be considered to have an extremely reasonable joining structure particularly suitable as the joining between the segments of the tunnel for water channel.

[0028] Thus, the steel shell 12 having an arc-shaped curve with a predetermined curvature along the bedrock of the tunnel is provided, wherein a plurality of main reinforcements 13 and shearing reinforcements 14 are respectively disposed as reinforcing bars in the steel shell 12, and concrete 15 is filled therein.

[0029] It is to be noted that the steel shell 12 is, in principle, made of cast iron or cast steel also inclusive of spheroidal graphite cast iron, and the main beam plates 1, the joint plates 2 and the back plate 3 are provided in the integral structure by casting. Alternatively, in the case of the steel shell made of steel, use of another assemble method of separately forming each of the main beam plates 1, the joint plates 2 and the back plates 3 to join them together later is also conceivable. In addition, corrosion-proof measures such as corrosion margin and corrosion-proof coating are applied to the surface of the steel shell 12.

[0030] The plurality of main reinforcements 13 are disposed, in an arc-shaped arrangement along the circumference direction Z of the tunnel, between the joint plates 2 at the opposite ends, and end parts 13a of the main reinforcements 13 are fixed to the joint plates 2 at the opposite ends through fixing plates 16 respectively. The main reinforcements 13 also may be provided in succession at need by using lap joints to connect several pieces of reinforcements in the circumference direction Z of the tunnel.

[0031] The fixing plates 16 are provided in a thin tie plate-like configuration continuing in the axial direction Y of the tunnel, and holes 16a capable of being engaged with the projections 10 are provided in fixing plate portions close to one side of the fixing plates at predetermined intervals in the axial direction Y of the tunnel so as to correspond to the intervals of the projections 10. The end parts 13a of the main reinforcements 13 are respectively connected to fixing plate portions close to the other side of the fixing plates by welding.

[0032] In addition, as shown in Figs. 4(a) and 4(b) for instance, the plurality of main reinforcements 13 and the fixing plates 16 are previously assembled in a panel-like configuration of a size equivalent to a planar shape of the steel shell 12. If a larger size is particularly required, the main reinforcements 13 and the fixing plates 16 are assembled, as shown in Fig. 4(b), into two or three parts at need in the axial direction Y of the tunnel.

[0033] The plurality of main reinforcements 13 and the fixing plates 16 thus assembled in the panel-like configuration are disposed in the steel shell 12, and the holes 16a of the fixing plates 16 and the projections 10 are engaged to fix the main reinforcements and the fixing plates in place in the steel shell 12. In this case, the previous assemblage of the plurality of main reinforcements 13 and the fixing plates 16 allows the plurality of main reinforcements to be disposed extremely efficiently.

[0034] It is to be noted that if each projection 10 and the corresponding hole 16a have therebetween a gap that causes looseness, a wedge 17 is inserted into the hole 16a at need as shown in Fig. 4(d).

[0035] As shown in Figs. 5(a) and 5(b) for instance, the shearing reinforcement 14 is provided in a portal configuration having a channel-like shape at the back plate 3-side (the bedrock side) by bending or the like, and hooks 14b, 14b projecting in the circumference direction Z of the tunnel are respectively provided on lower end parts of vertical parts 14a, 14a. It is to be noted that the vertical parts 14a, 14a at the opposite sides are slightly bent toward an inner side at need as shown in Fig. 5(b), for instance. This allows the main reinforcements 13 and the concrete 15 to have a higher binding force.

[0036] As shown in Fig. 5(c), for instance, the plurality of shearing reinforcements 14 thus provided are disposed at predetermined intervals in the circumference direction Z of the tunnel so as to hold the plurality of main reinforcements 13 between the main beam plates 1, 1 at the opposite sides, and the hooks 14b at the opposite ends are inserted into the fixing holes 11a of the ribs 11 or the fixing holes 5a of the lateral ribs 5 to fix the shearing reinforcements in place.

[0037] As described above, since the opposite ends of the main reinforcements 13 are fixed to the joint plates 2 at the opposite ends, and the opposite ends of the shearing reinforcements 14 are fixed to the bottom parts of the back plates 3, a completely integral structure among the steel shell 12, the main reinforcements 13 and the shearing reinforcements 14 may be provided, so that both of the main reinforcements 13 and the shearing reinforcements 14 may be evaluated not only as a mere crack-proofing material for the concrete 15 but as structural members for the composite segment equally to the steel shell 12. It is to be noted that use of back plates having a wave pattern (a corrugated pattern) makes the steel shell 12 adaptable to a configuration inclusive of one wherein a plurality of main beams are provided not only at the opposite side parts of the segment but also at the center part thereof, and besides, a plurality of longitudinal ribs are placed as a shearing reinforcement material in the steel shell 12. In addition, another method of fixing the end parts 13a of the main reinforcements 13 to the joint plates 2 of the steel shell 12 may be one of projectedly providing, at the inside of the joint plates, cylindrical fixing parts (not shown) as

the connection parts for fixing the main reinforcements, while providing, at the end parts 13a of the main reinforcements 13, L-shaped hooks (not shown) capable of being inserted into the fixing parts to insert the hooks into the fixing parts. In this case, the fixing parts of the main reinforcements are provided at predetermined intervals in the axial direction Y of the tunnel so as to correspond to the intervals of arrangement of the main reinforcements 13.

INDUSTRIAL APPLICABILITY

[0038] The present invention is as described above, more specifically, the connection parts for fixing the main reinforcements are provided on the joint plates of the steel shell to fix the end parts of main reinforcements to the connection parts, the ribs having the holes for fixing are projectedly provided on the inner side part of the steel shell, and the hooks for fixing are projectedly provided on the end parts of the shearing reinforcements, while the holes and the hooks are engaged to fix the end parts of the shearing reinforcements to the inner side part of the steel shell. Thus, the completely integral structure among the steel shell, the main reinforcements and the shearing reinforcements may be provided, so that both of the main reinforcements and the shearing reinforcements may be evaluated not only as the mere crack-proofing material for the concrete but as the structural members of the composite segment equally to the steel shell.

[0039] In addition, the joints formed of the dovetail grooves and the cotters, for instance, are provided in two stages as the joining between the mutually adjacent segments in the circumference direction Z of the tunnel, so that it is possible to cope with both of the stress states, i.e., the so-called outer tensile stress state and the so-called inner tensile stress state, and as a result, the composite segment is supposed to be particularly suitable as the lining material of the tunnel for water channel.

Claims

1. In a composite segment wherein a plurality of main reinforcements and shearing reinforcements are respectively disposed in a steel shell formed of main beam plates, joint plates and back plates, while concrete is filled therein, and joints are provided in and on said joint plates, the composite segment, **characterized in that** connection parts for fixing the main reinforcements are provided on said joint plates to fix the end parts of said main reinforcements to said connection parts, and said joints are provided in two stages.
2. In a composite segment wherein a plurality of main reinforcements and shearing reinforcements are re-

spectively disposed in a steel shell formed of main beam plates, joint plates and back plates, while concrete is filled therein, and joints are provided in and on said joint plates, the composite segment, **characterized in that** ribs having holes for fixing are projectedly provided at an inner side part of said steel shell, and hooks for fixing are projectedly provided at end parts of said shearing reinforcements, while said holes and said hooks are engaged to fix the end parts of said shearing reinforcements to the inner side of said steel shell, and said joints are provided in two stages.

3. The composite segment according to claim 1 or 2, wherein joints formed of dovetail grooves and coters engaged therewith are provided as a joining.

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FIG. 1

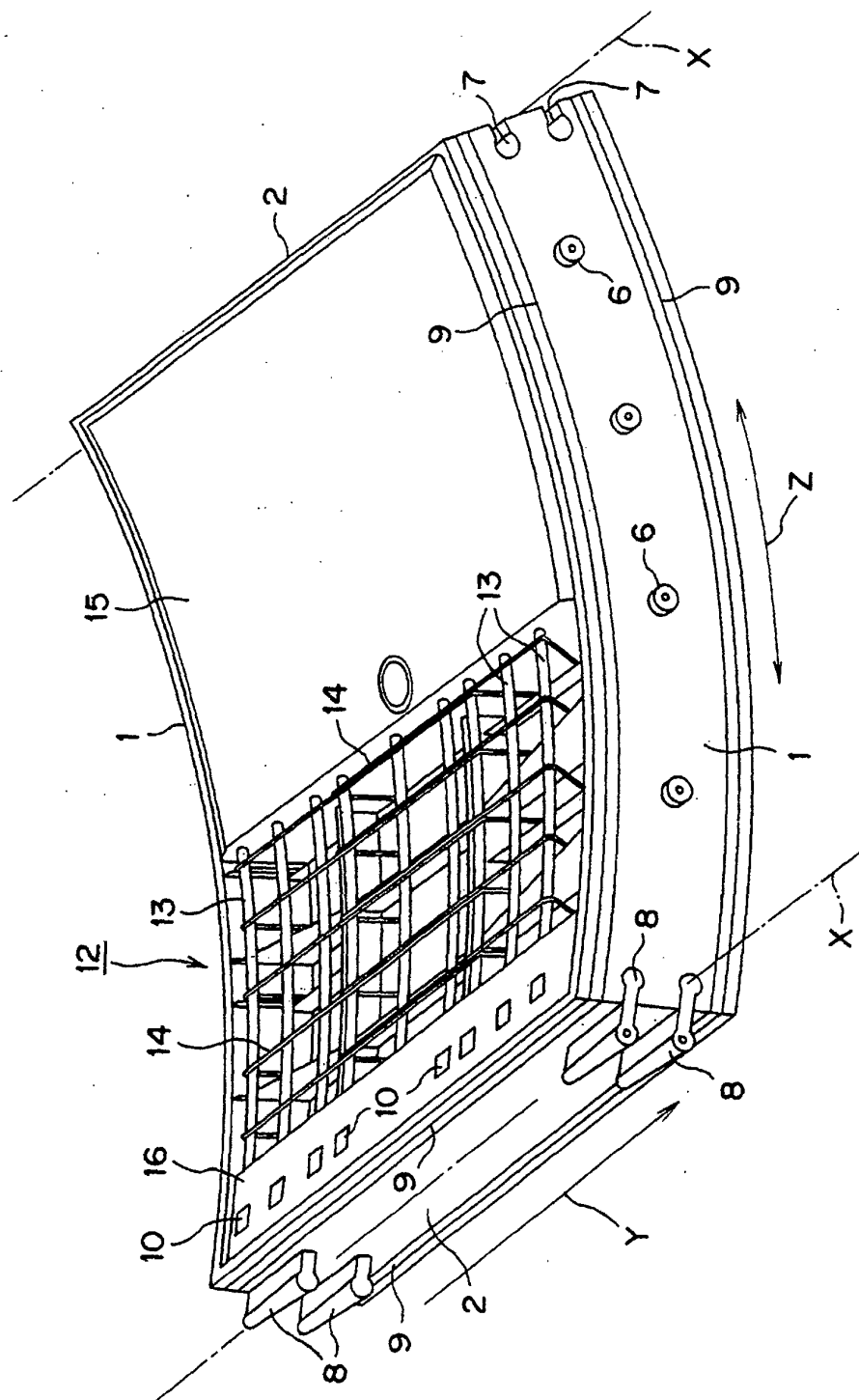


FIG. 2

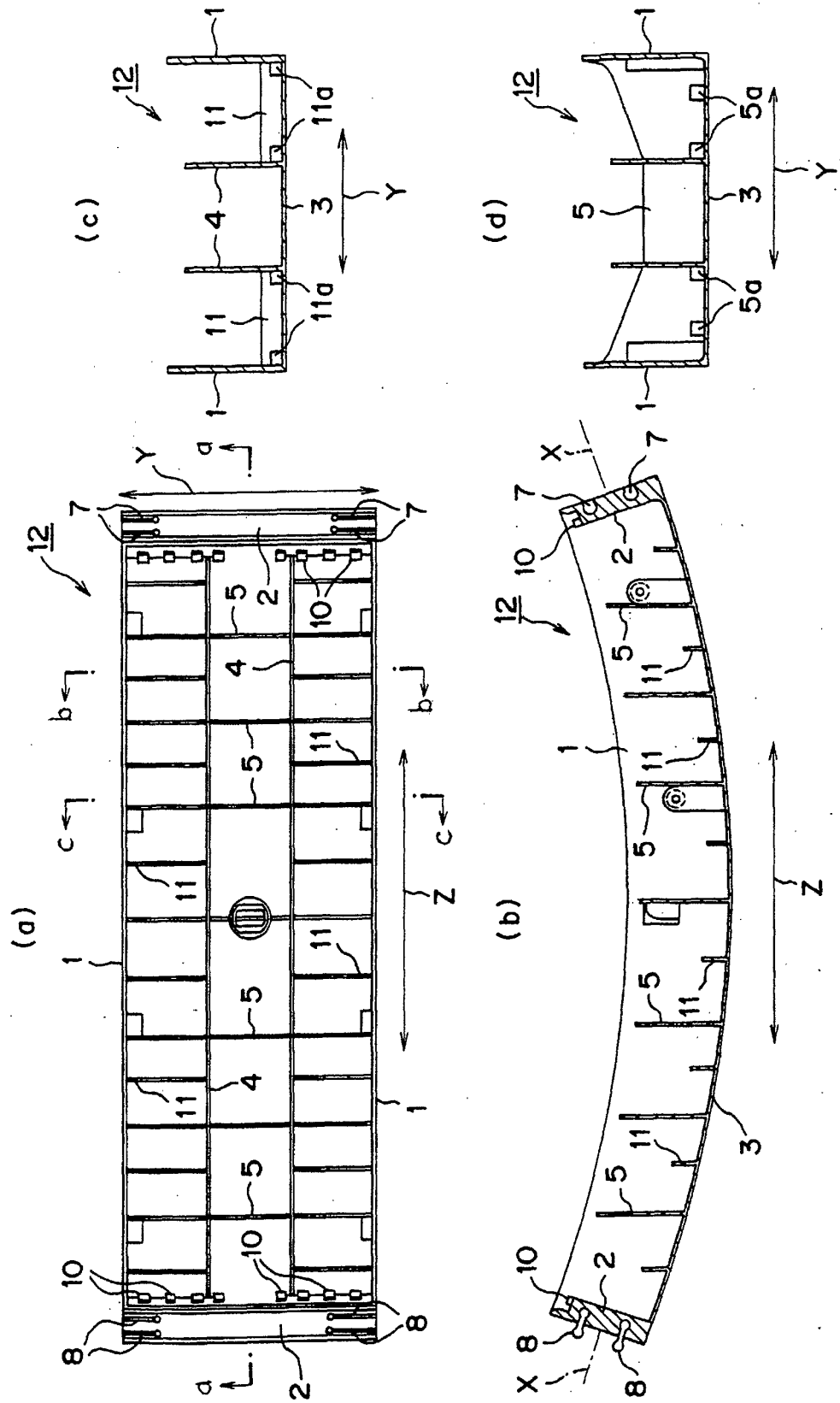


FIG. 3

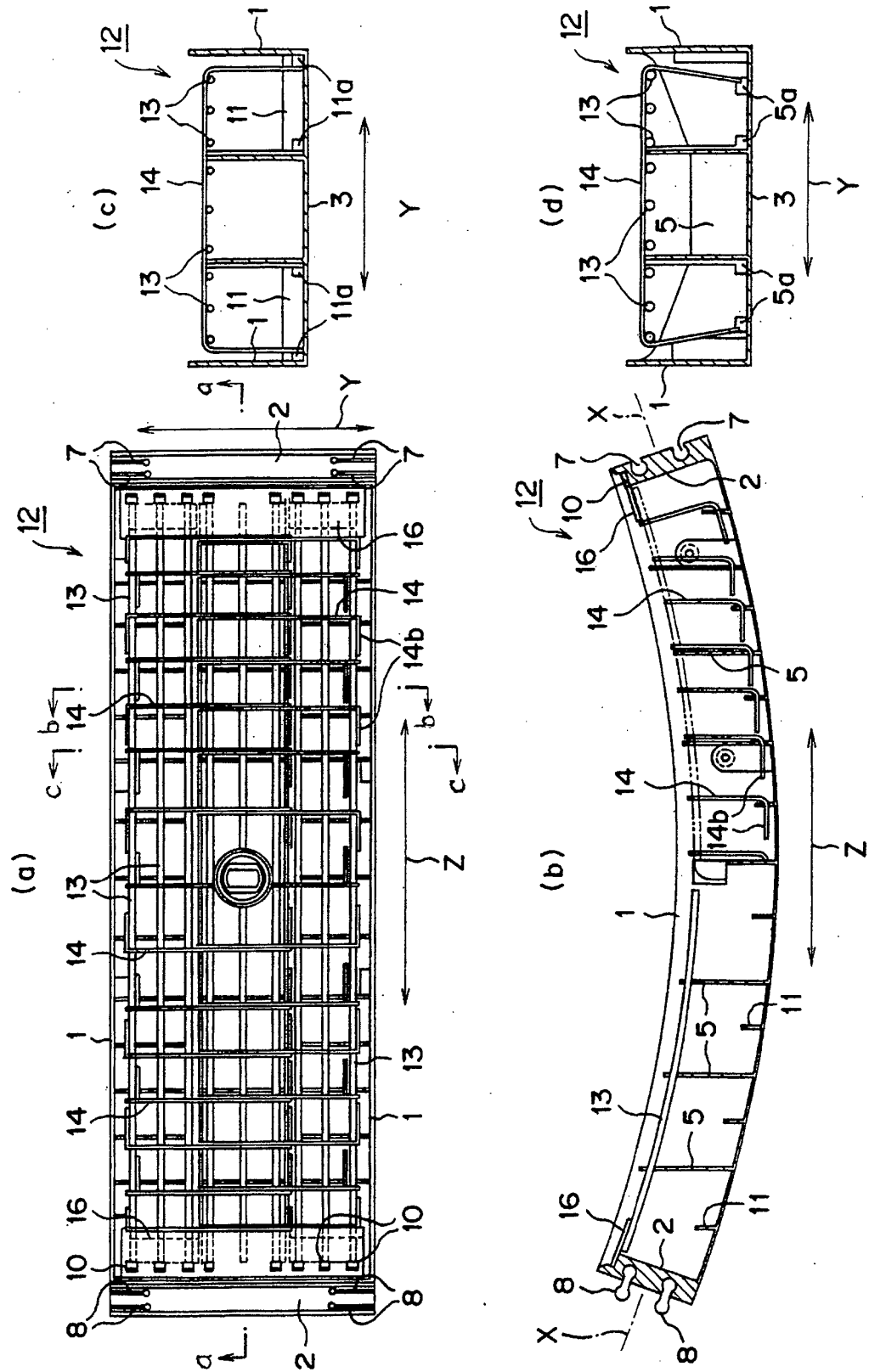


FIG. 4

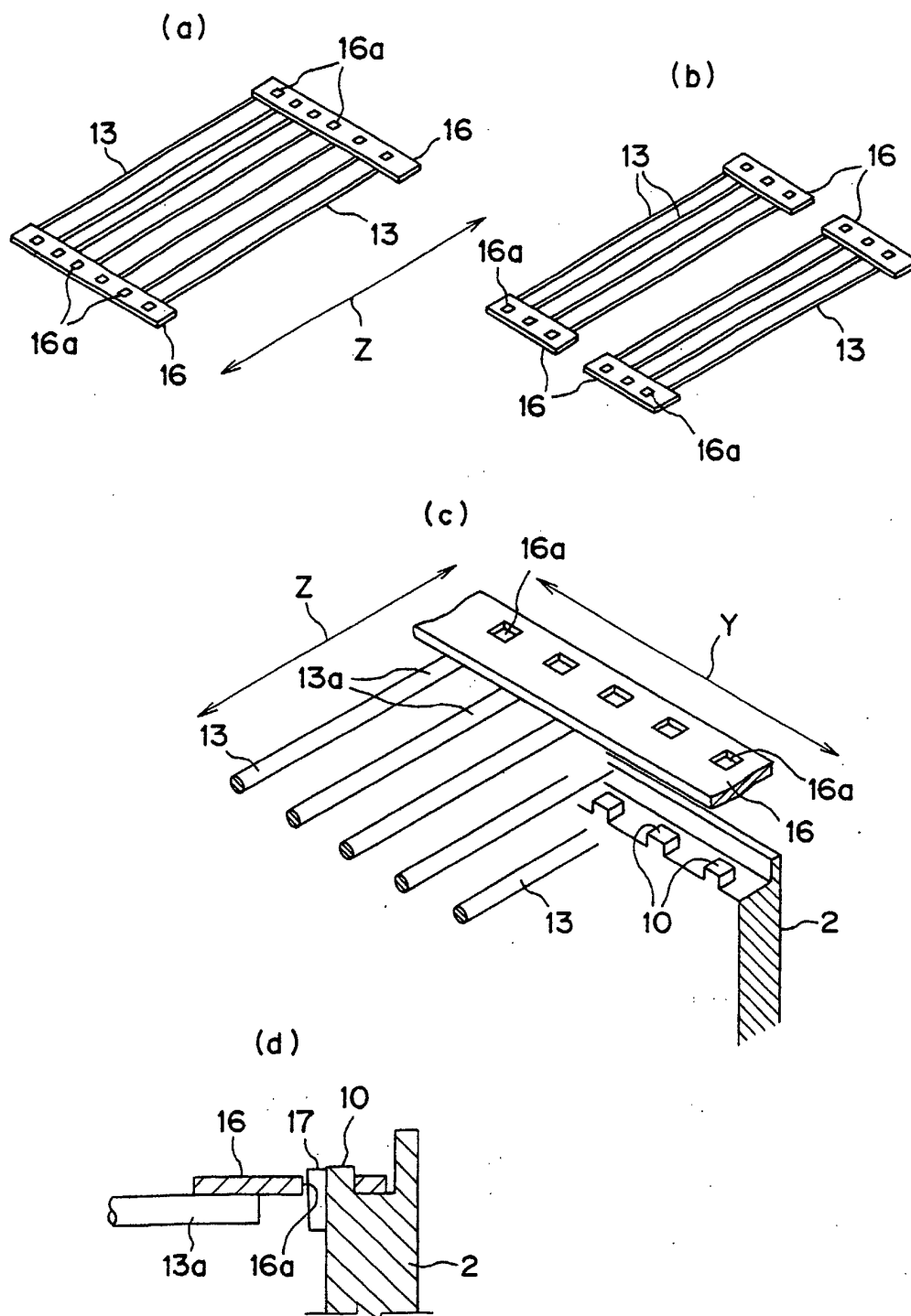


FIG. 5

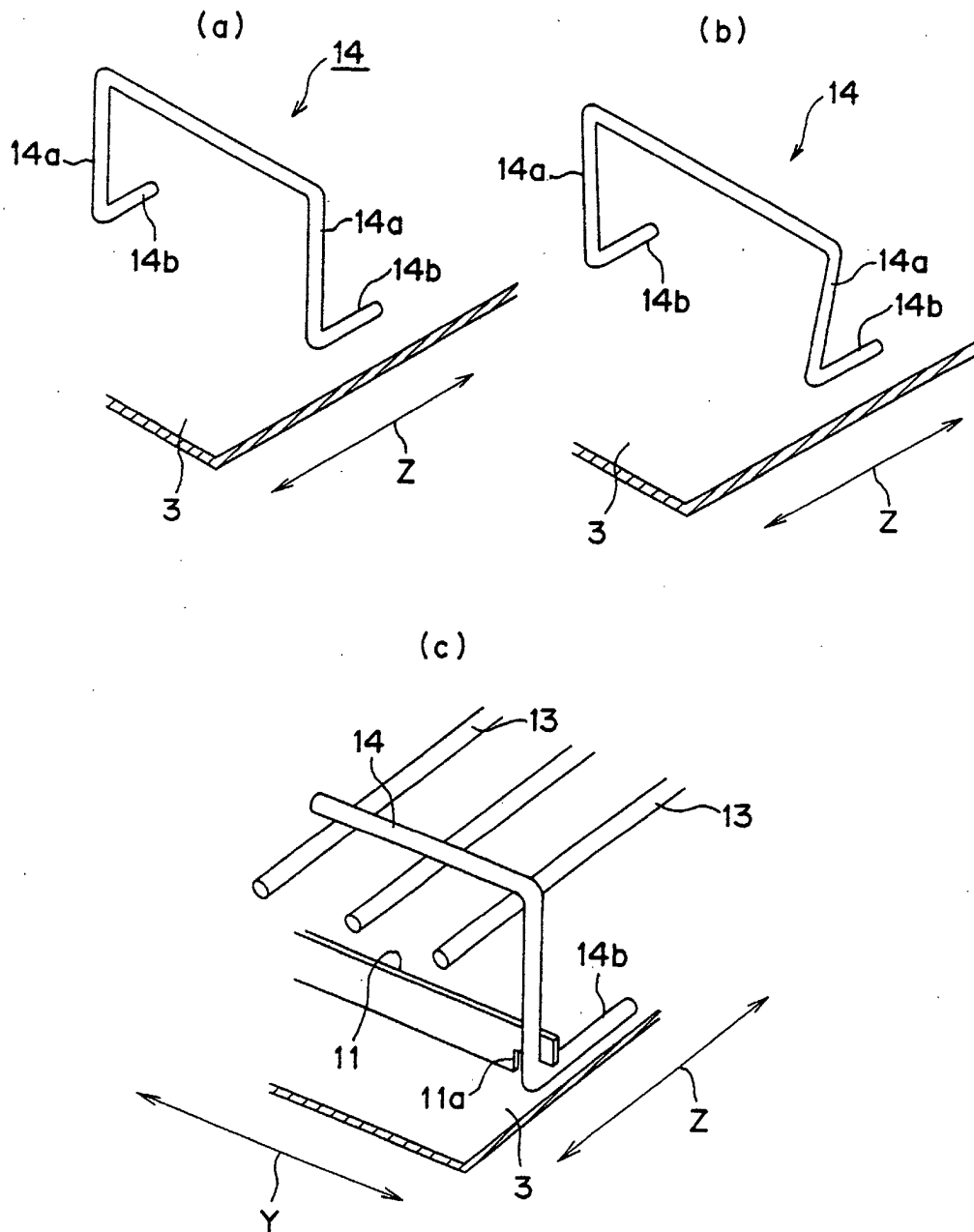


FIG. 6

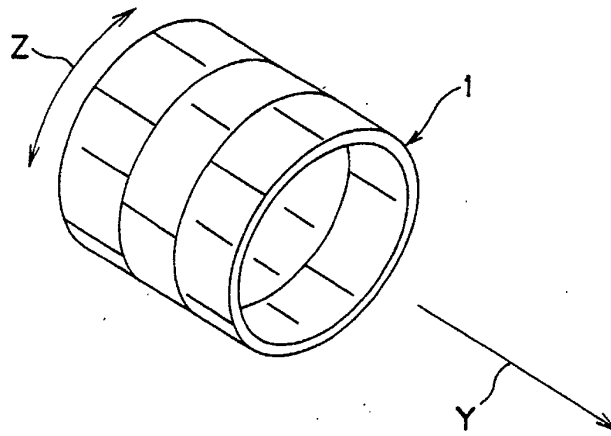
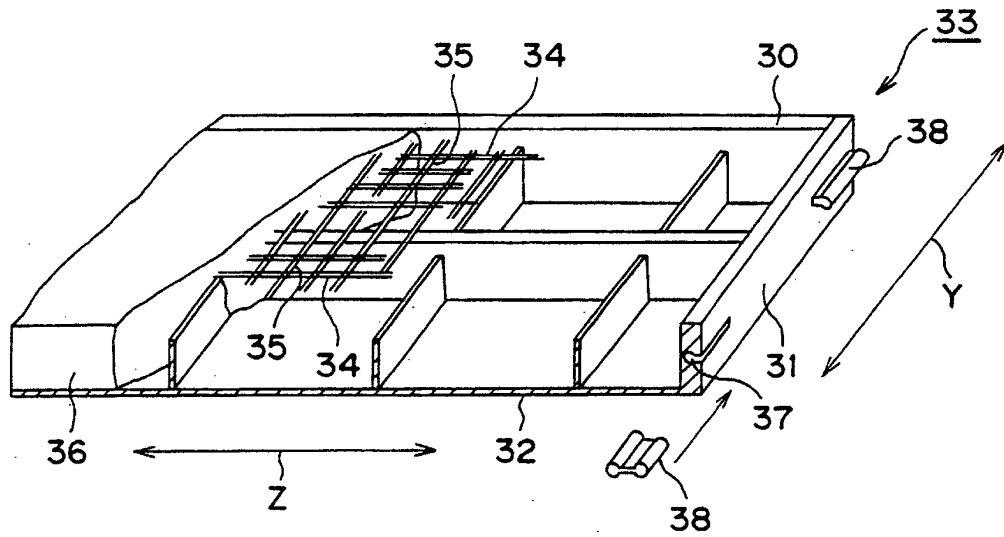
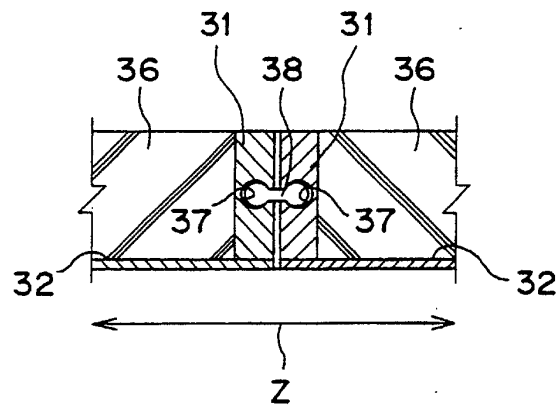


FIG. 7

(a)



(b)



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP01/09010

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ E21D11/04																						
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 E21D11/04																						
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2002 Kokai Jitsuyo Shinan Koho 1971-2002 Jitsuyo Shinan Toroku Koho 1996-2002																						
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	JP 11-229788 A (OBAYASHI CORPORATION), 24 August, 1999 (24.08.1999), Full text; all drawings (Family: none)	1-3																				
Y	JP 11-287093 A (Ishikawajima Constr. Materials Co., Ltd.), 19 October, 1999 (19.10.1999), Full text; all drawings (Family: none)	1-3																				
Y	JP 9-203297 A (Nippon Kokan Light Steel K.K.), 05 August, 1997 (05.08.1997), Full text; all drawings (Family: none)	1, 2																				
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.																						
<table border="0"> <tr> <td>* Special categories of cited documents:</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to</td> </tr> <tr> <td>"A" document defining the general state of the art which is not</td> <td>understand the principle or theory underlying the invention</td> </tr> <tr> <td>"E" earlier document but published on or after the international filing date</td> <td>"X" document of particular relevance; the claimed invention cannot be</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is</td> <td>considered novel or cannot be considered to involve an inventive</td> </tr> <tr> <td>cited to establish the publication date of another citation or other</td> <td>step when the document is taken alone</td> </tr> <tr> <td>special reason (as specified)</td> <td>"Y" document of particular relevance; the claimed invention cannot be</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other</td> <td>considered to involve an inventive step when the document is</td> </tr> <tr> <td>means</td> <td>combined with one or more other such documents, such</td> </tr> <tr> <td>"P" document published prior to the international filing date but later</td> <td>combination being obvious to a person skilled in the art</td> </tr> <tr> <td>than the priority date claimed</td> <td>"&" document member of the same patent family</td> </tr> </table>			* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to	"A" document defining the general state of the art which is not	understand the principle or theory underlying the invention	"E" earlier document but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be	"L" document which may throw doubts on priority claim(s) or which is	considered novel or cannot be considered to involve an inventive	cited to establish the publication date of another citation or other	step when the document is taken alone	special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be	"O" document referring to an oral disclosure, use, exhibition or other	considered to involve an inventive step when the document is	means	combined with one or more other such documents, such	"P" document published prior to the international filing date but later	combination being obvious to a person skilled in the art	than the priority date claimed	"&" document member of the same patent family
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